

GREAT TRINITY FOREST

# Forest Herbicides and Invasive Species

Volume 16

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## **Forest Herbicides**

Herbicides are an efficient, low impact, and economical method of vegetation control. Their use is recommended for managing vegetation within the Great Trinity Forest.

#### A Discussion of Competition and Forest Management

All living organisms compete for resources. In the forest, trees compete for light, water, and nutrients. When managing a forest some types of vegetation are less desirable than others, hindering the growth and development of desired species. These unwanted plants could be described as weeds, and weeds are simply plants growing in the wrong place. They can be herbaceous or woody; annual, biennial, or perennial; trees, shrubs, or vines. Weeds cause competition which can either delay or inhibit the development of plants. They also occupy valuable growing space.

In forest management, an operation to free up growing space typically involves a harvest or some type of timber stand improvement (TSI) operation. Harvests remove the stems and process them into a product, generating revenue; whereas TSI operations usually kill unwanted individuals and do not generate revenue. TSI operations include burning, broadcast herbicide applications, individual tree herbicide application. It should be noted that any plant not controlled during one of these operations is released, including not only crop trees but weeds. Therefore it is important to have a Forest Management Prescription for Vegetation Control when attempting to control unwanted vegetation. By filling out and following a prescription, it ensures that all of the proper steps and considerations have been made.

#### A Discussion of Forestry Herbicides

Forest herbicides are part of a number of tools used by forest managers in vegetation management. The application of herbicides when conducted properly is safe, effective, and efficient. Forest herbicides free up growing space and re-allocate resources for other plants to use.

Forest herbicides can be applied to a plant's foliage, stem, or directly to the soil. The herbicide can be broadcast or applied to individual stems. It enters the plant by being absorbed through the roots, bark or foliage. Herbicides kill plants by inhibiting the production of enzymes or by stopping the photosynthetic process. Others destroy the chlorophyll in plants and some work as auxin inhibitors which cause the plants to grown themselves to death. Still, there are even more that kill through ammonium toxicity or by inhibiting the germination of seed. These modes of action are said to kill the plant below the root collar, or in other words more effectively control vegetation than other means; such as burning, grazing or mechanical. Mechanical controls are either not selective of the vegetation type, or are very expensive. These would include mulching and shear-and-pile methods that have a much higher impact to the site. These methods also promote sprouting since the root system is still intact beneath the soil surface.

#### Vegetation Management, Herbicides, and the Great Trinity Forest

The Great Trinity Forest poses a unique situation to forest managers. There are a limited number of heavy mast producers on the site and relatively low tree species diversity. Although much of the forest has a vegetative composition that probably represents the climax forest type of the area, there are certain sites within the forest that are suitable for planting more desirable species. These sites are predominantly bottomland ridges, natural levees or hummocks, and upland areas. They generally have soils that are better drained and coarse textured. They are also less frequently inundated. Historically these are areas where the oaks, pecans, etc. would have more frequently occurred. To feasibly convert these areas into a more desirable species mix, the competing vegetating should be controlled to reduce competition and allow more light to hit the forest floor.

The desired method of control for unwanted vegetation is the application herbicides. The alternatives are limited. The forest's regional location makes any commercial timber harvesting unfeasible, and even then its proximity to urban areas and the management of the public's perception of such actions would make this alternative undesirable. Mechanical methods such as mulching or non-commercial thinning with chainsaws would be another option. The forest's soils and hydrology are not conducive to the operation of heavy equipment. Coupling that with the high expense and lack of control to sprouts would eliminate most mechanical means of control. The large scale operation of chainsaws requires skilled operators and has a higher degree of liability and associated risk and again sprouting would be an issue. Sprouts are very aggressive competitors to planted seedlings because of their larger root systems. Applying herbicide the sprout's foliage or to the immediately cut stem is the only effective means of controlling sprouts in the Trinity Forest.

What is the most appropriate method of herbicide application in the Great Trinity Forest? On larger trees, herbicide should be applied using the hack and squirt method. This is done by making incisions evenly around the trunk of the tree and injecting herbicide using something as simple as a squirt bottle.

The chemical best suited for this application would be Arsenal AC. On trees too small to inject, a basal bark treatment should be applied. Basal bark treatments require a backpack sprayer which is used at low pressure to soak the lower 12 to 14 inches of the stem. The chemical is absorbed through the bark. The recommended herbicide for this application is Pathfinder II. Small shrubs or trees can receive a foliar spray when all of the foliage is accessible, maybe up to 6 feet tall. This method would work well on Chinese privet infestations. It should be stressed to only use foliar sprays when it is certain that all of the foliage can be treated. When using a foliar treatment, a glyphosate such as ACCORD or Rodeo should be used.

#### A Brief Description of the Recommended Herbicides

#### Arsenal AC

Arsenal AC is an imazapyr herbicide. Its mode of action is that of an enzyme inhibitor; it reduces the level of amino acids produced. Arsenal AC is labeled for a variety of uses and is one of the most popular forestry herbicides in use today. In the Trinity Forest it should applied using the hack and squirt method. It is moderately mobile in the soil and therefore care should be taken not to spill or over-apply the product. When applying the product it should be mixed as a 25% solution and applied at a rate of 1mL of solution per incision. Incisions should be one for every 3 inches of diameter at breast height (DBH) and should be spread evenly around the tree at the same height. Incisions should be at a downward angle and completely penetrate the bark and cambium of the tree. This type of work is best done in late fall before the leaves change color, but the plant is drawing nutrients down into its roots.

#### Pathfinder II

Pathfinder II is a pre-mixed blend of Garlon and oil. Its active ingredient, Triclopyr, works as an auxin inhibitor and generally allows the plant to grow itself to death. Pathfinder II has limited soil activity which makes it an excellent candidate for basal bark treatment. Since it is a premixed blend it would also be very convenient for applicators to use. It is can be applied as a basal bark treatment anytime of the year provided there is no water or snow to prevent spraying to the ground line. The best method for applying this herbicide is at low volume with a backpack sprayer fitted with either a cone nozzle or a flat fan nozzle. The chemical should coat the entire stem and root collar from the ground to 12 to 14

inches up the tree. It should not be applied to the point of runoff, but only a thorough coating. It can also be applied to freshly cut stumps. Pathfinder II should also be used to control legumes such as honeylocust and black locust; which are not controlled by Arsenal AC.

#### ACCORD / Rodeo (Glyphosate)

Glyphosates include the commonly known herbicide "Round-Up". Glyphosates are enzyme inhibitors much like Arsenal AC. In the Trinity Forest glyphosates should be used as a foliar spray. It would be most useful for applying on smaller shrubs such as young privet sprouts. The herbicide is best applied from a backpack sprayer as a 3% solution. It is important to thoroughly wet all leaves.

**Great Trinity Forest Management Plan** 

## **FOREST HERBICIDES**

## Chemical Control for Woody Plants, Stumps and Trees



Killing unwanted trees or preventing stumps from sprouting is a problem for many property owners. Various herbicides and application methods can kill unwanted stumps or trees. First, you must identify which tree is causing the problem. Once you are sure of the culprit, you can use the charts in this bulletin to match the tree to the appropriate herbicide and application.

Successfully controlling unwanted trees or brush also means considering the consequences of the herbicide and application method you select. Herbicides that control undesirable woody plants vary in environmental stability, leachability, flashback potential, selectivity, and handling requirements. Control methods can damage surrounding vegetation and neighboring trees, contaminate groundwater, and prevent desirable vegetation from becoming established for several years.

Herbicide drift onto adjacent desirable plants has been a problem when using handheld equipment, especially when treating brush growing along fence rows. Apply only when there is little or no hazard from spray drift. Very small quantities of spray, which may not be visible, may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants near enough to be injured. When treating trees and brush use a low pressure coarse spray and treat all sides of the plant. Drift often occurs when trying to spray the entire plant from only one side.

Read and follow herbicide label directions carefully. This bulletin suggests ways to avoid problems, but does not supersede product label instructions or cover first aid, or storage and disposal requirements. The herbicide label lists hazards that may make it unsuitable for use in certain situations. Read and follow requirements on the herbicide label closely.

#### **Important Considerations**

Consider the following factors carefully before choosing a control method. Each factor can affect the success of your project.

#### **Suberization**

Plants use this natural healing process to prevent insects or diseases from infesting tissues after cuts or wounds occur. The plants develop a layer of protective "corky" cells over the damaged tissue. Suberization can reduce herbicide effectiveness by

preventing absorption. When you use frilling, cupping or cut stump methods of treatment, apply the herbicide immediately to achieve maximum absorption. Delaying application of water-soluble herbicide for as little time as one hour can reduce absorption and subsequent control of the undesirable woody plant.

#### **Root Grafts**

Sometimes the roots of different plants share vascular tissue through grafting. Root grafting occurs primarily within the same species, but may occur between plants within the same genus. This phenomenon can be of great importance. A herbicide can move (translocate) from a treated tree to an untreated desirable tree, killing or injuring it. Damage to desirable trees as a result of root grafting will occur from use of the following herbicides: amitrole, 2,4-D, dicamba, glyphosate, imazapyr, metsulfuron, picloram, and triclopyr.

#### Flashback

This term describes the passive loss of a herbicide from the roots of treated trees. Once the herbicide is released from one tree, it is available for uptake by another. The serious consequence of this is that a treated tree may release herbicide back into the environment, injuring other nearby trees and vegetation. This occurs with picloram, dicamba, and occasionally with 2,4-D.

#### **Formulations**

The herbicide formulation may affect its performance characteristics. Match the formulation and application method. For example, water-soluble amine formulations of 2,4-D and triclopyr are preferred for cut surface applications. Use oil-soluble ester formulations for best control on basal applications.

Other herbicide formulations include wettable powder, dry flowable, water dispersable granules, or flowables. These soil-applied formulations require moisture to move them into the soil and activate them. If you plan to use oil as the carrier or part of the carrier in the spray mix, use either diesel fuel or stove oil. Add an emulsifier when mixing fuel oil with water.

#### **Stains and Dyes**

Adding stains or dyes to the herbicide solution substantially increases applicator accuracy. Applicators use the dyes to monitor treated trees, so they are less likely to miss or respray targeted trees. Use of stains also will indicate personal exposure. The inexpensive, water-soluble stains wash off later.

#### Dripline

Refers to the area directly underneath the spread of the tree limbs or canopy. Herbicide labels frequently caution against making applications within the dripline to avoid damaging desirable trees. Tree roots often extend well beyond the dripline. More appropriate is the rule-of-thumb that tree roots extend a distance equal to the height of a tree growing east of the Cascades, and equal to half of the height for a tree growing west of the Cascades. If the tree has been topped, increase the height estimate to more

accurately gauge the drip line of the tree.

#### **Heavily Pruned Trees**

Some trees sprout prolifically, particularly after severe pruning. It is impossible to control the sprouts chemically without injuring the tree. Contact herbicides, such as paraquat (Gramoxone) and MSMA may be used to burn off these suckers. However, these non-selective herbicides will injure any plant incidentally sprayed. CAUTION: do not use paraquat around homes, school, or recreational areas.

#### **Methods of Application**

Several methods exist for control of woody vegetation. Some treatments apply herbicide to a localized area on the tree. Directed applications can reduce impacts on adjacent nontarget vegetation from drift or overspray. Other methods require thorough herbicide coverage on foliage or soil. Review the herbicide labels for registered application methods and choose the best system for your needs. For the methods listed below, it is important to calibrate your application equipment and follow all of the herbicide label guidelines.

#### **Cut Surface Treatments (frill, or cup treatments).**

Bark on larger trees (diameters larger than 5 inches) is often too thick for most water soluble sprays to penetrate. In this situation, it is necessary to provide a direct pathway for herbicide entry into the plant's vascular tissue. Do this by making a series of downward cuts through the bark, leaving the chip connected to the tree (frilling cuts overlay, and spaced-cut injection does not overlap). Make cuts around the entire circumference of the tree trunk with an axe or hatchet. Immediately apply the selected herbicide into the cuts. Avoid application during heavy upward sap flow in the spring, when sap flowing out of the wound will prevent good absorption. Apply herbicides registered for this use pattern undiluted or in dilution ratios of one-half to one-quarter strength. The amine formulations of picolinic acid (triclopyr and picloram) or phenoxy (2,4-D, dichlorprop, etc.) herbicides are generally more effective than the esters.



Make a series of downwards cuts, leaving the chip, and immediately apply herbicide into cuts.

#### Injection

This is similar to cut surface treatments. Use specialized equipment to inject a specific amount of herbicide into the tree when the cut is made. Treatments are effective when injections are made every 2 to 6 inches around the tree. For best results, treat trees 1.5 inches or more diameter at chest height.



as cut surface treatments do.

#### **Stump Treatment**

This involves cutting a tree down and treating the freshly cut surface with herbicide. Cut the top of the stump level to allow uniform herbicide coverage. Thoroughly wet the cambium layer next to the bark so the conducting tissue will carry the herbicide to the roots. On larger trees treat only the outer 2 to 3 inches of the stump (the internal heartwood of the tree is already dead). On trees 3 inches or less in diameter, treat the entire cut surface. Apply treatments immediately after cutting to achieve maximum effectiveness. If application is delayed after cutting, recut the stump and apply the herbicide to the live tissue. Delaying herbicide application to freshly cut trees can result in prolific sprouting from the tree collar and roots. Moisture stress may affect control during the summer and early fall. Applications during the spring upward sap flow are not as successful as late spring and early summer treatments. Undiluted water-soluble herbicide formulations are more effective than the esters.



In treating stumps, apply herbicide to cut area immediately.

#### **Basal Bark Treatments**

Apply the herbicide to the lower 12 to 18 inches of the tree trunk from early spring to mid-fall. Some species can be treated during winter. Use herbicide spray mixed with oil, until the bark is saturated. The low volatile ester formulations are the only oil soluble products registered for this use. This method is effective on trees of all sizes.

Apply herbicides evenly to the soil above the root zone in soil treatments. Rainfall or overhead moisture carry the herbicide into the root zone.



#### **Foliage Treatment**

Foliar spraying is a common method of applying herbicides to brush up to 15 feet tall. Make applications from early summer to late September, depending on choice of herbicide. Treatments are least effective during very hot weather and when trees are under severe water stress. Use 2,4-D, triclopyr, dicamba, and picloram in early summer, glyphosate in August and September, and imazapyr from June through September for best results. Fosamine and amitrole are additional choices. Except in very sensitive species, spraying plants with rapidly elongating stems will often result in excessive sprouting. Saturation of the tree is not necessary. Foliage treatments are used for brush up to 15 feet tall. Treatments are least effective during very hot weather or when trees are water stressed.



#### **Soil Treatment**

Herbicides applied evenly to the soil surface move into the root zone of the targeted plants with rainfall or overhead moisture. Common soil applied herbicide choices include: bromacil, hexazinone, and tebuthiuron. Hexazinone and tebuthiuron may be applied in narrow bands. Banding (also called lacing or streaking), applies concentrated solution to the soil in a line or band spaced every 2 to 4 feet. Use this type of application to kill large numbers of trees.

#### **Herbicides for Woody Plant Control**

Chemicals listed below are commercial packages and in some cases are restricted to licensed applicators. Materials described are not designed for homeowner use.

Apply herbicides evenly to the soil above the root zone in soil treatments. Rainfall or overhead moisture carry the herbicide into the root zone.



#### **Amitrole (Amitrol-T)**

Apply as a foliar spray to susceptible woody plants from the full leaf stage until the onset of dormancy. Amitrole is most effective when all plant parts (leaves, stems, and suckers) are wet. Use only on noncropland and hardwood nurseries. Do not allow spray or drift to contaminate edible crops or water intended for irrigation, drinking, or domestic purposes. Do not allow livestock to graze or feed on treated areas.

#### **Bromacil (Hyvar)**

Broadcast apply bromacil in the spring to control undesirable woody plants on noncropland. This herbicide may stay in the soil for several years. Avoid areas with standing water, irrigation ditches, rights-of-way or immediately adjacent areas with desirable trees, shrubs, or marketable timber. Do not use water from treated drainage ditches for irrigation or livestock. Do not contaminate water, food, or feed by improper application, storage, or disposal.

#### **2,4-D** (several trade names)

Apply the ester formulations as a water-based foliar spray during periods of active growth or as an oil-based basal spray. Apply undiluted. The amine formulations are effective on many species as a stump, cut surface, or injection treatment. Apply undiluted. Use in pastures, rangeland, forest and noncrop areas. Thorough coverage is necessary; hard to control species may require retreatment. Do not allow spray to drift onto nontarget plants. Check additional label precautions regarding individual formulations.

#### Dichlorprop (2,4-DP, Weedone 2,4-DP)

Use for control of mixed brush on highways, railroads, forests (limited uses), and utility rights-of-way. Apply as a foliage spray from full leaf stage until the start of dormancy. Thorough coverage is necessary, and hard to control species may require retreatment. Do not allow spray to drift onto cropland or nontarget plants.

#### **Dicamba (Banvel)**

Use as a cut surface, basal, stump, or foliage treatment to control woody plants on pasture, rangeland, forest (limited uses), and noncropland. Do not treat areas where downward movement into the soil, or surface washing can bring dicamba into contact with roots of desirable plants. Conifers are particularly sensitive. Avoid applying when environmental conditions may favor drift to sensitive crops. Do not contaminate irrigation ditches or water used for domestic purposes. Dicamba can flashback to adjacent trees.

#### **Fosamine** (Krenite)

Use to control brush in noncropland areas. Apply fosamine as a foliage treatment from full leaf in the spring to first fall coloration. Treatment does not immediately affect treated woody plants; they remain green for the remainder of the growing season. Treated susceptible plants fail to grow the next spring. A spray directed to only part of susceptible brush species will provide control of the portions sprayed, resulting in a trimming effect.

#### **Glyphosate (Roundup)**

Apply glyphosate to actively growing trees with fully elongated and developed foliage, in late summer or early fall for best results. Treat early-maturing species such as poison oak by July. Repeat applications may be necessary. Wait 7 or more days after application before removing or tilling brush. For good control, do not treat plants under severe water stress; do not treat mowed or tilled brush until after a full season of regrowth. Vegetation damaged by mechanical or previous chemical treatments may be resistant to glyphosate. Do not allow drift to nontarget plants. Spray foliage thoroughly, but not to the point of runoff. Rainfall occurring within 6 hours of the application may reduce effectiveness.

#### Hexazinone (Velpar)

To control undesirable vegetation in forests and noncropland primarily through soil uptake, make one foliar application in early spring, late fall, or winter. Fall applications generally give superior control in low rainfall areas. For best results, apply to brush seedlings or sprouts less than 18 inches tall. Use as a lace or streak application, but not on gravelly or rocky soils, on soils with greater than 85% sand, or on soils with less than 1% organic matter. Do not use in irrigation ditches or next to areas having desirable trees or shrubs.

#### Imazapyr (Arsenal)

Use to control brush in forest and noncropland areas, such as conifer plantations, rightsof-way, fence rows, and storage areas. Use as a foliage, frill, or stump treatment. Do not use on food or feed crops, contaminate irrigation water (as injury to crops may occur), or use on lawns, walks, driveways, tennis courts, or similar areas. This herbicide may persist in the soil for several years.

#### **Metsulfuron (Escort)**

Use as a foliar spray or soil treatment to control brush on noncropland. For best control, apply as soon as the brush is fully leafed out. Do not use on food or feed crops, or apply where roots of desirable trees may extend into the treated zone. Do not allow drift to contact nontarget plants. This herbicide may persist in the soil for several years.

#### **MSMA**

For forestry and noncropland use, apply as a cut surface or injection treatment. Do not feed clippings to livestock or graze treated areas for one growing season.

#### **Picloram (Tordon)**

Use as an all-season broadcast, stump, frill, or injection treatment to control woody plants in forest and noncropland areas such as fence rows or rights-of-way. Do not treat frozen soil. Do not contaminate cropland, water, or irrigation ditches. Avoid areas where downward movement into the soil or surface washing may cause picloram to reach the roots of desirable plants. This product can flashback, and may persist in the soil for several years. Do not use in western Washington where shallow water tables occur.

#### **Tebuthiuron (Spike)**

Use as an all-season broadcast, lacing, or spot treatment to control undesirable broadleaved or woody vegetation on noncrop areas only. Apply just before the wet season in dry regions. Do not apply to frozen or saturated oil, sidewalks, driveways, tennis courts, streets, lawns, patios, under asphalt or concrete pavement where future landscaping is planned, or to any area where desirable roots extend. Injury symptoms appear slowly and may depend on moisture and soil conditions. This herbicide may persist in the soil for several years. Do not use in western Washington where shallow water tables occur.

#### Triclopyr (Garlon 3A, Garlon 4, Crossbow).

Crossbow is a combination of triclopyr and 2,4-D. Use Garlon to control woody plants in forests and noncropland. Use Crossbow to control woody plants in noncropland, pasture, and rangeland. Best results are obtained during early summer. Do not permit spray or drift to contact desirable plants, as severe injury may occur. Do not apply to irrigation ditches or allow lactating animals to graze treated areas for 1 year following application.

#### **Plant Susceptibility**

Plant susceptibility depends on a number of factors: time of year; stage of plant growth; type of application and spray carrier; soil moisture before, during, and after application; precipitation (rain or snow); and temperatures of soil and air before, at, and immediately after the application. The addition of oil and/or a surfactant will enhance control of some species.

The susceptibility charts are complied from several sources. Use these charts only as a guide when planning control operations. Consult research reports, product labels, and knowledgeable personnel for additional information.

Label Clearances for Herbicides								
Type of Application								
Herbicide	Foliar	Soil	Frill	Stump	Basal	Inject		
Amitrole	Х							
Bromacil	Х	X						
2,4-D*	Х		Х	X	X	X		
Dicamba	Х		Х	X	X			
Dichlorprop (2,4-DP)	Х							
Fosamine	Х							
Glyphosate	Х		Х	X		X		
Hexazinone	Х	X						
Imazapyr	Х		Х	X	X			
Metsulfuron	Х	X						
Picloram*	Х		X	X		X		
Tebuthiuron		Х						
Triclopyr	Х		X	X	X	X		

Susceptibility to Cut Surface, Injection, and Stump Treatments									
Plant		Herbicide							
	2,4-D	Dicamba	Picloram	MSMA	Triclopyr	Imazapyr	Glyphosate		
A 1 1	0	0	pius 2,4-D		0	0	0		
Alder	G	G	G	Р	G	G	G		
Ash	Р	F	F	F	G	G	G		
Aspen, quaking	F	G	G	F	G	G	G		
Cherry	G-F	G	G	G	G	G	G		
Cottonwood	G	G	G	G	G	G	G		
Douglas Fir	Р		G	G	G				
Elm	F	G-F	G	G-F	G-F	G	G		
Locust	G-F	G-F	G	G-F	G	G	F		
Madrone	G	G	G	G	G	G	F		
Maple, Bigleaf	Р	Р	F	F	G	G	F		
Oak	G	G	G	G	G	G			
Pines	F		G-F	G					
Russian- olive	F	F	F		F	G	G		
Willow	F	G	G	Р	G	G	F		
G = Good con	G = Good control								

\*All formulations of these herbicides are not suitable for all the uses undicated. Check manufacturer's label for uses and additional precautions. FOLLOW LABEL INSTRUCTIONS.

G = Good controlF = Fair control, likely to need retreatment

 $\mathbf{P} = \mathbf{Poor \ control}$ 

Susceptibility to Foliage Treatments									
Plant		Herbicide							
	2,4- D	Dicamba	Glyphosate	Picloram plus 2,4- D	Triclopyr	Imazapyr	Amitrole	Metsulfuron	Fosamine
Alder	G	G	G	G	G	G	P		G
Ash	Р	G	G	Р	F		G	G	
Aspen, quaking	F-P	F	G	G-P	G	G		G	G
Barberry	Р	F	Р	F	F	G	F		
Blackberry	P	F-P	G-F	F	G-F	G-F	G	G	G
Cherry	F	F	G	G-F	G-F	G	F	G	
Chokecherry	G	F-P	G	G	G				
Cottonwood	F-P	G	G	F	G	G		G	G
Douglas Fir	F-P	G	G-P	G	G-P	G-F	G-P		
Elderberry	F	G	G	G	G-F	G	G		

					1				1
Elm	F-P	F-P	G	G	G-F	G		G	
Gorse	F-P		G-P	G-F	G-F			G	
Hazel	F	F-P	G	F	F	G	F		
Hemlock	F-P	G	F-P	F-P	G-P	G-F	F		
Locust	G-F	G	F	G	G		G		G
Madrone	G			G	G-F	G	Р		
Manzanita	G	F	Р	G	F	G-P			
Maple, Bigleaf	Р	Р	F	F-P	F-P	G	Р		
Oak	G-F	G	G	G	G	G		G	
Pine	G	G	Р	G	G	F	Р		
Poison Oak	P	Р	G-F	Р	F-P		G		
Rose Multiflora		G	G	G	G			G	
Russian- olive	F	G	G	G	F	G			
Sagebrush	G	G	F	G	G				
Salmonberry	F-P	Р	G	Р	F	F	G	G	G
Scotchbroom	G-F	G-F	G-F	G-F	G-F	G			
Snowberry	P	Р	G	G-P	F	G		G	
Sumac	G-F	G-F	G		G	G			G
Willow	G-P	G-P	G-F	G-F	G-P	G			
G = Good co	G = Good control								
F = Fair control, likely to need retreatment.									

P = Poor control

Susceptibility to Basal Bark Treatment with						
Plant	Herbicide					
	2,4-D	Triclopyr				
Alder	G-F	G				
Ash	Р					
Aspen, quaking	G-F					
Blackberry	Р	G				
Broom, Scotch	G-F	G				
Cherry	F-P	G				
Chokecherry	G-F	G				
Cottonwood	G	G				
Elderberry	G-F	G				
Elm	G-F	G-F				
Gorse	G-F	G				
Hazel	F	G				
Locust	F	F				
Madrone	G	G				
Manzanita	G	G				

Maple, Bigleaf	Р	G			
Oak	F	G			
Poison Oak		Р			
Sagebrush	G				
Salmonberry	Р	Р			
Snowberry	F-P	F-P			
Sumac	Р				
Willow	G-F	G-F			
G = Good control					
F = Fair control, likely to need retreatment.					

 $\mathbf{P} = \mathbf{Poor \ control}$ 

Susceptibility to Basal Bark Treatment							
Plant	Herbicide						
	Bromacil	Haxazinone	Picloram	Tabuthluron			
Alder	G	G	G	G			
Ash	G	G		G			
Aspen, quaking		G	G				
Barberry	G						
Blackberry	G	G	G	G-F			
Cherry	G-F		G	G			
Chokecherry	G			G			
Cottonwood	G			G			
Douglas Fir	G	Р	G	G			
Elderberry	G						
Elm	G	G		G			
Gorse							
Hazel	G						
Hemlock	F	Р	G				
Locust	G	G	G	F			
Madrone			G				
Manzanita				F			
Maple, Bigleaf				F			
Maple, Vine	Р		F	F			
Oak	G-F	G	G-F	G			
Pine	G	Р	G	G			
Poison Oak							
Rose Multiflora		G		G			
Russian-olive		G		G			
Sagebrush				G			
Salmonberry		G-F	Р				
Scotchbroom	G						
Snowberry	G						
Sumac	G	G	G	G			
Willow	G	G		G-F			

G = Good control
F = Fair control, likely to need retreatment.
P = Poor control

By Stott W. Howard, Ph.D., former Washington State University Extension Weed Scientist, WSU Mount Vernon, and Robert Parker, Ph.D., WSU Extension Weed Scientist, WSU Prosser. Illustrations by Dianna M. Miller.

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the

reach of children, pets, and livestock.

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EB1551

# Herbicides and Forest Vegetation Management

Controlling Unwanted Trees, Brush, and Other Competing Forest Vegetation

### PENNSTATE

College of Agricultural Sciences Agricultural Research and Cooperative Extension

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Prepared by David R. Jackson, associate extension educator, and James C. Finley, professor of forest resources.

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone 814-865-6713.

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**CAT UH174** 5M12/05ac4738

## Introduction

There are a number of ways to manage vegetation: manual, mechanical, biological, cultural, and chemical. Integrated pest management (IPM) uses a combination of these techniques. This publication examines the use of herbicides to manage forest vegetation and attempts to set aside some misconceptions concerning herbicide use in forests. Forestry labeled herbicides are effective and environmentally sound; however, their use remains controversial. Out of necessity, forest landowners and resource managers are increasingly turning to herbicides for vegetation management.

Many factors are increasing the need for vegetation management and the use of herbicides. These factors include vegetation that interferes with forest regeneration, poorly planned and executed timber harvesting practices, declining pulpwood markets, and increasing abundance of invasive plant species. Let us briefly examine each of these factors.

1. Shade cast by dense fern understories inhibits seedling germination and growth.



3

Interfering vegetation consists of plants that inhibit the germination and growth of seedlings by casting dense shade on the forest floor. Interfering plants benefit from specific light conditions and selective browsing preferences by deer that remove or reduce other plant competitors. Poorly planned and executed timber harvests, known as "high grading," leave behind trees with low commercial value. This has resulted in a shift toward less desirable tree species and poorer quality trees in our woodlots. With declining pulpwood markets, many overstocked stands of trees that would benefit from thinning are not receiving treatment. Thinning improves tree growth and insect and disease resistance. Lastly, the increasing abundance of invasive plants directly influences the ability of forests to retain native plant and wildlife diversity. Herbicides, when properly applied, can address all these issues safely, efficiently, and economically.

Herbicides are a proven safe and effective method for managing forest vegetation and are appropriate for achieving many objectives, including regeneration establishment, increased timber production, enhanced wildlife habitat, nonnative plant control, and road and facility maintenance. When properly applied, herbicides can increase property value, productivity, aesthetics, and utility. However, understand that choices exist. A well-developed and implemented integrated pest management plan will include alternative vegetation control approaches with and without the use of herbicides. This publication will help you identify the most efficient, environmentally sound, and costeffective solution for addressing your forest vegetation management needs.

2. Poorly executed timber harvests often leave behind trees of low commercial value.



3. Shady understory conditions and a low browsing preference by deer foster striped maple development.



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4. Grasses can reduce regeneration potential by casting heavy shade and providing cover for seed-eating small mammals.



5. Mountain laurel forms dense thickets that interfere with forest regeneration.



## Choosing the Right Forestry Herbicide and Application Method

No single herbicide, rate, or application method works for all vegetation management needs. Each situation requires advanced assessment to ensure that the lowest risk, most efficient, and most cost-effective control program is chosen. For a given situation the soil type, plant species, density, and size affect the herbicide prescription. Additional factors such as time of year and weather conditions are important because they affect plant growth, herbicide uptake, and translocation.

The section titled "Herbicide Summaries" on page 18 will help you quickly compare herbicides commonly used in Pennsylvania. It conveys key points found on the product label and allows you to select those products best suited to your situation. Always carefully read and follow the product label directions, precautions, and restrictions before applying any pesticide.

The first consideration when selecting an herbicide is the target plant's location. The pesticide product label refers to this as "site." Some examples are rights-of-way, wildlife openings, forests, wetlands, and industrial sites. The front page of the product label lists currently labeled sites. Applying a pesticide to a site not listed on the label is illegal. This

6. Shrub honeysuckle (*Lonicera* spp.) and other invasive plants reduce native plant and wildlife diversity.



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publication includes common herbicides currently labeled for forest sites in Pennsylvania (see Table 3 on page 18).

The Environmental Protection Agency (EPA) approves pesticide use and establishes restrictions. Only certified applicators can apply "restricted use" pesticides. Restricted use pesticides have a prominently displayed statement on the product label (see "Specimen Label" below). The restricted use statement will often indicate why the product has received a restricted use status.

Pesticides not containing the restricted use statement are referred to as "general use." General use pesticides do not require applicator certification as long as the product is applied to property owned or rented by the applicator or their employer. Virtually all vegetation control in the forest involves the application of general use herbicides. This provides forest landowners in Pennsylvania an opportunity to address vegetation management needs on their own properties without becoming certified. The necessity of safe herbicide handling and use carries with it the responsibility to read, understand, and follow label directions.

Product selectivity must be considered when choosing an appropriate herbicide. Selectivity refers to the resistance various classes of plants have to an herbicide. This will ensure that targeted species can be controlled by the chosen product. For example, some herbicides only control broadleaf weeds and woody vegetation and will not control grasses. Some herbicides are so selective that they can be applied directly over nontarget plants. On the other hand, broadspectrum herbicides are nonselective. Broad-spectrum herbicides can control all classes of plants. To protect nontarget plants, care must be taken when applying these types of herbicides.

Herbicide activity is an important consideration when selecting a product. Activity refers to how the product

Applicators of restricted use products must be certified and have a level of competence to ensure proper handling and application.

## Specimen Label

#### RESTRICTED USE PESTICIDE

May Injure (PLytotoxic) Susceptible Non-Farget Plants. For retail sale to and use only by Certifiert Applicators or persons under their direct supervision and only for those uses obviewed by the Certified Applicator's certification. Communical certified applicators must slad ensure that all persons involved in these activities are informed of the precautionary statements.



Speciality Herbicide \*Trademark of Dow AgroSciences U.C.

enters the plant—whether through the foliage, stem, or roots. Some herbicides will have more than one type of activity. When treating vegetation in the forest understory, be sure the product will not affect the overstory trees through soil activity.

The size and number of stems, number of acres, and time of year will influence your application method choice (see "Forest Herbicide Application Methods" on page 8). For example, if trees to be controlled are greater than 8 inches in diameter, a frill girdle or stem injection application method is appropriate. If the site contains 40 acres of fern in the understory, a ground foliar broadcast treatment using mechanization such as a skidder-mounted mist blower would be the most appropriate application method. The product label is your best source for application methods and rate information. Be sure to select the application method that will use the least amount of product to control the targeted plants.

Before applying any herbicide, it is important to properly calibrate equipment. A calibration check will show the amount of product applied under given field conditions and involves making a trial run over a known area and measuring the amount of material applied. By adjusting equipment to control application volume or chemical concentration the proper rate is obtained. Calibration is important because:

- applying pesticide at rate greater than labeled is illegal;
- nozzles and other equipment settings may vary depending upon operating conditions;
- cost-effective applications need to be made at proper rates.

#### Forest Herbicide Application Methods-Cut Surface Treatments

#### Frill Girdle (Hack and Squirt)

Use hatchet, machete, or similar device to make frill or cut at a downward angle at proper spacing, following label recommendations. Cuts should penetrate through the bark into living cambium tissue (the wood next to the bark) and produce a cupping effect to hold herbicide. Spray measured quantity into cuts using squirt bottle. Do not allow material to run out of cut. Not recommended for use during heavy sap flow in spring.

#### Uses

Generally used to control individual trees greater than 5 inches in diameter.

7. Hatchet and spray bottle for hack and squirt applications.



8. Making frill cuts to receive herbicide.



#### **Stem Injection**

Use a hatchet or lance-type tree injector calibrated to deliver the proper amount of herbicide with each blow. Following label recommendations, penetrate through the bark into the living cambium tissue at properly spaced intervals. Not recommended for use during heavy sap flow in spring.

#### Uses

Generally used to control individual trees greater than 5 inches in diameter.

9. Hypo-hatchet blade showing injector port.



11. The E-Z Ject lance injects capsules into stems.



10. Hypo-hatchet injects calibrated volume with each blow.



12. Compression stroke implants capsule through bark.



#### **Cut Stump**

For water-soluble herbicide mixtures, spray or paint the cambial area (the wood next to the bark) of freshly cut stumps immediately after cutting. If using an oil-soluble mixture, treatments can be applied to stumps up to 1 month following cutting. In this case, spray the sides of the stump to the root collar and the cambium area around the entire circumference of the cut surface until thoroughly wet, but not to the point of runoff.

#### Uses

Used to control resprouting of cut hard-wood stumps.

13. Cut stump treatment prevents resprouting.



14. Treat only the cambial area of cut stumps.



#### Forest Herbicide Application Methods-Bark, Foliage, and Soil Treatments

#### **Basal Bark**

Using a low-pressure backpack sprayer, thoroughly wet the lower 12 to 15 inches of the stem completely around tree including the root collar area. Do not spray to the point of runoff.

#### Uses

Generally used to control thin-barked trees when they are less than 6 inches in basal diameter.

15. For small trees, spray from ground line to a height of 12 to 15 inches.



16. Basal bark treatments use an oil carrier to penetrate the bark.



#### **Foliar Spray**

Using aerial or ground spray application equipment such as a helicopter, skidder, or backpack sprayer, mist herbicide mixture onto the foliage of targeted plants. Direct the spray to evenly cover plant foliage. Do not spray to the point of runoff.

#### Uses

Used to control many woody plants, herbaceous weeds, grasses, and vines.

17. Use a backpack sprayer to mist spray evenly over plants.



18. Mechanical air-blast sprayer treats understory vegetation up to 20 feet in height.



#### **Basal Soil**

Using an exact-delivery spotgun applicator, direct the spray at the soil within 2 to 3 feet of the target plant root collar, or in a grid pattern across the entire treatment area. The square grid pattern can range from 3 to 6 feet between soil application spots.

#### Uses

Used as a treatment to control many annual and perennial weeds and woody plants.

19. Spotgun dispenses measured volume with each trigger pull.



20. Spot spray mix to soil around plant base.



### Forestry Herbicide Toxicity

Many people believe that any product referred to as a "pesticide" is highly toxic and unsafe at any application rate. This is simply not the case for forestry herbicides. Research and development have produced products that are effective, low risk, and environmentally friendly when applied and used according to the label. Active ingredients used in forestry have passed rigorous EPA testing for toxicity and environmental fate.

Toxicity refers to a product's ability to cause injury or illness to living organisms. A pesticide's acute toxicity is the basis for assigning its toxicity category. Acute toxicity is based on a single, short-term exposure by one of three routes—swallowing (ingestion), breathing (inhalation), or through the skin (dermal). Acute toxicity is usually expressed as LD<sub>50</sub> (lethal dose 50). This is the amount of the product lethal by ingestion to 50 percent of a population of test animals (usually rats) under laboratory conditions. LD<sub>50</sub> values are expressed in milligrams of pesticide per kilogram of body weight (mg/kg). The larger the LD<sub>50</sub> value, the less toxic the chemical.

The LD<sub>50</sub>, or acute toxicity value, is the basis for assigning the signal word (see Table 1 on page 12). Signal words must appear in large letters on the front panel of every pesticide label. They are "Caution," "Warning," "Danger," or "Danger-Poison" with skull and crossbones. The designation indicates the relative acute toxicity to humans and other animals. Signal words allow the user to quickly assess the acute toxicity rating. They also assist the user in selecting the least toxic product that will provide the desired level of plant control.

Table 2 provides the signal words and acute oral toxicity values for many commonly used forestry herbicide chemicals. To provide an understanding of relative acute toxicity, the table includes  $LD_{50}$  values for commonly used chemicals and products such as table salt and caffeine.

How can a product be so effective at killing plants and have such a low toxicity to humans, wildlife, and fish? For example, glyphosate has an  $LD_{50}$ value greater than 4,000 mg/kg, which is practically nontoxic. Yet, glyphosate is one of the most effective active ingredients in forestry herbicides. Herbicide effectiveness relates to the mode of action. In general, forestry labeled herbicides use biochemical pathways unique to plants. These pathways do not occur in humans or animals, providing very low toxicity and extremely effective herbicides.

#### Table 1. Signal Words and Symbols.

By law, every pesticide label must include a signal word. The signal word gives the user an immediate indication of the product's acute toxicity to humans and animals. The signal word is found on the front panel of the product label along with the statement "Keep Out of Reach of Children." Signal words allow the user to select the least toxic chemical that will provide the desired control level.

Caution	Product is slightly toxic or practically nontoxic either orally, dermally, or through inhalation; or causes slight eye or skin irritation. Acute oral $LD_{50}$ values are greater than 500 mg/kg.
Warning	Product is moderately toxic either orally, dermally, or through inhalation; or it may cause moderate eye and skin irritation. Acute oral $LD_{50}$ values range from 50 to 500 mg/kg.
Danger	Without the skull and crossbones symbol, this word is used on products that cause severe skin irritation or eye damage, more so than what the acute oral $LD_{50}$ might suggest.
Danger Poison (skull and crossbones)	Displayed with a prominent skull and crossbones to indicate that the product is highly toxic based on either oral, dermal, or inhalation toxicity. Acute oral $LD_{50}$ values range from a trace to 50 mg/kg.

Note: LD<sub>50</sub> is the quantity or dose of a chemical lethal to 50 percent of test animals under laboratory conditions. It is expressed in milligrams (mg) of chemical per unit of body weight, expressed in kilograms (kg).

Source: Hock, W. K., ed. 1996. Pesticide Education Manual: A Guide to Safe Use and Handling. 3rd ed. University Park, Pa.: The Pennsylvania State University.

#### Table 2. Relative Toxicity of Commonly Used Forestry Herbicides.

Trade Names	Common Name	Signal Word	Toxicity (LD <sub>50</sub> )
Accord, Foresters, Razor	glyphosate	Caution	4,873
Arsenal, Chopper, Stalker	imazapyr	Caution	>5,000
Escort XP, Patriot	metsulfuron methyl	Caution	>5,000
Garlon, Tahoe, Pathfinder	triclopyr	Caution or Danger	630
Krenite	fosamine	Caution	>5,000
Oust XP, Spyder	sulfometuron methyl	Caution	>5,000
Tordon	picloram	Caution	>5,000
Transline	clopyralid	Caution	4,300
Vanquish	dicamba	Caution	1,039
Velpar	hexazinone	Danger	1,690
Compare to:	Sodium chloride (salt)		3,000
	Tylenol (Acetometaphin)		1,944
	Motrin (Ibuprofen)		636
	Malathion		290
	Sevin (Carbaryl)		230
	Caffeine		192

Toxicity based on oral  $LD_{50}$  value for rats.

Source: The Vermont SIRI MSDS Index, http://hazard.com/msds/index.php/.

#### **Personal Protective Equipment**

Personal protective equipment (PPE) reduces exposure to pesticides. The type of PPE used depends on the product and the type of application. The greatest risk of pesticide exposure occurs when handling concentrates during mixing and loading. Failing to follow appropriate safety precautions and application procedures can lead to exposure from diluted chemicals. Pesticide container labels specify the minimum amount of PPE recommended by the manufacturer. Exceeding the manufacturer's recommendations for PPE lowers exposure risks.

21. Minimum protection consists of long-sleeved shirt, long pants, shoes, and socks.



22. Some forestry herbicides may require additional PPE including protective eyewear and chemical-resistant gloves.



23. Other products require mixers to wear coveralls or chemical-resistant aprons.



## Forestry Herbicide Application: Talking Points

All of us need to be concerned about the long-term impacts of our forest management practices and the use of herbicides. After reviewing the chemical properties and product safety, we can draw the conclusion that proper use according to the label may improve forest productivity and not adversely affect biodiversity. The environmental impacts of forestry herbicide applications are generally minimal<sup>1</sup> for the following reasons:

- 1. Forestry herbicides are applied at very low rates (2 ounces to 2 quarts per acre) and on a very small percentage of the land annually.
- 2. Generally, only one application is made over an 80- to 100-year rotation for hardwood regeneration establishment.
- 3. Forestry herbicides are very low in acute toxicity. Of the 26 herbicides described in this publication,  $LD_{50}$  values range from 1,000 to more than 5,000 mg/kg, classifying them as either only slightly toxic or practically nontoxic.
- 4. Forestry herbicides do not bioaccumulate in the food chain. When ingested, these chemicals pass very quickly through the body and are excreted in urine and feces.
- 5. Forestry herbicides are biodegradable and do not persist in the environment. All of these chemicals have relatively short half-lives and undergo biological decomposition.

6. The potential human health risks from forestry herbicides are negligible. They are less hazardous than manual and mechanical methods of vegetation control.

These points provide a strong argument for using forestry herbicides. Despite the relatively low risk to humans, animals, and the environment, practicing care and environmental stewardship during application is essential to ensure continued product availability. Remember to always read and follow the label—it is a legal document.

<sup>&</sup>lt;sup>1.</sup> Revised from K. McNabb, *Environmental Safety of Forestry Herbicides*, Alabama Cooperative Extension System, 1997.
#### Silvicultural Objectives and Chemical Control Methods for Forestry

Land managers can use forestry herbicides to increase forest productivity by controlling competing and interfering vegetation. In general, herbicide applications reduce competition and improve survival and growth. Herbicides can control herbaceous and woody competing vegetation for natural or artificial regeneration, as well as for timber stand improvement practices and thinning.

#### **Timber Stand Improvement**

#### Objective

Remove poorly formed trees and/or undesirable species from a timber stand to make room for more desirable growing stock. Regulates species composition and improves stand quality.

Herbicide Application Methods Frill Girdle (Hack and Squirt) Stem Injection Basal Bark 24. Hack and squirt application deadens undesirable standing trees.



26. Basal bark treatment controls grapevines (*Vitis* spp.).

25. Basal bark treatment removes shade cast by understory saplings.





continued on next page

#### Silvicultural Objectives and Chemical Control Methods for Forestry (continued)

#### **Precommercial Thinning**

#### Objective

To control stand density and species composition by thinning dense stands of conifers or hardwoods. Increases individual tree growth by reducing stand density and allowing for crown expansion.

#### **Herbicide Application Methods**

Frill Girdle (Hack and Squirt) Stem Injection Basal Bark 27. Hack and squirt application to thin poletimber hardwood stand.



29. Use continuous frill girdle cuts and herbicide to deaden competing trees.

28. Hack and squirt treated poletimber pine stand.





#### **Site Preparation**

#### Objective

To control preexisting competing herbaceous and interfering woody vegetation prior to planting or establishing natural regeneration. Creates conditions conducive to the establishment and growth of the desired species.

#### **Herbicide Application Methods**

Foliar Spray Basal Bark Basal Soil 30. KMC track skidder with air-blast sprayer treating understory vegeta-tion.



31. Understory vegetation controlled to encourage natural regeneration.



#### **Release Operations**

#### Objective

To free young stands of planted or naturally established seedlings from competing or interfering vegetation that threatens to suppress growth. Gives the released trees enough light and growing space to develop.

#### **Herbicide Application Methods**

Frill Girdle (Hack and Squirt) Stem Injection Cut Stump Foliar Spray Basal Bark 32. Pine release using skidder-mounted air-blast sprayer.



34. Tree shelters can protect seedlings from herbicide.

**33.** Aerial pine release operation with helicopter and support truck.





#### **Invasive Plant Control**

#### Objective

To remove invasive plants that influence the forest's ability to retain native plant and wildlife diversity. Invasive plants are best controlled early when they are identified and before they have opportunities to spread.

#### **Herbicide Application Methods**

Frill Girdle (Hack and Squirt) Stem Injection Cut Stump Foliar Spray Basal Bark Basal Soil 35. Foliar application of multiflora rose.



36. Basal bark application used to control tree-of-heaven.



# **Herbicide Summaries**

#### Table 3. Herbicides Commonly Used in Forestry.

Herbicides commonly used in forestry are available under a variety of trade names. Therefore, it is best to become familiar with common names (active ingredient). The following table lists herbicides effective for controlling competing vegetation in northeastern hardwood and coniferous forests alphabetically by common name. The trade name and manufacturer are shown in the columns that follow. Trade names are grouped according to active ingredient. This table is strictly a guide and is not all inclusive. No endorsement or support of an individual product or company is given or implied.

Common Name (Active Ingredient)	Trade Name	Manufacturer
2,4-D	DMA 4 IVM	Dow AgroSciences
Clopyralid	Transline	Dow AgroSciences
Dicamba	Vanquish	Nufarm Turf and Specialty
Fosamine	Krenite S	DuPont
Glyphosate	Accord Concentrate	Dow AgroSciences
	Foresters'	Nufarm Turf and Specialty
	Razor	Nufarm Turf and Specialty
	Razor Pro	Nufarm Turf and Specialty
Glyphosate and Imazapyr	OneStep	BASF
Hexazinone	Velpar DF	DuPont
	Velpar L	DuPont
Imazapyr	Arsenal AC	BASF
	Chopper	BASF
	Stalker	BASF
Metsulfuron Methyl	Escort XP	DuPont
	Patriot	Nufarm Turf and Specialty
Picloram	Tordon K	Dow AgroSciences
Picloram and 2,4-D	Tordon 101 Mixture	Dow AgroSciences
	Pathway	Dow AgroSciences
Sulfometuron Methyl	Oust XP	DuPont
	Spyder	Nufarm Turf and Specialty
Sulfometuron Methyl and Metsulfuron Methyl	Oust Extra	DuPont
Triclopyr	Garlon 3A	Dow AgroSciences
	Garlon 4	Dow AgroSciences
	Pathfinder II	Dow AgroSciences
	Tahoe 3A	Nufarm Turf and Specialty
	Tahoe 4E	Nufarm Turf and Specialty

The following section summarizes pertinent information on commonly applied forestry herbicides labeled for use in Pennsylvania. This information is taken from product labels and material safety data sheets. (See http://www.greenbook. net/ for more information.) Summaries are organized alphabetically by trade name.

#### **Accord Concentrate**

Common Name: Glyphosate—53.8%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

#### Carriers: Water

Activity: Absorbed through foliage or cut surface

Mode of Action: Inhibits the production of an enzyme necessary for producing essential amino acids; also inhibits the synthesis of chlorophyll, causing the leaves to lose color

Selectivity: Nonselective, broad-spectrum control

**Precautions:** Avoid herbicide contact with foliage and green stems of desirable plants and trees

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

Uses: Controls annual and perennial weeds, grasses, vines, and woody plants; ground broadcast treatments for hardwood brush and fern control; ground or aerial broadcast treatments for pine release; specific formulation available for pine planting site preparation; can be used in and around water and wetlands found on forestry sites

#### **Arsenal AC**

Common Name: Imazapyr—53.1%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage, cut surface, and root uptake

Mode of Action: Accumulates in plant meristems (growth regions); inhibits the synthesis of an enzyme responsible for producing certain amino acids only found in plants

Selectivity: Conifers generally resistant

**Precautions:** Do not apply to areas where roots of sensitive desirable plants may extend

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

Uses: For postemergence and residual control of many grasses, herbaceous weeds, vines, and woody vegetation throughout the life cycle of coniferous forests; used primarily for site preparation and conifer release

#### Chopper

Common Name: Imazapyr—27.6%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, waterproof gloves, shoes, and socks.

Carriers: Water, penetrating oils, or seed oils

Activity: Absorbed through foliage, bark, cut surface, and root uptake

Mode of Action: Accumulates in plant meristems (growth regions); inhibits synthesis of enzyme responsible for producing certain amino acids only found in plants

Selectivity: Conifers generally resistant

**Precautions:** Do not apply to areas where roots of sensitive desirable plants may extend

**Application Methods:** Foliar spray, cut stump, basal bark

**Uses:** Used to control grasses, broadleaf weeds, vines, and woody vegetation for conifer crop species site preparation

#### DMA 4 IVM

Common Name: 2,4-D—46.3%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Danger

**Toxicity:** Slightly toxic; oral LD<sub>50</sub>: 1,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, socks, protective eyewear, and waterproof gloves; for containers larger than 1 gallon, but smaller than 5, loaders transferring contents must wear coveralls or chemicalresistant apron

#### Carriers: Water

Activity: Absorbed through foliage, cut surface, and root uptake

**Mode of Action:** Selective systemic, acts as a growth regulator (synthetic auxin)

Selectivity: Little or no impact on grasses; can be applied over conifers once they have hardened off in late summer

**Precautions:** Can cause irreversible eye damage; drift or runoff may adversely affect aquatic invertebrates and nontarget plants; use caution when handling to prevent contamination of ground-water

Application Methods: Foliar spray, frill girdle, stem injection, cut stump, basal bark

Uses: Controls many annual and perennial broadleaf weeds, vines, and woody plants when they are actively growing; generally used for forest site preparation and conifer release including Christmas trees

#### **Escort XP**

Common Name: Metsulfuron methyl—60%

Formulation: Dispersible solid granule

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and, to a lesser degree, through root uptake

Mode of Action: Inhibits the synthesis of key amino acids found only in plants; stops growth in the growing tips of both the roots and the shoots; has both preand postemergence activity

**Selectivity:** Grasses show high tolerance to this product

**Precautions:** May adversely affect nontarget plants at very low levels from contact with drift, runoff, or root systems

Application Methods: Foliar spray, basal soil

Uses: Controls many annual and perennial weeds and woody plants, especially effective on kudzu vine and multiflora rose; primarily used to control undesirable weeds and hardwoods in conifer site preparation and release; may also be used to control many weed species on sites where yellow poplar is growing or is to be planted

#### **Foresters'**

Common Name: Glyphosate—53.8%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage or cut surface

Mode of Action: Inhibits the production of an enzyme necessary for producing essential amino acids; also inhibits chlorophyll synthesis, causing the leaves to lose color

Selectivity: Nonselective, broadspectrum herbicide

**Precautions:** Avoid herbicide contact with foliage and green stems of desirable plants and trees

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

Uses: Controls annual and perennial weeds, grasses, vines, and woody plants; ground broadcast treatments for hardwood brush and fern control; ground or aerial broadcast treatments for pine release; used to control brush and weeds prior to planting; can be used in and around water and wetlands found on forestry sites

#### **Garlon 3A**

Common Name: Triclopyr-44.4%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Danger

**Toxicity:** Slightly toxic; oral  $LD_{50}$ : 2,574 mg/kg for males, 1,847 mg/kg for females

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, socks, protective eyewear, and chemical-resistant gloves

#### Carriers: Water

Activity: Absorbed through foliage or cut surface

Mode of Action: Acts as a systemic herbicide that deregulates plant growth metabolic pathways; accumulates in the plant meristems (growth regions), causing uneven cell division and growth

Selectivity: Little or no impact on grasses

**Precautions:** Can cause irreversible eye damage; use eye protection when mixing and handling concentrate; do not use in areas with permeable soils or shallow water tables; groundwater contamination may result

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

Uses: For controlling woody plants, broadleaf weeds, and vines; broadcast treatments for site preparation and release of spruce, fir, red pine, and white pine from competing hardwoods; may be used in and around standing water on forested sites

#### **Garlon 4**

Common Name: Triclopyr—61.6%

Formulation: Oil-soluble liquid, ester

Signal Word: Caution

**Toxicity:** Slightly toxic; oral  $LD_{50}$ : 1,581 mg/kg for males, 1,338 mg/kg for females

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, chemical-resistant gloves, shoes, and socks

**Carriers:** Water for foliar applications; for basal bark treatments use commercially available basal oil, diesel fuel, fuel oil, or kerosene

Activity: Absorbed through foliage, bark, or cut surface

Mode of Action: Acts as a systemic herbicide that deregulates plant growth metabolic pathways; accumulates in the plant meristems (growth regions), causing uneven cell division and growth

Selectivity: Little or no impact on grasses

**Precautions:** Do not apply to open water or ditches used to transport irrigation water

Application Methods: Foliar spray, basal bark, cut stump

Uses: For controlling unwanted woody plants, including mountain laurel, as well as annual and perennial weeds; broadcast treatments for site preparation and release of spruce, fir, red pine, and white pine from competing hardwoods; used to control cut stump resprouting of individual stems up to 6 inches in diameter; stumps can be treated up to one month following cutting; permissible for use in seasonally dry wetlands

#### **Krenite S**

Common Name: Fosamine—41.5%

Formulation: Water-soluble liquid (ammonium salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and cut surface

Mode of Action: When applied to foliage, it inhibits bud formation and susceptible species fail to leaf out; spraying only a part of a susceptible brush species will control only that portion, creating a trimming effect

**Selectivity:** Nonwoody plants are resistant

**Precautions:** Drift or spray mist contact with desirable plants may result in injury

Application Methods: Foliar spray and cut stump

Uses: Recommended for postharvest control of pine and hardwood species for southern pine planting site preparation; also used to control cut stump resprouting

#### **One Step**

**Common Name:** Glyphosate—69.51% and imazapyr—8.36%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Warning

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, socks, protective eyewear, and chemical-resistant gloves

#### Carriers: Water

**Activity:** Absorbed through foliage and root uptake

Mode of Action: Translocated through plant and accumulates in meristematic (active growth) regions; inhibits synthesis of enzyme responsible for production of specific amino acids only found in plants

Selectivity: Nonselective, broadspectrum control

**Precautions:** May cause substantial but temporary eye injury; do not apply to areas where roots of sensitive, desirable plants may extend

Application Methods: Foliar spray

Uses: Used as postemergent spray to control most annual and perennial grasses, broadleaf weeds, vines, and woody vegetation for conifer planting site preparation

#### **Oust Extra**

**Common Name:** Sulfometuron methyl—56.25% and metsulfuron methyl—15%

Formulation: Dispersible granule

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and roots

Mode of Action: Inhibits the synthesis of key amino acids only found in plants stopping growth in tips of both roots and shoots; has both pre- and postemergence activity

Selectivity: Coniferous species may be resistant

**Precautions:** Nontarget plants may be adversely affected by drift and runoff

Application Methods: Foliar spray

**Uses:** Used to control various woody plants, vines, and herbaceous weeds in conifer site preparation and release

#### Oust XP

**Common Name:** Sulfometuron methyl—75%

Formulation: Dispersible solid granule

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and roots

Mode of Action: Inhibits the synthesis of key amino acids only found in plants, which inhibits growth in growing tips of both roots and shoots; has both preand postemergence activity

**Selectivity:** Many coniferous and hard-wood species are resistant

**Precautions:** Applications over trees suffering a loss of vigor or following bud break may injure or kill trees

Application Methods: Foliar spray

Uses: Controls annual and perennial grasses and broadleaf weeds; primarily used in conifer and hardwood plantations for site preparation and release; also used to control herbaceous weeds on hardwood natural regeneration sites

#### Pathfinder II

Common Name: Triclopyr—13.6%

Formulation: Ready-to-use, oil-soluble liquid (ester)

Signal Word: Caution

**Toxicity:** Slightly toxic; oral  $LD_{50}$ : 2,389 mg/kg for males, 1,000 mg/kg for females

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, chemical-resistant gloves, shoes, and socks

Carriers: Ready to use, no mixing required

Activity: Absorbed through bark and cut surface

Mode of Action: Acts by disturbing plant growth; accumulates in plant meristems (growth regions)

Selectivity: Little or no impact on grasses

**Precautions:** Do not apply directly to open water or to water present in wetlands; toxic to fish; untreated trees can be affected by movement of herbicide through root grafts with treated trees

**Application Methods:** Basal bark and cut stump

Uses: Used any time of year to control individual stems and cut stump resprouting; stumps can be treated up to one month following cutting

#### Pathway

**Common Name:** Picloram—5.4% and 2,4-D—20.9%

**Formulation:** Ready-to-use liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, chemical-resistant gloves, protective eyewear, shoes, and socks; for containers larger than 1 gallon, but smaller than 5, loaders transferring contents must wear coveralls or chemical-resistant apron

**Carriers:** Ready to use, no mixing required

Activity: Absorbed through cut surface and root uptake

Mode of Action: Concentrates in actively growing tissue (meristems), causing uneven cell growth and division

Selectivity: Will not harm grasses

**Precautions:** Affects nontarget plants at very low concentrations if product is allowed to drift off site or is applied within root zone of desirable trees; do not apply to soils with rapid permeability, shallow water tables, or to soils containing sinkholes over limestone bedrock

Application Methods: Cut stump, stem injection, frill girdle

Uses: Used to control unwanted trees and brush on forestry sites by using cut surface application methods

#### Patriot

Common Name: Metsulfuron methyl-60%

Formulation: Water-dispersible granules

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and, to a lesser degree, through root uptake

**Mode of Action:** Inhibits plant cell division; controls weeds primarily by postemergence activity, although some pre-emergence activity is present

Selectivity: Nonselective, broadspectrum control; some native grasses resistant

**Precautions:** Nontarget plants may be adversely affected at very low levels from contact with drift, runoff, or root systems

**Application Methods:** Foliar spray, basal soil

Uses: Used for controlling and suppressing undesirable weeds and hardwoods on sites where conifers and yellow poplars are growing or are to be planted; also recommended to control certain noxious weeds including multiflora rose

# **Razor and Razor Pro (includes surfactant)**

Common Name: Glyphosate—41%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, socks, and protective eyewear

Carriers: Water

Activity: Absorbed through foliage or cut surface

Mode of Action: Inhibits production of enzyme necessary for producing essential amino acids; also inhibits chlorophyll synthesis, causing leaves to lose color

Selectivity: Nonselective, broadspectrum control

**Precautions:** Causes moderate eye irritation; avoid herbicide contact with foliage and green stems of desirable plants and trees

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

**Uses:** Used in planting-site preparation for both conifer and hardwood species; applied as a release treatment over conifers following the first growing season

#### Spyder

**Common Name:** Sulfometuron methyl—75%

Formulation: Dispersible solid granule

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and root uptake

Mode of Action: Inhibits synthesis of key amino acids only found in plants by stopping growth in growing tips of both roots and shoots; has both pre- and postemergence activity

Selectivity: Many coniferous and hardwood species are resistant

**Precautions:** Causes moderate eye irritation; application over trees suffering a loss of vigor or following bud break may injure or kill those trees

Application Methods: Foliar spray

Uses: Controls many annual and perennial grasses and broadleaf weeds; used in the site preparation and release of both coniferous and hardwood plantings; controls competing vegetation for hardwood natural regeneration

#### Stalker

Common Name: Imazapyr—27.6%

Formulation: Emulsifiable concentrate

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, waterproof gloves, shoes, and socks

Carriers: Water, diesel oil, or recommended seed oils and penetrating oils

Activity: Absorbed through foliage, bark, cut surface, and root uptake

Mode of Action: Accumulates in plant meristematic regions (growth regions); inhibits the synthesis of an enzyme responsible for the production of certain amino acids found only in plants

Selectivity: Conifers generally resistant

**Precautions:** Toxic to plants at very low concentrations; do not apply to areas where roots of sensitive desirable plants extend

**Application Methods:** Frill girdle, stem injection, cut stump, and basal bark

Uses: Used to control individual stems and cut stump resprouting

#### Tahoe 3A

Common Name: Triclopyr-44.4%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Danger

**Toxicity:** Slightly toxic; oral  $LD_{50}$ : 2,574 mg/kg for males, 1,847 mg/kg for females

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, socks, protective eyewear, and chemical-resistant gloves

#### Carriers: Water

**Activity:** Absorbed through foliage and cut surface

Mode of Action: Acts as a systemic herbicide deregulating plant metabolic pathways; accumulates in plant meristems (growth regions), causing uneven cell division and growth

Selectivity: Little or no impact on grasses

**Precautions:** Can cause irreversible eye damage; do not use in areas with permeable soils and high water tables

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

Uses: Used to control broadleaf weeds and woody plants; directed spray applications for conifer release and broadcast applications for conifer planting site preparation

#### Tahoe 4E

Common Name: Triclopyr-61.6%

Formulation: Oil-soluble liquid (ester)

Signal Word: Caution

**Toxicity:** Slightly toxic; oral  $LD_{50}$ : 1,581 mg/kg for males, 1,338 mg/kg for females

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, shoes, socks, and chemicalresistant gloves

**Carriers:** Water for foliar applications; commercially available basal oil, diesel fuel, fuel oil, or kerosene for basal bark treatments

Activity: Absorbed through foliage, bark, or cut surface

Mode of Action: Acts as a systemic herbicide deregulating plant metabolic pathways; accumulates in plant meristems (growth regions), causing uneven cell division and growth

Selectivity: Established grasses are tolerant of treatment

**Precautions:** Toxic to fish—do not apply to open water

Application Methods: Foliar spray, basal bark, cut stump

Uses: Used to control broadleaf weeds and woody plants; controls cut stump resprouting and individual stems up to 6 inches in diameter; also used for planting site preparation and conifer release

#### **Tordon 101 Mixture**

Common Name: Picloram—10.2% and 2,4-D—39.6%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Danger

**Toxicity:** Slightly toxic; oral LD<sub>50</sub>: 2,598 mg/kg

Use Classification: Restricted use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, chemical-resistant gloves, protective eyewear, shoes, and socks. For containers larger than 1 gallon, but smaller than 5, mixers must wear coveralls or chemical-resistant aprons

Carriers: Water

Activity: Absorbed through foliage, cut surface, and root uptake

Mode of Action: Concentrates in active growing tissue (meristems), causing uneven cell growth and division

Selectivity: Broad-spectrum, although most grasses are resistant

**Precautions:** Causes irreversible eye damage; toxic to nontarget plants at very low concentrations; known to leach through soil into groundwater in areas where soils are permeable and water table is shallow

Application Methods: Foliar spray, cut stump, stem injection, frill girdle

Uses: Used for postemergence control of most annual and perennial weeds, woody plants, vines, and pre-emergence control of most annuals; used primarily for conifer planting site preparation

#### Tordon K

Common Name: Picloram—24.4%

Formulation: Water-soluble liquid (potassium salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: Restricted use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, waterproof gloves, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage

Mode of Action: Concentrates in active growing tissue (meristems), causing uneven cell growth and division

Selectivity: Most grasses are resistant

**Precautions:** Affects nontarget plants at very low concentrations if allowed to drift off site; do not apply to sites with highly permeable soils and high water tables or to soils with sinkholes over limestone bedrock; groundwater contamination may result

Application Methods: Foliar spray

**Uses:** Used to control annual and perennial broadleaf weeds, woody plants, and vines; primarily for conifer planting site preparation

#### Transline

Common Name: Clopyralid—40.9%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Practically nontoxic; oral LD<sub>50</sub>: >5,000 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, waterproof gloves, shoes, and socks

Carriers: Water or oil

Activity: Absorbed through foliage and root uptake

**Mode of Action:** Acts as natural growth regulator by disrupting plant growth process; accumulates in plant growing points, resulting in plant death

Selectivity: Most established grasses are resistant

**Precautions:** Do not apply to soils with rapid permeability and shallow water table; applications to actively growing conifers and hardwoods may cause needle curling or leaf burning

Application Methods: Foliar spray

Uses: Provides postemergence control of most broadleaf weeds including thistle and kudzu vine; applied as either a site preparation or tree release application for both conifer and hardwood planting sites; can be applied to tolerant conifer and hardwood tree species (see supplemental label for tolerant species) anytime during the season

#### Vanquish

Common Name: Dicamba—56.8%

Formulation: Water-soluble liquid (amine salt)

Signal Word: Caution

**Toxicity:** Slightly toxic; oral LD<sub>50</sub>: 3,512 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, waterproof gloves, shoes, and socks

Carriers: Water, herbicidal oil, and emulsifier

**Activity:** Absorbed through foliage and root uptake

Mode of Action: Translocated through plant, causing targeted weeds to collapse

Selectivity: Nonselective, broadspectrum control

**Precautions:** Not recommended for areas with permeable soils and shallow water table

**Application Methods:** Foliar spray, cut surface, basal bark, basal soil

Uses: Controls many annual and perennial broadleaf weeds, woody brush (including hardwoods and pines), and vines; used for forest site preparation prior to planting; also used to control multiflora rose during the dormant season

#### Velpar DF

Common Name: Hexazinone—75%

Formulation: Water-dispersible, dry, flowable granule

Signal Word: Danger

**Toxicity:** Slightly toxic; oral LD<sub>50</sub>: 1,310 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, protective eyewear, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and root uptake

**Mode of Action:** Has both pre- and postemergence activity; sufficient soil moisture and rainfall are required for activation

**Selectivity:** Most conifer species show some resistance

**Precautions:** Causes irreversible eye damage; not recommended for use on highly permeable soils or on areas with shallow water tables; if applied within root zone, desirable trees and shrubs may be affected

Application Methods: Foliar spray, basal soil

**Uses:** Used to control most annual, biennial, and perennial weeds and woody vegetation for conifer planting site preparation and release

#### Velpar L

Common Name: Hexazinone—25%

Formulation: Water-dispersible liquid

Signal Word: Danger

**Toxicity:** Slightly toxic; oral LD<sub>50</sub>: 1,200 mg/kg

Use Classification: General use

Minimum Required Personal Protective Equipment: Long-sleeved shirt, long pants, protective eyewear, shoes, and socks

Carriers: Water

Activity: Absorbed through foliage and root uptake

Mode of Action: Has both pre- and postemergence activity; sufficient soil moisture is required for activation

**Selectivity:** Most conifer species and yellow poplar show some resistance

**Precautions:** Causes irreversible eye damage; not recommended for use on highly permeable soils or on areas with shallow water tables; if applied within root zone, desirable trees and shrubs may be affected

Application Methods: Foliar spray, basal soil

Uses: Used to control most annual, biennial, and perennial weeds and woody vegetation for conifer planting site preparation and release; recommended for controlling herbaceous weeds in the establishment of yellow poplar plantations when applied prior to seedling bud break

#### Table 4. Trees, Shrubs, Vines, and Ferns Controlled by Commonly Used Forestry Herbicides Registered for Use in Pennsylvania.

This table reflects plant species listed on respective product labels. Federal and state law permits herbicide applications to control target plants not specified on t the control of species not listed.

Plant	Accord	Arsenal AC	Chopper	DMA 4 IVM	Escort XP	Forest- ers'	Garlon 3A	Garlon 4	Krenite S	One Step	Oust Extra	
Alder	х	х	х	х		х	х	х	х	х		
Arrowwood	х						х	х		х		
Ash (green, white)	х	х	x	х	х	x	х	х	x	х		
Aspen	х	х	x	х	х	x	х	х	x			
Basswood	х						х	х	x			
Beech (American)	х	х	x				х	х		х		
Birch (white, yellow, black)	х	х	x	х		x	х	х	x	х		
Blackberry	х				х	x	х	х	x		х	
Blackgum	х	х	x				х	х	x	х		
Blueberry	х	х	x				х	х				
Boxelder	х	х	x					х		х		
Cedar (red)					х							
Cherry (black, pin, choke)	х	х	x		х	х	х	х	х	х		
Chinquapin		х	x				х	х		x		
Cottonwood		х	x		х		х	х	х	х		
Dewberry	х				х	х					х	
Dogwood	x	x	х	х		x	x	х	х	x		
Elderberry	х					x	х	х				
Elm	х			х	х	x	х	х	x			
Fern	х					x			x		х	
Grape (wild)	х	х	x		х		х	х	x	х		
Hackberry												
Hawthorn	х	х	x		х	x	х	х	x	х		
Hazel	х			х		x	х	х				
Hemlock												
Hickory	х	х	x	х		x	х	х	x	х		
Honeysuckle	х	х	x		х	х				х	х	
Hornbeam (American)	х					х	х	х				
Huckleberry	х	х	x				х	х		х		
Kudzu	х				х		х	х				
Locust (black, honey)	х				х	х	х	х	x			
Mountain laurel								х				
Maple (red, sugar, striped)	х	х	х	х	х	х	х	х	х	х		
Mulberry		х	х		х		х	х		х		
Oak (black, red, white)	х	х	х	х	х	х	х	х	х	х		

he label, provided the target plant is found on a site specifically listed on the label. You may also want to check with herbicide manufacturer representatives for

Oust XP	Path- finder II	Path way	Patriot	Razor	Spyder	Stalker	Tahoe 3A	Tahoe 4E	Tordon 101M	Tordon K	Trans- line	Van- quish	Velpar DF	Velpar L
	x	х		х		х	х	х	х			х		
	x	х					х	х	х	х				
	x	х	х	х		х	х	х				х	х	x
	x	х	x	х		x	х	х	х	x		х	х	x
	x	х							х	x		х		
	x	х		х		x	х	х	х	x		х		
	х	х		х		х	х	х	х	x		х	х	х
х	х		х	х	х		х	х	х	х		х	х	
	х	х		х		х	х	х	х	х		х	х	х
						х			х	х		х		
	x	х				х		х	х	х	х		х	
	х	х	х							х		х		
	х	х	х	х		х	х	х	х	х		х	х	х
						х	х	х				х		
	х	х	х			х	х	х	х	х		х		
			х	х								х		х
	х	х		х		х	х	х	х	х		х	х	х
	х	х	х	х		х	х	х	х	х				
	х	х	х	х		х	х	х	х	х		х	х	х
х				х	х				х			х		
	х	х	х						х	х		х		
	х	х							х	х		х		
		х	x	х		х	х	х				х	х	x
	х	х		х		х	х	х	х	х			х	х
									х	х		х		
	х	х		х		х		х	х	x		х	х	х
			х	х					х			х		
	x	х		х			Х	х	х	x		х		
						х			х	x		х	х	х
х			х	х	х		х	х	х		х	х		
	х	х	х	х		х	х	х	х	х	х	х		
	х								х	х				
	х	х	х	х		х	х	х	х	х		х	х	x
			х			х	х	х	х	х				
	х	х	х	х		х	х	х	х	х			х	x

continued on next page

#### Table 4 continued.

Plant	Accord	Arsenal AC	Chopper	DMA 4 IVM	Escort XP	Forest- ers'	Garlon 3A	Garlon 4	Krenite S	One Step	Oust Extra
Olive (autumn, Russian)	х	х	х		х	х				х	
Persimmon	х	х	x			х	x	x	х	х	
Pine							х	х	x		
Poison ivy	х	х	х			х	x	х		х	
Privet		х	х				x	х		х	
Raspberry	х					х	x	х			
Redbud (eastern)	х					х		х			
Rose (multiflora, wild)	х	х	x		х	х	х	х	х	х	x
Sassafrass	х	х	x			х	х	х	x	х	
Serviceberry	х						х	х			
Sourwood	х	х	х			х	х	х	x	х	
Spicebush											
Spruce					х						
Sumac (smooth, winged, poison)	х	х	х			х	х	х	х	х	
Sweetgum	х	х	х	х		х	х	х	х	х	
Sycamore	х	х	х				х	х	х	х	
Thimbleberry	х				х	х	х	х	х		
Tree of heaven	х	х	х		х		х	х	х	х	
Trumpet creeper	х	х	х			х				х	
Virginia creeper	х	х	х			х		x		х	
Walnut								х			
Willow	х	х	х	х	х	х	x	х	х	х	
Witchhazel											
Yellow poplar	х	х	х		х	х	х	х	х	х	

Trade names are used in this table only to give specific information. Penn State's College of Agricultural Sciences does not endorse or guarantee any product and does not specifically re-

Oust XP	Path- finder II	Path way	Patriot	Razor	Spyder	Stalker	Tahoe 3A	Tahoe 4E	Tordon 101M	Tordon K	Trans- line	Van- quish	Velpar DF	Velpar L
	х	х		х		х			х	х		х		
	х	х		х		х	х	х	х	х	х	х		
	х			х			х	х	х	х		х		
	х			х		х	х	х	х	х		х		
						х			х	х				
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	х	х							х	х		х		
	х	х		х		х			х	х			х	х
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	х			х		х	х	х	х	х		х	х	
	х	х		х		х	х	х	х	х		х	х	х
	х	х				х	х	х	х	х		х		
			х	х			х	х						
	x	х				х		х	х	х		х		
				х				х		х		х		
				х				х						
	х	х							х	х				
	х	х	х	х		х	х	х	х	х		х	х	х
												х		
	х	х	х	х		х	х	х	х	х		х		

ecommend any product. Before you apply any pesticide, be sure to read and follow the label. It is a legal document.



**Great Trinity Forest Management Plan** 

# **FOREST HERBICIDES**

Forest Herbicide Safety: Environmental Concerns and Proper Handling

# Forest Herbicide Safety: Environmental Concerns and Proper Handling

The increasing use of herbicides in forests and other agricultural areas has caused concerns about the damage these compounds can do to humans and the environment. Suggestions are presented on environmental safety and proper procedures for handling, storing, transporting, and applying herbicides. Although there are references to specific herbicides used in forest management, this information is applicable to any herbicide.

# **Environmental Safety**

Damage to the environment can occur due to accidents and misapplication because:

A. Mists from sprays and volatilized herbicides on hot days can drift for miles in high winds and may damage nearby crops.

- B. Runoff from treated areas may kill algae, aquatic organisms, and fish.
- C. Careless flushing of equipment can contaminate soil, wells, and surface water, killing desirable plants and trees.
- D. Off-site applications can occur if boundaries are not clearly marked and known by the applicator.

Because of potential environmental damage when using herbicides, the applicator must understand potential hazards and ways of avoiding problems. Drift depends on the wind conditions. Drift can cause problems off-site, and influence the rate of application on-site. For instance, if a gust of wind moves your swath 20 feet during a pass, you have an area that was skipped and an area that received a greater rate than required. You can avoid drift problems by knowing your product, your application equipment, and the degree that wind speed affects the herbicide's distribution. For instance, a granular formulation is less affected than a liquid spray. For your equipment, and the product you are using, develop wind speed guidelines that cause you to shut down. For liquid applications, that could be 5 mph. After setting that policy, follow it. If you held a job for 3 days because of the weather, the conditions you will accept for resuming work should be the same as the first day on the job.

Off-site movement due to volatilization can also be a problem. Liquid herbicides that are ester formulations are much more likely to volatilize than are amine formulations. If you expect temperatures to exceed 90-95 degrees and sensitive crops are planted in the vicinity, you do not apply products that may volatilize.

Since wind and temperature could cause problems, on-site monitoring and recording of weather conditions during application are necessary. By doing this, you will know when conditions require you to shut down, and the records will assist you if an adjacent landowner files a claim. You must know the location of crops, homesites, streams, ponds, and other sensitive areas within and adjacent to the treatment area. A pretreatment reconnaissance and sketch map are needed. Establish buffer strips around sensitive areas to protect from drift and runoff. You are liable for damages resulting from the application; thus, it is critical that the environmental concerns are a major concern of the applicator.

# **Terms and Definitions**

Acute toxicity: A measure of the ability of a chemical to cause injury or death from one exposure.

Chronic toxicity: The ability of a substance to cause injury or death after long-term exposure.

Dermal Toxicity: The ability of a substance to cause injury or death if passed through unbroken skin.

**Exposure:** Coming into contact with a chemical by swallowing, breathing, or through contact with the skin.

Hazard: The degree of exposure combined with the level of toxicity.

Herbicides: Chemicals that control plant pests.

LD<sub>50</sub>:The amount (or lethal dosage) of a chemical required to kill 50 percent of the test animals.

Oral Toxicity: The ability of a substance to cause injury or death if swallowed.

Pesticides: Chemicals that control, prevent, destroy, or regulate pests.

**PPM (Parts Per Million):** a way to express the amount of pesticide in water, plants, food, or animals. 1 ppm is equal to about 1 ounce in 62,500 pounds or 1 tablespoon in 3, 906 gallons.

Toxicity: The measure of the ability of a chemical to cause injury or death.

# **Measuring Toxicity**

Toxicity, the capacity of a substance to cause injury, varies depending on the chemical. Some chemicals are extremely toxic while others are essentially nontoxic. However, large enough quantities of almost any substance can cause a toxic response.

To understand the toxicity of herbicides, it helps to know how toxicity tests are conducted. Test animals (such as mice, rats, and rabbits) are fed measured doses of a chemical. By increasing the amounts of chemical fed to test animals, the amount required to kill one-half (50 percent) of the animals can be determined ( $LD_{50}$ ). This dosage is usually referred to in terms of the weight of the chemical and the weight of the test animal. For example, the herbicide Accord has an  $LD_{50}$  rating of 5,400 mg/kg. Approximately 1 pint of Accord in the concentrated form would have to be ingested for a 175-pound person to reach the  $LD_{50}$  dose.

Table 1 gives toxicity categories for pesticides, and Table 2 provides  $LD_{50}$  ratings for common herbicides. Other common substances frequently handled are listed for comparison. Also, Table 3 estimates the  $LD_{50}$  for a 175-pound person for a range of substances. From this information, several points can be made. As the  $LD_{50}$  rating becomes larger, the substance becomes lower in toxicity. For example, Product A with an  $LD_{50}$  rating of 40 mg/kg is much more toxic than Product B which has a  $LD_{50}$  rating of 4,000 mg/kg. Also, many herbicides have an acute toxicity rating less toxic than many frequently used household compounds.

Many people wonder how a herbicide that is extremely effective at killing unwanted plants can have such little toxicity for humans. Plants differ from humans in many ways. Researchers rely on those differences to produce chemicals that interrupt a plant's function, but have little effect on humans. For example, in a process called photosynthesis, plants produce their own food by using carbon dioxide from air, water from the soil, and sunlight. Since we do not have this ability, a chemical that blocks this process has a lethal effect on a plant yet does not affect humans. Other plant processes, such as blocking the synthesis of a particular amino acid that only plants can make, can be altered in a similar way. This too results in the death of the plant, but has no influence on people.

Although the acute LD<sub>50</sub> rating may indicate that the compound is relatively low in toxicity, take precautions when mixing, handling, or applying herbicides.

# Mixing, Handling, and Applying Herbicides

The first step in using herbicides safely is to read and understand the label before you mix or apply. The label contains precautionary statements and warnings as well as a list of protective clothing and equipment required

when using it. As mentioned earlier, herbicides generally interrupt a plant's function. Because of this, herbicides are usually the least toxic of all pesticides. However, when handling a concentrated herbicide, take precautions.

Avoid unnecessary exposure. In their concentrated form, many herbicides can cause skin irritation and eye damage. Therefore, always use protective eye wear when mixing herbicides and also wear neoprene or rubber gloves. Protective clothing includes long-sleeved shirts, long pants, and water- and chemical-resistant boots.

If you have cuts or abrasions on your skin, be sure they are properly bandaged before you apply the chemical. Always check your equipment for leaks and calibrate with water before application. Always stay upwind from the nozzle so the chemical is blown away from you. Bring out to the field with you wash water and detergent in clearly marked containers.

In case of a spill, wash the herbicide off immediately. Also, take a change of clothes with you to the application site so you can change if your clothes become contaminated. Before eating and or smoking, always wash your hands and face thoroughly. Always wash contaminated clothing separately from non-contaminated items.

Clean and thoroughly rinse your equipment after application. The best area for cleaning is on a wood rack or a concrete apron with a good sump. A second alternative is to carefully apply the rinse water on the site where the herbicide was applied.

When using herbicides, whether mixing, applying, or rinsing equipment after use, always be certain you are not contaminating someone's water supply. Several precautions can be taken to avoid this problem. Never apply any chemical near a well or other water source. When possible, use a nurse tank to mix only the herbicide needed for that day's work in the field. When filling from a well, use a separate pump with check valves to prevent back siphoning.

### Herbicide Disposal, Storage, and Transport

#### Disposal

After applying a herbicide, excess chemicals and empty containers should be disposed of or stored properly. Preventing pesticide surplus is the best way to minimize disposal problems. Before buying, check to make sure the herbicide is labeled for the usage you intend. Carefully estimate the amount of herbicide needed to complete the job and buy only what is needed. Wait until you have checked the site and are sure that the weather conditions will allow you to apply before you mix the herbicide into the tank. Also, mix only what is needed for that day.

Although steps can be taken to minimize any excess chemicals, empty containers must always be disposed of properly. After application, triple-rinse all empty containers. Pour rinsate back into the spray tank and not directly on the ground. It is also a good idea to punch holes in metal containers so they cannot be used again. Lastly, dispose of all containers in a sanitary landfill.

#### Storage

The proper storage of herbicides is essential to their safe use. Designate an area where only pesticides are to be stored. This area should be secured with a lock and each entrance prominently posted: Warning-Pesticides-Keep Out. Ideally, the storage area should be made of fire-resistant materials, including a concrete floor. The storage area should be cool, dry, and have an exhaust fan for proper ventilation.

Never store pesticides near food, feed, seed, or animals. Separate each type of chemical so herbicides, fungicides, and insecticides are stored separately. Also, each type of herbicide should be grouped separately. For example, group all containers of Garlon 4 together; then group containers of Roundup together. Always

store containers so labels can be clearly seen. It is also a good practice to store containers off the ground on wooden crates to avoid moisture problems. Keep an up-to-date inventory of all chemicals stored, including the date they were purchased, used, and placed into storage.

The storage area should be kept clean and orderly. Have an absorptive clay, activated charcoal, pet litter, or sawdust readily available at the storage site to help clean up any spills. Also, have a shovel, broom, and dustpan available. In case of fire, always keep a fire extinguisher in the storage area.

#### Transporting

The following precautions can be helpful in safely transporting herbicides:

- Check to make sure that containers are not damaged before loading or during transport.
- Take only the amount needed for that day with you.
- Do not transport herbicides in the passenger section of the vehicle. Do not transport herbicides in the trunk of passenger cars or in trucks with wooden beds. Use a trailer to transport herbicides when using a car.
- Use rope and straps to secure containers so they will not move during transport. During the trip, periodically check containers to be sure they have not shifted and spilled.

When at the application site, park the truck (or store the containers) in the shade. Direct sunlight can cause the containers to overheat, resulting in a pressure buildup. A tarp can be used to shade the containers as well.

## **Spill Procedures**

If an accident occurs during transport and a minor spill results, administer first aid to anyone who may have been injured. Confine the spill. If it starts to spread, dig a dike around the area to contain it. Always take a shovel with you when hauling herbicides. Use an absorbent or clay-like material, such as the ones mentioned in the storage section earlier, to soak up the herbicide. Dispose of the contaminated absorbent as you would excess herbicide.

If an accident results in a major spill (one that endangers people, property or the environment), administer first aid, then call the manufacturer. The number to call in case of an accident is prominently displayed on every label. The manufacturer will tell you which authorities to notify and what actions need to be taken.

## **Read the Label**

The label is your single most important source of information for safe herbicide use. The herbicide label contains comprehensive information and instructions that give the physical and chemical natures of the product, precautionary statements, and warning important for proper application. Additionally, detailed information is provided on the application, storage, and disposal of the product. The manufacturers address and phone number are also listed.

Information regarding the brand name, chemical name, type of formulation and EPA registration numbers are also included. This information is necessary for a physician to know in case of an accidental poisoning. The most important time spent in herbicide application is the time you take to read and understand the label.

Always read the label four times:

- 1. Before buying the herbicide
- 2. Before preparing the material for use

- 3. Before applying
- 4. Before storage or disposal.

Before purchasing a herbicide, read the label to ensure the chemical is properly labeled for your particular job, and that it is suitable for your equipment conditions, and site. Before preparing the chemical for use, read the label for any warning or precautionary statements, and use any protective equipment recommended.

The label tells you the amount of herbicide needed and its compatibility with other chemicals or carriers, such as diesel fuel. In addition, the label gives the waiting period for crops and animals, the rate and methods of application, and any restrictions in the use of the chemical.

Reading the label before storing or disposing of the product helps you determine where and how to store the chemical, as well as the proper methods for disposing of the containers or surplus product.

## Summary

Herbicides are effective tools that, when used properly, will accomplish many useful and necessary functions. However, those who use herbicides must educate themselves on the safe and proper ways to use the chemicals. The primary source of such information is the herbicide label. If, after reading the label, you are uncertain about something, stop and get help. There are numerous sources of information including your County Extension Office and the people who manufacture and distribute herbicides. When using herbicides, always remember: Read the label and when in doubt, stop and get assistance.

# Table 1. Toxicity categories.

Toxicity Category	Signal word	Oral LD <sub>50</sub> <sup>1</sup>	Dermal LD <sub>50</sub> <sup>1</sup>	Inhalation LD₅₀ <sup>1</sup>	Eye effects	Skin effects	Estimated amount needed (orally) to kill an average-sized person
		(mg/kg)	(mg/kg)	(mg/kg)			
Ι	Danger	<50	<200	<0.2	Corrosive; corneal opacity not reversible within 7 days	Corrosive	A taste (<7 drops) to a teaspoonful
II	Warning	50-500	200- 2,000	0.2-2.0	Corneal opacity reversible within 7 days; irritation persisting for 7 days	Severe irritation at 72 hours	A teaspoonful to an ounce
111	Caution	500- 5,000	2,000- 20,000	2.0-20	No corneal opacity; irritation reversible	Moderate irritation at 72 hours	An ounce to a pint

					within 7 days		
IV	Caution	>5,000	>20,000	>20	No irritation at 72 hours	Mild or slight irritation	Greater than a pint
<sup>1</sup> For the la	beled proc	duct.					
< less thar	ı						
> greater	than						
<u> </u>							

# Table 2: Oral toxicities of silvicultural herbicides and other products

Trade Name	Approximate LD <sub>50</sub> <sup>1</sup> (mg/kg)	Oral Toxicity Rating	Signal Word
AAtrex 80W	5,100	IV	Caution
AAtrex 4L	1,886	III	Caution
AAtrex Nine-0	1,600	III	Caution
Accord	5,400	IV	Caution
Acme Brush Killer	2,010	III	Caution
Arsenal Applicators Concentrate	>5,000	IV	Caution
Amizine	4,000	III	Caution
Banvel 520	1,707	III	Caution
Banvel 720	1,707	III	Caution
Banvel Herbicide	2,629	III	Caution
Banvel XG	5,300	IV	Caution
Garlon 4	2,460	III	Caution
Garlon 3A	2,830	III	Danger <sup>2</sup>
Krenite	24,000	IV	Caution
Krenite S	>5,000	IV	Warning <sup>2</sup>
Oust	>5,000	IV	Caution
Princep 80W	15,380	IV	Caution
Princep Caliper 90	>5,000	IV	Caution
Princep 4L	>5,000	IV	Caution
Pronone 10G	>5,000	IV	Caution
Tordon K	5,000-6,000	IV	Caution

Tordon 10K	5,000	III	Caution
Tordon 101 Mixture	3,000	III	Caution
Tordon 101R	8,000	IV	Warning <sup>2</sup>
Tordon RTU	8,000	IV	Warning <sup>2</sup>
Trans-Vert	1,400	III	Caution
Velpar L	7,080	IV	Danger <sup>2</sup>
Weedar 64	1,615	III	Caution
Weedone CB	2,140	III	Warning <sup>2</sup>
Weedone 170	2,000	III	Caution
Weedone 2,4D-P	2,200	III	Caution

# Other products for comparison

Trade Name	Approximate LD₅₀ <sup>1</sup> (mg/kg)	Oral Toxicity Rating	Signal Word
Table Salt	3,000	III	-
Baking Soda	3,500	III	-
Aspirin	1,240	III	-
Caffeine	200	II	-
Gasoline	150	II	-

<sup>1</sup> Unless otherwise indicated, values are for the formulated product.

<sup>2</sup> Severe eye irritants.

> greater than.

# Table 3: Estimated acute oral and dermal toxicity<sup>1</sup> (fluid ounces) of 18 chemicals for a 175 pound person

Chemical	Oral LD <sub>50</sub> <sup>2</sup> (ounces)	Toxicity Category	Dermal LD <sub>50</sub> (ounces)
Nicotine	0.02	Extremely	N/A3
Methyl Parathion (80%) <sup>4</sup>	0.03	Extremely	1.0
Caffeine	0.21	Extremely	N/A
Lindane (20%) <sup>4</sup>	2	Moderately	11.0
Sevin (50%)	2	Moderately	30.0
Aspirin	3.5	Moderately	N/A
2,4-D	3-7	Moderately	4.0
Malathion (91%)	4	Moderately	12.0
Table Salt	9	Moderately	N/A

Banvel	7	Moderately	6.0
Banvel CST	14	Slightly	6.0
Garlon	7	Moderately	11.0
Tordon 101 <sup>4</sup>	8	Moderately	7.0
Tordon 101R	18	Slightly	11.0
Oust	14	Slightly	6.0
Pronone 10G	14	Slightly	N/A
Accord	15	Slightly	14.0
Velpar L	20	Slightly	15.0

<sup>1</sup> The estimated toxicity for the pesticide is based on the formulated product (as in the container before any additional mixing)

<sup>2</sup> Most  $LD_{50}$ 's are expressed as a range reflecting experimental conditions, type carrier, test animals, and preciseness of the tests. These estimates fall within the range and are only projections based on animal tests.

<sup>3</sup> N/A indicates nonapplicable

<sup>4</sup> Restricted-use pesticides.

The information given in this publication is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement implied.

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#### Publication 1874

Extension Service of Mississippi State University, cooperating with <u>U.S. Department of Agriculture</u>. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. Ronald A. Brown, Director

rev. (500-08-00)

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# **FOREST HERBICIDES**

# Diagnosing Herbicide Injury

# **UF** UNIVERSITY of FLORIDA IFAS Extension

# **Diagnosing Herbicide Injury - 2007<sup>1</sup>**

J.A. Ferrell, W. M. Stall, and G.E. MacDonald, <sup>2</sup>

About 100-110 chemicals comprise the active ingredients in the several hundred herbicide formulations now available for weed control in Florida. All of these compounds are thoroughly and extensively evaluated for crop tolerance, persistence in soils, selectivity, toxicological and environmental effects before the product is marketed for use. A chemical is of little use if it injures the target crop or persists in soils for very long periods of time in areas where extensive crop rotation schemes are practiced. Some herbicides such as those used in citrus are persistant for longer periods than do most chemicals used in agronomic or vegetable crops. Herbicides with extended soil residual periods are extremely valuable in areas where crop rotation is not important (i.e., citrus groves) or in areas where total vegetative control is desired (i.e., fence rows and around out buildings).

Most herbicides, when applied according to label directions, do not exhibit soil carry-over problems. The compounds that may have some carry-over characteristic generally will provide the user with a warning statement on the label. Herbicide injury does not only occur with soil-applied weed control compounds; many times herbicide injury may be exhibited on susceptible species due to off-site drift of spray material or vaporization. Problems with drift or vaporization have led to the Florida Organo-Auxin Herbicide Rule (see fact sheet SS-AGR-12 *Florida's Organo-Auxin Herbicide Rule*). This rule limits the application of several organo-auxin herbicides with aerial equipment in certain parts of the state and requires specific record keeping and wind speed determinations to be completed before this group of compounds can be applied.

Although isolated cases of herbicide injury may occur when labeled practices are adhered to, most herbicide injury occurs whenever certain errors in rate calculations, spray calibration, chemical selection, drift of sprays or when unusual soil or climatic conditions exist. When herbicide injury does occur, diagnosis is often difficult and somewhat confusing since the symptoms of injury may vary depending on the herbicide, plant species, environment, time or method of application, and stage of growth of the plant. In addition, nutritional problems, physiological disorders, diseases, nematodes, and insects may often cause similar injury to certain herbicide families.

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 The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication does not signify our approval to the exclusion of other products of suitable composition.

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<sup>1.</sup> This document is SS-AGR-15, one of a series of the Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Revised January 2005. Reviewed: November 2006. Please visit the EDIS Website at http://edis.ifas.ufl.edu.

A fairly good reference publication entitled *Herbicide Injury Symptoms and Diagnosis*, 1978, from the North Carolina State University, shows several herbicide injury symptoms but many times there may not be a picture of injury caused by the particular herbicide with which you are concerned. Many herbicides can be classified into certain families of chemistry which often exhibit similar injury symptoms. Even if you are not familiar with a particular herbicide, you may be able to recognize the symptoms by knowing general injury characteristics that a herbicide exhibits.

The following information is intended to help interested parties classify herbicides by families (See Table 26). General symptoms of herbicide injury are given and may be of help in eliminating certain herbicide families as the probable cause of injury.

## Herbicide Families and Injury Symptoms

#### Family: Amides

Mode of Action and Symptoms: These herbicides are selective preemergence or preplant materials that exhibit little if any translocation within the plant. Amides generally interfere with cell division and inhibit growth in the terminal leaves, shoots, or root meristems. Rainfall or mechanical incorporation is needed for maximum activity. Amides are rapidly degraded upon entry into the soil therefore leaching is minimal. Symptoms vary but are usually associated with root growth inhibition, malformed shoots or leaves, and stunted growth. Within this group, naptalam has the unique property of altering the geotropic response of plants, often resulting in roots growing upward out of the soil. As a general rule, amides control grasses better than broadleaves. See Table 1.

#### Table 1. Herbicides (Amides)

Trade Name	Common Name
Devrinol	napropamide
Kerb	pronamide
Stam	propanil
Gallery	isoxaben

#### Family: Amino Acid Derivatives

Mode of Action and Symptoms: Amino acid derivatives (Table 2) are translocated foliar-applied herbicides which interfere with aromatic amino acid synthesis. Treated plants stop growing, wilt, become chlorotic and then necrotic. This is a slow process and may require 10 to 14 days. Trees and shrubs treated with sublethal doses may initiate new leaves which are twisted, curled, or generally malformed. As a group, these compounds are more effective on grasses than broadleaf weeds but they are generally considered to be nonselective foliar herbicides with little or no soil activity. Penetration is fairly slow so rainfall too soon after application may reduce control.

<b>Fable 2.</b> Herbicides (Amino Acid Derivatives)	)
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Trade Name	Common Name
Liberty, Finale, Ignite,	glufosinate
Rely	
Roundup WeatherMax	glyphosate
Rodeo,	
Glyphos,	
Glyphomax,	
Glyphomax Plus	
Glypro, Glypro Plus,	
Glyphosate,	
Glyphosate Original,	
Touchdown	
Touchdown 5	trimesium salt of
	glyphosate

#### Family: Aryl triazinone

Mode of Action and Symptoms: Sulfentrazone disrupts cell membranes. It is believed that they work similar to the diphenyl ether herbicides which inhibit protoporphyrinogen oxidase (PROTOX) which leads to peroxidation causing the toxic buildup of singlet oxygens. Symptoms include necrosis and death upon exposure to light. Foliar contact with sulfentrazone causes rapid desiccation and necrosis of exposed plant tissue. See Table 3.

Table 3. Herbici	es (Aryl triazinone)
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Trade Name	Common Name
Spartan	sulfentrazone
Aim	carfentrazone

#### Family: Aryloxyphenoxy propionate

Mode of Action and Symptoms: Aryloxyphenoxy propionates exhibit postemergence activity on grasses at very low rates. They inhibit acetyl-CoA carboxylase (ACCase), an enzyme required for fatty acid synthesis. This prevents new cell growth. As a general rule, these compounds can be applied in broadleaf crops with little or no injury. Some compounds within this group express soil activity when applied at higher rates. As a group, these compounds are readily translocated from the point of uptake to meristematic activity areas. Grasses damaged usually show symptoms within seven days after application. An initial chlorotic yellowing, and in some cases a reddening of the leaf tissue, is eventually followed by complete chlorosis and necrosis. They are 'rain fast' within one hour of application. Weather appears to have very little effect on their activity as long as susceptible plants are not stressed. Antagonism and reduced control have been noted from tank mixing this group with other herbicides. See Table 4.

Table 4. Herbicides	(Aryloxyphenoxy	propionates)
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Trade Name	Common Name
Assure II Fusilade DX, Fusilade II Hoelon Whip, Acclaim	quizalofop-P fluazifop-P diclofop-methyl fenoxaprop-ethyl

#### **Family: Benzoates**

Mode of Action and Symptoms: Pyrithiobac (Table 5) inhibits acetolactate synthase (ALS), also called acetohydroxylated synthase (AHAS), a key enzyme in the biosynthesis of the branched-chain amino acids isoleucine, leucine, and valine. Plant death results from events occurring in response to ALS inhibition, but the actual sequence of phytotoxic processes is unclear. Injury symptoms vary by species and generally include chlorosis and necrosis of the meristematic region followed by general foliar chlorosis, necrosis, and plant death. Table 5. Benzoates

Trade Name	Common Name
Staple	pyrithiobac

#### Family: Benzoic Acids

Mode of Action and Symptoms: Benzoic herbicides (Table 6) were first tested in the early 1940s and have auxin-like (growth hormone) properties which result in excessive cellular growth. Benzoics move from leaves to the terminal meristems of leaf, shoot, and root, and can also move in the transpiration stream. In some cases, benzoic herbicides applied to plant foliage may come in contact with the soil and then be absorbed by plant roots as well. Dicamba, especially when used for turf weed control, may be moved into surrounding susceptible ornamental roots and can be translocated to the leaves, thus causing herbicide injury. Secondary effects of these herbicides are thought to interfere with RNA and protein synthesis. Symptoms are much like the phenoxys but often with more epinasty (leaf cupping).

Table 6. Ber	nzoic Acids
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Trade Name	Common Name
Vanquish	dicamba
Clarity, Banvel	

#### Family: Benzothiadiazoles

Mode of Action and Symptoms: Presently only one commercial herbicide fits in this group, but it is of significant importance. Benzothiadiazoles (Table 7 ) kill broadleaf weeds and some nutsedges by inhibiting photosynthesis which inhibits chlorophyll from changing light energy to plant food. This class exhibits very little translocation, therefore it can only be used postemergence and requires thorough coverage of susceptible plants to be effective. Common symptoms include chlorotic yellowing followed by total necrosis. A transient leaf bronzing is sometimes evident on snapbeans and soybeans.

#### Table 7. Herbicides (Benzothiadiazoles)

Trade Name	Common Name
Basagran	bentazon

#### Family: Bipyridyllums

Mode of Action and Symptoms: Bipyridiliums (Table 8) were first discovered in the mid-1950s. They are primarily contact herbicides when applied to green plant tissue. They inhibit photosynthesis which causes total disruption of cell membranes. Very little translocation occurs so thorough coverage is essential for greatest activity. Herbicide molecules carry a strong positive charge and are tightly bound to soil colloidal matter upon contact, resulting in no soil activity. They require the presence of sunlight for activity and plants treated on cloudy days or in the dark will not express symptoms until placed in the light. Besides herbicide uses, the group can also be used as pre-harvest desiccants. Symptoms include total rapid plant necrosis in areas covered with spray particles. It is possible to have one-half of a leaf totally desiccated while the other half may still be green. Herbicides in this family may remain active up to 72 hours when sprayed on plastic mulch. When plants are exposed to an aerosol mist, first symptoms are virus-like, and small necrotic areas will later be evident.

#### Table 8. Herbicides (Bipyridiliums)

Trade Name	Common Name
Reward, Diquat	diquat
Gramoxone Extra, Gramoxone MAX, Boa	paraquat

#### **Family: Carbamates**

Mode of Action and Symptoms: Development of this family (Table 9) closely followed 2,4-D and they are often referred to as carbamates. A few materials in this group are applied preemergence, but most of the newer generation in this group are applied postemergence. Somewhat like the chloroacetamides, the carbamates are meristematic inhibitors which have the ability to translocate. Those in the group that are soil-applied can be taken up by seeds, shoots, and to a lesser degree, roots. Symptoms of injury include inhibition of root growth, stunted plants, and, when postemergence applied, yellowing and chlorosis.

#### Table 9. Herbicides Carbamates

Trade Name	Common Name
Asulox	asulam

#### Family: Chloroacetamides

Mode of Action and Symptoms: Chloroacetamides (Table 10) are thought to disrupt synthesis of very long chain fatty acid synthesis. Chloroacetamides do have the ability to translocate within the transpiration stream from roots to leaves. Chloroacetamides damage on corn may appear as twisted malformed leaves or leafing out underground. Soybean injury appears typically as heart-shaped leaves. Leaf crinkling or cupping and twisting has been seen in several vegetable species. If injury is not severe, plants will recover from symptoms. Chloracetamides will not control plants that have already emerged from the soil.

#### Table 10. Herbicides (Chloroacetamides)

Trade Name	Common Name
Pennant, Dual II Magnum, Dual Magnum, Cinch Me-Too-Lachlor, Stalwart Ramrod	S-metolachlor metolachlor propachlor

#### Family: Cyclohexanediones

Mode of Action and Symptoms: Cyclohexanediones inhibit acetyl CoA carboxylase (ACCase), the enzyme catalazing the first committed step in fatty acid synthesis. This blocks the production of phospholipids used in building new membranes required for cell growth. Growth stops soon after application. Leaf chlorosis and eventually necrosis develop within 1-3 wk of application. Leaves eventually turn reddish-purple. See Table 11.

Table 11. Herbicides	(Cyclohexanediones)
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Trade Name	Common Name
Poast, Poast Plus,	sethoxydim
Vantage Select, Envoy	clethodim

#### Family: Dinitroanilines

Mode of Action and Symptoms: Most dinitroanilines (Table 12) require soil incorporation to avoid volatilization and/or photodecomposition, which could render them useless as herbicides. Several within this group, i.e., Surflan, Prowl, and Sonalan, are less susceptible to volatility and photodecomposition and may be applied directly to the soil surface. Dinitroanilines are miotic inhibitors that prevent root growth. Shoot growth may also be inhibited if the herbicide is absorbed by the shoot or may be indirectly affected by reduced root growth. Damage symptoms are generally associated with inhibition of lateral root growth resulting in short, stubby, and/or swelled roots. Carry-over injury to corn or other grass crops typically appears as root pruning, short thickened roots, and red-tinged leaf margins. Injury is often in a distinct pattern due to localized concentrations caused by application or incorporation problems. Stunting and swollen hypocotyls are early injury symptoms in many vegetable crops, specifically cucurbits. Since dinitroanilines act at the root tip, control of emerged plants is generally not observed.

Table 12. Herbicides (	Dinitroanilines)
------------------------	------------------

Trade Name	Common Name
Balan	benefin
Prowl, Pendimax 3.3	pendimethalin
Sonalan	ethalfluralin
Surflan	oryzalin
Treflan	trifluralin

#### Family: Diphenylethers

Mode of Action and Symptoms: Diphenylethers (Table 13) are believed to be inhibitors of protoporphyrinogen oxidase (Protox), an enzyme important in the synthesis of chlorophyll and heme biosynthesis. Lipids and proteins are attacked and oxidized, resulting in a loss of chlorophyll and carotenoids and in leaky cell membranes which causes cells to rapidly disintegrate. Membrane destruction is due to creation of free oxygen radicals. Translocation within the plant is limited, so adequate spray coverage is essential for control. Broadleaf weeds are affected more than grasses. Activity is usually enhanced by higher volume sprays and the addition of surfactants. Symptoms are generally expressed on the foliage as a contact burn with "bronzing" or necrosis. Goal, among others, has a good deal of preemergence activity. Symptoms include crinkling and cupping, most times downward, and with interveinal chlorosis at higher rates.

able 13. Herbio	ides (Diphen	ylethers)
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Trade Name	Common Name
Ultra Blazer	acifluorfen
Cobra	lactofen
Goal	oxyfluorfen

#### Family: Imidazolinones

Mode of Action and Symptoms: Imidazolinones (Table 14) are meristematic inhibitors which interfere with amino acid synthesis. This group of herbicides has the same site of action as the sulfonylureas. Both groups inhibit acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) which is involved with the production of the essential amino acids leucine, isoleucine, and valine. Imidazolinones have both foliar and soil activity and vary greatly in soil persistence. As a general rule, they are more active on broadleaf weeds than grasses and are extremely low in mammalian toxicity. Symptoms include an immediate cessation of growth in susceptible species accompanied by a shortening of internodes and a general compactness of plant growth followed by interveinal chlorosis and eventually necrosis. Purpling of leaves and root pruning may also be observed. Imidazolinones are fairly slow in acting with symptoms lingering three to four weeks or longer in affected plants.

Table 14. Herbicides	(Imidazolinones)
----------------------	------------------

Trade Name	Common Name
Arsenal, Chopper	imazapyr
Scepter, Image	imazaquin
Pursuit, Pursuit Plus	imazethapyr
Cadre, Plateau	imazapic
Raptor	imazamox
Assert	imazamethabenz

#### Family: N-Phenylphthalimide

Mode of Action and Symptoms: The mechanism of action of N-Phenylphthalimides (Table 15) is thought to be similar to that of the diphenylether herbicides. They are believed to be inhibitors of protoporphyrinogen oxidase (Protox), an enzyme important in the synthesis of chlorophyll and heme biosynthesis. Lipids and proteins are attacked and oxidized, resulting in a loss of chlorophyll and carotenoids and in leaky cell membranes which causes cells to rapidly disintegrate. Symptoms of flumiclorac may appear within 1 day under bright sunlight and can include wilting and bleaching. Leaves then become brown, desiccated, and necrotic. Sensitive plants emerging from soils treated with the herbicide flumioxazin become necrotic and die shortly after exposure to sunlight. Foliar contact with flumioxazin causes rapid desiccation and necrosis of exposed plant tissues.

#### Table 15. N-Phenylphtalimide

Trade Names	Common Name
Resource	flumiclorac
Valor	flumioxazin

#### Family: Phthalic Acids

Mode of Action and Symptoms: The exact mode of action of the phthalic acids (Table 16) is unknown. **DCPA** may inhibit mitosis by affecting cell wall formation and microtubule arrangement of both root and shoot tips. **Endothall** inhibits messenger RNA, and thus limits protein synthesis. It decreases the rate of respiration and lipid metabolism and interferes with normal cell division. Under both terrestrial and aquatic conditions, **endothall** symptoms include defoliation and brown desiccated tissue.

Trade Name	Common Name
dacthal	DCPA
several	enthothall

#### **Family: Nitriles**

Mode of Action and Symptoms: Two common compounds fit in this category but the two exhibit different symptoms. Dichlobenil (Table 17) is usually applied preemergence to the weeds and acts primarily on the growing points of shoots and roots and usually results in swelling or collapse of stems, roots, and leaf petioles. In certain cases, marginal leaf chlorosis also may be observed. Dichlobenil has activity on germinating plants as well as shallow-rooted weeds which may have already germinated before application. Bromoxynil is the second common member of this family and is usually applied postemergence. It exhibits contact type activity on broadleaf weeds with little translocation. Bromoxynil acts as a photosynthetic inhibitor and results in rapid desiccation and necrosis of treated plants. Bromoxynil is registered in grain crops and seedling turf, and BXN cotton for postemergence broadleaf control.

#### Table 17. Herbicides (Nitriles)

Trade Name	Common Name
Buctril	bromoxynil
Casoron	dichlobenil

#### Family: Organic Arsenicals

Mode of Action and Symptoms: Organic arsenicals (Table 18) are an old family of herbicides generally thought to inhibit malic enzyme. This leads to a build up of malic acid and eventually cellular lysis. They are used in cotton and the turf industry as postemergence foliar compounds to control grasses and some broadleaf weeds. Symptoms include leaf chlorosis followed by necrosis. Leaves may exhibit a slight purple color before total necrosis occurs.

Trade Name	Common Name
(several trades)	MSMA
(several trades)	DSMA

#### Family: Phenoxys

Mode of Action and Symptoms: Phenoxys (Table 19) are a relatively old group of compounds that date back to the 1940s. The first herbicide of this group to be introduced was 2,4-D. Herbicides in this family have auxin-like properties which result in excessive cellular growth with symptoms appearing as abnormal growth of the plant. The first symptom of injury is usually stem twisting followed by deformities in terminal tissue which may lead to cupping or strapping of the leaves and total bending and twisting of the stems. Phenoxys are usually foliarly applied and are translocated within the food stream of plants. In some cases, phenoxys applied at higher rates may also exhibit soil activity on emerging broadleaf seedlings.

#### Table 19. Herbicides (Phenoxys)

Trade Name	Common Name
Several	2,4-DB
Several	2,4-D

#### Family: Substituted ureas

Mode of Action and Symptoms: These herbicides (Table 20) are classic photosynthetic inhibitor herbicides which cause disruption of cell membranes. They are relatively nonselective at high rates. Most are applied to the soil although a few have foliar activity as well. Substituted urea damage symptoms are generally interveinal chlorosis followed by necrosis. Root growth is not inhibited. Injury from this family of compounds is often difficult to separate from injury caused by compounds within the triazine family. Table 20. Herbicides (Substituted ureas)

Trade Name	Common Name
Cotoran, Meturon	fluometuron
Spike	tebuthiuron
Karmex, Direx	diuron
Lorox	linuron

#### Family: Picolinic Acids

Mode of Action and Symptoms: Herbicides in this group (Table 21) are very active auxin-like compounds which have excellent activity on broadleaf weeds. They have been termed "super-phenoxys" by some researchers because they exhibit similar damage symptoms at much lower use rates than phenoxys. Picolinic acids are hormone disruptors which translocate in both the phloem and xylem. They are excellent for the control of perennial broadleaf weeds and brush. Unlike the phenoxys, this group has significant soil activity. Currently, there are no picolinic acid

Table 21. Herbicides	(Picolinic Acids)
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Trade Name	Common Name
Garlon, Remedy	triclopyr
Stinger, Transline	clopyralid

#### Family: Pyridines and Pyridazinones

Mode of Action and Symptoms: This herbicide group (Table 22) is active on both grasses and broadleaf weeds and at higher rates may exhibit extended soil activity. These compounds are normally applied preemergence to weeds and are translocated throughout susceptible plants. Pyridazinones and pyridinones are quite compatible with a wide range of PPI, PRE, and POST applied herbicides. These compounds are carotenoid inhibitors and cause bleaching of green tissue. Norflurazon exhibits interveinal bleaching while clomazone exhibits intraveinal bleaching. Lethal doses will first appear a chlorotic white and then progress to total necrosis. Sub-lethal doses may leave plants in the white stage for an extended period of time.

Table 22. Herbicides	(Pyridines and	Pyridazinones)
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Trade Name	Common Name
Solicam, Zorial	norflurazon
Sonar	fluridone
Dimension	dithiopyr

#### Family: Sulfonylureas

Mode of Action and Symptoms: Sulfonylureas were (Table 23) first reported in the early 1970s. Sulfonylureas are meristemic inhibitors with both foliar and soil activity. Sulfonylureas inhibit acetolactate synthase (ALS), a key enzyme in the production of amino acids leucine, isoleucine, and valine for plant growth (same mode of action as imidazolinones). Sulfonylureas are extremely bioactive with application rates of less than one-half ounce per acre in most cases. In some areas of the country, sulfonylureas persist in the soil long enough to cause damage to sensitive rotational crops. Generally, soils higher in pH and O.M. in cooler climates have shown the most recropping problems. Symptoms of injury include an immediate cessation of growth, shortened internodes, chlorotic yellowing, and a gradual necrosis of leaf and stem tissue. Compounds within this family have extremely low acute and chronic mammalian toxicities and are very safe in the environment.

Table 23. Herbicides (Sulfonylureas)

Trade Name	Common Name
Ally, Escort	metsulfuron-methyl
Classic	chlorimuron-ethyl
Glean, Telar	chlorsulfuron
Oust	sulfometuron-methyl
Sempra, Permit,	halosulfuron
Manage	
Matrix	rimsulfuron
Accent	nicosulfuron
Londax	bensulfuron
Peak	prosulfuron

#### Family: Thiocarbamates

Mode of Action and Symptoms: Thiocarbamates (Table 24) also act as a type of meristematic inhibitor but have several different characteristics from previously discussed families. Thiocarbamates are relatively volatile and all thiocarbamates are soil incorporated to reduce surface loss. These herbicides inhibit both cell division and elongation, fatty acid and lipid biosynthesis, proteins, and also may alter plant hormone distribution within plants. Uptake occurs through seeds, shoots, or roots. Shoots are more affected than roots. Thiocarbamates act primarily by inhibiting growth of shoots of emerging seedlings. The major symptom in grasses is the failure of the leaves to emerge properly from the coleoptile. When this occurs, the growing leaf often forms a loop called "buggy whipping." In broadleaf plants, the seedling leaves often stick together or may be cupped or crinkled with necrotic edges. Thiocarbamates generally display a very strong pungent odor during application and for a period of time in the field thereafter.

Trade Name	Common Name
Bolero	thiobencarb
Eptam	EPTC
Sutan +	butylate
Tillam	pebulate

#### Family: Triazines

Mode of Action and Symptoms: Triazines (Table 25) were first tested for weed control in the early 1950s and are used primarily as preemergence soil-applied treatments. Some products in this family are also used widely for postemergence applications. Triazines are photosynthetic inhibitors and symptoms are generally leaf chlorosis followed by necrosis. Generally, outer leaf margins of lower leaves are most affected and if the entire leaf turns yellow some of the veins may remain somewhat green. Soil-applied triazines are taken up by the roots and move within the transpiration stream of the plant. Triazines applied postemergence exhibit an initial contact burn and are very effective on small broadleaves and some weedy grasses.
#### Table 25. Herbicides (Triazines)

Trade Name	Common Name
AAtrex	atrazine
Caparol	prometryn
Evik	ametryn
Sencor	metribuzin
Pramitol	prometon
Princep	simazine
Velpar	hexazinone

#### Family: Triazolopyrimidines

Mode of Action and Symptoms: The triazolopyrimidines (Table 26) inhibit acetolactate synthase (ALS), also called acetohydroxylated synthase (AHAS), a key enzyme in the biosynthesis of the branched-chain amino acids isoleucine, leucine, and valine. Plant death results from events occurring in response to ALS inhibition, but the actual sequence of phytotoxic processes is unclear. Most sensitive weed species are killed before emergence following soil applications of the triazolopyrimidines, but weeds may die after emergence under some conditions. Emerged sensitive species exhibit stunting, growing point effects, interveinal discoloration (purpling) and necrosis within 1-3 weeks. Postemergence symptoms following chloransulam applications usually occur within 3-10 days. These symptoms include stunting, growing point inhibition, and chlorosis followed by necrosis. Complete death of susceptible weeds occurs within 2-3 weeks.

Table 26. Triazolopyrimidines

Trade Name	Common Name
First Rate	chloransulam
Python	flumethsulam
Strongarm	diclosulam

#### Family: Uracils

Mode of Action and Symptoms: Uracils (Table 27) are also photosynthetic inhibitors which, like the triazines and phenylureas, block the Hill reaction. These herbicides are usually soil-applied and move

within the transpiration stream in plants. Uracil herbicides are used extensively in citrus and probably more total pounds of this family are used in Florida than any of the other herbicide families. Citrus is very tolerant to the uracils and, at rates of 3 to 5 pounds per application, good residual weed control can be obtained. Being photosynthetic inhibitors, symptoms of this group are generally leaf chlorosis followed by necrosis. Chlorosis is often first noticed in the leaf veins and later spreads to the interveinal areas.

Table 27. Herbicides	(Uracils)
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Trade Name	Common Name
Hyvar X, Hyvar X-L	bromacil
Sinbar	terbacil

#### **Other Herbicides - No Family**

Mode of Action and Symptoms: Bensulide (Table 29) inhibits root elongation or partially inhibits cell division (mitosis). The exact mechanism of action is not known. The mechanism of action of clomazone (Table 29) is not completely understood, but apparently inhibits an enzyme in the isoprenoid pathway after farnesyl pyrophosphate. Susceptible seedlings usually emerge from soils treated with clomazone, but are bleached white and become necrotic after several days. Suscpetible species in later growth stages may exhibit foliar bleaching when treated postemergence or when exposed to clomazone vapor, drifting from nearby treated areas. The mechanism of action for quinclorac (Table 29) is not completely understood. In susceptible broadleafs, quinclorac action appears to be similar to that of native auxin (IAA). In susceptible grasses, however, quinclorac may inhibit an enzyme associated with cellulose biosynthesis. Its effect on grasses may also be due to increases in ethylene and cyanide production. In certain susceptible broadleaf plants, symptoms of quinclorac may resemble those of auxin-type herbicides, including mild epinastic bending of stems and petioles, stem swelling (particularly at nodes) and elongation, and leaf cupping or curling. This is followed by growth inhibition, chlorosis at the growing points, wilting, and necrosis. In susceptible grasses, rapid chlorosis begins in a band at the zone of elongation in newly

expanding leaves, followed by general foliar chlorosis and necrosis.

#### Table 28. Unclassified

Trade Name	Common Trade
Prograss	ethofumesate

#### Table 29. None

Trade Name	Common Name
several	bensulide
Command	clomazone
Drive	quinclorac

Herbicide	Family	Herbicide	Family
A		n	
AAtrex	triazine	Accent	sulfonylurea
Acclaim	aryloxyphenoxy propionate	Aim	aryl triazinone
acetochlor + safener	chloroacetamide	acifluorfen	diphenylether
Alanap	amide	Ally	suflonylurea
Ally	sulfonylurea	ametryn	triazine
Arsenal	imidazolinone	Assert	imidazolinone
Assure II	aryloxyphenoxy propionate	asulam	carbamate
Asulox	carbamate	atrazine	triazine
Authority	aryl triazinone		
В			
Balan	dinitroaniline	Banvel	benzoic acid
Basagran	benzothiadiazole	Beacon	sulfonylurea
benefin	dinitroaniline	bensulide	none
bentazon	benzothiadiazole	Bolero	thiocarbamate
bromacil	uracil	bromoxynil	nitrile
Buctril	nitrile	Butoxone	phenoxy
butylate	thiocarbamate	Butyrac	phenoxy
Ultra Blazer	diphenylether	Воа	bipyridilium
С		я <u> </u>	

Herbicide	Family	Herbicide	Family
Cadre	imidazolinone	Caparol	triazine
Casoron	nitrile	chlorimuron-ethyl	sulfonylurea
chlorsulfuron	sulfonylurea	Chopper	imidazolinone
chloransulam	triazolopyrimidine	Classic	sulfonylurea
clethodim	cyclohexanedione	clomazone	pyridazinone, pyridinone
clopyralid	picolinic acid	Cobra	diphenylether
Command	pyridazinone, pyridinone	Cotoran	substituted urea
Clarity	benzoic acid	cycloate	thiocarbamate
D	L		L
DCPA	phthalic acid	dacthal	phthalic acid
DSMA	organic arsenical	Dimension	pyridazinone
desmedipham	carbanilate, phenyl carbamate	Devrinol	amide
dicamba	benzoic acid	dichlobenil	nitrile
diclofop-methyl	aryloxyphenoxy propionate	diquat	bipyridilium
diuron	substituted urea	diclosulam	triazolopyrimidine
Dual Magnum	chloroacetamide	Dual II Magnum	chloroacetamide
Drive	none	2,4-D	phenoxy
2,4-DB	phenoxy		
E	L		l
Envoy	cyclohexanedione	endothall	phthalic acids
EPTC	thiocarbamate	Eptam	thiocarbamate
Eradicane	thiocarbamate	ethalfluralin	dinitroaniline
Evik	triazine	Escort	sulfonylurea
ethofumesate	unclassified	1	
F	l	Л	Page 73 of 416

Herbicide	Family	Herbicide	Family
fenoxaprop-ethyl	aryloxyphenoxy propionate	Finale	amino acid derivative
fluazifop-P	aryloxyphenoxy propionate	fluometuron	substituted urea
fluridone	pyridazinone, pyridinone	fomesafen	diphenyl ether
Fusilade DX	aryloxyphenoxy propionate	Fusilade II	aryloxyphenoxy propionate
flumioxazin	N-phenylphtalimide	flumichlorac	N-phenylphtalimide
flumethsulam	triazolopyrimidine	First Rate	triazolopyrimidines
G			
Garlon	picolinic acid	Glean	sulfonylurea
glufosinate	amino acid derivative	glyphosate	amino acid derivative
Goal	diphenylether	Gramoxone Extra	bipyridilium
Gramoxone Max	bipyridilium	Gallery	amide
н			
halosulfuron	sulfonylurea	haloxyfop-methyl	aryloxyphenoxy propionate
Harmony Extra	sulfonylurea	hexazinone	triazine
Hoelon	aryloxyphenoxy propionate	Hyvar X, Hyvar XL	uracil
I			
Ignite	amino acid derivative	imazamethabenz	imidiazolinone
imazamox	imidiazolinone	imazapic	imidiazolinone
imazapyr	imidazolinone	imazaquin	imidazolinone
imazethapyr	imidazolinone	isopropalin	dinitroaniline
isoxaben	amide	1	
к			
Karmex	substituted urea	Kerb	amide
L	A	<b>x</b>	
lactofen	diphenylether	Liberty	amino acid derivative

Herbicide	Family	Herbicide	Family
linuron	sub. urea	Lorox	substituted urea
Londax	sulfonylurea		
м			
МСРА	phenoxy	МСРВ	phenoxy
МСРР	phenoxy	MSMA	organic arsenical
Matrix	sulfonylurea	mecoprop	phenoxy
metribuzin	triazine	metsulfuron-methyl	sulfonylurea
Milestone	triazolone	Milogard	triazine
Meturon	substituted urea	molinate	thiocarbamate
S-metolachlor	chloroacetamide	Manage	sulfonylurea
N			
napropamide	amide	naptalam	amide
nicosulfuron	sulfonylurea	norflurazon	pyridazinone, pyridinone
0			
Ordram	thiocarbamate	oryzalin	dinitroaniline
Oust	sulfonylurea	oxyfluorfen	diphenylether
Р		n	
Paarlan	dinitroaniline	paraquat	bipyridilium
pebulate	thiocarbamates	pendimethalin	dinitroaniline
Peak	sulfonylurea	Poast, Poast Plus	cyclohexanedione
Pramitol	triazine	Prefar	amide
primisulfuron	sufonylurea	Princep	triazine
prometon	triazine	prometryn	triazine
pronamide	amide	propachlor	chloroacetamide

Herbicide	Family	Herbicide	Family
propanil	amide	propazine	triazine
Prowl	dinitroaniline	Pursuit, Pursuit Plus	imidiazolinone
Permit	halosulfuron	Plateau	imidiazolinone
Prograss	unclassified	prodiamine	dinitroaniline
Pennant	chloroacetamide	prosulfuron	sulfonylurea
Pendimax 3.3	dinitroaniline	pyrithiobac	
Python	triazolopyrimidine		
Q			
quizalofop-P	arylxoyphenoxy propionate	quinclorac	none
R	·	a	
Ramrod	chloroacetamide	Raptor	imidazolinone
Reclaim	pyridinoxy, picolinic acid	Reflex	diphenyl ether
Remedy	picolinic acid	Reward	bipyridilium
Resource	N-phenylphtalimide	Ro-Neet	thiocarbamate
Rhomene	phenoxy	rimsulfuron	sulfonylurea
Rodeo	amino acid derivative	Roundup Ultra Max	amino acid derivative
Roundup Ultra	amino acid derivative		
S	·		
Scepter	imidazolinone	Select	cyclohexanedione
Sempra	sulfonylurea	Sencor	triazine
sethoxydim	cyclohexanedione	siduron	phenylurea, substituted urea
simazine	triazine	Sinbar	uracil
Sodium TCA	chlorinated aliphatic acid	Solicam	pyridazinone, pyridinone
Sonalan	dinitroaniline	Sonar	pyridazinone, pyridinone
Spartan	aryl triazinone	Spike	phenylurea, substituted urea

Herbicide	Family	Herbicide	Family
Stam	amide	Strongarm	triazolopyrimidine
Stinger	picolinic acid	sulfentrazone	aryl triazinone
sulfentrazone + chlorimuron-ethyl	aryl triazinone	sulfometuron-methyl	sulfonylurea
sulfosate	amino acid derivative	Surflan	dinitroaniline
Surpass+	acetochlor + safener	Sutan+	thiocarbamate
Staple	benzoate		
т			
tebuthiuron	substituted urea	terbacil	uracil
thiobencarb	thiocarbamate	Tillam	thiocarbamate
Telar	chlorsulfuron	Transline	picolinic acid
Touchdown	amino acid derivative	Treflan	dinitroaniline
tribenuron +thifensulfuron	sulfonylurea	triclopyr	picolinic acid
trifluralin	dinitroaniline	Triflusulfuron	sulfonylurea
Tupersan	phenylurea, substituted urea	Touchdown 5	amino acid derivative
U	·	л	
Upbeet	sulfonylurea		
V		n	
Valor	N-phenylphtalimide	Vanquish	benzoic acid
Velpar	triazine	Verdict	aryloxyphenoxy propionate
Vantage	cyclohexanediones		
W			
Whip	aryloxyphenoxy propionate		
Z			
Zorial	pyridazinone, pyridinone		

**Great Trinity Forest Management Plan** 

# **FOREST HERBICIDES**

### Sprayer Calibration Guide

Once a sprayer is calibrated, you will then be able to mix the herbicide in the spray tank properly. For example, if your recommended herbicide rate is 1 quart per acre and your sprayer is calibrated to deliver 15 gpa, you would then add 1 quart of herbicide for every 15 gallons of spray in the tank.

#### Keep these points in mind

- To properly calibrate a herbicide sprayer, you must be able to accurately set and maintain speed and pressure.
- Make sure all the nozzles are in good condition and of the proper type.
- Never use a knife or other hard object to clean or clear clogged nozzles.
- Nozzles wear. Recalibrate sprayers often and replace nozzles when they become worn.
- Most nozzles used for broadcast herbicide applications on rangeland are designed to operate between 20 and 30 psi.
- In general, a minimum total spray volume of 10 gpa is recommended when using ground broadcast equipment.
- A ground speed of 3 to 4 mph is generally optimum when applying a broadcast herbicide spray to rangeland.
- Broadcast sprays can drift, especially when boomless nozzles are used.
- Read and follow the herbicide label directions.

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Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Interim Director, Texas Cooperative Extension, The Texas A&M University System.

9.5M, New





# Sprayer Calibration Guide

Safe and effective four-step method to calibrate herbicide sprays

### Weed Treatment Series

Allan McGinty, Extension Range Specialist, San Angelo C. Wayne Hanselka, Extension Range Specialist, Corpus Christi Robert K. Lyons, Extension Range Specialist, Uvalde Charles R. Hart, Extension Range Specialist, Fort Stockton J. F. Cadenhead, Extension Range Specialist, Vernon The Texas A&M University System Sprayer calibration is important. If you apply too much herbicide, costs can become excessive; you may be in violation of the label; and you might cause environmental damage. If you apply too little herbicide, the weeds may not be controlled adequately.

Many sprayer calibration methods are available and can be used successfully. The Weed Busters procedure is relatively fast and simple and can be used for most spray systems.

To properly calibrate your sprayer, follow the four simple steps below.

### 1 Determine Speed

If your speedometer is accurate, you can skip this step. The speedometers of most "standard equipment" allterrain vehicles (ATVs) are inaccurate at low speeds.

If the spray vehicle is equipped with a tachometer, you can use it to set and hold an accurate speed. If not, you may need to buy an after-market speedometer.

To determine the correct number of miles per hour (mph), set two stakes 88 feet apart on terrain similar to application site. Hold the throttle at a defined rpm (revolutions per minute) and gear, and record in seconds the amount of time it takes to drive 88 feet.

Repeat this procedure at least once, then calculate the average number of seconds to travel 88 feet. To calculate mph, divide by 60 the number of seconds required to drive the course. Be sure to record the speed, rpm and gear for later reference.

*Example:* It takes 12 seconds to drive 88 feet.

$$60 \div 12 = 5 mph$$

### (2) Determine the Sprayer Swath Width

For boom sprayers, simply multiply the number of nozzles by the distance in inches between each nozzle and divide by 12.

*Example:* You have nine nozzles spaced 20 inches apart.

 $(9 \times 20) \div 12 = 15$  feet effective swath width

For boomless sprayers, operate the nozzle at the desired pressure on a dry surface. Measure the width of the spray swath. Then subtract 10 percent to calculate the effective swath width.

*Example:* The boomless nozzle has a swath width of 20 feet.

20 feet - (20 feet x 0.10) = 18 feet of effective swath width

# **3** Calculate the Amount of Time to Spray 1 Acre

Using the swath width and speed as determined above, calculate the amount of time needed with the following formula:

 $\frac{43,560 \div \text{ swath width (feet)}}{(mph \ x \ 88)} = \text{ minutes/acre}$ 

*Example:* Sprayer will travel at 3 mph and deliver a 15 ft swath.

 $\frac{43,560 \div 15\text{-foot swath}}{3 \text{ mph x 88}} = 11 \text{ minutes to spray 1 acre}$ 

# Determine the Number of Gallons/Acre

If the spray tank is marked in gallons, fill it with water to a specific level and record that number (such as 20 gallons). Operate the sprayer at a set pressure (20 to 30 pounds per square inch, or psi) for the number of minutes you calculated it takes to spray 1 acre. Record the volume of water remaining (such as 5 gallons).

The difference between the starting number of gallons and the remaining number of gallons is the number of gallons per acre the sprayer delivered (such as: 20 gallons to start - 5 gallons remaining = 15 gallons per acre delivered). The sprayer is now calibrated.

If the spray tank is not marked and you are using a spray boom, use the procedure above in terms of setting pressure and time, but capture the spray from one nozzle. To determine the number of gallons per acre, measure the amount of the spray collected and then multiply that amount by the number of nozzles on the spray boom.

Repeat this procedure on several nozzles and average the results. The sprayer is now calibrated.

*Example:* 1.5 gallons collected from one nozzle on a nine-nozzle spray boom.

1.5 gallons x 9 nozzles = 13.5 gallons per acre

If the spray tank is not marked and you are using a boomless nozzle, you will have to shroud the nozzle with a plastic bag or similar product to direct the spray into a collection container. The total volume of liquid collected over the amount of time to spray 1 acre is equal to the number of gallons per acre that the sprayer is delivering. The sprayer is now calibrated.

For any of the above spray systems, if you wish to increase the number of gallons per acre (gpa), you can either decrease speed of travel or increase the pressure and recalibrate. The reverse is true if you wish to decrease the gpa. **Great Trinity Forest Management Plan** 

# **FOREST HERBICIDES**

# Pesticide Applicator

#### **Pesticide Applicator**

The <u>Texas Pesticide Law</u> requires that a person may not use a restricted-use or state-limited-use pesticides or regulated herbicides unless licensed or certified by the Texas Department of Agriculture. Additionally, applicators are to keep records of pesticide applications for two years. Commercial applicators are required to have insurance and register their pesticide equipment. All applicators must obtain continuing education units (CEUs) to renew their license.

#### **Pesticide Classifications**

**General-use** -- can be purchased and used by the general public. Does not require a license to distribute or use.

**Restricted-use** -- for purchase and use only by certified pesticide applicators or persons under their direct supervision. Designation is placed on the product by EPA, and the label will state restricted-use.

**State-limited-use** -- pesticides containing certain active ingredients, with the potential to cause adverse effects to nontargeted vegetation, are classified as SLU when distributed in containers larger than one quart liquid or 2 pounds dry or solid. Also includes pesticides or devices for predation control.

**Regulated Herbicide** -- herbicides the department determines, if used as directed or in accordance with widespread and commonly recognized practice, require additional restrictions to prevent a hazard to desirable vegetation caused by drift or an uncontrolled application.

#### **Types of Pesticide Licenses**

**Private Applicator** -- A person who uses or supervises the use of restricted-use or state-limited-use pesticides for the purpose of producing an agricultural commodity on property owned or rented by the person or the person's employer or under the person's general control; or on the property of another person if applied without compensation other than the trading of personal services between producers of agricultural commodities. An agricultural commodity is defined as a plant or animal grown for sale, lease, barter, feed or human consumption and animals raised for farm or ranch work. Private applicator licenses are valid for five years, and the applicator must obtain 15 CEUs during that time to renew.

**Private Applicator Certificates** -- From 1977 through 1989, TDA issued private applicator certificates (not licenses) under a voluntary program. Private applicators who originally obtained a private applicator certification prior to January 10, 1989, were "grandfathered" by the legislature, meaning the certificate does not expire; however, in 1989 the Texas Pesticide Regulations were revised to require recertification for all applicators, including certified applicators, in order to purchase or use restricted-use or state-limited-use pesticides. The original Grandfathered certificate is recertified, the applicator is given a new certificate number. Certified private applicators may not supervise an application of restricted-use or state-limited-use pesticides. Certificate holders must obtain 15 CEUs every five years to keep the certificate valid.

**Commercial Applicator** -- A person who operates a business or is employed by a business that applies restricted-use or state-limited-use pesticides to the property of another person for hire or compensation. Commercial applicators must renew annually and obtain five CEUs each year.

**Noncommercial Applicator** -- A person required to use restricted-use or state-limited-use pesticides but who is not a private applicator or commercial applicator. Noncommercial applicators are generally government employees who apply restricted-use or state-limited-use pesticides in the course of their employment or persons employed by businesses applying such pesticides on their own property.

Noncommercial applicators must renew annually and obtain five CEUs each year.

#### Licensing with Structural Pest Control Board

The <u>Structural Pest Control Board</u> is the appropriate licensing agency for pesticide applicators needing certification for pesticide application inside buildings (including fumigation of processed food) and for commercial applicators involved with pest control around buildings and structures. Pesticide applicators needing to make applications in parks, along city streets, and on lawn and ornamentals, may license with either SPCB or TDA. All interior applications to structures, termite control and wood treatment are under the jurisdiction of the SPCB.

**Great Trinity Forest Management Plan** 

# **FOREST HERBICIDES**

## **Regulated Herbicides**

#### **Regulated Herbicides**

Because of their potential to cause adverse effects to nontargeted vegetation, all herbicide products containing the following active ingredients, alone or in mixtures, shall be classified as regulated herbicides when distributed in containers of a capacity larger than one quart for liquid material or two pounds for dry or solid material. If the products are marketed using metric measures, the classification applies to containers larger than one liter or one kilogram, respectively:

#### State-limited-use

- 2,4-dichlorophenoxyacetic acid (2,4-D)
- 2,4-dichlorophenoxy butyric acid (2,4-DB)
- 2,4-dichlorophenoxy propionic acid (2,4-DP)
- 2-methyl-4-chlorophenoxyacetic acid (MCPA)
- 3,6-dichloro-o-anisic acid (dicamba)
- 3,4-dichloropropionanilide (propanil)
- 5-bromo-3-sec-butyl-6-methyluracil (bromacil)
- 2,4-bis(isopropylamino)-6-methoxy-s-triazine (prometon)
- 3,7-dichloro-8-quinolinecarboxylic acid (quinclorac)
- devices using the active ingredients sodium fluoroacetate (Compound 1080) and sodium cyanide, in any quantity, for livestock predation

#### **Regulated Herbicides**

- 2,4-dichlorophenoxyacetic acid (2,4-D)
- 2-methyl-4-chlorophenoxyacetic acid (MCPA)
- 3,6-dichloro-o-anisic acid (dicamba)
- 3,7-dichloro-8-quinolinecarboxylic acid (quinclorac)

Formulations containing the active ingredients listed above are exempt from being classified as regulated herbicides if they meet one of the following criteria:

- specialty fertilizer mixtures that are labeled for ornamental use and registered in the Code, Chapter 63, concerning Commercial Fertilizer; or
- products that are ready for use and require no further mixing or dilution before use and are
  packaged in containers with a capacity of one gallon or less for liquid formulations and four
  pounds or less for dry or solid materials

#### **Spray Permits**

Applicators must obtain a spray permit from their regional TDA office before the application is made. Permits expire when acreage is sprayed or within 180 days. Applications with brush, mop, wick, basal treatment or injection are exempt.

#### Responsibility

It is the joint responsibility of the person in control of the crop and the applicator to ensure application complies with regulations. Spraying high volatile herbicides is prohibited when susceptible crops are within a four-mile radius.

#### **Record Keeping Requirements**

Records kept must include: the date and time of day each application started; the name of the person for whom the application was made; the location of the land where the application was made, stated in a manner that would permit inspection by authorized parties; the regulated herbicide applied, including: product name; EPA registration number; rate of product per unit; and total volume of spray mix, dust, granules, or other materials applied per unit; the pest for which it was used; the site treated (name of crop, etc.); total acres or volume of area treated; wind direction, velocity, & air temp; FAA "N" number of

aerial application equipment, or identification number of other types of application equipment, or decal number affixed to application unit; and the name and department license number of the applicator.

#### Pesticide Applicator Recordkeeping Form

### **Texas Department of Agriculture** Todd Staples, Commissioner **Regulated Herbicide Spray Permit**

TDA Use Only:		Type of Permit:
Region:		Permit Number:
County(s):		Date Issued:
Person applying for permit:		
Name		Phone
Address:	City	State Zin
Posponsible Licensee	City	State Zip
or Certified Applicator:		* ,
Name	License or Certif	icate No. Phone
Address: Street, Rt. or P.O. Box	City	State Zip
Total acres to be treated:	_ Product Name:	
Active ingredients:		
EPA Registration No:	List type of spray equipment	:
The following items pertain to indivi	dual spray parmits only:	
Intended data of amplication	uuai spray permits omy.	
Exact location of land to be treated:		
If using high volatile herbicides, list an sprayed:	ny susceptible crops in a four-mi	le radius from any point of the land to be
*List the nearest susceptible crops in a	ll directions from the target area	and distances:
TDA Remarks:		
The Herbicide Spray Permit expires when the a comes first.	creage for which the permit was granted	d has been sprayed or 180 days after issuance, whichever
Applications records, including spray permits, 1 date of application.	must be kept for two years after the	Return form to TDA Regional office at:
*Susceptible crops may include field crops, orc	hards, nurseries, gardens, etc.	
Inspector's Signature:	Insp	ector No: Date:

TDA Q527 1/07

#### Texas Department of Agriculture Todd Staples, Commissioner Pesticide Applicator Record

<b>Business Name</b>	
----------------------	--

\_\_\_\_\_ Address \_\_\_\_\_

Application Date	Time Started	Name of the person for whom the application was made	Location of Land Treat	ted		Site Treated		Wind Direction	Wind Velocity	Air Temp
Product Trade N	Name	EPA Registration Number	Target Pest	Rate of Product Per Unit	•	Equipment ID #		Spray l	Permit Num	ber
Licensed Applic	ator's Name an	d License Number U	Jnlicensed Applicator's N	ame, if applicable	Tot of A	tal Acres or Volume Area Treated	Total Volun or Other Ma	ne of Spray aterials App	Mix, Dust, C lied Per Uni	Franules it
Additional Infor	mation	·								

Application Date	Time Started	Name of the person for whom the application was made	Location of Land Treat	ted		Site Treated	I	Vind Direction	Wind Velocity	Air Temp
Product Trade N	Jame	EPA Registration Number	Target Pest	Rate of Product Per Unit	•	Equipment ID #		Spray F	'ermit Num	ber
Licensed Applic	ator's Name an	Id License Number	Unlicensed Applicator's Na	ame, if applicable	Tota of A	al Acres or Volume Area Treated	Total Volum or Other Ma	e of Spray I terials App	Mix, Dust, G lied Per Un	Franules it
Additional Infor	mation									

**Great Trinity Forest Management Plan** 

## **FOREST HERBICIDES**

*Texas Administrative Code:* 

## Title 4, Section 7.50

General Requirements for Regulated Herbicide Applicators

### **Texas Administrative Code**

	Applicators
<b>RULE §7.50</b>	<b>General Requirements for Regulated Herbicide</b>
SUBCHAPTER E	REGULATED HERBICIDES
CHAPTER 7	PESTICIDES
<u>PART 1</u>	TEXAS DEPARTMENT OF AGRICULTURE
<u>TITLE 4</u>	AGRICULTURE

(a) The following requirements are applicable to persons applying regulated herbicides in regulated counties. No person shall apply regulated herbicides as defined in §7.30 of this title (relating to Classification of Pesticides), without first obtaining a spray permit for such application. A blanket permit may be issued to a licensed or certified applicator. The department may require a licensed or certified applicator who has obtained a blanket permit to submit a supplemental report of any regulated herbicide applied under the terms of the permit.

(1) All permits expire when the acreage for which the permit was granted has been sprayed, or 180 days after issuance, whichever occurs first.

(2) Applications of regulated herbicides by brush, mop, wick, basal treatment, or injection method are hereby exempt from the requirements of obtaining a permit.

(3) Applications by an applicator licensed by the Texas Structural Pest Control Board in turf and weed control and a nurseryman licensed by the department in turf weed control for structural pest control applications are exempt from the permit requirements of this section.

(4) All persons applying regulated herbicides to lawns are exempt from the permit requirements of this section.

(b) All spraying of regulated herbicides must conform to these requirements in a regulated county regardless of whether or not a permit is required.

(1) Spraying high volatile herbicides is prohibited when there are susceptible crops within a four-mile radius from any point of the land to be sprayed. Highly volatile herbicides include methyl, ethyl, butyl, isopropyl, octylamyl, and pentyl esters containing various concentrations expressed in pounds of acid equivalent per gallon.

(2) No person shall spray regulated herbicides when the wind velocity exceeds 10 miles per hour or as specified on the product label, if the label is more restrictive.

(3) The use of any turbine or blower-type ground application equipment to apply regulated herbicides is prohibited.

**Source Note:** The provisions of this §7.50 adopted to be effective December 4, 1997, 22 TexReg 11652.



# Chemical Weed and Brush Control Suggestions for Rangeland

*Allan McGinty, Jim Ansley, J. F. Cadenhead, Wayne Hamilton, Wayne C. Hanselka, Charles Hart and Darrell N. Ueckert\** 

This publication is intended to provide general suggestions for herbicide use to control brush and weeds on Texas rangelands and information on the levels of control expected. The information is presented in good faith, but no warranty, express or implied, is given. Weed and brush control results may vary tremendously if treatments are applied under less than optimum conditions. Users of this publication may find the "Expert System for Brush and Weed Control Technology Selection" (EXSEL) helpful. EXSEL is a decision support expert system designed to recommend the best mechanical and chemical rangeland brush and weed control treatments in Texas. It also provides an analysis of prescription fire potential and will produce a preburn checklist. The user may select the desired plant-kill efficacy level, force the system to consider certain types of treatments, or let the system choose the best alternative. EXSEL is on the World Wide Web (*http://cnrit.tamu.edu/rsg/exsel*) and can be accessed free of charge.

Tommy Welch, former Associate Department Head; Professor and Extension Program Leader for Rangeland Ecology and Management was the original author of this publication. After his retirement in 1995, the Herbicide Use Committee, Rangeland Ecology and Management (members listed above), assumed the responsibility for updating and maintaining this publication.

\*Professor and Extension Range Specialist; Professor, Texas Agricultural Experiment Station; Assistant Professor and Extension Range and Brush Control Specialist; Senior Lecturer, Department of Rangeland Ecology and Management; Associate Department Head, Professor and Extension Program Leader; Professor and Extension Range Specialist; and Regents Fellow and Professor, Texas Agricultural Experiment Station; The Texas A&M University System.

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illions of acres of Texas rangeland support an excessive cover of woody plants and forbs. Dense stands of brush and weeds use valuable water for growth, reduce grass production and result in soil erosion. These noxious plants must be managed effectively for rangelands to reach their productive potential. Use of herbicides provides an effective and efficient alternative for controlling brush and weeds for improvement and maintenance of rangelands in a highly productive condition.

This publication lists current suggestions for herbicide use to control brush and weeds on rangeland. Some herbicides provide a high degree of control of certain species; however, seldom is a species eradicated. Consider other potential rangeland uses when developing a brush management program. Many trees, shrubs and forbs are valuable as food and cover for wildlife and may be an important component in livestock diets. Therefore, a brush management program should provide for use of control methods that give optimum benefits to livestock and wildlife.

Herbicide application may increase palatability of poisonous plants. Thus, they are more likely to be consumed by livestock. To prevent losses to toxic plants, herbicide-treated areas with poisonous plants present should not be grazed until the toxic plants dry up and lose their palatability.

Properly used herbicides are effective and safe. Misuse can result in poor brush and weed control and possible hazards associated with herbicidal drift, dangerous residues, or killing desirable plants. Listed below are points to follow for proper herbicide use:

- Identify the weed or brush species and evaluate the need for control.
- Consider expected benefits, costs and alternative control practices.
- Select and purchase the suggested herbicide for the weed or brush species.
- Read and follow herbicide label directions for allowable uses, application rates and special handling or mixing requirements.
- Provide and require the use of proper safety equipment.
- Calibrate spray equipment.
- Mix herbicides in a ventilated area, preferably outside.
- Spray under conditions that prevents drift to susceptible crops.
- Apply the herbicides at the suggested rate and time.
- Keep a record of the herbicide used, the time required to spray, weather conditions, rate of herbicide in carrier, date, location and the person using the herbicide.

The sprayer used must apply the correct quantity of herbicide mixture to a specific area. To calibrate spray equipment, see Extension publication L-5465, "Weed Busters: Sprayer Calibration Guide."

Suggestions on use of herbicides made by Texas Cooperative Extension are based upon effectiveness under Texas conditions.

Broadcast and individual plant treatments are presented in Table 1 and Table 2. Individual plant treatments are suited for control of thin stands of brush and selective control. Broadcast treatments are useful for dense stands of brush and for weed control.

Suggested herbicides must be registered and labeled for use by the Environmental Protection Agency. *Because the status of herbicide label clearance is subject to change, be certain that the herbicide is currently labeled for the intended use.* 

The user is always responsible for the effects of herbicide residue on his livestock and crops, as well as for problems that could arise from drift or movement of the herbicide from his property to that of others. *Always read and follow carefully the instructions on the container label.* 

*Texas Digital Diagnostics (TDD) provides a quick way to identify plants. Accurate plant identification is critical for selecting proper control technologies. TDD uses digital images and the internet to provide this service. Contact your County Extension Agent to learn more about this program.* 

### **Treatment Control Ratings**

A control rating, based on the effectiveness of a herbicide treatment in controlling a target plant, has been assigned to each herbicide use suggestion. These ratings were determined from research and result demonstration data and from observations of commercial applications. The rating represents a degree of plant mortality of the target plant species when the treatment is properly applied under optimum conditions. The rating categories and degree of plant mortality are:

Control rating	Percent of plants killed
Very high	76-100
High	56-75
Moderate	36-55
Low	0-35

	Common, Chemical and Product Name	es of Herbicides*	
Herbicide common name	Chemical name	Product name	Active ingredient or acid equivalent
Clopyralid	3,6-dichloro-2-pyridinecarboxylic acid	Reclaim	3 lbs./gal.
2,4-D	(2,4-dichlorophenoxy) acetic acid	Several including Weedar 64, Formula 40,Hi-Dep, Weedone LV4,Esteron 99C and others	amine salts and esters
Dicamba	3,6-dichloro-2-methoxybenzoic acid	Banvel, Clarity	4 lbs./gal.
Dicamba:2,4-D(1:3)	See dicamba and 2,4-D	Weedmaster, Banvel + D, RangeStar	4 lbs./gal.
Diesel fuel oil or kerosene	refined petroleum fractions	Several manufacturers	
Glyphosate	N-(phosphonomethyl) glycine	Several including Rodeo, Roundup, Roundup Ultra, Glypro, Glyphos and others	isopropylamine salt*, concentration varies depending on the product
Hexazinone	3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione	Velpar L, Pronone Power Pellet	2 lbs./gal. (Velpar L) 75% (Pronone Power Pellet)
Imazapyr	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3- pyridinecarboxylic acid	Arsenal, Habitat	2 lbs./gal.
Metsulfuron methyl	methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino] sulfonyl] benzoate	Escort, Cimarron	60%
Metsulfuron methyl Dicamba:2,4-D(1:3)	See metsulfuron methyl, dicamba and 2,4-D	Cimarron Max	60% (Part A) 3.87 lbs./gal. (PartB)
Paraquat	I, I'-dimethyl-4,4'-bipyridinium dichloride	Gramoxone Extra	2.5 lbs./gal.
Picloram	4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid	Tordon 22K	2 lbs./gal.
Picloram:Fluroxypyr (1:1)	See picloram and I-methylheptyl ester:((4-amino-3,5-dichloro-6-fluoropyridin-2- yl)oxy)acetic acid	Surmount	1.34 lbs./gal
Picloram:2,4-D(1:4)	See picloram and 2,4-D	Grazon P+D	2.5 lbs./gal.
Tebuthiuron	N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea	Spike 20P, Spike 80 DF	20% (Spike 20P) 80% (Spike 80 DF)
Triclopyr	[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid	Remedy, Pathfinder II	4 lbs./gal. (Remedy) 0.75 lbs./gal (Pathfinder II)
Triclopyr:Fluroxypyr (3:1)	See triclopyr and 1-methylheptyl ester:((4-amino-3,5-dichloro-6-fluoropyridin-2- yl)oxy)acetic acid	PastureGard	2.0 lbs./gal.
Triclopyr:2,4-D(1:2)	See triclopyr and 2,4-D	Crossbow	3 lbs./gal.

\*Herbicides have been identified by the accepted Weed Science Society of America common name, and when practical, one or more product names. For herbicides marketed under three or more labels, the designation "several manufacturers" has been used rather than attempting to list all the trade formulations.

Liq	uid	Weight
- I gallon (gal) = 4 guarts (gt)	pint = 16 ounces	1  pound (lb) = 16  ounces
gallon = 8 pints (pt)	1  pint = 473.12  milliliters	l pound = $453.6$ grams (g)
gallon = 16 cups (c)	l cup (c) = 8 ounces	I ounce = 28.35 grams
gallon = 128 ounces (oz)	l ounce (oz) = 2 tablespoons (tbs)	l kilogram (kg) = 2.2 pounds
gallon = 3784.96 milliliters (ml)	l ounce (oz) =29.57 milliliters	
quart (qt) = 2 pints	l tablespoon (tbs) = 3 teaspoons (tsp)	Area
quart = 4 cups	I tablespoon = $\frac{1}{2}$ ounce	Area
quart = 32 ounces	l tablespoon = 14.79 milliliters	I acre = 43,560 square feet (sq ft)
quart = 946.24 milliliters	l teaspoon (tsp) = 4.98 milliliters	I hectare (ha) = 2.471 acres
pint (pt) = 2 cups		

Guide to	Quantity of Herbicide Formulation for Total Volume of Spray Mix	C
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Tatal Samu			Her	bicide Con	centration	Desired for	Individual	Plant and S	Spot Treatr	nent		
Volume	<sup>1</sup> /4 %	1/2 %	<sup>3</sup> /4 %	1%*	I 1⁄2 %	2%	3%	4%	5%	10%	15%	25%
Desired		•			Quant	ity of Herb	icide Form	ulation				
l gal.	⅓ oz.	<sup>2</sup> / <sub>3</sub> oz.	l oz.	I ⅓ oz.	2 oz.	2 ⅔ oz.	4 oz.	5 ¼ oz.	6 ½ oz.	13 oz.	19 oz.	l qt.
3 gals.*	l oz.	2 oz.	3 oz.	4 oz.*	6 oz.	8 oz.	12 oz.	15 ½ oz.	19 oz.	38 oz.	57 oz.	3 qts.
5 gals.	I ⅔ oz.	3 ¼ oz.	5 oz.	6 ½ oz.	10 oz.	13 oz.	19 oz.	26 oz.	l qt.	2 qts.	3 qts.	l ¼ gals.
10 gals.	3 ¼ oz.	6 ½ oz.	10 oz.	13 oz.	19 oz.	26 oz.	38 oz.	51 oz.	2 qts.	l gal.	I 1/2 gals.	2 ½ gals.
25 gals.	8 oz.	l pt.	24 oz.	l qt.	48 oz.	2 qts.	3 qts.	l gal.	l ¼ gals.	2 ½ gals.	3 ¾ gals.	6 ¼ gals.
50 gals.	l pt.	l qt.	48 oz.	2 qts.	3 qts.	l gal.	l ½ gals.	2 gals.	2 ½ gals.	5 gals.	<b>7</b> ½ gals.	12 ½ gals.
100 gals.	l qt.	2 qts.	3 qts.	l gal.	I ½ gals.	2 gals.	3 gals.	4 gals.	5 gals.	10 gals.	15 gals.	25 gals.

\*Example: To prepare 3 gallons of a spray mixture (herbicide, water and surfactant) containing 1% herbicide, add 4 oz. of herbicide.

Note: Add 1/4 % to 1/2 % commercial, non-ionic surfactant for mixtures using only water as the herbicide carrier. Add 5% diesel fuel if an oil-in-water emulsion is desired to be the herbicide carrier. An oil emulsifying agent (emulsifier) should be added according to label directions. Agitation and the emulsifier are necessary to prevent separation of the spray mixture.

Caution: Non-ionic surfactants are not emulsifying agents and will not result in the formation of an emulsion when diesel fuel and water are mixed and agitated. The emulsifier should be added at 1 to 3 ounces per gallon of the diesel fuel prior to adding the diesel fuel to the spray tank. The spray tank should be filled to about half the desired volume with water prior to adding the diesel fuel-emulsifier premix. The diesel fuel-emulsifier premix is then added to the spray tank slowly, with agitation, after which the spray tank is filled to the desired volume with water.

Table 1. Herbicides for Controlling Weeds on Rangeland.								
Weed controlled	Herbicide (common and chemical names	Herbicide (active ingredient )	e quantity rate in parenthesis)	Spray volume (per acre for broadcast,	Time to apply	Remarks		
	-page 4)	Broadcast rate per acre	Individual plant/spot treatment*	as described for individual plant)				
African rue	Velpar L		VH** 2 ml/plant	Use an exact delivery handgun to apply undiluted herbicide to soil surface at the edge of the plant canopy.	Spring or summer.	Do not use on heavy clay or caliche soils.		
	Pronone Power Pellet		VH I pellet/plant					
Berlander lobelia, bitter sneezeweed, broomweed (annual or common), buffalobur, camphorweed, cocklebur, croton, horehound, marshelder (sumpweed, sulfaweed), plantain (tallowweed), prairie gerardia (see remarks),	2,4-D amine or low volatile ester	VH <sup>***</sup> I pt. to I qt. ( <sup>1</sup> /2 to I lb.) 4 lbs./gal. product	VH 1% (4 lbs./gal. product)	2 to 4 gals. water for aerial spray; 10 to 25 gals. water for ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. surfactant per 100 gals. of water.	Spring, weed 4 to 6 inches high, good moisture condition.	Use 2,4-D amine in areas with 25 inches of rainfall or more. Use 2,4-D low volatile ester in drier areas where no susceptible crops are nearby. For Western bitterweed control use 2,4-D low volatile ester or amine at 1 qt./acre before plants flower and temperature (above 72°F.) and soil moisture favor plant growth. When three fourths of plants are blooming		
ragweed, smartweed, sunflower, thistles, Western bitterweed (see remarks),	Weedmaster	VH   pt. to   qt. (½ to   lb.)	VH I%			and/or temperature is less than 60°F, use Weedmaster, 2,4-D plus Banvel, Grazon P+D or 2,4-D plus Tordon 22K. For prairie gerardia control use I ½ qts./acre of 2,4-D or the low rate of Weedmaster. Banvel plus 2,4-D, Grazon P+D or Tordon 22K plus 2,4-D when plants are 4 to 6 inches high. Use I qt./acre of Grazon P+D or <sup>1</sup> / <sub>0</sub> pt of 2.4-D/acre		
Western ragweed, wild carrot and others	Tank mix Banvel with 2,4-D amine or low volatile ester	VH 1/4 to 1/2 pt. (1/8 to 1/4 lb.) Banvel + 3/4 to 1 1/2 pts. (3/8 to 3/4 lb.) 2, 4-D, 4 lbs./gal. product	VH !/4 % Banvel + 3⁄4 % 2,4-D (4 lbs./gal. product)					
	Grazon P+D	VH   pt. to   ½ qts. (0.3 to 0.9 lb.)	VH I%			when plants are 6 to 10 inches high before flowering.		
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester	VH 1/4 to 3/4 qts. (1/16 to 3/16 lb.) Tordon 22 K + 1/2 to 1 1/2 pts. (1/4 to 3/4 lb.) 2,4-D 4 lbs./gal. product	VH 1/4 % Tordon 22K + 1/2 % 2,4-D (4 lbs./gal. product)					

Weed controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant/spot treatment*	as described for individual plant)		
	Cimarron Max	VH** Rate∣to Rate 2	VH I%			
	Surmount	VH 1.5 pt. to 1 qt. (0.25 to 0.33 lb.)	VH I%	_		Use high end of rate range for camphorweed, marshelder and smartweed.
	PastureGard	H I to I.5 qt. (0.5 to 0.75 lb.)	VH I%	_		Use high end of rate range for camphorweed, marshelder and smartweed. PastureGard efficacy on smartweed is marginal.
Broomweed (annual or common), plantain (tallowweed), wild carrot	Escort or Cimarron	VH ½10 oz. (½16 oz.)		2 to 4 gals. water for aerial spray; 10 to 25 gals. water for ground broadcast application. Add 1 to 2 qts. surfactant per 100 gals. of water.	Spring, weeds less than 4 inches tall.	
Broom snakeweed (perennial broomweed)	Tordon 22K	VH   pt. to   qt. (½ to ½ lb.)	VH ½%	2 to 4 gals. water for aerial spray; 10 to 25 gals. water for ground broadcast application.	During and after full flower stage in fall when growth conditions are	Add emulsifer to oil for proper emulsion when oil-in-water emulsion is used. Use I pt./acre
	Grazon P+D	VH 2 qts. (1 ¼ lbs.)	VH I%	I horoughly wet foliage for individual plant treatment. Add I to 2 qts. surfactant per	good; or spring during peak plant growth when growth conditions are	of lordon 22K only in the fall. Use I qt./acre of Tordon 22K in the spring. Poor control may
	Surmount	VH 1.5 to 3 qt. (0.5 to 1.0 lb.)	VH I%	100 gals. of water.	good.	be expected if Weedmaster or Banvel:2,4-D mixture is used when growth conditions are less than
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester.	VH   pt. (¼ lb.) Tordon 22K +   pt. to   qt. (½ to   lb.) 2,4-D, 4 lbs./gal. product	VH 1⁄4 % Tordon 22K + 1⁄2 % 2,4-D (4 lbs./gal. product)	_		optimum if Grazon P+D or Tordon 22K:2,4-D mixture is used in the spring.
	Weedmaster	VH   qt. (  lb.)	VH I%	_		
	Tank mix Banvel with 2,4- D amine or low volatile ester.	VH <sup>1</sup> / <sub>2</sub> pt. ( <sup>1</sup> / <sub>4</sub> lb.) Banvel + I <sup>1</sup> / <sub>2</sub> pts. ( <sup>3</sup> / <sub>4</sub> lb.) 2,4-D, 4 lbs./gal. product	VH <sup>1</sup> /4% Banvel + <sup>3</sup> /4% 2,4-D (4 lbs./gal product)			

Weed controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant/spot treatment*	as described for individual plant)		
Broom snakeweed (perennial broomweed)	Escort or Cimarron	VH** 5% oz. (¾ oz.)		2 to 4 gals. water for aerial spray; 10 to 25 gals. water for	Optimum time is in the fall, but may be applied	
(continued)	Cimarron Max	H to VH Rate I to Rate 2		Add I to 2 qts. surfactant or 2 gals. crop oil per 100 gals. of water.	in spring.	
	Spike 20P	VH 3.75 lbs. of pellets (¾ lb.)	VH ½ oz. of pellets (½ oz.) per 100 sq. ft.		Any time-optimum period is Oct. I to April I except in Trans-Pecos where optimum period is May I to July I	Use only on sand, loamy sand, sandy loam, loam, silt loam, silt or sandy clay loam soils.
Bullnettle, Carolina horsenettle, dogfennel, silverleaf	Grazon P+D	VH I to I ½ qts. (0.6 to 0.9 lb.)	VH I%	2 to 4 gals. water for aerial spray; 10 to 25 gals. water for ground broadcast application.	Spring (see remarks).	Spray bullnettle, Carolina horsenettle, silverleaf nightshade and western horsenettle when plants
nightshade, upright prairie-coneflower, western horsenettle (treadsalve), yankeeweed (rosin weed)	Tank mix Tordon 22K with 2,4-D amine or low volatile ester:	(0.8 to 0.9 lb.)         gro           on 22K         VH         VH         Indi           ne or low         1/2 to 3/4 pt.         1/4 % Tordon 22K         Ad           (1/6 to 3/16 lb.)         +         Per         Fordon 22K         Ad           1 to 1 1/2 pts.         (1/2 to 3/4 lb.) 2,4-D,         4 lbs /gal. product)         Per	Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. of surfactant per 100 gals. of water.		begin to flower in the spring. Spray dogfennel and yankeeweed when plants are 8 to 10 inches tall. Spray upright prairie-coneflower when plants are 2 to 6 inches tall before flowering.	
	Surmount	VH I.5 to 2 pt. (0.25 to 0.33 lb.)	VH I%			
	Cimarron Max	H to VH Rate I to Rate 2				
	Weedmaster	VH I qt. (I lb.)	VH I%			
	Tank mix Banvel with 2,4- D amine or low volatile ester.	VH <sup>1</sup> / <sub>2</sub> pt. ( <sup>1</sup> / <sub>4</sub> lb.) Banvel + I <sup>1</sup> / <sub>2</sub> pts. ( <sup>3</sup> / <sub>4</sub> lb.) 2,4-D,	VH 1/4 % Banvel + 3/4% 2,4-D			
		4 lbs./gal. product	(4 lbs./gal. product)			

Weed controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant/spot treatment*	as described for individual plant)		
Common goldenweed, Drummond's goldenweed	2,4-D low volatile ester	VH** 2 qts. (2 lbs.) 4 lbs./gal. product	VH 2% (4 lbs./gal. product)	2 to 4 gals. water for aerial spray; 10 to 25 gals. water for ground broadcast application.	Spring when growth conditions are good.	Grazon P+D, Weedmaster and mixtures of Banvel:2,4-D and Tordon 22K:2,4-D are more effective than
	Weedmaster	VH 3 pts. (1 ½ lbs.)	VH 2%	Thoroughly wet foliage for individual plant treatment.		2,4-D alone when growth conditions are less than optimal.
	Surmount         VH         VH         Ito 2 pt. (0.33 lb.)         Ito 1.5 qt.         Ito 1.5 qt.         Ito 1.6 lto 2 qt. surfactant per 100 gals. of water.           PastureGard         H         VH         VH         Ito 1.5 qt.         1%           (0.5 to 0.75 lb.)         Ito 1.5 qt.         1%         Ito 1.5 qt.         1%		When oil-in-water emulsion is used, add emulsifier to oil for proper			
			emulsion.			
	Cimarron Max	VH Rate 3				
	Tank mix Banvel with 2,4-D amine or low volatile ester.	VH <sup>3</sup> / <sub>4</sub> pt. ( <sup>3</sup> / <sub>8</sub> lb.) Banvel + 2 <sup>1</sup> / <sub>4</sub> pts. (1.125 lbs.) 2,4-D, 4 lbs./gal. product	VH ½ % Banvel + I ½ % 2,4-D (4 lbs./gal. product)			
	Grazon P+D	VH 3 pts. (0.94 lb.)	VH 2%			
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester.	VH <sup>3</sup> / <sub>4</sub> pt. (0.19 lb.) Tordon 22K + I <sup>1</sup> / <sub>2</sub> pts. ( <sup>3</sup> / <sub>4</sub> lb.) 2,4-D, 4 lbs./gal. product	VH ½ % Tordon 22K + 1% 2,4-D (4 lbs./gal. product)			
Garboncillo, threadleaf groundsel, wooly	Grazon P+D	VH 3 pts. (0.94 lb.)	VH 2%	2 to 4 gals. water for aerial spray; 10 to 25 gals. water for	Fall, good moisture conditions.	Herbicide application may increase palatability of these poisonous
locoweed	Tank mix Tordon 22K with 2,4-D amine or low volatile ester.	VH <sup>3</sup> / <sub>4</sub> pt. (0.19 lb.) Tordon 22K + I <sup>1</sup> / <sub>2</sub> pts. ( <sup>3</sup> / <sub>4</sub> lb.) 2,4-D, 4 lbs./gal. product	VH ½ % Tordon 22K + 1% 2,4-D (4 lbs./gal. product)	ground broadcast application. Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. of surfactant per 100 gals. water.		plants. Therefore, treated areas should not be grazed until the toxic plants dry up and lose their palatability.
	Surmount	VH 2 pt. (0.33 lb.)	VH 1%			
	PastureGard	H I to I.5 qt. (0.5 to 0.75 lb.)	VH I%			
	Cimarron Max	VH Rate 2				

Weed controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks	
	-page 4)	Broadcast rate per acre	Individual plant/spot treatment*	as described for individual plant)			
Garboncillo, threadleaf groundsel, wooly	Weedmaster	VH** I qt. (I lb.)	VH 2%				
locoweed (continued)	Tank mix Banvel with 2,4-D amine or low volatile ester.	VH <sup>3</sup> / <sub>4</sub> pt. ( <sup>3</sup> / <sub>8</sub> lb.) Banvel + 2 <sup>1</sup> / <sub>4</sub> pts. (1 <sup>1</sup> / <sub>8</sub> lbs.) 2 4 D 4 lbs (rol product	VH 1/2 % Banvel + 1 1/2 %, 2,4-D (4 1/2 (rail product)				
Gray goldaster, narrowleaf goldaster	2,4-D low volatile ester	VH	VH I%	2 to 4 gals. oil-in-water emulsion (2 gts. of diesel fuel	Spring during bud stage (pre-bloom).	Bud stage usually occurs during mid- May to early lune.	
	Grazon P+D	VH I.6 qts. (I lb.)	VH I%	oil and water to make 2 to 4 gals./acre) as aerial spray.			
	Tank mix Tordon 22K with 2,4-D low volatile ester.	VH 0.8 pt. (0.2 lb.) Tordon 22K + 0.8 qt. (0.8 lb.) 2,4-D, 4 lbs./gal. product	VH 1⁄4 % Tordon 22K + 1⁄2 % 2,4-D (4 lbs./gal product)	10 to 25 gals. oil-in-water emulsion (1 gal. diesel fuel oil and water to make 10 to 25 gals./acre) as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion). Oil-in-water emulsion requires use of emulsifier.			
	Surmount	VH 2 pt. (0.33 lb.)	VH I%				
	PastureGard	H   to  .5 qt. (0.5 to 0.75 lb.)	VH I%				
	Cimarron Max	H to VH Rate I to Rate 2					
	Weedmaster	VH   qt. (  lb.)	VH I%	_			
	Tank mix Banvel with 2,4-D low volatile ester.	VH <sup>1</sup> / <sub>2</sub> pt. ( <sup>1</sup> / <sub>4</sub> lb.) Banvel + I <sup>1</sup> / <sub>2</sub> pts. ( <sup>3</sup> / <sub>4</sub> lb.) 2,4-D, 4 lbs./gal. product	VH <sup>1</sup> /4 % Banvel + <sup>3</sup> /4 % 2,4-D (4 lbs./gal. product)				
Lespedeza	Remedy	VH I to 2 pts. (½ to 1 lb.)		Ground broadcast 20 to 30 gals. per acre with 1 to 2 qts. of surfactant per 100 gals. of water.	June through August under good growing conditions.	Plants need to be 12 to 18 inches tall before spraying. Use the higher rate if plants are large, approaching maturity, or if the infestation level is high.	
	Escort or Cimarron	H <sup>1</sup> / <sub>2</sub> oz. ( <sup>3</sup> / <sub>10</sub> oz.)				Begin application at flower bud initiation through full bloom.	
	Cimarron Max	H Rate 2					

Weed controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant/spot treatment*	as described for individual plant)		
	Surmount	VH** I.5 to 2 pt. (0.25 to 0.33 lb.)	VH I%			
	PastureGard	VH I.5 to 2 pt. (0.38 t 0.5 lb.)	VH 0.75%			
Rayless goldenrod (jimmyweed)	Escort or Cimarron	VH ¾ oz. (0.45 oz.)		2 to 4 gals. water for aerial spray; 10 to 25 gals. water for	Fall.	
	Surmount	VH         VH         ground broadcast application           6 pt. (1.0 lb.)         2%         Individual plant treatment	ground broadcast application. Thoroughly wet foliage for individual plant treatment.			
	Tordon 22K	VH   qt. (½ lb.)	VH 1%	Add I to 2 qts. surfactant per I00 gals. of water.		
Spiny aster (wolfweed)	Grazon P+D	VH I qt. (0.63 lbs.)	VH 1%	10 to 25 gals. water for ground broadcast application.	Spring during good moisture and growth	Shred plants during winter. Regrowth will have leaves. Apply herbicide when regrowth is 10 to 12 inches tall.
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester.	VH ½ pt. (½ lb.) Tordon 22K + I pt. (½ lb.) 2,4-D, 4 lbs./gal. product	VH <sup>1</sup> /4 % Tordon 22K + <sup>1</sup> /2 % 2,4-D (4 lbs./gal. product)	Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. surfactant per 100 gals. of water.	conditions.	
	Surmount	VH 1.5 to 2 pt. (0.25 to 0.33 lb.)	VH I%			
	PastureGard	H 2 to 3 pt. (0.5 to 0.75 lb.)	VH I%	-		
	Weedmaster	VH   qt. (  lb.)	VH 1%			
	Tank mix Banvel with 2,4-D amine or low volatile ester.	VH <sup>1</sup> / <sub>2</sub> pt. ( <sup>1</sup> / <sub>4</sub> lb.) Banvel +	VH 1/4 % Banvel +			
		1 ½ pts. (¾ lb.) 2,4-D, 4 lbs./gal. product	%4 % 2,4-D (4 lbs./gal. product)			
Threadleaf groundsel	Escort or Cimarron	VH ∜₁₀ oz. (¼ oz.)		2 to 4 gals. water for aerial spray; 10 to 25 gals. water for	Fall.	
	Cimarron Max	VH Rate 2		ground broadcast application. Add I to 2 qts. surfactant per 100 gals. of water.		

Weed controlled	Herbicide (common and chemical names -page 4)	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
		Broadcast rate per acre	Individual plant/spot treatment*	individual plant)		
Twinleaf senna (twoleaf senna)	Grazon P+D		VH** 1%	Thoroughly wet foliage. Mix with water and add I to 2 qts. surfactant per 100 gals. spray mix.	Late spring, good moisture and growth conditions.	
	Surmount		VH 1%			
	Weedmaster		VH 1%			
Upright prairie- coneflower	Escort or Cimarron	VH ⅔10 oz. (½ oz.)		2 to 4 gals. water for aerial spray. 10 to 25 gals. water for ground broadcast application. Add 1 to 2 qts. surfactant per 100 gals. of water.	Spring, before flower stalk development.	

	Table 2. Herbicides for Controlling Brush on Rangeland.								
Brush controlled	Herbicide (common and chemical names	Herbicide (active ingredient i	e quantity rate in parenthesis)	Spray volume (per acre for broadcast,	Time to apply	Remarks			
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)					
Ashe juniper (blueberry cedar)	Velpar L		VH <sup>™</sup> 2 ml. per 3 ft. of height or canopy diameter, whichever is greater	Late winter through summer.	Apply undiluted Velpar L, Tordon 22K or Pronone Power Pellets between the stem base and the edge of the canopy. Use an exact				
	Pronone Power Pellet		VH I pellet per 3 ft. of height or canopy diameter, whichever is greater			delivery handgun applicator to apply Velpar L and Tordon 22K. If plant size requires more than a single 2 ml. or 4 ml. application of Velpar L or Tordon 22K, or more than I Pronone Power Pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.			
	Tordon 22K		VH 4 ml. per 3 ft. of height or canopy diameter, whichever is greater						
Ashe juniper (blueberry cedar), cholla, dog cactus, redberry juniper (redberry cedar), tasajillo	Tordon 22K		VH 1% H rating for cholla	Thoroughly wet foliage and stems or joints and stems for individual plant treatment. Mix with water and add I-2 qts. surfactant per 100 gals. spray mix.	Anytime.				
Baccharis (dryland willow, Roosevelt willow, seep willow or willow baccharis)	2,4-D low volatile ester	H 3 pts. to 3 qts. (1 ½ to 3 lbs.) 4 lbs./gal. product	H 1%	4 to 5 gals. of water for aerial spray; 15 to 20 gals. water for ground broadcast. For individual plant treatment, thoroughly wet the entire foliage, stems and trunks. Add 1 to 2 qts. surfactant per 100 gals. of water.	Spring.	Individual plant treatment with 2,4-D may be applied anytime during the growing season when soil moisture is available for active growth. However, spring treatment provides the best control.			

Brush controlled	Herbicide (common and chemical names	Herbicide (active ingredient	e quantity rate in parenthesis)	Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Baccharis (dryland villow, Roosevelt willow, seep willow or willow baccharis) (continued)	Velpar L		VH <sup>™</sup> 2 ml. per 3 ft. of height or canopy diameter, whichever is greater	Late winter through summer	Late winter through summer	Apply undiluted Velpar L or Pronone Power Pellet to soil surface between the stem base and the edge of the canopy. Use an exact delivery
	Pronone Power Pellet		VH I pellet per 3 ft. of height or canopy diameter, whichever is greater		L. If plant size requires more than a single 2 ml. application of Velpar L, or a single Pronone Power Pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils	
Baccharis (dryland willow, Roosevelt willow, seep willow or willow baccharis), blackbrush, bois d'arc, catclaw acacia, catclaw mimosa, Chinese tallowtree, elm,	Remedy		VH 25% in diesel fuel oil	Apply to lower 12 to 18 inches of trunk to wet the trunk; do not spray to point of runoff. Apply completely around the trunk	Anytime–optimum time is during growing season when plants have mature leaves.	This is commonly called the low volume basal application method. Use a fan or hollow cone nozzle. Use only on plants with smooth bark and a trunk diameter less than 4 inches. For Texas persimmon, apply in spring after leaves mature but before June 15.
greenbriar, hackberry, huisache, pricklyash, (Hercules club), Texas persimmon (see remarks), winged elm, yaupon	Remedy		VH 25% in diesel fuel oil 10% d,I-limonene (a penetrant) may be added to the mixture- see remarks	Apply to the trunk in a 3- to 4-inch-wide band near ground level or at line dividing smooth bark from corky bark. Apply completely around the trunk.	Anytime—optimum time is during growing season when plants have mature leaves.	This is commonly called the streamline basal application method. Use a straight stream nozzle. Use only on plants with smooth bark and trunk diameter less than 4 inches. Addition of a penetrant to the mixtures aids with coverage around the trunk and increases the degree of control for most species. Trade names for d,l limonene are Quick Step II, AD 100, Cide-Kick II and Cide-Kick. Other penetrants may be effective but have not been tested on rangeland in Texas. For Texas persimmon, apply in spring after leaves mature but before June 15.
Bigelow shinoak (white shinoak)	Spike 20P	VH 7.5 lbs. of pellets (1½ lbs.)	VH ½ oz. of pellets (½ oz.) per 100 sq. ft.		Anytime during year- optimum period is Oct. I to April I	For individual plant treatment, apply pellets evenly on the soil under the plant canopy and I ft. beyond canopy edge.
Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
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	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Blackberry	Surmount	VH <sup>≉∗</sup> 3 to 4 pt. (0.5 to 0.67 lb.)	VH I to 2%	Use at least 10 gallons of water per acre, but increased volume up to 25 gallons per acre will improve coverage, and subsequent herbicide penetration into the plant. Add 1 to 2 qts. surfactant per 100 gals. spray mix.	Apply when leaves are fully expanded and the foliage is dark green, either before first flower or after fruit drop. Do not treat blackberries in the same year after shredding, or burning.	
	PastureGard	H 3 to 4 pt. (0.75 to 1.0 lb.)	VH I to 2%			
Blackbrush, guajillo	Spike 20P	H 10 to 15 lbs. pellets (2 to 3 lbs.)	VH ½ oz. of pellets (¼10 oz.) per 45 sq. ft. or 2 to 4 inches of stem diameter		Anytime during year– optimum period is Oct. I to April I.	Use higher rate on deep soils with higher clay content. For individual plant treatment apply pellets evenly on the soil under the plant canopy and I ft. beyond canopy edge. Best results are expected on coarse- textured soils.
Blackjack oak, bois d'arc, elm, hackberry, lotebush, post oak, pricklvash (Hercules	Velpar L		VH 4 ml. per 3 ft. of canopy diameter or height, whichever is greater		Late winter through summer.	Apply undiluted Velpar L or Pronone Power Pellets to soil surface between the stem base and the edge of the canopy. Use an
club), whitebrush (beebrush, beebush), willow, winged elm	Pronone Power Pellet		VH 2 pellets per 3 ft. of canopy diameter or height, whichever is greater		Anytime during year- optimum period is Oct. I to April I Splications o spaced around use these trea poorly draine- classified as cl expected on o	exact delivery handgun applicator to apply Velpar L. If plant size requires more than a single 4 ml. application of Velpar L, or 2 Pronone Power Pellets, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
Blackjack oak, post oak, winged elm	Spike 20P	VH 10 lbs. of pellets (2 lbs.)	VH ½ oz. of pellets (½ oz.) per 45 sq. ft. or 2 to 4 inches of stem diameter		Anytime during year– optimum period is Oct. I to April I	For individual plant treatment apply pellets evenly on the soil under the plant canopy and I ft. beyond canopy edge.
Blackgum, sweetgum and other hardwoods	Crossbow		H 4% in diesel fuel oil	Apply to freshly cut surface of stump immediately after cutting	Anytime-best results when soil is dry	

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Catclaw mimosa	Spike 20P	H** 3.75 lbs. of pellets (¾ lb.)	VH ½ oz. of pellets (½0 oz.) per 100 sq. ft. or 2 to 4 inches of stem diameter		Anytime during year- optimum period is May I to July I in Trans-Pecos and Oct. I to April I in rest of state.	Use only when brush is growing on sand, loamy sand or sandy loam soil. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and I ft. beyond canopy edge.
Cenizo	Spike 20P	VH 3.75 lbs. of pellets ( <sup>3</sup> /4 lb.)	VH ½ oz. of pellets (½ oz.) per 100 sq. ft. or 2 to 4 inches of stem diameter		Anytime during year– optimum period is Oct. I to April I	For individual plant treatment apply the pellets evenly on soil under the plant canopy and I ft. beyond canopy edge.
Chinese tallowtree	Grazon P+D	VH I gal. (2.5 lbs.)	VH I%	5 to 15 gals. as aerial spray or 10 to 25 gals. for ground	oray Spring or fall. ound	
	Tank mix Tordon 22K with 2,4-D amine	VH I qt. (½ lb.) Tordon 22K + 2 qts (2 lbs.) 2,4-D, 4 lbs./gal. product	VH 1⁄4 % Tordon 22K + 1⁄2 % 2,4-D (4 lbs./gal. product)	broadcast application. Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. of surfactant per 100 gals. water.		
	Surmount	VH 5 pts. (0.84 lbs.)	VH I%			
	Tordon 22K	VH I qt. (½ lb.)	VH 1⁄2 %			
	Tank mix Tordon 22K with Remedy	VH I qt. (½ lb.) Tordon 22K +	VH <sup>1</sup> / <sub>2</sub> % Tordon 22K + <sup>1</sup> / <sub>4</sub> % Remedy	-		
	Velpar L		VH 4 ml. per 3 ft. of canopy diameter or height, whichever is greater		Late winter through summer.	Apply undiluted Spike 20P, Velpar L or Pronone Power Pellets to soil between stem base and the edge of the canopy. Use an exact delivery
	Pronone Power Pellet		VH 2 pellets per 3 ft. of canopy diameter or height, whichever is greater	t,	handgun applicator to apply Velpar L. If plant size requires more than a single 4 ml. application of Velpar L, or 2 Pronone Power Pellets, apply	
	Spike 20P		VH ½ oz. of pellets (½ oz.) per 45 sq.ft. or 2 to 4 inches of stem diameter		Anytime during year– optimum period is Oct. I to April 1.	equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.

Brush controlled	Herbicide (common and chemical names	Herbicid (active ingredient	e quantity rate in parenthesis)	Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Chinese tallowtree (continued)	Remedy		VH** I 5% in diesel fuel	Apply to lower 12-18 inches of trunk to wet the bark, but	Anytime–optimum time is during growing season	Use only on plants with a smooth bark and/or a trunk diameter less
	Pathfinder II		VH Undiluted	not to point of runoff. Apply completely around the trunk.	leaves.	called the low-volume basal application method. A 5500-X1 nozzle is preferred.
	Remedy		VH 25% in diesel fuel			Use on plants with rough, corky bark and/or a trunk diameter of 4 in. or greater. This is commonly called the low-volume basal application method. A 5500-X1 nozzle is preferred.
Christ thorn	Remedy		VH 1%	Add I to 2 qts. of surfactant per 100 gals. of water.	Early summer.	
	Tank mix Remedy with Tordon 22K		VH ½ % Remedy + ½ % Tordon 22K	Thoroughly wet foliage.		
Common or Eastern persimmon	Banvel	L 2 qts. (2 lbs.)	H 1%	Ground broadcast 15 to 20 gals. water. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. of surfactant per 100 gals. of water.	Spring, when leaves are fully developed.	
	Surmount		VH I to 2%			
Creosotebush, tarbush, whitethorn acacia	Spike 20 P	H 3.75 to 5 lbs. of pellets ( <sup>3</sup> /4 to 1 lb.)	VH 1/2 oz. of pellets (1/10 oz.) per 100 sq. ft.		Anytime during year- optimum period is May I to July I.	Use 5 lbs. of pellets/acre when soil is a loam, silt loam, silt, sandy clay loam or clay loam. Use low rate when soil is a sand, loamy sand or sandy loam. Do not treat mountainside or gravelly ridges with slopes of 7 percent or more. Do not treat if soils have a cation exchange capacity greater than 30 meq. per 100 grams (commonly called "gyp" soils.) For individual plant treatment apply pellets evenly on soil under the plant canopy and 1 ft. beyond the canopy edge.

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Eastern redcedar	Tordon 22K		VH <sup>***</sup> 4 ml. per 3 ft. of height or canopy diameter, whichever is greater	Spring or fall.	Apply undiluted Velpar L, Tordon 22K or Pronone Power Pellets to soil surface between the stem base and the edge of the canopy. Use an exact	
	Velpar L		VH 4 ml. per 3 ft. of height or canopy diameter, whichever is greater, or I inch of trunk diameter		Late winter through summer.	Velpar L and Tordon 22K. If plant size requires more than a single 4 ml. application of Velpar L or Tordon 22K, or more than 2 Pronone Power Pellets apply subsequent applications
	Pronone Power Pellet		VH 2 pellets per 3 ft. of height or canopy diameter, whichever is greater, or I inch of trunk diameter			or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse- textured soils.
Elm, granjeno (spiny hackberry), hackberry, huisache, lotebush, pricklyash (Hercules club), yaupon	Spike 20P		VH 1/2 oz. of pellets (1/10 oz.) per 45 sq. ft. or 2 to 4 inches of stem diameter L rating for huisache and lotebush		Anytime during year- optimum period is Oct. I to April I except in Trans-Pecos where optimum period is May I to July I.	Apply pellets evenly on the soil under the plant canopy and I ft. beyond canopy edge.
Flameleaf sumac	Grazon P+D		VH 1%	2 to 4 gals. of oil-in-water emulsion (1 to 5 oil to water ratio is considered optimum) or 2 to 4 gals. of water with 1 to 2 qts. of surfactant per	Late spring, when leaves mature.	
	Surmount	H 3 to 6 pt. (0.5 to 1.0 lb.)	VH 0.75%			
	Tordon 22K	H I to 2 pts. (¼ to ½ lb.)	VH 1⁄2 %	spray. Ground broadcast use 10 to 25 gals. oil-in-water		
	Tank mix Tordon 22K with Remedy	H I pt. ( <sup>1</sup> /4 lb.) Tordon 22K +	VH 1/4 % Tordon 22K +	emulsion (½ to 1 gal. diesel fuel oil and water to make 10 to 25 gals./acre) or 10 to 25 gals. of water with 1 to 2 qts. of surfactant per 100 gals. water as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion). Oil-in-water emulsion requires use of emulsifier.		
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester	72 pa (74 10.) removy	VH 1/4 % Tordon 22K + 1/2 %, 2,4-D (4 lbs./gal. product)			

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Greenbriar	Tank mix Banvel with 2,4-D low volatile ester		H** I ½ % Banvel + 3% 2,4-D (4 lbs./gal. product) in diesel fuel oil	Thoroughly wet stems with diesel/herbicide mix.	Winter.	Use as dormant stem treatment. Constant agitation is needed to maintain proper mixture.
Hardwoods with a diameter of more than I inch except mesquite and huisache	2,4-D amine		H Undiluted	Use tree injector or other injecting equipment. Apply in cuts spaced 2 inches apart at base of trees. Apply until 2,4- D runs from each end of cut.	Summer or winter.	
Honeylocust	Grazon P+D		VH I%	Add I to 2 qts. of surfactant per 100 gals. water. Apply to the leaves. Thoroughly wet foliage, but not to the point of dripping.	Spring, when leaves mature.	
Huisache	Remedy		H I 5% in diesel fuel oil	Apply to lower 12 to 18 inches of trunk to wet the trunk; do not spray to point of runoff.Apply completely around the trunk.	Anytime–optimum time is growing season when	This is commonly called the low- volume basal application method.
	Pathfinder II		VH Undiluted		plants have mature leaves.	A 5500-X1 adjustable cone nozzle is preferred.
	Grazon P+D		VH 1%	Add 1 to 2 qts. of surfactant per 100 gals. water. Apply to the leaves. Thoroughly wet foliage, but not to the point of dripping.	Best results are generally obtained in the fall.	If plants are shredded, wait until regrowth is 3 ft. tall or higher before treatment.
Huisache, retama	Tank mix Tordon 22K with Remedy	L to M I qt. (½ lb.) Tordon 22K + I pt. (½ lb.) Remedy	H ½ % Tordon 22K + ½ % Remedy	<ul> <li>4-5 gals. oil-in-water emulsion as aerial spray (1 qt. to 1 gal. diesel fuel oil and water to make 4-5 gals./acre; a 1-5 oil to water ratio is considered optimum); 20-25 gals. oil-in- water emulsion (½ to 1 gal. diesel fuel oil and water to make 20-25 gals./acre) or 20-</li> </ul>	Spring, with mature foliage or fall with good soil moisture and foliage.	When using oil-in-water emulsion, use emulsifier added to oil for proper emulsion.
	Tank mix Tordon 22K with Reclaim	L to M I qt. (½ lb.) Tordon 22K + ⅓ to ⅔ qt. (¼ to ½ lb.) Reclaim	H ½ % Tordon 22K + ½ % Reclaim			
	Surmount	L to M 6 pt. (1.0 lb.)	H 1%	(1 to 2 qts. of surfactant per 100 gals. water) as ground		
	Tordon 22K	L to M I qt. (½ lb.)	H I%	broadcast. Thoroughly wet foliage for individual plant treatment. Add 1-2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion requires use of emulsifier.		

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Lotebush	Remedy		VH I 5% in diesel fuel	Apply to lower 12-18 in. of the trunk to wet the bark. Do	Antime–optimum time is during growing season	
	Pathfinder II		VH Undiluted	not spray to point of runoff. Apply completely around the trunk.	when plants have mature leaves.	
Macartney rose (mowed and other disturbed stands within 3 years of disturbance)	2,4-D amine	L** 2 qts. (2 lbs.) 4 lbs./gal. product	L I % (4 lbs./gal. product)	5 to 15 gals. water as aerial spray; 25 to 30 gals. water as ground broadcast. Thoroughly	Spring before June 1, good growth conditions.	Avoid spraying earlier than 9 to 12 months following mowing or when plants have high percentage of
	Grazon P+D	H I gal. (2.5 lbs.)	VH I%	wet foliage and stems for individual plant treatment. Add L to 2 gts. of surfactant	Spring or fall, good growing conditions.	new growth. Poor control may be expected if plants are less than 3 ft. tall when sprayed Repeat treatment
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester	H I qt. (½ lb.) Tordon 22K + 2 qts. (2 lbs.) 2,4-D, 4 lbs./gal. product	VH 1⁄4 % Tordon 22K + 1⁄2 % 2,4-D (4 lbs./gal. product)	per 100 gals. of water.	when necessary.	when necessary.
	2,4-D low volatile ester	L 2 qts. (2 lbs.) 4 lbs./gal. product	L I% (4 lbs./gal. product)	_	Fall, under good moisture conditions, before Nov. I.	
Macartney rose (undisturbed stands)	2,4-D amine	L I gal. (4 lbs.) 4 lbs./gal. product	L I % (4 lbs./gal. product)	5 to 15 gals. water as aerial spray; 25 to 30 gals. water as ground broadcast. Thoroughly	Spring before June 1, good growth conditions.	
	Grazon P+D	H I gal. (2.5 lbs.)	VH I%	wet foliage and stems for individual plant treatment. Add L to 2 gts. of surfactant	Spring or fall, good growth conditions.	
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester	H I qt. (½ lb.) Tordon 22K +	VH 1/4 % Tordon 22K +	per 100 gals. of water.		
		2 qts. (2 lbs.) 2,4-D, 4 lbs./gal. product	<sup>1</sup> /2 % 2,4-D (4 lbs./gal. product)			
	2,4-D low volatile ester	L 3 qts. (3 lbs.) 4 lbs./gal. product	L I % (4 lbs./gal. product)	5 to 15 gals. water as aerial spray; 25 to 30 gals. water as ground broadcast. Thoroughly wet foliage and stems for individual plant treatment. Add I to 2 qts. of surfactant per 100 gals. of water.	Fall, under good moisture conditions, before Nov. I.	
Mesquite, huisache, twisted acacia	Diesel fuel oil, kerosene		н	Apply to base of trunk from 12 to 18 inches above soil surface down to soil surface. Apply until solution puddles on soil surface.	Anytime soil is dry and pulled away from the trunk.	Apply sufficient oil to penetrate to plant bud zone. Diesel fuel oil does not evaporate as fast as kerosene.

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Mesquite, huisache	Velpar L		M to H <sup>™</sup> 4 to 8 ml. per 3 ft. of canopy diameter or height, whichever is greater.		Late winter through summer.	Apply undiluted Velpar L or Pronone Power Pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery
	Pronone Power Pellet		M to H 2 to 4 pellets per 3 ft. of canopy diameter or height, whichever is greater.			handgun applicator to apply Velpar L. If plant size requires more than a single 4 ml. application of Velpar L, or 2 Pronone Power Pellets, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.
Mesquite (basal stem diameter 1½ inches	Mesquite (basal stem liameter 1½ inches or less)       Remedy       VH       Apply to lower 12 to 18       Anytime-of is during g when plan of runk; do not spray to point         Pathfinder II       Pathfinder II       VH       trunk; do not spray to point       when plan leaves.	Anytime–optimum time is during growing season	This is commonly called the low volume basal application method.			
or less)			VH Undiluted	trunk; do not spray to point of runoff. Apply completely around the trunk.	when plants have mature leaves.	nozzle. Use only on plants with smooth bark and a trunk diameter
Mesquite (basal stem diameter greater than 1½ inches), Christ thorn	Remedy		VH 25% in diesel fuel oil			less than 4 inches.
Mesquite (basal stem diameter 1½ inches or less)	Remedy		VH 15% in diesel fuel oil 10% d,l limonene (a penetrant) may be added to the mixture-see remarks	Apply to the trunk in a 3- to 4-inch-wide band near ground level or at line dividing smooth bark from corky bark. Apply completely around the	Anytime-optimum time is during growing season when plants have mature leaves.	This is commonly called the streamline basal application method. Use a straight stream nozzle. Use only on plants with smooth bark and a trunk diameter less than
Mesquite (basal stem diameter greater than 1½ inches)	Remedy		VH 25% in diesel fuel oil 10% d,l limonene (a penetrant) may be added to the mixture-see remarks	Trunk.		4 inches. Addition of a penetrant to the mixture aids with coverage around the trunk. Trade names for d,l limonene are Quick Step II, Cide-Kick, Cide-Kick II and AD 100. Other penetrants may be effective but have not been tested on rangelands in Texas.
Mesquite (seedlings and saplings)	Remedy		VH 5% in diesel fuel oil	Apply to lower 12 to 18 inches of trunk to point of runoff, but not to the point of puddling.	May through August	This is commonly called the low volume basal application method. Use a 5500XI adjustable cone nozzle.

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	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Mesquite, Christ thorn and other hardwoods	Remedy		VH** I 5% in diesel fuel oil	Spray the sides of the stump and the outer portion of	Any season of the year, except when snow or	This is commonly called the cut stump application method. Apply with a backpack or knapsack sprayer using low pressures and a solid cone or flat fan nozzle. This is an excellent treatment to use after cutting mesquite with hydraulic shears.
(cut stumps)	PastureGard		VH 30% in diesel fuel oil	the cut surface, including the cambium, immediately after cutting to thoroughly wet the	water prevent spraying to the ground line.	
	Pathfinder II		VH Undiluted	stem and root collar area, but not to the point of runoff.		
Mesquite (suppression and weed control)	2,4-D amine (including Hi- Dep) or low volatile ester	L 2 to 4 qts. (2 to 4 lbs.)	M 2% (4 lbs./gal. product)	2 to 4 gals. oil-in-water emulsion as aerial spray	Late spring to mid-summer with mature	Treatments will control many weeds. When using oil-in-water emulsion,
	Grazon P+D	L I to I ½ qts. (0.6 to 0.9 lb.)		(1 pt. to 1 gal. diesel fuel oil and water to make 2 to 4 gals./acre; 1 to 5 oil to water ratio is considered optimum;	leaves (dark green color). Optimum period of application begins when soil temperature at a depth of 12 inches reaches 75°F and continues for 45 days thereafter. If treatment is applied prior to optimum soil temperatures, efficacy rates will be lower and multiple applications over a period of years may be necessary to maintain less than 10% canopy cover.	use emulsifier. Use of a treatment with a low control rating may result in multi-stem growth form that may be more difficult to control in the
	Weedmaster	L   to   ½ qts. (  to   ½ lbs.)		20 to 25 gals. oil-in-water emulsion ( $\frac{1}{2}$ to 1 gal. diesel fuel oil and water to make		future.
	Cimarron Max	L Rate I to Rate 2		20 to 25 gals./acre) or 20 to 25 gals. water/acre plus surfactant (1 to 2 qts. surfactant per 100 gals. water as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. surfactant per 100 gals. of water or 5 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion). Oil-in-water emulsion requires use of emulsifier.		
	Tank mix Tordon 22K with 2,4-D amine or low volatile ester	L ½ to ¾ pt. (½ to ¾ b.) Tordon 22K + 1 to 1 ½ qts. (1 to 1 ½ lbs.) 2,4-D, 4 lbs./gal. product				
	Tank mix Banvel with 2,4-D amine or low volatile ester	L 1⁄2 to 3⁄4 pt. (1⁄4 to 3⁄8 lb.) Banvel + 3⁄4 to 1 1⁄8 qts. (3⁄4 to 1 1⁄8 lbs.) 2,4-D, 4 lbs./gal. product				
	Remedy	L I pt. to I qt. (½ to I lb.)	M 1%			
	Banvel	L   pt. to   qt. (½ to   lb.)	M 1%			

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Mesquite Ro	Remedy		VH** 2% in diesel fuel oil	Apply to base of trunk from 12 to 18 inches above soil surface down to soil surface. Apply until solution puddles on soil surface.	Anytime soil is dry and pulled away from trunk.	
	Reclaim	M to H <sup>1</sup> / <sub>3</sub> qt. to <sup>2</sup> / <sub>3</sub> qt. ( <sup>1</sup> / <sub>4</sub> to <sup>1</sup> / <sub>2</sub> lb.)	VH 1%	2 to 4 gals. oil-in-water emulsion as aerial spray (I pt. to I gal. diesel fuel oil and water to make 2 to 4	Late spring to mid- summer with mature leaves (dark green color). Optimum period	Use I pt./acre Tordon 22K plus 1/2 pt./acre Remedy, 1/2 pt./acre Banvel plus 1/2 pt./acre Remedy, I pt./acre Tordon 22K plus 1/2 pt./acre Banvel, I pt./acre Tordon 22K plus 1/3 qt./acre Reclaim and 1/3 qt./acre Reclaim only in West Texas. Banvel and Banvel mixtures have been more effective in West Texas than in other parts of the state. Use mixtures that include 1/4 pt./acre Remedy and 1/3 pt./acre Reclaim only in Montague, Wise, Parker, Hood, Somervell, Bosque, Coryell, Lampasas, Burnet, Blanco, Kendall, Bandera, Real, Edwards and Val Verde counties and those counties north and west of the named counties. Mixtures that include 1/2 pt. Remedy and 2/3 pt. Reclaim will give better control than mixtures with 1/4 pt. Remedy and 1/3 pt. Reclaim. When using oil-in- water emulsion, use emulsifier added to oil for proper emulsion. Use of a treatment with a low- control rating may result in a multi- stem growth form that may be more difficult to control in the future.
	Tank mix Remedy with Tordon 22K	M 1⁄2 to 1 pt. (1⁄4 to 1⁄2 lb.) Remedy + 1 to 2 pts. (1⁄4 to 1⁄2 lb.) Tordon 22K	M to H 1⁄2 % Remedy + 1⁄2 % Tordon 22K	gais./acre, i to 5 on to water ratio is considered optimum); 20 to 25 gals. oil-in-water emulsion (½ to 1 gal. diesel fuel oil and water to make 20 to 25 gals./acre) or 20 to 25 gals. water/acre plus surfactant (1 to 2 qts. surfactant per 100 gals. water) as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in- water emulsion). Oil-in-water emulsifier.	<ul> <li>when soil temperature at a depth of 12 inches reaches 75°F and continues for 45 days thereafter; when Reclaim is used alone or in a tank mix the period should</li> <li>continue for 60 days. For optimum root kill, do not spray if white flowers or bean elongation are observable, if over 25% of the leaf canopy is damaged due to insects, disease or hail, if soil temperatures are less than 75 deg. I ft. deep, or if new vegetative growth is present due to recent rains.</li> </ul>	
	Tank mix Remedy with Banvel	L 1⁄2 to 1 pt. (1⁄4 to 1⁄2 lb.) Remedy + 1⁄2 to 1 pt. (1⁄4 to 1⁄2 lb.) Banvel	M 1⁄2 % Remedy + 1⁄2 % Banvel			
	Tank mix Remedy with Reclaim (see remarks)	M to H <sup>1</sup> /4 to 1 pt. (1/8 to 1/2 lb.) Remedy + <sup>1</sup> /3 to <sup>2</sup> /3 pt. (1/8 to 1/4 lb.) Reclaim	VH ½% Remedy + ½% Reclaim			
	Tank mix Tordon 22K with Banvel	M I to 2 pts. (¼ to ½ lb.) Tordon 22K + ½ to I pt. (¼ to ½ lb.) Banvel	H 1⁄2 % Tordon 22K + 1⁄2 % Banvel			
	Tank mix Tordon 22K with Reclaim	M to H I to 2 pts. (¼ to ½ lb.) Tordon 22K + ⅓ to ⅔ qt. (¼ to ½ lb.) Reclaim	VH ½ % Tordon 22K + ½ % Reclaim			

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast, as described for	Time to apply	Remarks
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Mesquite (continued)	Tank mix Remedy, Reclaim and Tordon 22K	M to H** 1/4 to 1/2 pt. (1/8 to 1/4 lb.) Remedy + 1/3 to 2/3 pt. (1/8 to 1/4 lb.) Reclaim + 2 pts. (1/2 lb.) Tordon 22K				Recommended for mixtures of mesquite and pricklypear cactus.
	Reclaim (see remarks)	H ⅔ qt. (½ lb.)	VH 1%		Aug. I to Sept. 30 with a soil temperature of 75°F or more at a depth of 12 inches. Do not apply after a frost has occurred.	Use only in Montague, Wise, Coryell, Lampasas, Burnet, Blanco, Kendall, Bandera, Real, Edwards and Val Verde Counties and those counties north and west of the named counties.
	Tordon 22K		VH I gal. (2 lbs.)	Applied with a carpeted roller.	Late spring throughMuAugust with maturetalleaves (dark green color).roBest control duringstatthe period that beginsof	Mesquite should be less than 6 ft. tall and should pass under carpeted roller without breaking the main stem. Mix recommended quantity of herbicide with water to make
	Reclaim		VH ⅔ gal. (2 lbs.)	_		
	Tank mix Tordon 22K with Reclaim	nk mix Tordon 22K with cclaim 2 qts. (1 lb.) Tordon 22K + 1 <sup>1</sup> / <sub>3</sub> qt. (1 lb.) Reclaim		when soil temperature at a depth of 12 inches reaches 75°F and continued for 45 days thereafter; when Reclaim is used alone or in a tank mix the period should continue for 60 days after soil temperature reaches 75°F.	8 gals. of mixture.Add 3 to 6 ozs. of surfactant for each 8 gals. mixed.	
Mesquite, western honey	Tank mix Remedy with Reclaim		VH I/2 % Remedy + I/2 % Reclaim	Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in- water emulsion). Oil-in-water emulsion requires use of emulsifier.	Begin spraying in the spring after the soil temperature has reached 75°F, at 12 in. deep. This often coincides with the change in color of the foliage from a light pea green to a uniform dark green. The spray period will last through September.	Western honey mesquite is most common in the western portion of the Trans-Pecos region of Texas. This variety of mesquite is not usually killed by broadcast sprays.

Brush controlled	Herbicide (common and chemical names	Herbicid (active ingredient	e quantity rate in parenthesis)	Spray volume (per acre for broadcast, as described for	Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Mixed brush (South Texas - will include several of the following: blackbrush, catclaw acacia, guajillo, granjeno or spiny hackberry, huisache, mesquite, pricklypear, retama, skunkbush, tasajillo, twisted acaciaTank mix Tordon 22K with ReclaimTank mix Tordon 22K with ReclaimTank mix Tordon 22K with Reclaim	Tank mix Tordon 22K with Remedy	M** 2 pts. (½ lb.) Tordon 22K + I pt. (½ lb.) Remedy	H 1/2 % Tordon 22K + 1/2 % Remedy	4 gals. oil-in-water emulsion as aerial spray (1 qt. to 1 gal. diesel fuel oil and water to make 4 gals./acre; a 1 to 5 oil	Late spring to mid- summer with mature leaves (dark green color). Optimum period	The mixture of I qt.Tordon 22K plus <sup>3</sup> / <sub>3</sub> qt. Reclaim will usually provide better results than the I qt.Tordon 22K plus <sup>1</sup> / <sub>3</sub> qt. Reclaim mixture. Mixtures will control most weeds. When using oil-in-water emulsion, use emulsifier added to oil for proper emulsion.
	Tank mix Tordon 22K with Reclaim	M I qt. (½ lb.) Tordon 22K + ⅓ to ⅔ qt. (¼ to ½ lb.) Reclaim	H 1⁄2 % Tordon 22K + 1⁄2 % Reclaim	to water ratio is considered optimum); 20 to 25 gals. oil- in-water emulsion (½ to I gal. diesel fuel oil and water to make 20 to 25 gals./acre) or 20 to 25 gals. water/acre	of application begins when soil temperature at a depth of 12 inches reaches 75°F and continues for 45 days thereafter: with the	
	Tank mix Tordon 22K with Banvel	M 2 pts. (½ lb.) Tordon 22K + I pt. (½ lb.) Banvel	H 1⁄2 % Tordon 22K + 1⁄2 % Banvel	plus surfactant per 100 gals. water) as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion). Oil-in-water emulsion requires use of emulsifier.	Reclaim tank mix the period should continue for 60 days after soil temperature reaches 75°F. If mesquite has 10% canopy cover or less, application may be made in spring or fall.	
Mixed brush - Davis Mountains (includes catclaw acacia, catclaw mimosa and whitebrush)	Spike 20P	M** 7.5 to 10 lbs. of pellets (1.5 to 2 lbs.)	H ½ oz. of pellets (½ oz.) per 50 to 100 sq. ft.		Anytime during year- optimum period is May I to July I.	Use 10 lbs. of pellets/acre when soil is a loam, silt loam, silt, sandy clay loam or clay loam. Use low rate when soil is a sand, loamy sand or sandy loam. For individual plant treatment apply pellets evenly on soil under the plant canopy and 1 ft. beyond the canopy edge.
Mohrs shinoak	Spike 20P	VH 5 lbs. of pellets (1 lb.)	VH ½ oz. of pellets (¼o oz.) per 100 sq. ft.		Anytime during year– optimum period is Oct. I to April I.	Use only when oak stand is predominantly Mohrs shinoak. These stands are generally found in Taylor, Nolan, Coke, Sterling and Mitchell counties. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and I ft. beyond canopy edge.

Brush controlled	Herbicide (common and chemical names	Herbicide (active ingredient i	Herbicide quantity (active ingredient rate in parenthesis)		Time to apply	Remarks
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)		
Pricklypear, tasajillo	Tordon 22K	H** I pt. to I qt. (¼ to ½ lb.)	VH 1%	2 to 4 gals. oil-in-water emulsion as aerial spray	Anytime; best results have been obtained with late summer through fall applications.	Use emulsifier added to oil for proper emulsion. Use 1 pt./acre Tordon 22K only on High Plains where no brush overstory is present. Late summer or fall
	Surmount	H 4 pt. (0.67 lb.)	VH 1%	(1 pt. to 1 gal. diesel fuel oil and water to make 2 to 4 gals /acre: a 1 to 5 oil to		
	Grazon P+D	H I gal. (2.5 lbs.)	VH 2%	4 gals./acre; a 1 to 5 oil to water ratio is considered optimum); 20 to 25 gals. oil-in-water emulsion (½ to 1 gal. diesel fuel oil and water to make 20 to 25 gals./acre) as ground broadcast or 20 to 25 gals. of water/acre (with 1 to 2 qts. of surfactant per 100 gals. of water) as ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. surfactant per 100 gals. of water or 5 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion). Oil-in- water emulsion requires use of emulsifiar		application will provide best results. Aerially spray in the winter if heavy overstory of woody plants is present or if damage to live oak is a concern.
	Gramoxone Extra		L 3%	Complete coverage of pricklypear plant is essential.	May through September when sun is shining and/or when sunshine is expected for several days.	Most grass and other herbaceous plants sprayed with Gramoxone Extra will be damaged and may be killed.
	Tank mix Tordon 22K with Gramoxone Extra		VH I% Tordon 22K + 3% Gramoxone Extra			Gramoxone Extra is a restricted use pesticide because of acute toxicity. Carefully read and follow use directions on label.

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks	
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)			
Pricklypear, tasajillo (continued)	Prescribed burn + Tordon 22K	VH <sup>***</sup> <sup>1</sup> ⁄ <sub>2</sub> pt. to I pt. (1∕8 to <sup>1</sup> ⁄4 lb.)	VH 1%	For individual plant treatment, thoroughly wet all pads and crowns that survive the fire. Use a water carrier and add 1-2 qts. surfactant/100 gals. of water.	After burn, when new pads are 3 in. tall. If new pads do not develop spray by April 30.	Carry out prescribed burn between December and March. Sufficient fine fuel with good fuel continuity should be present to provide a uniform burn with moderate to high intensity. Spray the burned area within 5 months of the burn but no later than April 30 (May 31 if new pads do not develop by April 30). Use ½ pt.Tordon 22K when the prescribed burn is sufficiently intense to brown-out most pricklypear pads with less than 10 percent of the pricklypear green 2 weeks after the burn. Use 1 pt.Tordon 22K following moderate intensity burn with more than 10 percent of the pricklypear green 2 weeks after the burn. The prescribed burn plus Tordon 22K treatment is not recommended for the Rio Grande Plains land resource area.	
Redberry juniper (redberry cedar)	Velpar L (plants less than 6 ft. tall) Pronone Power Pellet (plants less than 6 ft. tall) Velpar L (plants more than 6 ft. tall) Pronone Power Pellet (plants more than 6 ft. tall)		VH 2 ml. per 3 ft. of height or canopy diameter (whichever is greater) VH I pellet per 3 ft. of height or canopy diameter (whichever is greater) H 4 ml. per 3 ft. of height or canopy diameter (whichever is greater) H 2 pellets per 3 ft. of height or canopy diameter (whichever is greater)		Late winter through summer.	Apply undiluted Velpar L or Pronone Power Pellets to soil surface between the stem base and the edge of the canopy. Use an exact delivery handgun applicator to apply Velpar L. If plant size requires more than a single 2 or 4 ml. application of Velpar L, or I Pronone Power Pellet, apply subsequent applications or pellets equally spaced around the plant. Do not use these treatments on marshy or poorly drained sites nor on soils classified as clays. Best results are expected on coarse-textured soils.	

Brush controlled	Herbicide (common and chemical names	Herbicide (active ingredient i	e quantity rate in parenthesis)	Spray volume (per acre for broadcast,	Time to apply	Remarks	
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)			
Redberry juniper (redberry cedar) (continued)	Tordon 22K		VH <sup>***</sup> 4 ml. per 3 ft. of height or canopy diameter (whichever is greater)		Spring through fall, before expected rainfall.	Apply undiluted Tordon 22K to the stem base at or near the ground line. Use an exact delivery handgun applicator to apply the 4 ml. dose. If plant size requires more than a single 4 ml. application, space subsequent applications equally around the plant. Do not use on marshy or poorly drained sites nor on soils classified as clays.	
Redberry juniper (cut stumps)	Tordon 22K		VH 4% in water	Spray the sides of the stump and the cut surface, including the cambium, immediately after cutting, to thoroughly wet the stem and root collar area, but not to the point of runoff. Add I to 2 qts. surfactant to 100 gals. spray mix.	Any season of the year, except when snow or water prevent spraying to the ground line.	This is commonly called the cut stump application method. Apply with a backpack or knapsack sprayer using low pressures and a solid cone or flat fan nozzle. Add 1 to 2 qts. surfactant per 100 gals. of water.	
Running Live Oak	Spike 20P	VH 5 to 10 lbs. of pellets (1 to 2 lbs.)	VH ½ oz. of pellets (¼o oz.) per 50 to 100 sq. ft.		Anytime during year- optimum period is Oct. I to April I.	Use low rate on brush 2 to 8 ft. tall. Use 7.5 lbs. of pellets/acre when brush is 2 to 8 ft. tall on rolling or hummocking site and when live oak plants are 8 ft. or taller without understory species such as yaupon. Use 10 lbs. of pellets/acre when live oak plants are taller than 8 ft. and an understory of yaupon and other species is present. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft. beyond canopy edge.	
Sacahuista	Spike 20P		H <sup>1</sup> /4 oz. of pellets (0.05 oz.) per plant		Anytime during year- optimum period is Oct. I to April I except in Trans-Pecos where optimum period is May I to July I.	Apply pellets evenly on the soil under the plant canopy near the stem base.	

Brush controlled	Herbicide (common and chemical names	Herbicide quantity (active ingredient rate in parenthesis)		Spray volume (per acre for broadcast,	Time to apply	Remarks	
	-page 4)	Broadcast rate per acre	Individual plant treatment*	as described for individual plant)			
Saltcedar	Arsenal	VH** 2 qts. (1 lb.)	VH 1%	Minimum 10 gals./acre for aerial or ground broadcast	July through September, or until leaves begin to	When exposure to aquatic environments is possible and tank	
	Tank mix Arsenal with Roundup (glyphosate)	VH I qt. (½ lb.) Arsenal + I pt. (½ lb.) Roundup	VH ½% Arsenal + ½% Roundup	sprays. Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. surfactant per 100 gals. of water.	turn yenow.	mixes of Arsenal herbicide and glyphosate are desirable, use the Rodeo brand of glyphosate. Check Arsenal label for special restrictions on use related to endangered species and grazing restrictions. Arsenal alone or in combination with Rodeo or Roundup will cause damage to grasses, forbs and other desirable trees. These treatment recommendations should only be used to control saltcedar north of Hwy. 90.	
	Tank mix Arsenal with Rodeo (glyphosate)	VH I qt. (½ lb.) Arsenal + 3/4 pt. (½ lb.) Rodeo	VH ½ % Arsenal + ½ % Rodeo				
	Remedy		VH 25% in diesel fuel oil	Apply to lower 12 to 18 inches of trunk to wet the trunk; do not spray to point of runoff.Apply completely around the trunk.	Growing season when plants have mature leaves.	This is commonly called the low volume basal application method. Use a hollow cone nozzle.	
Sand sagebrush	2,4-D low volatile ester	H I qt. (I lb.) 4 lbs./gal. product {up to 2 qts. (2 lbs.) for ground broadcast}	VH I % (4 lbs./gal. product)	2 to 4 gals. oil-in-water emulsion as aerial spray (1 pt. to 1 gal. diesel fuel oil and water to make 2 to 4 gals./acre; a 1 to 5 oil to water	May I to June I5 under good growth conditions with plants fully leafed.	Do not spray when plants are defoliated by late freeze, hail or unfavorable growth conditions.	
	Cimarron Max + 2,4-D low volatile ester	H Rate I Cimarron Max + I pt. (0.5 lb.) 2, 4-D 4 lbs./gal. product		ratio is considered optimum). Ground broadcast 20 to 25 gals. oil-in-water emulsion (I gal. diesel fuel oil and water to make 20 to 25 gals./acre) or 20 to 25 gals. of water/acre with I to 2 qts. of surfactant per 100 gals of water. Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. surfactant per 100 gals. of water or 5 gals. of diesel fuel oil per 100 gals. spray mix (1:19 oil-in-water emulsion). Oil-in-water emulsion requires use of emulsifier.			

Brush controlled	Herbicide (common and chemical names	Herbicide (active ingredient i	e quantity rate in parenthesis)	Spray volume (per acre for broadcast,	Time to apply	Remarks
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Sand shinnery oak	Spike 20P	VH 3.75 to 5 lbs. of pellets (¾ to 1 lb.)	VH ½ oz. of pellets (½ oz.) per ۱00 sq. ft.		Anytime during year- optimum period is Oct. I to April I except in Trans-Pecos where optimum period is May I to July I.	Use 3.75 lbs. of pellets/acre in southern High Plains and Rolling Plains. Use 5 lbs. of pellets/acre in eastern Panhandle north of Prairie Dog Town Fork of the Red River. For individual plant treatment, apply pellets evenly on the soil under the plant canopy and 1 ft. beyond canopy edge.
Whitebrush (beebrush, beebush)	Spike 20P	VH <sup>≉*</sup> 5 to 7.5 lbs. of pellets (I to I ½ lbs.)	VH <sup>1</sup> /2 oz. of pellets (//10 oz.) per 50 to 100 sq. ft.		Anytime during year- optimum period is Oct. I to April I except in Trans-Pecos where optimum period is May I to July I.	Use 5 lbs. of pellets/acre on sand, loamy sand or sandy loam soils. Use 6.25 lbs. of pellets/acre on soils with 20 to 30 percent clay. Use 7.5 lbs. of pellets/acre on areas with grass production greater than 1,500 lbs./ acre or on areas where mesquite, Texas persimmon or other woody plants have a canopy cover of 20 percent or more with whitebrush that is 6 ft. tall or taller. For individual plant treatment apply pellets evenly on the soil under the plant canopy and 1 ft. beyond canopy edge.
Үисса	Remedy		H 2% in diesel fuel oil	Spray the center of each individual whorl of leaves to the point of runoff.	Anytime.	Complete coverage of leaves is not necessary. The crown of each plant must be thoroughly wet with the herbicide mixture.
			H 2% in 1:5 diesel fuel oil: water emulsion	Spray the center of each individual whorl of leaves to the point of runoff.	May through September.	Use emulsifier and agitate to maintain emulsion. Complete coverage of leaves is not necessary.The crown of each plant must be thoroughly wet with the herbicide mixture.
	Remedy		VH I 5% in diesel fuel oil	Use an adjustable cone nozzle (XI orifice), spray a 2 second	Spring and summer.	Direct spray into the center of each plant whorl.
	Pathfinder II		VH Undiluted	burst.		
	Remedy		H Undiluted 2 to 4 ml. per plant whorl	Use an exact delivery handgun set at 2 or 4 ml. per dose.		Using an exact delivery handgun applicator, apply the recommended amount of undiluted Remedy into the center of each plant whorl.

Funding for this publication was provided in part by Dow AgroSciences, Dupont Agricultural Products and BASF.

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Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Interim Director, Texas Cooperative Extension, The Texas A&M University System.

10M, Revision



	Common, Chemical and Product Names	of Herbicides*	
Herbicide common name	Chemical name	Product name	Active ingredient or acid equivalent
Aminopyralid	2-pyridine carboxylic acid, 4-amino-3, 6-dichloro-2-pyrdine carboxylic acid, triisopropanolammonium salt	Milestone	2 lbs./gal.
Aminopyralid 1:8, 2, 4-D	See aminopyralid and 2, 4-D	Forefront	3 lbs./gal.
Clopyralid	3,6-dichloro-2-methoxybenzoic acid	Reclaim, Pyramid R&P	3 lbs./gal.
2,4-D	(2,4-dichlorophenoxy) acetic acid	Weedar 64, Formula 40, Hi-Dep, Weedone LV4, Esteron 99 and others	concentration varies depending on product
Dicamba	3,6-dichloro-2-methoxybenzoic acid	Banvel, Clarity, Vision	4 lbs./gal.
Dicamba:2,4-D(1:3)	See dicamba and 2,4-D	Weedmaster, Banvel + 2,4-D, RangeStar	4 lbs./gal.
Diesel fuel oil or kerosene	refined petroleum fractions	Several manufacturers	
Fluroxypyr	I-methylheptyl ester: ((4-amino-3,5-dichloro-6-fluoropyridin-2-yl)oxy)acetic acid	Vista	1.5 lbs./gal.
Glyphosate	N-(phosphonomethyl) glycine	Several including Rodeo**, Roundup, Roundup Ultradry, Glyposate 417	isopropylamine salt <sup>*</sup> , concentration varies depending on the product
Hexazinone	Hexazinone     3-cyclohexyl-6-(dimethylamino)-I-methyl-I,3,5-triazine-2,4(IH, 3H)-dione     Velpar L, Pronone Power Pellet		2 lbs./gal. (Velpar L) 75% (Pronone Power Pellet)
Imazapyr	2-[4,5-dihydro-4-methyl-4-(I-methylethy)-5-oxo-IH-imidazol-2-yl]-3-pyridinecarboxylic acid	Arsenal, Habitat**	2 lbs./gal.
Metsulfuron methyl	methyl 2[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino] sulfonyl] benzoate	Escort, Clean Pasture, MSM 60DF	60%
Metsulfuron:Chlorosulfuron 3:1	See Metsulfuron methyl + 2-Chloro-N-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl) aminocarbonyl]benzenesulfonamide	Cimarron Plus	48% metsulfuron I 5% Chlorosulfuron
Metsulfuron:Chlorosulfuron 1:1	See metsulfuron: Chlorosulfuron	Cimarron X-Tra	30% Metsulfuron 37.5% Chlorosulfuron
Metsulfuron methyl Dicamba:2,4-D(1:3)	See metsulfuron methyl, vision and 2,4-D	Cimarron Max	60% (Part A) 3.87 lbs./gal. (Part B)
Picloram	4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid	Tordon 22K, Triumph 22K, Picloram 22K	2 lbs./gal.
Picloram:Fluroxypyr(1:1)	See picloram and Fluroxypyr	Surmount	1.34 lbs./gal.
Picloram:2,4-D(1:4)	See Picloram and 2,4-D	Grazon P+D, Gunslinger	2.5 lbs./gal.
Tebuthiuron	N-[5-(1,1-dimethylethy)-1,3,4-thiadiazol-2-yl}-N-N'-dimethylurea	Spike 20P, Spike 80 DF	20% (Spike 20P) 80% (Spike 80 DF)
Triclopyr	{(3,5,6-trichloro-2-pyridinyl)oxy}acetic acid	Clear Pasture, Pathfinder II Remedy Ultra, Triclopyr 4 EC	0.75 lbs./gal. (Pathfinder II) 4 lbs./gal. (all others)
Triclopyr:Fluroxypr (3:1)	See triclopyr and I-methylhepty ester:((4-amino-3,5-dichloro-6-fluoropyridin-2-yl)oxy)acetic acid	PastureGard	2.0 lbs./gal.
Triclopyr:2,4-D(1:2)	See triclopyr and 2,4-D	Crossbow	3 lbs./gal.

\*Herbicides have been identified by the accepted Weed Science Society of America common name, and when practical, one or more product names. \*\*Aquatic label

# Items in gray boxes are recent changes approved by the Rangeland Herbicide Use Committee.

Page	Weed Controlled	Herbicide (common and	Herbicide (active ingredient	e quantity rate in parenthesis)	Spray volume (per acre for broadcast, as	Time to apply	Remarks
		chemical names – page 4)	Broadcast rate per acre	Individual plant/ spot treatment	described for individual plant)		
6	African rue	Velpar L		VH 2 ml/plant	Use an exact delivery handgun to apply undiluted herbicide to soil surface at the edge of the plant canopy.	Spring or summer.	Do not use on heavy clay or caliche soils.
		Pronone Power Pellets		l pellet/plant			
		Spike 20 P	H 7.5 lbs. (1.5 lbs.)				
		Arsenal	H I qt. (0.5 lbs.)	VH 0.5%	10 to 25 gal./ac. for ground broadcast. Thoroughly wet foliage for individual plant treatment. Add 1 to 2 qts. of surfactant per 100 gals. water.	Late September through October (to first frost).	Applications should be made to fall regrowth that is in good growing conditions. Recommend using individual plant treatment when growing with desirable vegetation to reduce non-target damage. Arsenal is a non-selective herbicide and will kill or damage desirable vegetation if sprayed.
7	Broomweed (annual or common),	Escort or Cimarron	VH 0.1 oz.		2 to 4 gals. water for aerial spray; 10 to 25 gals. water for ground	Spring, weeds less than 4 inches tall	
	plantain (tallow weed), wild carrot	Cimarron Plus	VH 0.125 oz.	_	of surfactant per 100 gals. of water.		
		Cimarron X-tra	VH 0.2 oz.				
8	Broom snakeweed (perennial broomweed) (continued)	Escort or Cimarron	VH 0.6 oz.		2 to 4 gals. water for aerial spray; 10 to 25 gals water for ground broadcast application. Add 1 to 2 qts. of surfactant per 100 gals. of water.	Optimum time is in the fall, but may be applied in the spring	
		Cimarron Plus	VH 0.75 oz.			the spring.	
		Cimarron X-tra	VH I.2 oz.				
		Cimarron Max	H to VH Rate I to Rate 2				
		Spike 20P	VH 3.75 lbs. of pellets (¾ lb.)	VH ½ oz. of pellets (½ oz.) per 100 sq. ft.		Any time—optimum period is Oct. I to April I, except in the Trans-Pecos where optimum period is May I to July I.	Use only on sand, loamy sand, sandy loam, loam, silt loam, silt or sandy clay loam soils.
10	Lespedeza	Remedy	VH   to 2 pts. (½ to 1 lb.)		Ground broadcast 20 to 20 gals. per acre with 1 to 2 qts. of surfactant per 100 gals. of water.	June through August under good growing conditions.	Plants need to be 12 to 18 inches tall before spraying. Use the higher rate if plants are large, approaching maturity, or if the infestation level is high.
		Escort or Cimarron	H 0.5 oz.	-			Begin application at flower bud initiation through full bloom.
		Cimarron Plus	H 0.7 oz.				
		Cimarron X-tra	H I.0 oz.				
		Cimarron Max	H Rate 2				

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11	Rayless goldenrod (jimmyweed)	Escort or Cimarron	VH 0.75 oz.		2 to 4 gals. of water for aerial spray; 10 to 25 gals. of water for ground	Fall.	
		Cimarron Plus	VH 1.0 oz.		Thoroughly wet foliage for individual plant treatment. Add I to 2 qts. of surfactant per 100 gals. of water.		
		Cimarron X-tra	VH 1.5 oz.				
		Surmount	VH 6 pt. (1.0 lb.)	VH 2%			
		Tordon 22K	VH I qt. (½ lb.)	VH 1%			
11	Threadleaf Groundsel	Escort or Cimarron	VH 0.4 oz.		2 to 4 gals. of water for aerial spray; 10 to 25 gals. of water for ground broadcast application. Add 1 to 2 qts. of surfactant per 100 gals. of water.		
		Cimarron Plus	VH 0.5 oz.				
		Cimarron X-tra	VH 0.8 oz.				
		Cimarron Max	VH Rate 2				
12	Upright Prairie-coneflower	Escort or Cimarron	VH 0.2 oz.		2 to 4 gals. water for aerial spray; 10 to 25 gals. of water for ground	Spring, before flower stalk development.	
		Cimarron Plus	VH 0.25 oz.		broadcast application. Add 1 to 2 qts. of surfactant per 100 gals. of water.		
		Cimarron X-tra	VH 0.4				
13	Baccharis (dryland willow, Roosevelt willow, seep willow or willow baccharis)	2,4-D low volatile ester	H 3 pts. to 3 qts. (1.5 to 3 lbs.) 4 lb./gal. product	H 1%	4 to 5 gals. of water for aerial spray. 15 to 20 gals. water for ground broadcast. For individual plant treatment thoroughly wet the entire foliage, stems and trunks. Add 1 to 2 qts. of surfactant per 100 gals. of water.	Spring, when leaves are fully expanded and dark green in color.	
		Grazon P+D		H 1%	For individual plant treatment thoroughly wet the entire foliage,		
		Weedmaster		H 1%	stems and trunks. Add I to 2 qts. of surfactant per 100 gals. of water.		

Page	Weed Controlled	Herbicide (common and	Herbicide (active ingredient )	e quantity rate in parenthesis)	Spray volume (per acre for broadcast, as	Time to apply	Remarks
		chemical names – page 4)	Broadcast rate per acre	Individual plant/ spot treatment	described for individual plant)		
22	Mesquite (suppression and weed control)	2,4-D amine or low volatile ester Grazon P+D Weedmaster Cimarron Max Tordon 22K + 2,4-D amine or low volatile ester Banvel + 2,4-D amine or low volatile ester	L 2 to 4 qts. (2 to 4 lbs.) L I to I.5 qts. (0.6 to 0.9 lbs.) L I to I.5 qts. (1 to I.5 qts. (1 to I.5 lbs.) L Rate I to Rate 2 L 0.5 to 0.75 pt. ( <sup>1</sup> / <sub>8</sub> to <sup>3</sup> / <sub>6</sub> lb.) Tordon 22K + I to I.5 qts. (I to I.5 lbs.) 2,4-D, 4 lbs./gal. product L 0.5 to 0.75 pt. ( <sup>1</sup> / <sub>4</sub> to <sup>3</sup> / <sub>8</sub> lb.) Banvel	M 2% (4 lbs./gal. product)	For aerial applications suggested total spray volume is 4 gals./acre. Use oil-in-water emulsion (1 to 5 oil to water ratio considered optimum), or water plus surfactant, crop oil or methylated seed oil. For ground broadcast applications the suggested total spray volume is 10 to 25 gals./acre. Use oil-in-water emulsion (1 to 5 oil to water ratio considered optimum), or water plus surfactant, crop oil or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 1 to 2 qts. of surfactant per 100 gals. of water or an oil-in-water emulsion (5% diesel + 95% water).	Late spring to mid-summer with mature leaves (dark green color). Optimum period of application begins when soil temperature at a depth of 12 inches reaches 75 degrees F and continues for 45 days. If treatment is applied prior to optimum soil temperatures, efficacy will be decreased and multiple applications over a period of years may be necessary to maintain less than 10% canopy.	Treatments will control many weeds. When using oil-in-water emulsion use emulsifier. Use of a treatment with a low control rating may result in multi-stem growth that may be more difficult to control in the future.
			+ <sup>3</sup> / <sub>4</sub> to 1 <sup>1</sup> / <sub>8</sub> qts. ( <sup>3</sup> / <sub>4</sub> to 1 <sup>1</sup> / <sub>8</sub> lbs.) 2,4-D, 4 lbs./gal. product	M 1%			
		Remedy	L I pt. to I qt. (0.5 lb. to I lb.)				
		Banvel	L   pt. to   qt. (0.5 lb. to   lb.)	M 1%			

Page	Weed Controlled	Herbicide (common and	Herbicide (active ingredient i	e quantity rate in parenthesis)	Spray volume (per acre for broadcast, as	Time to apply	Remarks
		chemical names – page 4)	Broadcast rate per acre	Individual plant/ spot treatment	described for individual plant)		
23	Mesquite	Remedy		VH 2% in diesel fuel oil	Apply to the base of the trunk from 12 to 18 inches above the soil surface. Apply until solution puddles on soil surface.	Anytime soil is dry and pulled away from the trunk.	
		Reclaim	M to H <sup>1</sup> ⁄3 qt. to <sup>2</sup> ⁄3 qt. ( <sup>1</sup> ⁄4 to <sup>1</sup> ⁄2 lb.)	VH 1%	For aerial applications suggested total spray volume is 4 gals./acre. Use oil-in-water emulsion (1 to 5 oil to water ratio considered optimum), or water plus surfactant, crop oil or methylated seed oil. For ground broadcast applications the suggested total spray volume is 10 to 25 gals./acre. Use oil-in-water emulsion (1 to 5 oil to water ratio considered optimum), or water plus surfactant, crop oil or methylated seed oil. Thoroughly wet foliage for individual plant treatments. Add 1 to 2 qts. surfactant per 100 gals. of water or an oil-in-water emulsion (5% diesel + 95% water).	Late spring to mid-summer with mature leaves (dark green color). Optimum	Use I pt./ac.Tordon 22K plus ½ pt./ac. Remedy, ½ pt./ac. Banvel plus ½ pt./ac. Remedy, I pt./ac.Tordon 22K plus ½ pt./ac.
		Remedy + Tordon 22K	M <sup>1</sup> / <sub>2</sub> to 1 pt. (1/4 to <sup>1</sup> / <sub>2</sub> lb.) Remedy + 1 to 2 pts. (1/4 to <sup>1</sup> / <sub>2</sub> lb.) Tordon 22K	M to H ½% Remedy + ½% Tordon 22K		when soil temperature at a depth of 12 inches reaches 75 degrees F and continues for 45 days thereafter. When Reclaim is used alone or in a tank mix the period should continue for 60 days. For optimum root kill do not spray if white flowers or bean elongation are observable, if over 25% of the leaf canopy is damaged due to insects, disease or hail, if soil temperatures are less than 75 degrees F, I ft. deep, or if new vegetative growth is present due to recent rains.	Baivel, 1 pt./ac. for only 22K pitos /3 qt./ac. Reclaim and <sup>1</sup> / <sub>3</sub> qt./ac. Reclaim only in West Texas. Banvel and Banvel mixtures have been more effective in West Texas than in other parts of the state. Use mixtures that include <sup>1</sup> / <sub>4</sub> pt./ac. Remedy and <sup>1</sup> / <sub>3</sub> pt/ac. Reclaim only in Montague, Wise, Parker, Hood, Somervell, Bosque, Coryell, Lampasas, Burnet, Blanco, Kendall, Bandera, Real, Edwards and Val Verde counties and those counties north and west of the named counties. Mixtures that include <sup>1</sup> / <sub>2</sub> pt./ac. Remedy and <sup>2</sup> / <sub>3</sub> pt./ac. Reclaim will give better control than mixtures with <sup>1</sup> / <sub>4</sub> pt./ac. Remedy and <sup>1</sup> / <sub>3</sub> pt./ac. Reclaim. When using oil-in-water emulsion, use emulsifier added to oil for proper emulsion. Use of a treatment with a low- control rating may result in a multi-stem growth form that may be more difficult to control in the future.
		Remedy + Banvel	L 1/2 to 1 pt. (1/4 to 1/2 lb.) Remedy + 1/2 to 1 pt. (1/4 to 1/2 lb.) Banvel	M 1⁄2% Remedy + 1⁄2% Banvel			
		Remedy + Reclaim	M to H <sup>1</sup> / <sub>4</sub> to 1 pt. ( <sup>1</sup> / <sub>8</sub> to <sup>1</sup> / <sub>2</sub> lb.) Remedy + <sup>1</sup> / <sub>3</sub> to <sup>2</sup> / <sub>3</sub> pt. ( <sup>1</sup> / <sub>8</sub> to <sup>1</sup> / <sub>2</sub> lb.) Reclaim	VH ½% Remedy + ½% Reclaim			
		Tordon 22K + Banvel	M I to 2 pts. (¼ to ½ lb.) Tordon 22K +½ to I pt. (¼ to ½ lb.) Banvel	H 1⁄2% Remedy + 1⁄2% Banvel			
		Tordon 22K + Reclaim	M to H I to 2 pts. (¼ to ½ lb.) Tordon 22K + ⅓ to ⅔ qt. (¼ to ½ lb.) Reclaim	VH ½% Tordon 22K + ½% Reclaim			
26	Pricklypear, tasajillo	Tordon 22K	H   pt. to   qt. (¼ lb. to ½ lb.)	VH 1%	2 to 4 gals. oil-in-water emulsion as aerial spray (a 1 to 5 diesel fuel oil to water ratio is considered optimum).	Anytime; best results have been obtained with late summer through fall	Use emulsifier when adding diesel fuel oil to water. Use I pt./ac.Tordon 22K only on High Plains where no brush overstory is
		Surmount	H I pt. to I qt. (¼ lb. to ½ lb.)	VH 1%	20 to 25 gals. oil-in water emulsion as ground broadcast (1 gal. diesel fuel oil per 20 to 25 gals. water) or 20 to 25 gals. water per acre plus 1 to 2 qts. surfactant per 100 gals. water). Thoroughly wet plants for individual	applications.	present. Late summer or fall applications, especially with Vista, will provide best results, but aerially spray in the winter or early spring if heavy overstory of woody
		Grazon P+D	H I gal. (2.5 lbs.)	VH 2%		plants is prese is a concern.	plants is present or if damage to live oak is a concern.
	V	Vista		VH I%	plant treatment adding 1 to 2 qts. surfactant per 100 gals. of spray mix.		
		Gramoxone Extra	These two treatments a	are deleted from B-1466.			
		Tank mix Tordon 22K with Gramoxone Extra					

Page	Weed Controlled	Herbicide (common and	Herbicide	e quantity rate in parenthesis)	Spray volume (per acre for broadcast, as	Time to apply	Remarks
		chemical names – page 4)	Broadcast rate per acre	Individual plant/ spot treatment	described for individual plant)		
29	Saltcedar	Arsenal	VH 2 qts. (1 lb.)	VH 1%	Minimum 10 gals./acre for aerial or ground broadcast sprays. Thoroughly	July through September or until leaves begin to turn	When exposure to aquatic environments is possible use aquatic labels of Arsenal and
		Arsenal + Roundup	VH I qt. (½ lb.) Arsenal + I pt. (½ lb.) Roundup	VH ½% Arsenal + ½% Roundup	treatment. Add I to 2 qts. of surfactant per 100 gals. water.	yellow.	Roundup (see table "Common, Chemical and Product Names of Herbicides"). Arsenal alone or in combination with Roundup will cause damage to desirable
		Remedy		VH 25% in diesel fuel oil	Apply to lower 12 to 18 inches of trunk to wet the trunk; do not spray to point of runoff. Apply completely around the trunk.	Growing season when leaves have mature leaves.	This is commonly called the low volume basal application method. Use a hollow cone nozzle with XI orifice.
		Tank mix Arsenal with Rodeo (glyphosate)			This recommendation is deleted, and mo	oved to the remarks section.	
30	Yucca	Remedy		H 2% in diesel fuel oil	Spray the center of each individual whorl of leaves to the point of runoff	Anytime	Complete coverage of leaves is not necessary. The crown of each plant must be thoroughly wetted with the herbicide mixture.
				H 2% in I:5 diesel fuel oil:water emulsion		May through September.	Use emulsifier and agitate to maintain emulsion. Complete coverage of leaves is not necessary. The crown of each plant must be thoroughly wetted with the herbicide mixture.
				VH 15% in diesel fuel oil	Use an adjustable cone nozzle (XI orifice) and spray a 2 second burst into each whorl.	Spring and summer.	Direct spray into the center of each whorl.
				H Undiluted 2 to 4 ml./plant whorl	Use an exact delivery handgun set at 2 or 4 ml. per whorl dose.		
		Pathfinder II		VH Undiluted	Use an adjustable cone nozzle (XI orifice) and spray a 2 second burst into each whorl.		
		Cimarron Max + 2,4-D low volatile ester	H Rate 2 Cimarron Max + I pt. to I.5 pts. 2,4-D (4 lb. a.i./gal. product)		Crop oil concentrate, modified seed oil or modified seed oil/ organosilicone are the preferred adjuvants. For aerial applications a minimum of 4 gals./ac. total spray volume is recommended.	Spring through fall prior to frost.	A second follow-up application of Cimarron Max at Rate 1 or Rate 2 plus 2,4-D low volatile ester at 0.5 to 0.75 lbs. a.i./ac. within 2 years of the initial application may be required to control yucca seedlings and regrowth from rootstocks
New	Burrobrush	Tordon 22K		VH I%	Thoroughly wet foliage for individual plant treatment.	April through July.	
		Grazon P+D		VH 2%			

Funding for this publication was provided in part by Dow AgroSciences, Dupont Agricultural Products and BASF.

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Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Director, Texas Cooperative Extension, The Texas A&M University System.

# Specimen Label





# Herbicide

For control of annual and perennial weeds and woody plants in forests, non-crop sites, and in and around aquatic sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression and grazed areas on these sites.

Avoid contact of herbicide with foliage, green stems, exposed nonwoody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Active Ingredient(s):

glyphosate<sup>†</sup> N-(phosphonomethyl)glycine,

isopropylamine salt	53.8%
Inert Ingredients	46.2%
Total Ingredients	100.0%

<sup>†</sup>Contains 5.4 pounds per gallon glyphosate, isopropylamine salt (4 pounds per gallon glyphosate acid).

EPA Reg. No. 62719-324

# Keep Out of Reach of Children CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

# **Precautionary Statements**

# Hazards to Humans and Domestic Animals

### Harmful If Inhaled

Avoid breathing spray mist. Remove contaminated clothing and wash before reuse. Wash thoroughly with soap and water after handling.

# Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- · Long-sleeved shirt and long pants
- · Shoes plus socks.

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

# **Engineering Controls**

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

# User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

# **First Aid**

If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouthto-mouth if possible. Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

# **Environmental Hazards**

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of leak or spill, soak up and remove to a landfill.

# **Physical or Chemical Hazards**

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

Do not mix, store or apply this product or spray solutions of this product in galvanized steel or unlined steel (except stainless steel) containers or spray tanks. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas, which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

Notice: Read the entire label. Use only according to label directions. Before using this product, read Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.pagegr3.cofr416

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

### **Directions for Use**

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

### This is an end-use product. Dow AgroSciences does not intend and has not registered it for reformulation. See individual container label for repackaging limitations.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

### Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves made of any waterproof material
- Shoes plus socks

### Storage and Disposal

Do not contaminate water, food, feed or seed by storage or disposal. **Pesticide Storage: Store above 10°F (-12°C) to keep product from crystallizing.** Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using.

**Pesticide Disposal:** Wastes resulting from use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state or local procedures.

**Container Disposal:** Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed. Do not reuse this container. Triple rinse (or equivalent). Then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

# General Information (How this product works)

This product is a water-soluble liquid, which mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants. This product is intended for control of annual and perennial weeds and woody plants in forests, pine straw plantations, non-crop sites such as utility rights-of-way, and in and around aquatic sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression and grazed areas on these sites.

The active ingredient in this product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days, 7 days or more on most perennial weeds, and 30 days or more on most woody plants. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects include gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product and surfactant within the recommended range when vegetation is heavy or dense, when treating dense multi-canopied sites or woody vegetation or difficult-to-control herbaceous or woody plants.

Do not treat weeds, brush or trees under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced control of target vegetation may also occur if foliage is heavily covered with dust at the time of treatment.

Reduced control may result when applications are made to woody plants or weeds following site disturbance or plant top growth removal from grazing, mowing, logging or mechanical brush control. For best results, delay treatment of such areas until resprouting and foliar growth has restored the target vegetation to the recommended stage of growth for optimum herbicide exposure and control.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

This product does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

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**Note:** The maximum rates stated throughout this product's labeling apply to this product combined with the use of all other herbicides containing glyphosate or sulfosate as the active ingredient, whether applied as mixtures or separately. Calculate the application rates and ensure that the total use of this and other glyphosate or sulfosate containing products does not exceed the maximum use rates.

**Grazing Restrictions:** This product may be used to treat undesirable vegetation in utility rights-of-way that pass through pastures, rangeland, and forestry sites that are being grazed. For tank mix applications, comply with all restrictions appearing on the tank mix product label.

Except for lactating dairy animals there are no grazing restrictions following the labeled applications of this product.

- For lactating dairy animals there are no grazing restrictions for the following labeled applications of this product:
  - Where the spray can be directed onto undesirable woody brush and trees, such as in handgun spray-to-wet or low volume directed spray treatments.
  - For tree injection of frill applications and for cut stump treatments
- For broadcast applications, observe the following restrictions for lactating dairy animals:
  - For application rates of greater than 4.5 but not to exceed 7.5 quarts per acre, no more than 15 percent of the available grazing area may be treated.
  - For application rates that do not exceed 4.5 quarts per acre, no more than 25 percent of the available grazing area may be treated.
- These restrictions do not apply to pastures, rangeland or forestry sites outside of utility rights-of-way.

**NOTE:** Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

### ATTENTION: Avoid drift. Extreme care must be used when applying this product to prevent injury to desirable plants and crops.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. Avoid applying at excessive speed or pressure.

# Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications, public health uses or to applications using dry formulations.

- 1. The distance of the outer most nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
- Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following **Aerial Drift Reduction Advisory Information**:

**Importance of Droplet Size:** The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversion section of this label).

**Controlling Droplet Size:** Volume-Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows product larger droplets.

Pressure-Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.

Number of nozzles-Use the minimum number of nozzles that provide uniform coverage.

Nozzle Orientation-Orienting nozzles so that the spray is released backwards, parallel to the airstream will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

Nozzle Type-Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.

Boom Length-For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application-Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

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Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2-10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. Note: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a temperature inversion, because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a connected cloud (under low wind conditions) indicates an inversion, while smoke that moves upwards and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

### Mixing And Application Instructions

Apply these spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes. Hand-gun applications should be properly directed to avoid spraying desirable plants. Note: reduced results may occur if water containing soil is used, such as water from ponds and unlined ditches.

### Mixing

This product mixes readily with water. Mix spray solutions of this product as follows:

- Fill the mixing or spray tank with the required amount of water while adding the required amount of this product (see "Directions for Use" and "Weeds Controlled" sections of this label).
- Near the end of the filling process, add the required surfactant and mix well. Remove hose from tank immediately after filling to avoid siphoning back into the water source.

**Note:** If tank mixing with Garlon<sup>®</sup> 3A herbicide, ensure that Garlon 3A is well mixed with at least 75 percent of the total spray volume before adding this product to the spray tank to avoid incompatibility.

During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, place the filling hose below the surface of the spray solution (only during filling), terminate by-pass and return lines at the bottom of the tank, and, if needed, use an approved anti-foam or defoaming agent.

Keep by-pass line on or near bottom of tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh. Carefully select correct nozzle to avoid spraying a fine mist. For best results with conventional ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

**IMPORTANT:** When using this product, unless otherwise specified, mix with a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. For conifer release (pine release) use only surfactants that are approved for conifer release, and specified on the surfactant label as safe for use in conifer release (pine release). Always read and follow the manufacturer's surfactant label recommendations for best results.

Colorants or marking dyes approved for use with herbicides may be added to spray mixtures of this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilutions. Use colorants or dyes according to the manufacturer's label recommendations.

Clean sprayer and parts immediately after using this product by thoroughly flushing with water and dispose of rinsate according to labeled use or disposal instructions.

Carefully observe all cautionary statements and other information appearing in the surfactant label.

# **Application Equipment And Techniques**

ATTENTION: AVOID DRIFT. EXTREME CARE MUST BE EXERCISED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift, or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to crops, plants, or other areas on which the treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

**Note:** Use of this product in a manner not consistent with this label may result in injury to persons, animals, or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

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Specimen Label Revised 12-14-06

### **Aerial Equipment**

See the supplemental label for use of this product by air in California.

For control of weed or brush species listed in this label using aerial application equipment: For aerial broadcast application, unless otherwise specified, apply the rates of this product and surfactant recommended for broadcast application in a spray volume of 3 to 20 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. Aerial applications of this product may only be made as specifically recommended in this label. For aerial application of this product in California, refer to Federal supplemental label for this product entitled "For Aerial Application in California Only". In California, aerial application may be made in aquatic sites and noncrop areas, including aquatic sites present in noncrop areas that are part of the intended treatment.

Forestry and Utility Rights-of-Way Sites: It is recommended that this product be applied by helicopter only in forestry sites and utility rights-of-way. Apply the rate of this product and surfactant recommended for broadcast sprays in a spray volume of 5 to 30 gallons per acre.

In California, aerial application may be made only in non-residential, forestry sites or chaparral areas.

AVOID DRIFT. Do not apply during inversion conditions, when winds are gusty or under any other condition which will allow drift. Drift may cause damage to any vegetation contacted to which treatment is not intended. To prevent injury to adjacent desirable vegetation, appropriate buffer zones must be maintained.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing in the additive label. The use of a drift control agent for conifer and herbaceous release applications may result in conifer injury and is not recommended.

**Ensure uniform application.** To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Thoroughly wash aircraft, especially landing gear, after each day of spraying to remove residues of this product accumulated during spraying or from spills. Prolonged exposure of this product to uncoated steel surfaces may result in corrosion and possible failure of the part. Landing gear are most susceptible. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion.

# Ground Broadcast Equipment

For control of weed or brush species listed in this label using conventional boom equipment: For ground broadcast application, unless otherwise specified, apply the rates of this product and surfactant recommended for broadcast application in a spray volume of 3 to 30 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. As density of vegetation increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select correct nozzle to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

**Forestry and Utility Rights-of-Way Sites:** This product is recommended for broadcast applications using suitable ground equipment in forestry sites, utility sites, and utility rights-of way. Apply the recommended rates of this product and surfactant in a spray volume of 10 to 60 gallons per acre. Check for even distribution of spray droplets.

# Hand-Held and High-Volume Equipment (Use Coarse Sprays Only)

For control of weeds listed in this label using knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements:

**High volume sprays:** Prepare a **3/4 to 2 percent solution** of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "Weeds Controlled" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

Low volume directed sprays: This product may be used as a 5 to 10 percent solution in low-volume directed sprays for spot treatment of trees and brush. This treatment method is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, openbranched trees need only be treated from one side. If the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

Prepare the desired volume of spray solution by mixing the amount of this product in water, shown in the following table:

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Desired	Amount of this product									
Volume	3/4%	1%	1 1/4%	1 1/2%	2%	5%	8%	10%		
1 gal	1 fl oz	1 1/3 fl oz	1 2/3 fl oz	2 fl oz	2 2/3 fl oz	6 1/2 fl oz	10 1/4 fl oz	12 3/4 fl oz		
25 gal	1 1/2 pt	1 qt	1 1/4 qt	1 1/2 qt	2 qt	5 qt	2 gal	2.5 gal		
100 gal	3 qt	1 gal	1 1/4 gal	1 1/2 gal	2 gal	5 gal	8 gal	10 gal		

2 tablespoons = 1 fluid ounce

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill the knapsack sprayer with the mixed solution and add the correct amount of surfactant.

# Selective Equipment

This product may be applied through shielded sprayers or wiper application equipment. This equipment may be used to selectively control undesirable vegetation without harming desirable vegetation.

Shielded sprayers direct the herbicide solution onto weeds while shielding desirable vegetation from the spray solution. Any recommended rate or tank mixture of this product may be used employing this equipment.

Wiper applicators physically wipe product directly onto undesirable vegetation. Care should be taken to avoid wiping desirable vegetation. Use a 33 to 100 percent solution of this product, diluted in water for wiper applications. Use a 33 percent solution for wick or gravity feed systems. Higher concentrations may be used in pressurized systems that are capable of handling thicker solutions. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

# Weeds Controlled

### **Annual Weeds**

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

**Broadcast Application Rates:** For weeds less than 6 inches tall, use 1 1/2 pints of this product per acre plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus a non-ionic surfactant containing 80% or greater active ingredient.

Hand-Held, High-Volume Application Rates: Use a 3/4 percent solution of this product in water plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Apply to foliage of vegetation to be controlled.

When applied as directed, this product plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient will control the following annual weeds:

### Common Name

Balsamapple<sup>†</sup> Barley Barnyardgrass Bassia, fivehook Bluegrass, annual Bluegrass, bulbous Brome Buttercup Cheat Chickweed, mouseear Cocklebur Corn. volunteer Craborass Dwarfdandelion Falseflax, smallseed Fiddleneck Flaxleaf fleabane Fleabane Foxtail Foxtail, Carolina Groundsel, common Horseweed/Marestail Kochia Lambsquarters, common Lettuce, prickly Morningglory Mustard, blue Mustard, tansv Mustard, tumble Mustard, wild Oats, wild Panicum Pennycress, field Pigweed, redroot Pigweed, smooth Ragweed, common Ragweed, giant Rocket, London Rye Ryegrass, Italian # Sandbur, field Shattercane Shepherd's-purse Signalgrass, broadleaf Smartweed, Pennsylvania Sowthistle, annual Spanishneedles <sup>tt</sup> Stinkgrass Sunflower Thistle, Russian Spurry, umbrella

#### Scientific Name

Momordica charantia Hordeum vulgare Echinochloa crus-galli Bassia hyssopifolia Poa annua Poa bulbosa Bromus spp. Ranunculus spp. Bromus secalinus Cerastium vulgatum Xanthium strumarium Zea mavs Digitaria spp. Krigia cespitosa Camelina microcarpa Amsinckia spp. Conyza bonariensis Erigeron spp. Setaria spp. Alopecurus carolinianus Senecio vulgaris Convza canadensis Kochia scoparia Chenopodium album Lactuca serriola Ipomoea spp. Chorispora tenella Descurainia pinnata Sisymbrium altissimum Sinapis arvensis Avena fatua Panicum spp. Thlaspi arvense Amaranthus retroflexus Amaranthus hybridus Ambrosia artemisiifolia Ambrosia trifida Sisymbrium irio Secale cereale Lolium multiflorum Cenchrus spp. Sorahum bicolor Capsella bursa-pastoris Brachiaria platyphylla Polygonum pensylvanicum Sonchus oleraceus Bidens bipinnata Eragrostis cilianensis Helianthus annuus Salsola kali Holosteum umbellatum

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Common Name Velvetleaf Wheat Witchgrass Scientific Name Abutilon theophrasti Triticum aestivum Panicum capillare

<sup>†</sup>Apply with hand-held equipment only.

"Apply 3 pints of this product per acre.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

# Perennial Weeds

Apply this product to control most vigorously growing perennial weeds. Unless otherwise directed, apply when target plants are actively growing and most have reached early head or early bud stage of growth. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

**NOTE:** If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

Specific Weed Control Recommendations: For perennial weeds, apply the recommended rate plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

When applied as directed, this product plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient will control the following perennial weeds: (Numbers in parentheses "(-)" following common name of a listed weed species refer to "Specific Perennial Weed Control Recommendations" for that weed which follow the species listing.)

### Common Name

Alfalfa (31) Alligatorweed (1) Anise/Fennel (31) Artichoke, Jerusalem (31) Bahiagrass (31) Bermudagrass (2) Bindweed, field (3) Bluegrass, Kentucky (12) Blueweed, Texas (3) Brackenfern (4) Bromegrass, smooth (12) Canarygrass, reed (12) Cattail (5) Clover, red (31) Clover, white (31) Cogongrass (6) Cordgrass (7) Cutgrass, giant \* (8) Dallisgrass (31) Dandelion (31) Dock, curly (31) Dogbane, hemp (9)

### Scientific Name

Medicago sativa Alternanthera philoxeroides Foeniculum vulgare Helianthus tuberosus Paspalum notatum Cynodon dactylon Convolvulus arvensis Poa pratensis Helianthus ciliaris Pteridium spp. Bromus inermis Phalaris arundinacea Typha spp. Trifolium pratense Trifolium repens Imperata clylindrica Spartina spp. Zizaniopsis miliacea Paspalum dilatatum Taraxacum officinale Rumex crispus Apocynum cannabinum

Fescue (31) Fescue, tall (10) Guineagrass (11) Hemlock, poison (31) Horsenettle (31) Horseradish (9) Ice Plant (22) Johnsongrass (12) Kikuyugrass (21) Knapweed (9) Lantana (13) Lespedeza, common (31) Lespedeza, sericea (31) Loosestrife, purple (14) Lotus, American (15) Maidencane (16) Milkweed (17) Muhly, wirestem (21) Mullein, common (31) Napiergrass (31) Nightshade, silverleaf (3) Nutsedge, purple (18) Nutsedge, yellow (18) Orchardgrass (12) Pampasorass (19) Paragrass (16) Phragmites<sup>tt</sup> (20) Quackgrass (21) Reed, giant (22) Ryegrass, perennial (12) Smartweed, swamp (31) Spatterdock (23) Starthistle, yellow (31) Sweet potato, wild † (24) Thistle, artichoke (25) Thistle, Canada (25) Timothy (12) Torpedograss <sup>†</sup>(26) Tules, common (27) Vaseygrass (31) Velvetgrass (31) Waterhyacinth (28) Waterlettuce (29) Waterprimrose (30) Wheatgrass, western (12) Festuca spp. Festuca arundinacea Panicum maximum Conium maculatum Solanum carolinense Armoracia rusticana Mesembryanthemum crystallinum Sorahum halepense Pennisetum clandestinum Centaurea repens Lantana camara Lespedeza striata Lespedeza cuneata Lythrum salicaria Nelumbo lutea Panicum hematomon Asclepias spp. Muhlenbergia frondosa Verbascum thapsus Pennisetum purpureum Solanum elaeagnifolium Cyperus rotundus Cyperus esculentus Dactylis glomerata Cortaderia iubata Brachiaria mutica Phragmites spp. Agropyron repens Arundo donax Lolium perenne Polygonum coccineum Nuphar luteum Centaurea solstitialis Ipomoea pandurata Cynara cardunculus Cirsium arvense Phleum pratense Panicum repens Scirpus acutus Paspalum urvillei Holcus spp. Eichornia crassipes Pistia stratiotes Ludwigia spp. Agropyron smithii

<sup>†</sup>Partial control.

<sup>11</sup> Partial control in southeastern states. See "Specific Weed Control Recommendations" below.

### **Specific Perennial Weed Control Recommendations:**

- Alligatorweed: Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.
- 2. Bermudagrass: Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seedheads appear.

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- 3. Bindweed, field / Silverleaf Nightshade / Texas Blueweed: Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.
- Brackenfern: Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.
- 5. Cattail: Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.
- 6. Cogongrass: Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.
- 7. Cordgrass: Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.
- 8. Cutgrass, giant: Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10-leaf stage prior to retreatment.
- Dogbane, hemp / Knapweed / Horseradish: Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.
- 10. Fescue, tall: Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.
- 11. **Guineagrass:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.
- 12. Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth / Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western: Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.
- 13. Lantana: Apply this product as a 3/4 to 1 percent solution with handheld equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

- 14. Loosestrife, purple: Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.
- 15. Lotus, American: Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.
- 16. Maidencane / Paragrass: Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.
- 17. **Milkweed, common:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.
- 18. Nutsedge: purple, yellow: Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.
- 19. **Pampasgrass:** Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.
- 20. Phragmites: For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer or fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.
- Quackgrass / Kikuyugrass / Muhly, wirestern: Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3 to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.
- 22. Reed, giant / ice plant: For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.
- 23. **Spatterdock:** Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.
- 24. Sweet potato, wild: Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

- 25. Thistle, Canada / artichoke: Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.
- 26. Torpedograss: Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.
- 27. **Tules, common:** Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.
- 28. Waterhyacinth: Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.
- 29. Waterlettuce: For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.
- 30. Waterprimrose: Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.
- 31. Other perennial weeds listed above: Apply 4 1/2 to 7 1/2 pints per acre as a broadcast spray or apply as a 3/4 to 1 1/2 percent solution with hand-held equipment.

# Woody Brush and Trees

**NOTE:** If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

### Application Rates and Timing

When applied as a 5 to 8 percent solution as a directed application as described in the "Hand-Held and High-Volume Equipment" section, this product will control or partially control all wood brush and tree species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Specific Brush or Tree Control Recommendations: Numbers in parentheses "(-)" following the common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" which follow the species listing. See this section for specific application rates and timing for listed species.

For woody brush and trees, apply the recommended rate plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information. Make applications when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions. When applied as directed, this product plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient will control the following woody brush plants and trees: (Numbers in parentheses "(-)" following common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" for that species which follow the species listing.)

### Common Name

Alder (1) Ash † (20) Aspen, quaking (2) Bearclover, Bearmat (20) Birch (3) Blackberry (1) Broom, French (4) Broom, Scotch (4) Buckwheat, California (5) Cascara † (20) Catsclaw <sup>†</sup>(6) Ceanothus (20) Chamise (17) Cherry, bitter (7) Cherry, black (7) Cherry, pin (7) Coyote brush (8) Creeper, Virginia (20) Dewberry (1) Dogwood (9) Elderberry (3)

Scientific Name

Alnus spp. Fraxinus spp. Populus tremuloides Chamaebatia foliolosa Betula spp. Rubus spp. Cytisus monspessulanus Cytisus scoparius Eriogonum fasciculatum Rhamnus purshiana Acacia greggi Ceanothus spp. Adenostoma fasciculatum Prunus emarginata Prunus serotina Prunus pensylvanica Baccharis consanguinea Parthenocissus quinquefolia Rubus trivialis Cornus spp. Sambucus spp.

### Common Name

Elm <sup>†</sup>(20) Eucalyptus, bluegum (10) Hasardia 1(5) Hawthorn (2) Hazel (3) Hickory (9) Holly, Florida (11) (Brazilian peppertree) Honeysuckle (1) Hornbeam, American (20) Kudzu (12) Locust, black \* (20) Manzanita (20) Maple, red <sup>†</sup>(13) Maple, sugar (14) Maple, vine \* (20) Monkey flower <sup>†</sup>(5) Oak, black <sup>†</sup>(20) Oak, northern pin (14) Oak, post (1) Oak, red (14) Oak, southern red (7) Oak, white t (20) Persimmon <sup>†</sup>(20) Poison-ivy (15) Poison-oak (15) Poplar, yellow (20) Prunus (7) Raspberry (1) Redbud, eastern (20) Rose, multiflora (16) Russian-olive (20) Sage: black (17), white Sagebrush, California (17) Salmonberry (3) Salt cedar \* (9) Saltbush, sea myrtle (18) Sassafras (20) Sourwood †(20) Sumac, poison <sup>†</sup>(20) Sumac, smooth + (20) Sumac, winged <sup>†</sup>(20) Sweetgum (7) Swordfern <sup>†</sup>(20) Tallowtree, Chinese (17) Thimbleberry (3) Tobacco, tree t(5) Trumpetcreeper (2) Waxmyrtle, southern <sup>†</sup>(11) Willow (19)

### Scientific Name

Ulmus spp. Eucalyptus globulus Haplopappus squamosus Crataegus spp. Corylus spp. Carya spp. Schinus terebinthifolius

Lonicera spp. Carpinus caroliniana Pueraria lobata Robinia pseudoacacia Arctostaphylos spp. Acer rubrum Acer saccharum Acer circinatum Mimulus guttatus Quercus velutina Quercus palustris Quercus stellata Quercus rubra Quercus falcata Quercus alba Diospyros spp. Rhus radicans Rhus toxicodendron Liriodendron tulipifera Prunus spp. Rubus spp. Cercis canadensis Rosa multiflora Elaeagnus angustifolia Salvia spp. Artemisia californica Rubus spectabilis Tamarix spp. Baccharis halimifolia Sassafras aibidum Oxydendrum arboreum Rhus vernix Rhus glabra Rhus copallina Liquidambar styraciflua Polystichum munitum Sapium sebiferum Rubus parviflorus Nicotiana glauca Campsis radicans Myrica cerifera Salix spp.

<sup>†</sup>Partial control (See below for control or partial control instructions.)

#### Specific Brush or Tree Control Recommendations:

- Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry: For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
- Aspen, Quaking / Hawthorn / Trumpetcreeper: For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

- 3. Birch / Elderberry / Hazel / Salmonberry / Thimbleberry: For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
- 4. Broom, French / Broom, Scotch: For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.
- Buckwheat, California / Hasardia / Monkey flower / Tobacco, tree: For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
- Catsclaw: For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
- Cherry, bitter / Cherry, black / Cherry, pin / Oak, southern red / Sweetgum / Prunus: For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.
- Coyote brush: For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
- Dogwood / Hickory / Salt cedar: For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.
- Eucalyptus, bluegum: For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to droughtstressed plants.
- 11. Holly, Florida / Waxmyrtle, southern: For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.
- Kudzu: For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.
- Maple, red: For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.
- Maple, sugar / Oak: northern pin / Oak, red: For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
- 15. Poison-ivy / Poison-oak: For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.
- Rose, multiflora: For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.
- Sage, black / Sagebrush, California / Chamise / Tallowtree, Chinese: For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
- 18. Saltbush, sea myrtle: For control, apply this product as a 1 percent solution with hand-held equipment.
- Willow: For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with handheld equipment.
- Other woody brush and trees listed above: For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

### Aquatic and other Noncrop Sites

Apply this product as directed and under conditions described to control or partially control weeds and woody plants listed in the "Weeds Controlled" section in industrial, recreational and public areas or other similar aquatic or terrestrial sites on this label.

### Noncrop Sites

This product may be used to control the listed weeds in and around aquatic sites and on noncrop sites such as :

### Airports

Golf Courses Habitat Restoration & Management Areas Highways & Roadsides Industrial Plant Sites Lumberyards Parking Areas Parks Petroleum Tank Farms Pipeline, Power, Telephone & Utility Rights-of-Way Pumping Installations Railroads Schools Storage Areas Similar Sites

### **Aquatic Sites**

This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

- This product does not control plants which are completely submerged or have a majority of their foliage under water.
- There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.
- Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.
- NOTE: Do not apply this product directly to water within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made only in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.

- For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.
- Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.
- Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.
- When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

### Forestry Sites and Utility Rights-of-Way

In forest and utility sites, this product is recommended for the control or partial control of woody brush, trees, and annual and perennial herbaceous weeds. This product is also recommended for use in preparing or establishing wildlife openings within these sites, in pine straw plantations for maintaining logging roads, and for side trimming along utility rights-of-way.

In forestry sites, this product is recommended for use in site preparation prior to planting any tree species, including Christmas trees and silvicultural nursery sites.

In utility sites, this product is recommended for use along electrical power, pipeline, and telephone rights-of-way, and in other utility sites associated with these rights-of-way, such as substations.

### Application Rates<sup>†</sup>:

Method of Application	Application Rate	Spray Volume (gal/acre)
Broadcast		
Aerial	1.5 to 7.5 qt/acre	5 to 30
Ground	1.5 to 7.5 qt/acre	10 to 60
Spray-to-Wet		
Handgun, Backpack	0.75 to 2%	spray-to-wet
Mistblower	by volume	
Low Volume Directed Spray <sup>++</sup>	5% to 10%	partial coverage
Handgun, Backpack Mistblower	by volume	

<sup>†</sup>Where repeat applications are necessary, do not exceed 8.0 quarts per acre per year.

<sup>th</sup> For low volume directed spray applications, coverage should be uniform with at least 50 percent of the foliage contacted. For best results, coverage of the top one-half of the plant is important.

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In forestry site preparation and utility rights-of-way applications, this product requires use with a surfactant such as a non-ionic surfactant containing greater than 80 percent active ingredient. Use of this product without surfactant will result in reduced herbicideperformance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

Use higher rates of this product within the recommended rate ranges for control or partial control of woody brush, trees and hard-to-control perennial herbaceous weeds. For best results, apply to actively growing woody brush and trees after full leaf expansion and before fall color and leaf drop. Use increased rates within the recommended rate range to control of perennial herbaceous weeds from emergence up to the appearance of seedheads, flowers or berries appear. Use lower rates within the recommended rate range to control annual herbaceous weeds and actively growing perennial herbaceous weeds after seedheads, flowers or berries appear. Apply to foliage of actively growing annual herbaceous weeds anytime after emergence.

#### **Tank Mixtures**

This product may be used in tank mix combination with other herbicide products to broaden the spectrum of vegetation controlled. When tank mixing, read and observe applicable use directions, precautions and limitations on the respective product labels. Use according to the most restrictive precautionary statements for each product on the mixture. Any recommended rate of this product may be used in a tank mix.

**Note:** For forestry site preparation, make sure the tank mix product is approved for use prior to planting the desired species. Observe planting interval restrictions. For side trimming treatments in utility rights-of-way, tank mixtures with Arsenal 2WSL herbicide are not recommended. For side trimming treatments, it is recommended that this product be used alone as recommended, or as a tank mix with Garlon.

Product	Broadcast Rate	Use Sites
Arsenal Applicators Concentrate	2 to 16 fl oz/acre	Forestry site preparation
Oust	1 to 4 oz/acre	Forestry site preparation, utility sites
Garlon 3A <sup>1</sup>	1 to 4 qt/acre	Forestry site preparation, utility sites
Garlon 4	1 to 4 qt/acre	Forestry site preparation, utility sites
Arsenal 2WSL	2 to 32 fl oz/acre	Utility sites
	Spray-to-Wet Rates	
Arsenal Applicators Concentrate	1/32% to 1/2% by volume	Forestry site preparation
Arsenal 2WSL	1/32% to 1/2% by volume	Utility sites
	Low Volume Directed Spray Rates	
Arsenal Applicators Concentrate	1/8% to 1/2% by volume	Forestry site preparation
Arsenal 2WSL	1/8% to 1/2% by volume	Utility sites

<sup>t</sup>Ensure that Garlon 3A is thoroughly mixed with water before adding this product. Agitation is required while mixing this product with Garlon 3A to avoid compatibility problems.

For control of herbaceous weeds, use the lower recommended tank mixture rates. For control of dense stands or difficult-to-control woody brush and trees, use the higher recommended rates.

#### Forestry Conifer and Hardwood Release

#### **Directed Sprays and Selective Equipment**

This product may be applied as a directed spray or by using selective equipment in forestry conifer and hardwood sites, including Christmas tree plantations and silvicultural nurseries. This product requires use with a surfactant. Use only surfactants that are approved for conifer release and specified on the surfactant label as safe for use in conifer release (pine release). Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

Tank Mixing: In hardwood plantations, tank mixtures with Oust may be used. In pine plantations, tank mixtures with Garlon 4 or Arsenal AC may be used. Comply with all site restrictions, forestry species limitations, and precautions on the tank mix product labels.

Avoid contact of spray drift, mist or drips with foliage, green bark or non-woody surface roots of desirable plant species. See "Application Equipment and Techniques" section of this label for specific recommendations and precautions.

Spray-to-Wet Applications: Use a 2 percent spray solution to control undesirable woody brush and trees. To control herbaceous weeds, use a 1 to 2 percent spray solution.

Low Volume Directed Spray Applications: Use a 5 to 10 percent spray solution. Coverage should be uniform with at least 50 percent of the foliage contacted. Coverage of the top one-half of the unwanted vegetation is important.

**Broadcast Applications:** For equipment calibrated for broadcast applications, use 1 1/2 to 7 1/2 quarts of this product per acre. Apply in 10 to 60 gallons of clean water per acre. Shielded application equipment may be used to avoid contact of the spray solution with desirable plants. Shields should be adjusted to prevent spray contact with the foliage of green bark of desirable vegetation.

**Wiper Application Equipment:** See the "Selective Equipment" section of this label for equipment and application rate recommendations.

#### Broadcast Application

Note: Except where specifically recommended below, make broadcast applications of this product only where conifers have been established for more than one year.

## Broadcast application must be made after formation of final conifer resting buds in the fall or prior to initial bud swelling in the spring.

Injury may occur to conifers treated for release, especially where spray patterns overlap or the higher rates are applied. Damage can be accentuated if applications are made when conifers are actively growing, or are under stress from drought, flood water, improper planting, insects, animal damage or diseases. Accord Concentrate requires use with a surfactant. Use a surfactant that is labeled/recommended for use in over-the-top release applications. Use of this product without a surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

## For release of the following conifer species outside the Southeastern United States:

Douglas fir (*Pseudotsuga menziesii*) Fir (*Abies* species) Hemlock <sup>++</sup> (*Tsuga* species) Pines <sup>+</sup> (*Pinus* species) Redwood, California <sup>++</sup> (*Sequoia* species)

- <sup>†</sup>Includes all species except loblolly pine, longleaf pine, shortleaf pine or slash pine.
- <sup>tt</sup> Use of a surfactant is not recommended for release of hemlock species or California redwood. In mixed conifer stands, injury to these species may result if a surfactant is used.

Application Rate for Conifer Release: Apply 3/4 to 1 1/2 quarts per acre as a broadcast spray. In Maine and New Hampshire, up to 2 1/4 quarts per acre of this product may be used for the control and suppression of difficult-to-control hardwood species.

To release Douglas fir, and pine and spruce species at the end of the first growing season (except in California), apply 3/4 to 1 1/8 quarts per acre of this product. Make sure that all conifers are well hardened off.

Note: For release of Douglas fir with this product or recommended tank mixtures, a nonionic surfactant recommended for over-the-top foliar spray may be used. To avoid possible conifer injury, nonionic surfactants may be used at 2 fluid ounces per acre at elevations above 1500 feet, or 1 fluid ounce per acre in the coastal range or at elevations below 1500 feet. Use of surfactant rates exceeding those listed above may result in unacceptable conifer injury and are not recommended. Make sure that the nonionic surfactant has been adequately tested for safety to Douglas fir before use.

Tank Mixtures with Oust: To release jack pine, white pine and white spruce, apply 3/4 to 1 1/2 quarts of this product with 1 to 3 ounces (1 to 1 1/2 ounces for white pine) of Oust per acre. Make applications to actively growing weeds as a broadcast spray over the top of established conifers. Applications at these rates should be made after formation of conifer resting buds in the late summer or fall.

Tank Mixtures with Arsenal Applicators Concentrate: This product may be tank mixed with Arsenal Applicators Concentrate for release of Douglas fir. Tank mix 3/4 to 1 1/8 quarts of this product with 2 to 6 fluid ounces of Arsenal Applicators Concentrate per acre. For release of balsam fir and red spruce, apply a mixture of 1 1/2 quarts of this product with 1 to 2 1/2 fluid ounces of Arsenal Applicators Concentrate per acre.

In Maine and New Hampshire for the release of red pine, balsam fir, red spruce, white spruce, Norway spruce, and black spruce with dense tough-to-control brush and where maples make up a large component of the undesirable trees, up to 2 1/4 quarts per acre of this product may be tank mixed with 1 to 2 1/2 fluid ounces per acre of Arsenal Applicators Concentrate herbicide and applied as a broadcast spray.

Tank mixtures with Arsenal Applicators Concentrate and Oust or Oust XP Herbicides: In Maine and New Hampshire for release of red pine, balsam fir, red spruce, white spruce, Norway spruce and black spruce with heavy grass and herbaceous weed densities, tough-to-control brush and where maples make up a large component of the undesirable trees up to 2 1/4 quarts per acre of this product may be tank mixed with 1 to 2.5 fluid ounces per acre of Arsenal Applicators Concentrate and 1 to 3 oz of Oust or Oust XP herbicides and applied as a broadcast spray.

## For release of the following conifer species in the Southeastern United States:

Loblolly pine (Pinus taeda) Eastern white pine (Pinus strobus) Shortleaf pine (Pinus echinata) Slash pine (Pinus elliottii) Virginia pine (Pinus virginiana) Longleaf pine (Pinus palustris)

Apply 1 1/8 to 1 7/8 quarts of this product per acre as a broadcast spray during late summer or early fall after the conifers have hardened off. For applications at the end of the first growing season, use 3/4 quart of this product alone or in a recommended tank mixture.

Tank Mixtures with Arsenal Applicators Concentrate: For conifer release, apply 3/4 to 1 1/2 quarts of this product with 2 to 16 fluid ounces of Arsenal Applicators Concentrate per acre as a broadcast spray. Use only on conifer species that are labeled for over-the-top spray for both products. Use the higher recommended rates for dense tough-to-control wood brush and trees.

Read and observe label claims, cautionary statements and all information on the labels of each product used in these tank mixtures. Use according to the most restrictive precautionary statements for each product in the mixture.

#### **Herbaceous Release**

When applied as directed, this product plus listed residual herbicides provides postemergence control of the annual weeds and control or suppression of the perennial weeds listed in this label, and residual control of the weeds listed in the residual herbicide label. Make applications to actively growing weeds as a broadcast spray over the top of labeled conifers.

Tank Mixtures with Oust: To release loblolly pines, tank mix 12 to 18 fluid ounces of this product with 2 to 4 ounces of Oust per acre.

To release slash pines, tank mix 9 to 12 fluid ounces of this product with 2 to 4 ounces of Oust per acre.

In Maine and New Hampshire for release of red pine, balsam fir, red spruce, white spruce, Norway spruce, and black spruce with heavy grass and herbaceous weeds infesting the site, up to 2 1/4 quarts per acre of may be tank mixed with 1 to 3 oz of Oust herbicide or Oust XP herbicide to control grass, herbaceous weeds and woody brush, and applied as a broadcast spray.

For tank mixtures with Oust use a surfactant that is labeled/ recommended for use in over-the-top herbaceous release applications. Use of this product without a surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

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Weed control may be reduced if water volumes exceed 25 gallons per acre for these treatments.

**Tank Mixture with Atrazine:** To release Douglas fir, apply 3/4 quart of this product with 4 pounds a.i. of atrazine per acre. Apply only over Douglas fir that has been established for at least one full growing season. Apply in the early spring, usually mid-March through early April. Injury will occur if applications are made after bud swell in the spring. For this use, do not add surfactant to the tank mixture.

Always read and follow the manufacturer's label for all herbicides and surfactants used.

#### Wetland Sites

This product may be used in and around water (aquatic areas) and wetlands found in forestry and in power, telephone and pipeline rightsof-way sites, including where these sites are adjacent to or surrounding domestic water supply reservoirs, supply streams, lakes and ponds. Read and observe the following before making applications in and around water.

Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat in such areas.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

**Note:** Do not apply this product directly to water within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as a lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after application. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the application. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.

Do not spray open bodies of water where woody brush, trees and herbaceous weeds do not exist. The maximum application rate of 3 3/4 quarts per acre must not be exceeded in a single over-water broadcast application except as follows, where any recommended rate may be applied:

- Stream crossings in utility right-of-way.
- Where applications will result in less than 20 percent of the total water area being treated.

#### Wildlife Habitat Restoration and Management Areas

This product is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas. Habitat Restoration and Maintenance: When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl, and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots: This product may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness.

#### Wiper Applications

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weed Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results

#### Cut Stump Application

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting. Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will **control**, **partially control or suppress** most woody brush and tree species, some of which are listed below:

Common Name Alder Coyote brush <sup>†</sup> Dogwood <sup>†</sup> Eucalyptus Hickory <sup>†</sup> Madrone Maple <sup>†</sup> Oak Poplar <sup>†</sup> Reed, giant Salt cedar

#### Scientific Name

Alnus spp. Baccharis consanguinea Cornus spp. Eucalyptus spp. Carya spp. Arbutus menziesii Acer spp. Quercus spp. Populus spp. Arundo donax Tamarix spp.

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Specimen Label Revised 12-14-06

#### Common Name

Sweet aum <sup>†</sup> Sycamore <sup>†</sup> Tan oak Willow

Scientific Name Liquidambar styraciflua Platanus occidentalis Lithocarpus densiflorus

<sup>†</sup>This product is not approved for this use on these species in the state of California.

Salix spp.

#### Injection and Frill Applications

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

#### This treatment will control the following woody species:

Common Name	Scientific Name
Oak	Quercus spp.
Poplar	Populus spp.
Sweet gum	Liquidambar styraciflua
Sycamore	Platanus occidentalis

#### This treatment will suppress the following woody species:

Common Name	Scientific Name
Black gum <sup>†</sup>	Nyssa sylvatica
Dogwood	Cornus spp.
Hickory	Carya spp.
Maple, red	Acer rubrum

<sup>†</sup>This product is not approved for this use on this species in the state of California.

#### Release of Bermudagrass or **Bahiagrass on Noncrop Sites**

#### **Release Of Dormant Bermudagrass** And Bahiagrass

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

#### Weeds Controlled

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

#### Weeds Controlled or Suppressed <sup>†</sup>

Note:	C =	Controlled;	S =	Suppress	sed
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Rate (Eluid Ounces Per Acre)						
Weed Species	6	9	12	18	24	48
Barley, little Hordeum pusillum	S	С	С	С	С	С
Bedstraw, catchweed Galium aparine	S	С	С	С	С	С
Bluegrass, annual Poa annua	S	С	С	С	С	С
Chervil Chaerophyllum tainturieri	S	С	С	С	С	С
Chickweed, common Stellaria media	S	С	С	С	С	
Clover, crimson Trifolium incarnatum	•	S	S	С	С	С
Clover, large hop Trifolium campestre	•	S	S	С	С	С
Speedwell, corn Veronica arvensis	S	С	С	С	С	С
Fescue, tall Festuca arundinacea	•	•	•	•	S	S
Geranium, Carolina Geranium carolinianum	•	•	S	S	С	С
Henbit Lamium amplexicaule	•	S	С	С	С	С
Ryegrass, Italian Lolium multiflorum	•	•	S	С	С	С
Vetch, common Vicia sativa	•	•	S	С	С	С

<sup>†</sup>These rates apply only to sites where an established competitive turf is present.

#### Release Of Actively Growing Bermudagrass

#### NOTE: Use only on sites where bahiagrass or bermudagrass are desired for ground cover and some temporary injury or yellowing of the grasses can be tolerated.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient.. Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass <sup>†</sup>
Dallisgrass	Trumpetcreeper **
Fescue (tall)	Vaseygrass

<sup>†</sup>Johnsongrass is controlled at the higher rate. <sup>#</sup>Suppression at the higher rate only.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

#### Bahiagrass Seedhead and Vegetative Suppression

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product in 10 to 25 gallons of water per acre, plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient.. Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence. Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

#### Annual Grass Growth Suppression

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of water per acre plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

#### Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitations of Remedies.

#### Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

#### Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Crop injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. To the fullest extent permitted by law, all such risks shall be assumed by buyer.

#### Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

- Refund of purchase price paid by buyer or user for product bought, or
- (2) Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. To the fullest extent permitted by law, in no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

<sup>®</sup>Trademark of Dow AgroSciences LLC Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A. Label Code: D02-145-003 Replaces Label: D02-145-002 LOES Number: 010-00111

EPA-accepted 07/13/06

#### **Revisions:**

- 1. Revised marketing claims to remove pine plantations and add grazed areas on these sites
- 2. Added/revised surfactant instructions
- 3. Revised nonionic surfactant instructions to 80% active ingredient
- 4. Revised use site text under Aquatic and other Noncrop Sites

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# Supplemental Labeling



Dow AgroSciences LLC

9330 Zionsville Road

Indianapolis, IN 46268-1054 USA

## Accord<sup>®</sup> Concentrate herbicide

EPA Reg. No. 62719-324

Uses listed in this supplemental labeling have been added to the label for Accord Concentrate. Users may apply Accord Concentrate according to this supplemental labeling until such time as labeling which includes these additional uses is fully available on product in channels of trade.

Additional Uses:

- Aquatic & Other Noncrop Sites
- Release of Bermudagrass or Bahiagrass on Noncrop Sites
- Bahiagrass Seedhead and Vegetative Suppression
- Annual Grass Growth Suppression

## (Not for Distribution or Use in New York)

## ATTENTION

- It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
- This labeling must be in the possession of the user at the time of application.
- Read the label affixed to the container for Accord<sup>®</sup> Concentrate herbicide before applying. Follow all applicable directions, restrictions, and precautions on the EPA registered label.
- Except as described in this supplemental labeling, use of Accord Concentrate is subject to all use precautions and limitations imposed by the label affixed to the product container.

## **Directions for Use**

## Aquatic and other Noncrop Sites

Apply Accord Concentrate as directed and under conditions described to control or partially control weeds and woody plants listed in the "Weeds Controlled" section in industrial, recreational and public areas or other similar aquatic or terrestrial sites on this label.

## Noncrop Sites

Accord Concentrate may be used to control the listed weeds in the following terrestrial noncrop sites and/or in aquatic sites within these areas:

- Airports
- Golf Courses
- Habitat Restoration & Management Areas
- Highways & Roadsides
- Industrial Plant Sites
- Lumberyards
- Parking Areas
- Parks

- Petroleum Tank Farms
- Pipeline, Power, Telephone & Utility Rights-of-Way
- Pumping Installations
- Railroads
- Schools
- Storage Areas
- Similar Sites

## Aquatic Sites

Accord Concentrate may be applied to emerged weeds in seeps, irrigation and drainage ditches, wildlife habitat restoration and management areas and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

- Accord Concentrate does not control plants which are completely submerged or have a majority of their foliage under water.
- There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.
- Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.
- NOTE: Do not apply this product directly to water within ½ mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within ½ mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made **only** in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.
- For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.
- Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.
- Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.
- When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

## Release of Bermudagrass or Bahiagrass on Noncrop Sites

## **Release of Dormant Bermudagrass And Bahiagrass**

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

## Weeds Controlled

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

## Weeds Controlled or Suppressed <sup>†</sup>

	Rate of Accord Concentrate (Fluid Ounces Per Acre)					
Weed Species	6	9	12	18	24	48
Barley, little Hordeum pusillum	S	С	C	С	С	С
Bedstraw, catchweed Galium aparine	S	С	С	С	С	С
Bluegrass, annual Poa annua	S	С	С	С	С	С
Chervil Chaerophyllum tainturieri	S	С	С	С	С	С
Chickweed, common Stellaria media	S	С	С	С	С	
Clover, crimson Trifolium incarnatum	•	S	S	С	С	С
Clover, large hop Trifolium campestre	•	S	S	С	С	С
Speedwell, corn Veronica arvensis	S	С	С	С	С	С
Fescue, tall Festuca arundinacea	•	•	•	•	S	S
Geranium, Carolina Geranium carolinianum	•	•	S	S	С	С
Henbit Lamium amplexicaule	•	S	С	С	С	С
Ryegrass, Italian Lolium multiflorum	•	•	S	С	С	С
Vetch, common Vicia sativa	•	•	S	С	С	С

**Note:** C = Controlled; S = Suppressed

<sup>†</sup>These rates apply only to sites where an established competitive turf is present.

## **Release of Actively Growing Bermudagrass**

## NOTE: Use only on sites where bahiagrass or bermudagrass are desired for ground cover and some temporary injury or yellowing of the grasses can be tolerated.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass Johnsongrass<sup>†</sup> Dallisgrass Trumpetcreeper<sup>††</sup> Fescue (tall) Vaseygrass

<sup>†</sup> Johnsongrass is controlled at the higher rate. <sup>††</sup> Suppression at the higher rate only.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

## Bahiagrass Seedhead and Vegetative Suppression

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

## Annual Grass Growth Suppression

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

\*Trademark of Dow AgroSciences LLC

R-145-001 EPA –Accepted 11-10-2003 Initial printing.

## MATERIAL SAFETY DATA SHEET

**Dow AgroSciences** 

## ACCORD\* CONCENTRATE HERBICIDE

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 3/23/04 Product Code: 84820 MSDS: 006694

1. PRODUCT AND COMPANY IDENTIFICATION:	EXTINGUISHING MEDIA: Foam, CO <sub>2</sub> , Dry Chemical
PRODUCT: Accord* Concentrate Herbicide COMPANY IDENTIFICATION: Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268-1189	FIRE AND EXPLOSION HAZARDS: Foam fire extinguishing system is preferred because uncontrolled water can spread possible contamination. Toxic irritating gases may be formed under fire conditions. FIRE-FIGHTING EQUIPMENT: Use positive-pressure, self-
2. COMPOSITION/INFORMATION ON INGREDIENTS:	equipment.
Glyphosate IPA:CAS # 038641-94-053.8%N-(phosphono-methyl)glycine, Isopropylamine53.8%Salt46.2%	6. ACCIDENTAL RELEASE MEASURES: ACTION TO TAKE FOR SPILLS: Absorb small spills with an inert absorbent material such as Hazorb, Zorball, sand, or dirt. Report large spills to Dow AgroSciences on 800-
3. HAZARDOUS IDENTIFICATIONS:	992-5994.
EMERGENCY OVERVIEW	7. HANDLING AND STORAGE:
Clear, pale yellow liquid. May cause eye irritation. Slightly toxic to aquatic organisms. EMERGENCY PHONE NUMBER: 800-992-5994	PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapors and spray mist. Handle concentrate in ventilated
<ul> <li>FIRST AID:</li> <li>EYE: Flush eyes thoroughly with water for several minutes. Remove contact lenses after initial 1-2 minutes and continue flushing for several additional minutes. If effects</li> </ul>	area. Wash thoroughly with soap and water after handling and before eating, chewing gum, using tobacco, using the toilet or smoking. Keep away from food, feedstuffs, and water supplies. Store in original container with the lid tightly closed. Store above 10°F (-12°C) to keep from crystallizing.
occur, consult a physician, preferably an ophthalmologist.	8. EXPOSURE CONTROLS/PERSONAL PROTECTION:
SKIN: Wash skin with plenty of water. INGESTION: No emergency medical treatment necessary.	These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.
<b>INHALATION</b> : Remove person to fresh air; if effects occur, consult a physician	EXPOSURE GUIDELINES: None established
<b>NOTE TO PHYSICIAN</b> : No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.	<b>ENGINEERING CONTROLS</b> : Good general ventilation should be sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.
5. FIRE FIGHTING MEASURES:	RECOMMENDATIONS FOR MANUFACTURING,
FLASH POINT: >214°F (>101°C) METHOD USED: Setaflash FLAMMABLE LIMITS:	WORKERS: EYE/FACE PROTECTION: Use safety glasses. SKIN PROTECTION: No precautions other than clean
UFL: Not applicable	body-covering clothing should be needed.

## **MATERIAL SAFETY DATA SHEET**



## ACCORD\* CONCENTRATE HERBICIDE

**RESPIRATORY PROTECTION**: For most conditions, no respiratory protection should be needed; however, if

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 3/23/04 Product Code: 84820 MSDS: 006694

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: For a

similar material, glyphosate, in animals, effects have been

discomfort is experienced, use a NIOSH approved air- purifying respirator.	reported on the following organ: liver.
APPLICATIONS AND ALL OTHER HANDLERS: Please	<b>CANCER INFORMATION</b> : A similar material, glyphosate, did not cause cancer in laboratory animals.
and equipment.	<b>TERATOLOGY (BIRTH DEFECTS):</b> For glyphosate IPA, available data are inadequate for evaluation of potential to
9. PHYSICAL AND CHEMICAL PROPERTIES:	cause birth defects.
APPEARANCE: Clear, pale yellow liquid DENSITY: 10.0 - 10.5 lbs/gal pH: 4.8 – 5.0 ODOR: None	<b>REPRODUCTIVE EFFECTS</b> : For glyphosate IPA, available data are inadequate to determine effects on reproduction.
SOLUBILITY IN WATER: Miscible SPECIFIC GRAVITY: 1.21 gm/L FREEZING POINT: -7°F10°F (-21°C25°C)	<b>MUTAGENICITY:</b> For a similar material, glyphosate, in- vitro and animal genetic toxicity studies were negative.
10. STABILITY AND REACTIVITY:	12. ECOLOGICAL INFORMATION:
STABILITY: (CONDITIONS TO AVOID) Stable under	ENVIRONMENTAL DATA:
normal storage conditions.	ECOTOXICOLOGY:
<b>INCOMPATIBILITY:</b> (SPECIFIC MATERIALS TO AVOID) Galvanized or unlined steel (except stainless steel) containers or spray tanks may produce hydrogen gas which may form a highly combustible gas mixture.	Material is practically non-toxic to aquatic organisms on an acute basis ( $LC_{50}$ or $EC_{50}$ is >100 mg/L in most sensitive species tested). Acute $LC_{50}$ for rainbow trout <u>(Oncorhynchus mykiss)</u> is >2500 mg/L.
HAZARDOUS DECOMPOSITION PRODUCTS: None known.	Acute immobilization $EC_{50}$ in water flea <u>(Daphnia magna)</u> is 918 mg/L. Material is practically non-toxic to birds on an acute basis
HAZARDOUS POLYMERIZATION: Not known to occur.	(LD <sub>50</sub> is >2000 mg/kg). Acute oral LD <sub>50</sub> in bobwhite <u>(Colinus virginianus)</u> is >2000
11. TOXICOLOGICAL INFORMATION:	mg/kg.
<b>EYE:</b> May cause slight temporary eye irritation. Corneal injury is unlikely.	Acute contact LD <sub>50</sub> in honey bee <u>(Apis mellifera)</u> is >100 $\mu$ g/bee.
<b>SKIN:</b> Essentially non-irritating to skin. Prolonged skin contact is unlikely to result in absorption of harmful amounts. The $LD_{50}$ for skin absorption in rabbits is >5000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.	Acute oral LD <sub>50</sub> in honey bee <u>(Apis mellifera)</u> is >100 $\mu$ g/bee. Growth inhibition EC <sub>50</sub> in green alga <u>(Selenastrum</u> <u>capricornutum</u> ) is 127 mg/L. Growth inhibition EC <sub>50</sub> in duckweed <u>(Lemna sp.)</u> is 24.4 mg/L.
INGESTION: Very low toxicity if swallowed. Harmful effects	13. DISPOSAL CONSIDERATIONS:
not anticipated from swallowing small amounts. The oral $LD_{50}$ for rats is >5000 mg/kg.	<b>DISPOSAL METHOD:</b> If wastes and/or containers cannot be disposed of according to the product label directions,
<b>INHALATION:</b> Brief exposure (minutes) is not likely to cause adverse effects. The aerosol $LC_{50}$ for rats is >6.37 mg/L for 4 hours.	local or area regulatory authorities.

## MATERIAL SAFETY DATA SHEET



## ACCORD\* CONCENTRATE HERBICIDE

This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations.

If the material as supplied becomes a waste, follow all applicable regional, national and local laws and regulations.

### 14. TRANSPORT INFORMATION:

## U.S. DEPARTMENT OF TRANSPORTATION (DOT) INFORMATION:

For all package sizes and modes of transportation: This material is not regulated for transport.

### **15. REGULATORY INFORMATION:**

**NOTICE:** The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

## U.S. REGULATIONS

SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

Not to have met any hazard category

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 3/23/04 Product Code: 84820 MSDS: 006694

STATE RIGHT-TO-KNOW: This product is not known to contain any substances subject to the disclosure requirements of

New Jersey Pennsylvania

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

CATEGORY	RATING
Health	1
Flammability	1
Reactivity	0

#### **16. OTHER INFORMATION:**

MSDS STATUS: Revised Sections: 3,4,11,12,13,14 & 15 Reference: DR-0361-8028 Replaces MSDS Dated: 1/12/00 Document Code: D03-145-002 Replaces Document Code: D03-145-001

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

# **APPLICATORS CONCENTRATE**

## For control of vegetation on forestry sites.

ACTIVE INGREDIENT:	2
Isopropylamine salt of imazapyr(2-[4,5-dihydro-4-methyl-4-	
(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridinecarboxylic acid)*	
INERT INGREDIENT:	
TOTAL:	
* Equivalent to 43.3% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-3- pyridinecarboxylic acid or 4 pounds acid per gallon.	

EPA Reg. No. 241-299

SPECIMEN

U.S. Patent No. 4,798,619

EPA Est. No.

R

herbicide

53.1%

46.9%

100.0%

## KEEP OUT OF REACH OF CHILDREN CAUTION/PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

See inside booklet for complete First Aid, Precautionary Statements, Directions For Use, Conditions of Sale and Warranty and state-specific crop and/or use site restrictions.

BASF Corporation Agricultural Products 26 Davis Drive Research Triangle Park, NC 27709



1.1	FIRST AID
If inhaled	<ul> <li>Move person to fresh air.</li> <li>If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.</li> <li>Call a poison control center or doctor for further treatment advice.</li> </ul>
If in eyes	<ul> <li>Hold eye open and rinse slowly and gently with water for 15-20 minutes.</li> <li>Remove contact lenses, if present, after first 5 minutes, then continue rinsing eye.</li> <li>Call a poison control center or doctor for treatment advice.</li> </ul>
f on skin or clothing	<ul> <li>Take off contaminated clothing.</li> <li>Rinse skin immediately with plenty of water for 15-20 minutes.</li> <li>Call a poison control center or doctor for treatment advice.</li> </ul>
	HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact BASF Corporation for emergency medical treatment information: 1-800-832-HELP (4357).

## PRECAUTIONARY STATEMENTS

## HAZARDS TO HUMANS

## CAUTION

Harmful if inhaled. Avoid contact with skin, eyes, or clothing. Avoid breathing spray mist.

## Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- · Shoes plus socks

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

## USER SAFETY RECOMMENDATIONS

#### Users should:

- 1. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- 2. Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

## ENVIRONMENTAL HAZARDS

For terrestrial uses, **DO NOT** apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. **DO NOT** contaminate water when disposing of equipment washwaters or rinsate. This herbicide is phytotoxic at extremely low concentrations. Nontarget plants may be adversely affected from drift.

## PHYSICAL AND CHEMICAL HAZARDS

Spray solutions of Arsenal® herbicide Applicators

**Concentrate** should be mixed, stored, and applied only in stainless steel, fiberglass, plastic, and plastic-lined steel containers.

DO NOT mix, store, or apply Arsenal herbicide Applicators Concentrate or spray solutions of Arsenal herbicide Applicators Concentrate in unlined steel (except stainless steel) containers or spray tanks.

## DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

**DO NOT** apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.

For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Arsenal herbicide Applicators Concentrate may be used only in accordance with recommendations and restrictions on the booklet label. Keep containers closed to avoid spills and contamination.

Arsenal herbicide Applicators Concentrate may be applied using helicopters, ground-operated sprayers, lowvolume hand-operated spray equipment such as backpack and pump-up sprayers, and tree injection equipment.

Observe all cautions and limitations in the package labels of products used in combination with **Arsenal herbicide Applicators Concentrate**.

### AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

The requirements in this box apply to use on trees being grown for sale or other commercial use, or for commercial seed production, or for production of timber or wood products, or for research purposes.

**DO NOT** enter or allow worker entry into treated areas during the restricted-entry interval (REI) of **12 hours**.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Shoes plus socks

#### NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Noncrop weed control is not within the scope of the Worker Protection Standard. See the **GENERAL INFORMATION** section of this label for a description of noncrop sites.

**DO NOT** enter treated areas without protective clothing until sprays have dried.

### STORAGE AND DISPOSAL

**DO NOT** contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE: DO NOT store below 10° F.

**PESTICIDE DISPOSAL:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL FOR QUART, 1.0 GALLON, 2.5 GALLON, 15 GALLON AND 30 GALLON: Triple

rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in an approved sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

CONTAINER DISPOSAL FOR FIELD KEG, MINIBULK AND BULK: When this container is empty, replace the cap and seal all openings that have been opened during use, and return the container to the point of purchase, or to a designated location. This container must only be refilled with the pesticide product. DO NOT reuse the container for any other purpose. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices. Check for leaks after refilling and before transport. DO NOT transport if this container is damaged or leaking. If the container is damaged or leaking, or obsolete and not returned to the point of purchase or to a designated location, triple rinse emptied container and offer for recycling. Disposal of container must be in compliance with state and local regulations.

### IMPORTANT

DO NOT use on food or feed crops. DO NOT use on Christmas trees. DO NOT treat irrigation ditches, or water used for crop irrigation or for domestic uses. Keep from contact with fertilizers, insecticides, fungicides, and seeds to prevent unintentional exposure of desirable vegetation to Arsenal® herbicide Applicators Concentrate. DO NOT apply or drain or flush equipment on or near sensitive desirable plants, or on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots. DO NOT side trim desirable vegetation with this product. Prevent drift of spray to desirable plants.

Clean application equipment after using this product by thoroughly flushing with water.

## **GENERAL INFORMATION**

Arsenal herbicide Applicators Concentrate is a surfactant-free aqueous solution to be mixed in water and generally applied as a postemergence spray for control of most annual and perennial grasses, broadleaf weeds, vines and brambles, and hardwood brush and trees for forestry site preparation and release of conifers from woody and herbaceous competition.

Arsenal herbicide Applicators Concentrate may be used for selective woody and herbaceous weed control in natural regeneration of certain conifers (see CONIFER RELEASE TREATMENTS). Arsenal herbicide Applicators Concentrate may also be mixed in water and used for stump and cut-stem treatment for control of unwanted woody vegetation. Arsenal herbicide Applicators Concentrate may be applied to control undesirable woody vegetation along forest roads that are contiguous with the treated forestry area.

Arsenal herbicide Applicators Concentrate is also recommended for the control of undesirable vegetation along nonirrigation ditchbanks and for the establishment and maintenance of wildlife openipage (957-074) to the state of California. See use directions for STUMP AND CUT-

#### STEM TREATMENTS, HERBACEOUS WEED CON-TROL, and USE ARSENAL® HERBICIDE APPLICA-TORS CONCENTRATE FOR SPOT TREATMENT OF UNDESIRABLE HARDWOOD VEGETATION.

Arsenal herbicide Applicators Concentrate may be applied on forestry sites that contain areas of temporary surface water caused by the collection of water between planting beds, in equipment ruts, or in other depressions created by forest management activities, except in the states of California and New York. It is permissible to treat drainage ditches, intermittent drainage, intermittently flooded low-lying sites, seasonally dry flood plains, and transitional areas between upland and lowland sites when no water is present, except in the states of California and New York. Only the edge of drainage ditches can be treated for drainage ditches that contain water. It is also permissible to treat marshes, swamps, and bogs after water has receded, as well as seasonally dry flood deltas, except in the states of California and New York. DO NOT make applications to natural or man-made bodies of water such as lakes, reservoirs, ponds, streams, rivers and canals.

## SYMPTOMOLOGY

Arsenal herbicide Applicators Concentrate is readily absorbed through foliage and roots and is translocated rapidly throughout the plant with accumulation in the meristematic regions. Treated plants stop growing soon after spray application. Chlorosis first appears in the youngest leaf tissue. In perennials, the herbicide is translocated into the roots, thus preventing most resprouting. Chlorosis and tissue necrosis may not be apparent in some plant species for several weeks after application. Woody plants, brush, and trees normally **DO NOT** display the full extent of herbicide control until several months following application.

## MIXING AND APPLICATION INSTRUCTIONS

## MANAGING OFF-TARGET MOVEMENT

The following information is provided as general guidance for managing off-target movement. Specific use recommendations for **Arsenal herbicide Applicators Concentrate** may differ depending on the application technique used and the vegetation management objective.

**Spray Drift:** Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

Spray drift from applying this product may result in damage to sensitive plants adjacent to the treatment area. Only apply this product when the potential for drift to these and other adjacent sensitive areas (e.g. residential areas, bodies of water, known habitat for threatened or endangered species, or nontarget crops) is minimal. **DO NOT** apply when the following conditions exist that increase the likelihood of spray drift from intended targets: high or gusty winds, high temperatures, low humidity, temperature inversions. To minimize spray drift, the applicator should be familiar with and take into account the following drift reduction advisory information. Additional information may be available from state enforcement agencies or the Cooperative Extension on the application of this product.

The best drift management strategy and most effective way to reduce drift potential is to apply large droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential but will not prevent drift if applications are made improperly or under unfavorable environmental conditions (see **Wind**, **Temperature and Humidity** and **Temperature Inversions**).

## **Controlling Droplet Size:**

- Volume Use high flow-rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- Pressure DO NOT exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow-rate nozzles instead of increasing pressure.
- Number of Nozzles Use the minimum number of nozzles that provide uniform coverage.
- Nozzle Orientation Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is recommended practice. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- Nozzle Type Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid-stream nozzles oriented straight back produce the largest droplets and the lowest drift. **DO NOT** use nozzles producing a mist droplet spray.

**Application Height:** Making applications at the lowest possible height (aircraft, ground-driven spray boom) that is safe and practical reduces exposure of droplets to evaporation and wind.

**Swath Adjustment:** When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the application equipment (e.g. air-craft, ground) upwind. Swath adjustment distance should increase with increasing drift potential (higher wind, smaller droplets, etc.).

**Wind:** Drift potential is lowest between wind speeds of 3-10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 3 mph due to variable wind direction and high inversion potential. **NOTE:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

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**Temperature and Humidity:** When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Drift potential is high during a temperature inversion. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud, which can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

**Wind Erosion:** Avoid treating powdery, dry or light sandy soils when conditions are favorable for wind erosion. Under these conditions, the soil surface should first be settled by rainfall or irrigation.

Aerial Application Methods and Equipment: Use 2 or more gallons of water per acre. The actual minimum spray volume per acre is determined by the spray equipment used.

Use adequate spray volume to provide accurate and uniform distribution of spray particles over the treated area and to avoid spray drift.

Managing Spray Drift from Aerial Applications:

Applicators must follow these requirements to avoid offtarget drift movement: 1) boom length - the distance of the outermost nozzles on the boom must not exceed ¾ the length of the wingspan or rotor, 2) nozzle orientation nozzles must always point backward parallel with the air stream and never be pointed downward more than 45 degrees, and 3) application height - without compromising aircraft safety, applications should made at a height of 10 feet or less above the crop canopy or tallest plants. Applicators must follow the most restrictive use cautions to avoid drift hazards, including those found in this labeling as well as applicable state and local regulations and ordinances.

**Ground Application (Broadcast):** Use 5 or more gallons of water per acre. The actual minimum spray volume per acre is determined by the spray equipment used. Use adequate spray volume to provide accurate and uniform distribution of spray particles over the treated area and to avoid spray drift.

### HELICOPTER SPRAY EQUIPMENT

Thoroughly mix the recommended amount of **Arsenal® herbicide Applicators Concentrate** in 5 to 30 gallons of water per acre and uniformly apply with properly calibrated aerial equipment. A suitable nonionic surfactant may be added to the spray solution to enhance control of undesirable vegetation. All precautions should be taken to minimize or eliminate spray drift. Applications should not be made under windy or gusty conditions. The use of controlled droplet booms and nozzle configurations is recommended. A drift control agent may be added at the recommended label rate. A foam-reducing agent may be added at the recommended label rate, if needed.

**IMPORTANT: DO NOT** make applications by fixed wing aircraft. Maintain adequate buffer zones. Thoroughly clean application and mixing equipment, including landing gear, immediately after use. Prolonged exposure of this product to uncoated steel (except stainless steel) surfaces may result in corrosion and failure of the exposed part.

### **GROUND-OPERATED SPRAY EQUIPMENT**

Thoroughly mix and apply the recommended amount of **Arsenal herbicide Applicators Concentrate** in 5 to 100 gallons of water per acre. A suitable nonionic surfactant may be added to the spray solution to enhance control of undesirable vegetation. A drift control agent and a foam-reducing agent may be added at the recommended label rates, if needed. If desired, a spray pattern indicator may be added at the recommended label rate.

For best results, uniformly cover the foliage of the vegetation to be controlled with the spray solution.

**IMPORTANT: DO NOT** spray under windy or gusty conditions. Maintain adequate buffer zones. Clean application and mixing equipment after using this product by thoroughly flushing with water.

DIRECTED FOLIAR OR SPOT SPRAY EQUIPMENT

When making directed or spot spray applications with helicopter or ground spray equipment or low-volume handoperated spray equipment, thoroughly mix a solution of 1 to 5 percent by volume of **Arsenal herbicide Applicators Concentrate** and a minimum of 1/4 percent by volume nonionic surfactant in water.

To mix the spray solution, add the volume of **Arsenal herbicide Applicators Concentrate** and nonionic surfactant indicated in the table below to the desired amount of water.

## SPRAY SOLUTION MIXING GUIDE

Solution Volume	Arsenal <sup>®</sup> herbicide Applicators Concentrate (%)			Surfactant
(gaions)	1	2.5	5	
1	1-1/3 oz	3-1/3 oz	6-2/3 oz	. 1/3 oz
5	6-2/3 oz	1 pint	2 pints	1-2/3 oz
10	13-1/3 oz	2 pints	4 pints	3-1/3 oz
25	2 pints	5 pints	10 pints	8 oz
100	1 gallon	2.5 gallons	5 gallons	2 pints

2 tablespoons = 1 fluid ounce

For best results, uniformly cover the foliage of the vegetation to be controlled with the spray solution. Avoid making applications directly to desirable conifers. For low-volume directed applications on bigleaf maple, a 2.5% by volume spray solution is recommended.

**IMPORTANT: DO NOT** overapply causing runoff from the treated foliage. Avoid direct application to desired plant species as injury may occur. **DO NOT** exceed recommended dosage rate per acre.

STUMP AND CUT-STEM TREATMENTS

Arsenal herbicide Applicators Concentrate may be used to control undesirable woody vegetation in forest management by applying a solution of the herbicide in water to the cambium area of freshly cut stump surfaces or to cuts on the stem of the target woody vegetation. Applications can be made at any time of the year except during periods of heavy sap flow in the spring. Tree injection and cut-stem treatments are most effective in late summer and early fall.

#### MIXING

Arsenal herbicide Applicators Concentrate may be mixed as either a concentrated or dilute solution for stump and cut-stem treatments. The dilute solution may be used for applications to the surface of the stump or to cuts on the stem of the target woody vegetation. Concentrated solutions may be used for applications to cuts on the stem. Use of the concentrated solution permits application to fewer cuts on the stem, especially for large diameter trees.

Follow the application instructions to determine proper application techniques for each type of solution.

#### APPLICATION WITH DILUTE SOLUTIONS

To prepare a dilute solution, mix 6 fluid ounces of **Arsenal herbicide Applicators Concentrate** with one gallon of water.

For cut-stump treatments: Spray or brush the solution onto the cambium area of the freshly cut stump surface. Insure that the solution thoroughly wets the entire cambium area (the wood next to the bark of the stump).

For tree-injection treatments: Using standard injection equipment, apply 1 mL of solution at each injection site around the tree with no more than one-inch intervals between cut edges. Insure that the injector completely penetrates the bark at each injection site.

For frill or girdle treatments: Using a hatchet, machete, or similar device, make cuts through the bark at intervals around the tree with no more than two-inch intervals between cut edges. Spray or brush the solution into each cut until thoroughly wet.

### APPLICATION WITH CONCENTRATED SOLUTIONS

To prepare a concentrated solution, use undiluted product or mix with up to 75% water, by volume.

For tree-injection treatments: Using standard injection equipment, apply 1 mL of solution at each injection site. Make at least one injection cut for every three inches of diameter at breast height (dbh) on the target tree. For example, a three-inch dbh tree will receive 1 injection cut, and a six-inch dbh tree will receive 2 injection cuts. On trees requiring more than one injection site, place the injection cuts at approximately equal intervals around the tree.

For hack and squirt treatments: Using a hatchet or similar device, make cuts at a downward angle completely through the bark and cambium at approximately equal intervals around the tree. Make at least one cut for every three inches of diameter at breast height (dbh) on the target tree. For example, a three-inch dbh tree will receive 1 cut and a six-inch dbh tree will receive 2 cuts. Using a squirt bottle, syringe, or similar device, apply 1 mL of the concentrated mix into each cut, ensuring that the solution does not run out of the cut.

**NOTE:** Injury may occur to nontarget or desirable woody plants if they extend from the same root system or their root systems are grafted to those of the treated tree.

## SITE PREPARATION TREATMENTS

Arsenal<sup>®</sup> herbicide Applicators Concentrate may be used to control labeled grasses, broadleaf weeds, vines and brambles, and woody brush and trees on forest sites in advance of regeneration for the following conifer crop species:

Crop Species	Rate (oz/A)	
Loblolly Pine (Pinus taeda)	24-40	
Loblolly X Pitch Hybrid	24-40	
Longleaf Pine (Pinus palustris)	24-40	
Shortleaf Pine (Pinus echinata)	24-40	
Virginia Pine (Pinus virginiana)	24-40	
Slash Pine (Pinus elliottii)	20-32	
Douglas Fir (Pseudotsuga menziesii)	12-24	
Coastal Redwood (Sequoia sempervirens)	12-24	
Western Hemlock (Tsuga heterophylla)	12-24	
California Red Fir (Abies magnifica)	12-20	
California White Fir (Abies concolor)	12-20	
Jack Pine (Pinus banksiana)	12-16	
Lodgepole Pine (Pinus contorta)	12-16	
Pitch Pine (Pinus rigida)	12-16	
Ponderosa Pine (Pinus ponderosa)	12-16	
Sugar Pine (Pinus lambertiana)	12-16	
White Pine (Pinus strobus)	12-16	
Black Spruce (Picea mariana)	12-16	
Red Spruce (Picea rubens)	12-16	
White Spruce (Picea glauca)	12-16	

Use the recommended rate of **Arsenal herbicide Applicators Concentrate** per acre applied as a broadcast foliar spray for long-term control of labeled woody plants and residual control of herbaceous weeds. Within 4 to 6 weeks of treatment, grasses and other herbaceous weeds will be controlled and may provide fuel to facilitate a site preparation burn, if desired, to control conifers or other species tolerant to the herbicide.

Apply the recommended rate of **Arsenal herbicide Applicators Concentrate** per acre in 5 to 30 gallons total spray solution for helicopter applications or 5 to 100 gallons total spray solution for mechanical ground spray and backpack applications. Use a minimum of 1/2 percent by volume nonionic surfactant. Use the higher label rates of **Arsenal herbicide Applicators Concentrate** and higher spray volumes when controlling particularly dense or multi layered canopies of hardwood stands or difficult to control species.

Tank mixes may be necessary for chemical control of conifers and other species tolerant to **Arsenal herbicide Applicators Concentrate** in certain cases. Observe all precautions and restrictions on the product labels. Always follow the most restrictive label. Combinations with other products labeled for forest site preparation may kill certain plants such as legumes and blackberry, which are desirable for wildlife habitat.

Where quick initial brown out (deadening of foliage) is desired for burning, apply a tank mixture of 16 to 32 oz **Arsenal herbicide Applicators Concentrate** with 16 to 64 oz glyphosate or 16 to 48 oz triclopyr ester per acre. For control of seedling pines, apply 16 to 32 oz **Arsenal herbicide Applicators Concentrate** with 3 to 4 quarts glyphosate. For site preparation, rates less than 24 oz **Arsenal herbicide Applicators Concentrate** will provide suppression of hardwood brush and trees, and some resprouting may occur.

**DO NOT** plant seedlings of black spruce (*Picea mariana*) or white spruce (*Picea glauca*) on sites that have been broadcast treated with **Arsenal herbicide Applicators Concentrate** or into the treated zone of spot or banded applications for three months following application or injury may occur.

### HERBACEOUS WEED CONTROL

Use **Arsenal herbicide Applicators Concentrate** for selective weeding in the following conifers:

Crop Species	Rate (fl oz/A)	
Loblolly Pine (Pinus taeda)	6 - 10	
Loblolly X Pitch Hybrid	6 - 10	
Virginia Pine (Pinus virginiana)	6 - 10	
Longleaf Pine (Pinus palustris)	4 - 6	
Slash Pine (Pinus elliottii)1	4 - 6	
Douglas Fir (Pseudotsuga menziesii) <sup>1</sup>	4 - 6	
Douglas Fir (Pseudotsuga menziesii) <sup>1</sup>	4 - 6	

<sup>1</sup> Use of surfactant is not recommended.

Arsenal herbicide Applicators Concentrate may be applied as a broadcast treatment, banded over tree rows, or as a directed spray for release of young conifers from herbaceous weeds. To prevent possibility of conifer injury, DO NOT apply Arsenal herbicide Applicators Concentrate when conifers are under stress from drought, diseases, animal or winter injury, planting shock

drought, diseases, animal or winter injury, planting shock, or other stresses reducing conifer vigor. Broadcast applications may be made by helicopter, ground, or backpack sprayer. For difficult-to-control weeds, use the higher labeled rates. Where herbaceous weeds have overtopped conifer seedlings, a nonionic surfactant may be added to improve weed control (except for slash pine, long-leaf pine, and Douglas Fir) at a rate not to exceed 1/4 percent of spray solution volume. Some minor conifer growth inhibition may be observed when herbaceous weed control treatments are made during periods of active conifer growth.

Arsenal herbicide Applicators Concentrate may also be applied using backpack or hand-held sprayers to control herbaceous weeds around individual conifer seedlings. Mix 0.4 to 0.6 oz Arsenal herbicide Applicators Concentrate and 0.2 oz nonionic surfactant per gallon of water. Direct the spray to the weeds and minimize the amount applied to conifer foliage for best conifer tolerance. Ensure that maximum labeled rates per acre listed for crop species above are not exceeded.

Arsenal herbicide Applicators Concentrate may be tank mixed with sulfometuron to broaden the spectrum of weeds controlled. For loblolly pipe 6 apply 4 to 6 oz Arsenal herbicide Applicators Concentrate plus 1-2 oz sulfometuron per acre. The application of **Arsenal®** herbicide Applicators Concentrate plus sulfometuron on other conifer species may cause growth suppression.

## CONIFER RELEASE TREATMENTS

Arsenal herbicide Applicators Concentrate may be applied as a broadcast or directed spray application for suppression of labeled brush, tree, and herbaceous weed species. Directed spray applications may be made with low-volume applications in conifer stands of all ages by targeting the unwanted vegetation and avoiding direct application to the conifer. Ensure that maximum labeled rates per acre listed for crop species below are not exceeded.

## Use broadcast applications of Arsenal herbicide Applicators Concentrate for release of the following conifers from hardwood competition:

Crop Species	Rate (fl oz/Acre)	
Loblolly Pine (Pinus taeda)3	12 - 20	
Loblolly X Pitch Hybrid <sup>3</sup>	12 - 20	
Virginia Pine (Pinus virginiana)3	12 - 20	
Longleaf Pine (Pinus palustris)	12 - 16	
Pitch Pine (Pinus rigida)	12 - 16	
Shortleaf Pine (Pinus echinata)	12 - 16	
Slash Pine (Pinus elliottii)	12 - 16	
White Pine (Pinus strobus)1	8 - 16	
California Red Fir (Abies magnifica)	8 - 12	
California White Fir (Abies concolor)	8 - 12	
Lodgepole Pine (Pinus contorta) <sup>2</sup>	8 - 12	
Douglas Fir (Pseudotsuga menziesii) <sup>2</sup>	8 - 12	
Jack Pine (Pinus banksiana) <sup>2</sup>	6 - 12	
Black Spruce (Picea mariana) <sup>2</sup>	6 - 12	
Red Spruce (Picea rubens) <sup>2</sup>	6 - 12	
White Spruce (Picea glauca) <sup>2</sup>	6 - 12	

<sup>1</sup> DO NOT make applications to white pine stands younger than three years old. To minimize potential white pine injury, release treatments should not be made prior to July 15.

- <sup>2</sup> Applications should be made after formation of final conifer resting buds in the fall or height growth inhibition may occur.
- <sup>3</sup> Mid-rotation release: For broadcast applications below the pine canopy in established stands of loblolly pine, loblolly X pitch hybrid, and Virginia pine, use 16-32 oz product per acre. For mid-rotation release of other species, use rates listed above.

For slash pine and longleaf pine, broadcast release treatments over the top of pines for the purpose of woody plant control must be made after August 15 and only in stands 2 through 5 years old. For applications over the top of slash pine and longleaf pine, DO NOT add surfactant and use lower labeled rates on sandy soils.

Apply the recommended rate of **Arsenal herbicide Applicators Concentrate** per acre when making broadcast applications with helicopter or ground spray equipment. Refer to mixing and application instructions for proper spray volumes. A nonionic surfactant may be added at no more than 1/4 percent by volume. Use the higher label rates of **Arsenal herbicide Applicators Concentrate** when controlling particularly dense stands or difficult-to-control species.

Some minor conifer growth inhibition may be observed when release treatments are made during periods of active conifer growth. To minimize potential conifer height growth inhibition, **DO NOT** make broadcast applications to conifer stands, except loblolly pine, before the end of the second growing season. To minimize potential conifer height growth inhibition, broadcast release treatments may be made late in the growing season. To prevent possibility of conifer injury, **DO NOT** apply **Arsenal herbicide Applicators Concentrate** when conifers are under stress from drought, diseases, animal or winter injury, or other stresses reducing conifer vigor.

Arsenal herbicide Applicators Concentrate may be used to release loblolly pine seedlings during the first growing season following planting or for one-year-old natural loblolly pine regeneration. For one-year-old loblolly pine release, apply 12-20 oz/A of Arsenal herbicide Applicators Concentrate after July 15. The use of rates below 16 oz/A is intended for hardwood growth suppression and some hardwood resprouting should be expected.

## USE ARSENAL HERBICIDE APPLICATORS CON-CENTRATE FOR SPOT TREATMENT OF UNDESIR-ABLE HARDWOOD VEGETATION

Arsenal herbicide Applicators Concentrate may be used as a directed foliar or cut-stem application to control undesirable brush and hardwoods in the management of stands of all ages for the conifer species listed in the broadcast application section above. Refer to mixing and application instructions in the directed foliar or cut-stem sections above for proper use rates, equipment, and application techniques. Ensure that the maximum labeled rates per acre listed for crop species are not exceeded. Cut-stem applications may be used for spot treatment of undesirable hardwoods in Ponderosa pine stands using 12 oz or less of product per acre.

Avoid direct application to desired plant species as injury may occur. Injury may occur to nontarget or desirable hardwoods or conifers if they extend from the same root system or their root systems are grafted to those of the treated tree or if their roots extend into the treated zone.

## LATE ROTATION VEGETATION CONTROL IN WESTERN CONIFERS

In California, the Pacific Northwest and Inland Northwest, broadcast aerial applications of **Arsenal herbicide Applicators Concentrate** up to 24 oz/A are permissible in conifer stands that are targeted for harvesting the year following treatment. Use minimum spray volume of 15 gallons per acre. Significant conifer injury or mortality must be expected. **DO NOT** use this treatment if conifer injury or mortality cannot be tolerated.

## BAG AND SPRAY APPLICATIONS FOR CONIFER RELEASE

In Douglas Fir and Ponderosa pine stands, broadcast applications of **Arsenal® herbicide Applicators** 

**Concentrate** up to 16 oz/A are permissible when the trees are covered by bags prior to the application. The bags must prevent the spray mix from contacting the conifer foliage. On sites with coarse textured soils (e.g. decomposed granite, pumice, sandy or rocky sites) or low levels of soil organic matter (generally 5% or less), significant conifer growth inhibition and mortality is possible. **DO NOT** use this treatment on these types of sites if conifer growth inhibition and mortality cannot be tolerated.

## WEEDS CONTROLLED

Arsenal herbicide Applicators Concentrate will provide postemergence control and some residual control of the following target vegetation species. Degree of control is both species and rate dependent. Arsenal herbicide Applicators Concentrate should be used only in accordance with the recommendations on this label.

## GRASSES

The species of annual and perennial grasses controlled by **Arsenal herbicide Applicators Concentrate** include the following:

Annual bluegrass (Poa annua) Bahiagrass (Paspalum notatum) Barnyardgrass (Echinochloa crus-galli) Beardgrass (Andropogon spp.) Bermudagrass (Cynodon dactylon)1 Big bluestem (Andropogon gerardii) Broadleaf signalgrass (Brachiaria platyphylla) Canada bluegrass (Poa compressa) Cattail (Typha spp.) Cheat (Bromus secalinus) Cogongrass (Imperata cylindrica)<sup>2</sup> Crabgrass (Digitaria spp.) Crowfootgrass (Dactyloctenium aegyptium) Dallisgrass (Paspalum dilatatum) Downy brome (Bromus tectorum) Fall panicum (Panicum dichotomiflorum) Feathertop (Pennisetum villosum) Fescue (Festuca spp.) Foxtail (Setaria spp.) Giant reed (Arundo donax) Goosegrass (Eleusine indica) Guineagrass (Panicum maximum) Italian ryegrass (Lolium multiflorum) Itchgrass (Rottboellia exaltata) Johnsongrass (Sorghum halepense)1 Junglerice (Echinochloa colonum) Kentucky bluegrass (Poa pratensis) Lovegrass (Eragrostis spp.)1 Orchardgrass (Dactylis glomerata) Panicum spp. Paragrass (Brachiaria mutica) Phragmites (Phragmites australis) Prairie cordgrass (Spartina pectinata) Prairie threeawn (Aristida oligantha) Quackgrass (Agropyron repens)

### GRASSES (continued)

Reed canary grass (Phalaris arundinacea) Saltgrass (Distichlis stricta) Sand dropseed (Sporobolus cryptandrus) Sandbur (Cenchrus spp.) Smooth brome (Bromus inermis) Sprangletop (Leptochloa spp.) Timothy (Phleum pratense) Torpedograss (Panicum repens) Vaseygrass (Paspalum urvillei) Wild barley (Hordeum spp.) Wild oats (Avena fatua) Wirestem muhly (Muhlenbergia frondosa) Witchgrass (Panicum capillare) Woolly cupgrass (Eriochloa villosa) <sup>1</sup> Use higher labeled rates. <sup>2</sup> Use minimum of 24 oz per acre.

## **BROADLEAF WEEDS**

The species of annual and perennial broadleaf weeds controlled by Arsenal herbicide Applicators Concentrate include the following: Arrowwood (Pluchea sericea) Broom snakeweed (Gutierrezia sarothrae) Bull thistle (Cirsium vulgare) Burclover (Medicago spp.) Burdock (Arctium spp.) Camphorweed (Heterotheca subaxillaris) Canada thistle (Cirsium arvense) Carolina geranium (Geranium carolinianum) Carpetweed (Mullugo verticillata) Chickweed, mouseear (Cerastium vulgatum) Clover (Trifolium spp.) Cocklebur (Xanthium strumarium) Common chickweed (Stellaria media) Common ragweed (Ambrosia artemisiifolia) Cudweed (Gnaphalium spp.) Dandelion (Taraxacum officinale) Desert camelthorn (Alhagi pseudalhagi) Diffuse knapweed (Centaurea diffusa) Dock (Rumex spp.) Dogfennel (Eupatorium capillifolium) Fiddleneck (Amsinckia intermedia) Filaree (Erodium spp.) Fleabane (Erigeron spp.) Giant ragweed (Ambrosia trifida) Goldenrod (Solidago spp.) Gray rabbitbrush (Chrysothamnus nauseosus) Henbit (Lamium aplexicaule) Hoary vervain (Verbena stricta) Horseweed (Convza canadensis) Indian mustard (Brassica juncea) Japanese bamboo/knotweed (Polygonum cuspidatum) Knotweed, prostrate (Polygonum aviculare) Kochia (Kochia scoparia) Lambsquarters (Chenopodium album) Little mallow (Malva parviflora) Milkweed (Asclepias spp.) Miners lettuce (Montia perfoliata) Page 163 of 416 Mullein (Verbascum spp.)

#### **BROADLEAF WEEDS** (continued)

Nettleleaf goosefoot (Chenopodium murale) Oxeye daisy (Chrysanthemum leucanthemum) Pepperweed (Lepidium spp.) Piqweed (Amaranthus spp.) Plantain (Plantago spp.) Pokeweed (Phytolacca americana) Primrose (Oenothera kunthiana) Puncturevine (Tribulus terrestris) Purple loosestrife (Lythrum salicaria) Purslane (Portulaca spp.) Pusley, Florida (Richardia scabra) Rocket, London (Sisymbrium irio) Rush skeletonweed (Chondrilla juncea) Russian knapweed (Centaurea repens) Russian thistle (Salsola kali) Saltbush (Atriplex spp.) Shepherdspurse (Capsella bursa-pastoris) Silverleaf nightshade (Solanum elaeagnifolium) Smartweed (Polygonum spp.) Sorrell (Rumex spp.) Sowthistle (Sonchus spp.) Spurge, annual (Euphorbia spp.) Stinging nettle (Urtica dioica) Sunflower (Helianthus spp.) Sweet clover (Melilotus spp.) Tansymustard (Descurainia pinnata) Texas thistle (Cirsium texanum) Velvetleaf (Abutilon theophrasti) Western ragweed (Ambrosia psilostachya) Wild carrot (Daucus carota) Wild lettuce (Lactuca spp.) Wild parsnip (Pastinaca sativa) Wild turnip (Brassica campestris) Woollyleaf bursage (Ambrosia grayi) Yellow starthistle (Centaurea solstitialis) Yellow woodsorrel (Oxalis stricta)

#### VINES AND BRAMBLES

The species of vines and brambles controlled by Arsenal® herbicide Applicators Concentrate include the following:

- Field bindweed (Convolvulus arvensis) Hedge bindweed (Calystegia sequium) Honeysuckle (Lonicera spp.)1 Morningglory (Ipomoea spp.) Poison ivy (Rhus radicans) Redvine (Brunnichia cirrhosa) Trumpetcreeper (Campsis radicans) Virginia creeper (Parthenocissus guinguefolia) Wild buckwheat (Polygonum convolvulus) Wild grape (Vitis spp.) Wild rose (Rosa spp.)1 Including: Multiflora rose (Rosa multiflora)
- Macartney rose (Rosa bracteata) <sup>1</sup> Use higher labeled rates.

#### WOODY BRUSH AND TREES

The species of woody brush and trees controlled by Arsenal herbicide Applicators Concentrate include the following: Alder (Alnus spp.) American beech (Fagus grandifolia) Ash (Fraxinus spp.)1 Aspen (Populus spp.) Autumn olive (Elaeagnus umbellata) Bald cypress (Taxodium distichum) Bigleaf maple (Acer macrophyllum) Birch (Betula spp.)1 Black oak (Quercus kelloggii) Blackgum (Nyssa sylvatica)<sup>2</sup> Boxelder (Acer negundo) Brazilian peppertree (Schinus terebinthifolius) Ceanothis (Ceanothis spp.) Cherry (Prunus spp.)1.2 Chinaberry (Melia azedarach) Chinese tallow tree (Sapium sebiferum) Chinquapin (Castanopsis chrysophylla) Cottonwood (Populus trichocarpa and Populus deltoides) Cypress (Taxodium spp.) Dogwood (Cornus spp.)1 Eucalyptus (Eucalyptus spp.) Hawthorn (Crataegus spp.) Hickory (Carya spp.)1 Huckleberry (Gaylussacia spp.) Lyonia spp. Including: Fetterbush (Lyonia lucida) Staggerbush (Lyonia mariana) Madrone (Arbutus menziesii) Maple (Acer spp.) Melaleuca (Melaleuca quinquenervia) Mulberry (Morus spp.)1.3 Oak (Quercus spp.)4 Persimmon (Diospyros virginiana)<sup>2</sup> Poison oak (Rhus diversiloba) Popcorn tree (Sapium sebiferum) Poplar (Populus spp.) Privet (Ligustrum vulgare) Red alder (Alnus rubra) Red maple (Acer rubrum) Saltcedar (Tamarix pentandra) Sassafras (Sassafras albidum) Sourwood (Oxydendrum arboreum)<sup>2</sup> Sumac (Rhus spp.) Sweetgum (Liquidambar styraciflua) Sycamore (Platanus occidentalis) Tanoak (Lithocarpus densiflorus)1 Titi (Cyrilla racemiflora)5 Tree of heaven (Ailanthus altissima) Vaccinium spp. Including: Blueberry (Vaccinium spp.) Sparkleberry (Vaccinium arboreum) Willow (Salix spp.) Yellow poplar (Liriodendron tulipifera)1 <sup>1</sup> Use higher labeled rates. <sup>2</sup> Best control with applications prior to formation of fall leaf color. <sup>3</sup> The degree of control may be species dependent. <sup>4</sup> For Water oak (Quercus nigra), Laurel oak (Q. laurifloria), Willow oak

(Q. phellos) and Live oak (Q. virginiana), use higher labeled rates. Page 164 of 416

<sup>5</sup> Suppression only.

## **Conditions of Sale and Warranty**

The **Directions For Use** of this product reflects the opinion of experts based on field use and tests. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or use of the product in a manner inconsistent with its labeling, all of which are beyond the control of BASF CORPORATION ("BASF") or the Seller. All such risks shall be assumed by the Buyer.

BASF warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes referred to in the **Directions For Use**, subject to the inherent risks, referred to above.

BASF MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY OR ANY OTHER EXPRESS OR IMPLIED WARRANTY. TO THE EXTENT PERMITTED BY LAW, BASF AND THE SELLER DISCLAIM ANY LIABILITY FOR CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT. BASF and the Seller offer this product, and the Buyer and User accept it, subject to the foregoing **Conditions of Sale and Warranty** which may be varied only by agreement in writing signed by a duly authorized representative of BASF.

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000241-00299.20061026.**NVA 2006-04-104-0264** Based on: NVA 2005-04-104-0357

> BASF Corporation Agricultural Products 26 Davis Drive Research Triangle Park, NC 27709



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## 1. Substance/preparation and company identification

Company BASF CORPORATION 100 Campus Drive Florham Park, NJ 07932 24 Hour Emergency Response Information CHEMTREC: (800) 424-9300 BASF HOTLINE: (800) 832-HELP

Substance number: Molecular formula: Molecular weight: Chemical family: Synonyms: 00000057487 C(13) H(15) N(3) O(3). C(3) H(9) N 320.4 g/mol imidazole derivative Isopropylamine salt of imazapyr (active ingredient)

## 2. Composition/information on ingredients

CAS Number 81510-83-0 Content (W/W) 53.1 % 46.9 % <u>Chemical name</u> Isopropylamine salt of imazapyr Proprietary ingredients

## 3. Hazard identification

#### Emergency overview

CAUTION: KEEP OUT OF REACH OF CHILDREN. Avoid contact with the skin, eyes and clothing. Avoid inhalation of mists/vapours.

#### Potential health effects

See Product Label for additional precautionary statements.

#### Primary routes of exposure

Routes of entry for solids and liquids include eye and skin contact, ingestion and inhalation. Routes of entry for gases include inhalation and eye contact. Skin contact may be a route of entry for liquified gases.

#### Acute toxicity:

Relatively nontoxic after single ingestion. Slightly toxic after short-term skin contact. Relatively nontoxic after short-term inhalation.

#### Irritation:

May cause slight but temporary irritation to the eyes. May cause slight irritation to the skin.

#### Sensitization:

Skin sensitizing effects were not observed in animal studies.

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#### Repeated dose toxicity:

No other known chronic effects.



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#### Potential environmental effects

#### Aquatic toxicity:

There is a high probability that the product is not acutely harmful to fish. There is a high probability that the product is not acutely harmful to aquatic invertebrates. Acutely harmful for aquatic plants.

#### Terrestrial toxicity:

With high probability not acutely harmful to terrestrial organisms.

### 4. First-aid measures

#### General advice:

First aid providers should wear personal protective equipment to prevent exposure. Remove contaminated clothing. Move person to fresh air. If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or physician for treatment advice. Have the product container or label with you when calling a poison control center or doctor or going for treatment.

#### If inhaled:

Remove the affected individual into fresh air and keep the person calm. Assist in breathing if necessary.

#### If on skin:

Rinse skin immediately with plenty of water for 15 - 20 minutes.

#### If in eyes:

Hold eyes open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after first 5 minutes, then continue rinsing.

#### If swallowed:

Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to by a poison control center or doctor. Never induce vomiting or give anything by mouth if the victim is unconscious or having convulsions.

#### Note to physician

Antidote:	No known specific antidote.	
Treatment:	Treat symptomatically.	

## 5. Fire-fighting measures

Flash point:	> 210 °F
Autoignition:	approx. 200 °F

#### Suitable extinguishing media:

foam, dry extinguishing media, carbon dioxide, water spray

#### Hazards during fire-fighting:

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carbon monoxide, carbon dioxide, Nitrogen oxide, If product is heated above decomposition temperature, toxic vapours will be released. The substances/groups of substances mentioned can be released if the product is involved in a fire.



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#### Protective equipment for fire-fighting:

Firefighters should be equipped with self-contained breathing apparatus and turn-out gear.

Reactivity: 0

#### Further information:

Evacuate area of all unnecessary personnel. Contain contaminated water/firefighting water. Do not allow to enter drains or waterways.

#### NFPA Hazard codes:

Health : 1 Fire: 1

Special:

### 6. Accidental release measures

#### Personal precautions:

Take appropriate protective measures. Clear area. Shut off source of leak only under safe conditions. Extinguish sources of ignition nearby and downwind. Ensure adequate ventilation. Wear suitable personal protective clothing and equipment.

#### Environmental precautions:

Do not discharge into the subsoil/soil. Do not discharge into drains/surface waters/groundwater. Contain contaminated water/firefighting water.

#### Cleanup:

Dike spillage. Pick up with suitable absorbent material. Place into suitable containers for reuse or disposal in a licensed facility. Spilled substance/product should be recovered and applied according to label rates whenever possible. If application of spilled substance/product is not possible, then spills should be contained, solidified, and placed in suitable containers for disposal. After decontamination, spill area can be washed with water. Collect wash water for approved disposal.

## 7. Handling and storage

#### Handling

#### General advice:

RECOMMENDATIONS ARE FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS. PESTICIDE APPLICATORS & WORKERS must refer to the Product Label and Directions for Use attached to the product for Agricultural Use Requirements in accordance with the EPA Worker Protection Standard 40 CFR part 170. Ensure adequate ventilation. Provide good ventilation of working area (local exhaust ventilation if necessary). Keep away from sources of ignition - No smoking. Keep container tightly sealed. Protect contents from the effects of light. Protect against heat. Protect from air. Handle and open container with care. Do not open until ready to use. Once container is opened, content should be usedup as soon as possible. Avoid aerosol formation. Avoid dust formation. Provide means for controlling leaks and spills. Do not return residues to the storage containers. Follow label warnings even after container is emptied. The substance/product may be handled only by appropriately transperies. Avoid and all direct contact with the substance/product. Avoid contact with the skin, eyes and clothing. Avoid inhalation of dusts/mists/vapours. Wear suitable personal protective clothing and equipment.



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#### Protection against fire and explosion:

The relevant fire protection measures should be noted. Fire extinguishers should be kept handy. Avoid all sources of ignition: heat, sparks, open flame. Sources of ignition should be kept well clear. Avoid extreme heat. Keep away from oxidizable substances. Electrical equipment should conform to national electric code. Ground all transfer equipment properly to prevent electrostatic discharge. Electrostatic discharge may cause ignition.

#### Storage

#### General advice:

Keep only in the original container in a cool, dry, well-ventilated place away from ignition sources, heat or flame. Protect containers from physical damage. Protect against contamination. The authority permits and storage regulations must be observed.

#### Storage incompatibility:

General: Segregate from incompatible substances. Segregate from foods and animal feeds. Segregate from textiles and similar materials.

## 8. Exposure controls and personal protection

Users of a pesticidal product should refer to the product label for personal protective equipment requirements.

#### Advice on system design:

Whenever possible, engineering controls should be used to minimize the need for personal protective equipment.

#### Personal protective equipment

## RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

#### **Respiratory protection:**

Wear respiratory protection if ventilation is inadequate. Wear a NIOSH-certified (or equivalent) TC23C Chemical/Mechanical type filter system to remove a combination of particles, gas and vapours. For situations where the airborne concentrations may exceed the level for which an air purifying respirator is effective, or where the levels are unknown or Immediately Dangerous to Life or Health (IDLH), use NIOSH-certified full facepiece pressure demand self-contained breathing apparatus (SCBA) or a full facepiece pressure demand self-contained breathing apparatus (SCBA) or a full facepiece pressure demand supplied-air respirator (SAR) with escape provisions.

#### Hand protection:

Chemical resistant protective gloves, Protective glove selection must be based on the user's assessment of the workplace hazards.

#### Eye protection:

Safety glasses with side-shields (frame goggles) (f.e. EN 166)

#### Body protection:

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Body protection must be chosen depending on activity and possible exposure, e.g. head protection, apron, protective boots, chemical-protection suit.



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#### General safety and hygiene measures:

Wear long sleeved work shirt and long work pants in addition to other stated personal protective equipment. Work place should be equipped with a shower and an eye wash. Handle in accordance with good industrial hygiene and safety practice. Personal protective equipment should be decontaminated prior to reuse. Gloves must be inspected regularly and prior to each use. Replace if necessary (e.g. pinhole leaks). Take off immediately all contaminated clothing. Store work clothing separately. Hands and/or face should be washed before breaks and at the end of the shift. No eating, drinking, smoking or tobacco use at the place of work. Keep away from food, drink and animal feeding stuffs.

## 9. Physical and chemical properties

Form: Odour:	liquid strong, ammonia-like	
Colour: pH value:	green 5.5 - 7.5	
Boiling point: Density:	approx. 212 °F 1.11 - 1.12 g/cm3	( 760 mmHg)

### 10. Stability and reactivity

#### Conditions to avoid:

Avoid all sources of ignition: heat, sparks, open flame. Avoid extreme temperatures. Avoid prolonged exposure to extreme heat. Avoid contamination. Avoid electro-static discharge. Avoid prolonged storage.

#### Substances to avoid:

oxidizing agent, strong alkalies

#### Hazardous reactions:

The product is chemically stable. Hazardous polymerization will not occur. No hazardous reactions if stored and handled as prescribed/indicated.

#### Decomposition products:

Hazardous decomposition products: No hazardous decomposition products if stored and handled as prescribed/indicated., Prolonged thermal loading can result in products of degradation being given off.

#### Thermal decomposition:

Possible thermal decomposition products: carbon monoxide, carbon dioxide, Nitrogen oxide Stable at ambient temperature. If product is heated above decomposition temperature toxic vapours may be released. If product is heated above decomposition temperature hazardous fumes may be released.

## 11. Toxicological information

#### Acute toxicity

**Oral:** LD50/rat: > 5,000 mg/kg Slightly toxic to practically nontoxic. Page 170 of 416



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Inhalation: LC50/rat/male/female: 4.62 mg/l / 4 h

Dermal: LD50/rabbit: > 5,000 mg/kg Slightly toxic.

Skin irritation: rabbit: Mildly irritating. (Primary skin irritation test)

Eye irritation : rabbit: Nonirritating.

Genetic toxicity: Information on: imazapyr No mutagenic effect was found in various tests with microorganisms and mammals.

Carcinogenicity:

Information on: imazapyr In long-term studies in rats and mice in which the substance was given by feed, a carcinogenic effect was not observed.

**Reproductive toxicity:** Information on: imazapyr The results of animal studies gave no indication of a fertility impairing effect.

Developmental toxicity/teratogenicity: Information on: imazapyr No indications of a developmental toxic / teratogenic effect were seen in animal studies.

## 12. Ecological information

Information on: imazapyr

Environmental toxicity

Information on: imazapyr Acute and prolonged toxicity to fish: Rainbow trout/LC50 (96 h): > 100 mg/l

Information on: imazapyr Acute toxicity to aquatic invertebrates: Daphnia magna/EC50 (48 h): > 100 mg/l Page 171 of 416



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Information on: imazapyr Toxicity to aquatic plants: green algae/EC50: 71 mg/l

Information on: imazapyr Other terrestrial non-mammals: mallard duck/LC50: > 5,000 ppm With high probability not acutely harmful to terrestrial organisms. Honey bee/LD50: > 100 ug/bee With high probability not acutely harmful to terrestrial organisms.

#### Other ecotoxicological advice:

Do not discharge product into the environment without control. No data available for the preparation. The ecological data given are those of the active ingredient.

### 13. Disposal considerations

#### Waste disposal of substance:

Pesticide wastes are regulated.

Improper disposal of excess pesticide, spray mix or rinsate is a violation of federal law. If pesticide wastes cannot be disposed of according to label instructions, contact the State Pesticide or Environmental Control Agency or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

#### Container disposal:

Rinse thoroughly at least three times (triple rinse) in accordance with EPA recommendations. Consult state or local disposal authorities for approved alternative procedures such as container recycling. Recommend crushing, puncturing or other means to prevent unauthorized use of used containers.

## 14. Transport information

Reference Bill of Lading

### 15. Regulatory information

Federal Regulations

Registration status: TSCA, US

released / exempt

 OSHA hazard category:
 Chronic target organ effects reported, Acute target organ ef

SARA hazard categories (EPCRA 311/312): Acute



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### 16. Other information

#### Refer to product label for EPA registration number.

Recommended use: crop protection product

Local contact information Product Stewardship 919 547-2000

IMPORTANT: WHILE THE DESCRIPTIONS, DESIGNS, DATA AND INFORMATION CONTAINED HEREIN ARE PRESENTED IN GOOD FAITH AND BELIEVED TO BE ACCURATE, IT IS PROVIDED FOR YOUR GUIDANCE ONLY. BECAUSE MANY FACTORS MAY AFFECT PROCESSING OR APPLICATION/USE, WE RECOMMEND THAT YOU MAKE TESTS TO DETERMINE THE SUITABILITY OF A PRODUCT FOR YOUR PARTICULAR PURPOSE PRIOR TO USE. NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR PURPOSE, ARE MADE REGARDING PRODUCTS DESCRIBED OR DESIGNS, DATA OR INFORMATION SET FORTH, OR THAT THE PRODUCTS, DESIGNS, DATA OR INFORMATION MAY BE USED WITHOUT INFRINGING THE INTELLECTUAL PROPERTY RIGHTS OF OTHERS. IN NO CASE SHALL THE DESCRIPTIONS, INFORMATION, DATA OR DESIGNS PROVIDED BE CONSIDERED A PART OF OUR TERMS AND CONDITIONS OF SALE. FURTHER, YOU EXPRESSLY UNDERSTAND AND AGREE THAT THE DESCRIPTIONS, DESIGNS, DATA, AND INFORMATION FURNISHED BY BASF HEREUNDER ARE GIVEN GRATIS AND BASF ASSUMES NO OBLIGATION OR LIABILITY FOR THE DESCRIPTION, DESIGNS, DATA AND INFORMATION GIVEN OR RESULTS OBTAINED, ALL SUCH BEING GIVEN AND ACCEPTED AT YOUR RISK.

END OF DATA SHEET

# Specimen Label



## Herbicide

\*Trademark of Dow AgroSciences LLC

For control of annual and perennial weeds and woody plants in forests, non-crop sites, and in and around aquatic sites; also for use in pine straw plantations, wildlife habitat areas, for perennial grass release, and grass growth suppression.

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Active Ingredient(s):

glyphosate <sup>+</sup> N-(phosphonomethyl)glycine,	
isopropylamine salt	53.8%
Inert Ingredients	46.2%
Total Ingredients	100.0%

<sup>†</sup>Contains 5.4 pounds per gallon glyphosate, isopropylamine salt (4 pounds per gallon glyphosate acid).

EPA Reg. No. 62719-324

# Keep Out of Reach of Children CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

### **Precautionary Statements**

## Hazards to Humans and Domestic Animals

Harmful If Inhaled

Avoid breathing spray mist. Remove contaminated clothing and wash before reuse. Wash thoroughly with soap and water after handling.

## Personal Protective Equipment (PPE)

- Applicators and other handlers must wear:
- Long-sleeved shirt and long pants
   Shace plug coole
- Shoes plus socks.

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

#### Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

### **User Safety Recommendations**

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

#### First Aid

If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-tomouth if possible. Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

### **Environmental Hazards**

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of leak or spill, soak up and remove to a landfill.

### **Physical or Chemical Hazards**

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

Do not mix, store or apply this product or spray solutions of this product in galvanized steel or unlined steel (except stainless steel) containers or spray tanks. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas, which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

Notice: Read the entire label. Use only according to label directions. Before using this product, read "Warranty Disclaimer," Inherent Risks of Use," and "Limitation of Remedies" elsewhere on this label. If terms are unacceptable, return at once unopened.

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Specimen Label Revised 02-06-06

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

#### **Directions for Use**

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

#### This is an end-use product. Dow AgroSciences does not intend and has not registered it for reformulation. See individual container label for repackaging limitations.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

#### Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- · Chemical-resistant gloves made of any waterproof material
- Shoes plus socks

#### Storage and Disposal

Do not contaminate water, food, feed or seed by storage or disposal. **Pesticide Storage: Store above 10°F (-12°C) to keep product from crystallizing.** Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using.

**Pesticide Disposal:** Wastes resulting from use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state or local procedures.

**Container Disposal:** Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed. Do not reuse this container. Triple rinse (or equivalent). Then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

#### General Information (How this product works)

This product herbicide is a water-soluble liquid, which mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants. Glypro is intended for control of annual and perennial weeds and woody plants in forests, non-crop sites, and in and around aquatic sites; also for use in pine straw plantations, wildlife habitat areas, for perennial grass release and grass growth suppression.

The active ingredient in Glypro moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days, 7 days or more on most perennial weeds, and 30 days or more on most woody plants. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects include gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of Glypro and surfactant within the recommended range when vegetation is heavy or dense, when treating dense multi-canopied sites or woody vegetation or difficult-to-control herbaceous or woody plants.

Do not treat weeds, brush or trees under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced control of target vegetation may also occur if foliage is heavily covered with dust at the time of treatment.

Reduced control may result when applications are made to woody plants or weeds following site disturbance or plant top growth removal from grazing, mowing, logging or mechanical brush control. For best results, delay treatment of such areas until resprouting and foliar growth has restored the target vegetation to the recommended stage of growth for optimum herbicidal exposure and control.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

Glypro does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

**Note:** The maximum rates stated throughout this product's labeling apply to this product combined with the use of all other herbicides containing glyphosate or sulfosate as the active ingredient, whether applied as mixtures or separately. Calculate the application rates and ensure that the total use of this and other glyphosate or sulfosate containing products does not exceed the maximum use rates.

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**Grazing Restrictions:** This product may be used to treat undesirable vegetation in utility rights-of-way that pass through pastures, rangeland, and forestry sites that are being grazed. For tank mix applications, comply with all restrictions appearing on the tank mix product label.

Except for lactating dairy animals there are no grazing restrictions following the labeled applications of this product.

- For lactating dairy animals there are no grazing restrictions for the following labeled applications of this product:
  - Where the spray can be directed onto undesirable woody brush and trees, such as in handgun spray-to-wet or low volume directed spray treatments.
  - For tree injection of frill applications and for cut stump treatments
- For broadcast applications, observe the following restrictions for lactating dairy animals:
  - For application rates of greater than 4.5 but not to exceed 7.5 quarts per acre, no more than 15 percent of the available grazing area may be treated.
  - For application rates that do not exceed 4.5 quarts per acre, no more than 25 percent of the available grazing area may be treated.
- These restrictions do not apply to pastures, rangeland or forestry sites outside of utility rights-of-way.

**NOTE:** Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

#### ATTENTION: Avoid drift. Extreme care must be used when applying this product to prevent injury to desirable plants and crops.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. Avoid applying at excessive speed or pressure.

#### Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications, public health uses or to applications using dry formulations.

- 1. The distance of the outer most nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
- 2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following **Aerial Drift Reduction Advisory Information**:

Importance of Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversion section of this label).

**Controlling Droplet Size:** Volume-Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows product larger droplets.

Pressure-Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.

Number of nozzles-Use the minimum number of nozzles that provide uniform coverage.

Nozzle Orientation-Orienting nozzles so that the spray is released backwards, parallel to the airstream will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

Nozzle Type-Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.

Boom Length-For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application-Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind. Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2-10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. Note: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a temperature inversion, because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a connected cloud (under low wind conditions) indicates an inversion, while smoke that moves upwards and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

#### Mixing And Application Instructions

Apply these spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes. Hand-gun applications should be properly directed to avoid spraying desirable plants. Note: reduced results may occur if water containing soil is used, such as water from ponds and unlined ditches.

#### Mixing

Glypro mixes readily with water. Mix spray solutions of this product as follows:

- Fill the mixing or spray tank with the required amount of water while adding the required amount of this product (see "Directions for Use" and "Weeds Controlled" sections of this label).
- Near the end of the filling process, add the required surfactant and mix well. Remove hose from tank immediately after filling to avoid siphoning back into the water source.

**Note:** If tank mixing with Garlon\* 3A herbicide, ensure that Garlon 3A is well mixed with at least 75 percent of the total spray volume before adding Glypro to the spray tank to avoid incompatibility.

During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, place the filling hose below the surface of the spray solution (only during filling), terminate by-pass and return lines at the bottom of the tank, and, if needed, use an approved anti-foam or defoaming agent.

Keep by-pass line on or near bottom of tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh. Carefully select correct nozzle to avoid spraying a fine mist. For best results with conventional ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

**IMPORTANT:** When using this product, unless otherwise specified, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Use a nonionic surfactant labeled for use with herbicides. The surfactant must contain 50 percent or more active ingredient.

Always read and follow the manufacturer's surfactant label recommendations for best results.

Colorants or marking dyes approved for use with herbicides may be added to spray mixtures of this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilutions. Use colorants or dyes according to the manufacturer's label recommendations.

Clean sprayer and parts immediately after using this product by thoroughly flushing with water and dispose of rinsate according to labeled use or disposal instructions.

Carefully observe all cautionary statements and other information appearing in the surfactant label.

#### Application Equipment And Techniques

ATTENTION: AVOID DRIFT. EXTREME CARE MUST BE EXERCISED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift, or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to crops, plants, or other areas on which the treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

**Note:** Use of this product in a manner not consistent with this label may result in injury to persons, animals, or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.
#### Aerial Equipment

See the supplemental label for use of this product by air in California.

For control of weed or brush species listed in this label using aerial application equipment: For aerial broadcast application, unless otherwise specified, apply the rates of Glypro and surfactant recommended for broadcast application in a spray volume of 3 to 20 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. Aerial applications of this product may only be made as specifically recommended in this label.

**Forestry and Utility Rights-of-Way Sites:** It is recommended that Glypro be applied by helicopter only in forestry sites and utility rights-ofway. Apply the rate of Glypro and surfactant recommended for broadcast sprays in a spray volume of 5 to 30 gallons per acre.

In California, aerial application may be made only in non-residential, forestry sites or chaparral areas.

AVOID DRIFT. Do not apply during inversion conditions, when winds are gusty or under any other condition which will allow drift. Drift may cause damage to any vegetation contacted to which treatment is not intended. To prevent injury to adjacent desirable vegetation, appropriate buffer zones must be maintained.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing in the additive label. The use of a drift control agent for conifer and herbaceous release applications may result in conifer injury and is not recommended.

**Ensure uniform application.** To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Thoroughly wash aircraft, especially landing gear, after each day of spraying to remove residues of this product accumulated during spraying or from spills. Prolonged exposure of this product to uncoated steel surfaces may result in corrosion and possible failure of the part. Landing gear are most susceptible. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion.

#### **Ground Broadcast Equipment**

For control of weed or brush species listed in this label using conventional boom equipment: For ground broadcast application, unless otherwise specified, apply the rates of Glypro and surfactant recommended for broadcast application in a spray volume of 3 to 30 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. As density of vegetation increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select correct nozzle to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

Forestry and Utility Rights-of-Way Sites: Glypro is recommended for broadcast applications using suitable ground equipment in forestry sites, utility sites, and utility rights-of way. Apply the recommended rates of Glypro and surfactant in a spray volume of 10 to 60 gallons per acre. Check for even distribution of spray droplets.

Hand-Held and High-Volume Equipment (Use Coarse Sprays Only)

For control of weeds listed in this label using knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements:

**High volume sprays:** Prepare a **3/4 to 2 percent solution** of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "Weeds Controlled" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

Low volume directed sprays: Glypro may be used as a 5 to 10 percent solution in low-volume directed sprays for spot treatment of trees and brush. This treatment method is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, open-branched trees need only be treated from one side. If the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

Prepare the desired volume of spray solution by mixing the amount of this product in water, shown in the following table:

#### **Spray Solution**

Desired	Amount of Glypro							
Volume	3/4%	1%	1 1/4%	1 1/2%	2%	5%	8%	10%
1 gal	1 fl oz	1 1/3 fl oz	1 2/3 fl oz	2 fl oz	2 2/3 fl oz	6 1/2 fl oz	10 1/4 fl oz	12 3/4 fl oz
25 gal	1 1/2 pt	1 qt	1 1/4 qt	1 1/2 qt	2 qt	5 qt	2 gal	2.5 gal
100 gal	3 qt	1 gal	1 1/4 gal	1 1/2 gal	2 gal	5 gal	8 gal	10 gal

2 tablespoons = 1 fluid ounce

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill the knapsack sprayer with the mixed solution and add the correct amount of surfactant.

#### Selective Equipment

This product may be applied through shielded sprayers or wiper application equipment. This equipment may be used to selectively control undesirable vegetation without harming desirable vegetation.

Shielded sprayers direct the herbicide solution onto weeds while shielding desirable vegetation from the spray solution. Any recommended rate or tank mixture of this product may be used employing this equipment.

Wiper applicators physically wipe product directly onto undesirable vegetation. Care should be taken to avoid wiping desirable vegetation. Use a 33 to 100 percent solution of this product, diluted in water for wiper applications. Use a 33 percent solution for wick or gravity feed systems.

Higher concentrations may be used in pressurized systems that are capable of handling thicker solutions. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

#### Weeds Controlled

#### Annual Weeds

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application Rates: Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application Rates: Use a 3/4 percent solution of this product in water plus 2 or more guarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed, Glypro plus nonionic surfactant will control the following annual weeds:

**Common Name** Balsamapple <sup>t</sup> Barlev Barnyardgrass Bassia, fivehook Bluegrass, annual Bluegrass, bulbous Brome Buttercup Cheat Chickweed, mouseear Cocklebur Corn, volunteer Craborass Dwarfdandelion Falseflax, smallseed Fiddleneck Flaxleaf fleabane Fleabane Foxtail Foxtail, Carolina Groundsel, common Horseweed/Marestail Kochia Lambsquarters, common Lettuce, prickly Morningglory Mustard, blue Mustard, tansy Mustard, tumble Mustard, wild Oats, wild Panicum Pennycress, field Pigweed, redroot Pigweed, smooth Ragweed, common Ragweed, giant Rocket, London Rve Ryegrass, Italian # Sandbur, field Shattercane Shepherd's-purse Signalgrass, broadleaf Smartweed, Pennsylvania Sowthistle, annual Spanishneedles <sup>tt</sup> Stinkgrass Sunflower Thistle, Russian Spurry, umbrella Velvetleaf Wheat Witchgrass

#### Scientific Name

Momordica charantia Hordeum vulgare Echinochloa crus-galli Bassia hyssopifolia Poa annua Poa bulbosa Bromus spp. Ranunculus spp. Bromus secalinus Cerastium vulgatum Xanthium strumarium Zea mavs Digitaria spp. Krigia cespitosa Camelina microcarpa Amsinckia spp. Conyza bonariensis Erigeron spp. Setaria spp. Alopecurus carolinianus Senecio vulgaris Conyza canadensis Kochia scoparia Chenopodium album Lactuca serriola Ipomoea spp. Chorispora tenella Descurainia pinnata Sisymbrium altissimum Sinapis arvensis Avena fatua Panicum spp. Thlaspi arvense Amaranthus retroflexus Amaranthus hybridus Ambrosia artemisiifolia Ambrosia trifida Sisymbrium irio Secale cereale Lolium multiflorum Cenchrus spp. Sorghum bicolor Capsella bursa-pastoris Brachiaria platyphylla Polygonum pensylvanicum Sonchus oleraceus Bidens bipinnata Eragrostis cilianensis Helianthus annuus Salsola kali Holosteum umbellatum Abutilon theophrasti Triticum aestivum Panicum capillare

<sup>†</sup>Apply with hand-held equipment only. "Apply 3 pints of this product per acre.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

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#### Perennial Weeds

Apply Glypro to control most vigorously growing perennial weeds. Unless otherwise directed, apply when target plants are actively growing and most have reached early head or early bud stage of growth. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

**NOTE:** If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

Specific Weed Control Recommendations: For perennial weeds, apply the recommended rate plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. See the "General Information", "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

When applied as directed, Glypro plus nonionic surfactant will control the following perennial weeds: (Numbers in parentheses "(-)" following common name of a listed weed species refer to "Specific Perennial Weed Control Recommendations" for that weed which follow the species listing.)

#### Common Name Alfalfa (31)

Alligatorweed (1) Anise/Fennel (31) Artichoke, Jerusalem (31) Bahiagrass (31) Bermudagrass (2) Bindweed, field (3) Bluegrass, Kentucky (12) Blueweed, Texas (3) Brackenfern (4) Bromegrass, smooth (12) Canarygrass, reed (12) Cattail (5) Clover, red (31) Clover, white (31) Cogongrass (6) Cordgrass (7) Cutgrass, giant 1 (8) Dallisgrass (31) Dandelion (31) Dock, curly (31) Dogbane, hemp (9) Fescue (31) Fescue, tall (10) Guineagrass (11)

Scientific Name Medicago sativa Alternanthera philoxeroides Foeniculum vulgare Helianthus tuberosus Paspalum notatum Cynodon dactylon Convolvulus arvensis Poa pratensis Helianthus ciliaris Pteridium spp. Bromus inermis Phalaris arundinacea Typha spp. Trifolium pratense Trifolium repens Imperata clylindrica Spartina spp. Zizaniopsis miliacea Paspalum dilatatum Taraxacum officinale Rumex crispus Apocynum cannabinum Festuca spp. Festuca arundinacea

Panicum maximum

Hemlock, poison (31) Horsenettle (31) Horseradish (9) Ice Plant (22) Johnsongrass (12) Kikuyugrass (21) Knapweed (9) Lantana (13) Lespedeza, common (31) Lespedeza, sericea (31) Loosestrife, purple (14) Lotus, American (15) Maidencane (16) Milkweed (17) Muhly, wirestem (21) Mullein, common (31) Napiergrass (31) Nightshade, silverleaf (3) Nutsedge, purple (18) Nutsedge, yellow (18) Orchardgrass (12) Pampasgrass (19) Paragrass (16) Phragmites<sup>tt</sup> (20) Quackgrass (21) Reed, giant (22) Ryegrass, perennial (12) Smartweed, swamp (31) Spatterdock (23) Starthistle, yellow (31) Sweet potato, wild † (24) Thistle, artichoke (25) Thistle, Canada (25) Timothy (12) Torpedograss <sup>†</sup>(26) Tules, common (27) Vaseygrass (31) Velvetgrass (31) Waterhyacinth (28) Waterlettuce (29) Waterprimrose (30) Wheatgrass, western (12) Conium maculatum Solanum carolinense Armoracia rusticana Mesembrvanthemum crvstallinum Sorahum halepense Pennisetum clandestinum Centaurea repens Lantana camara Lespedeza striata Lespedeza cuneata Lythrum salicaria Nelumbo lutea Panicum hematomon Asclepias spp. Muhlenbergia frondosa Verbascum thapsus Pennisetum purpureum Solanum elaeagnifolium Cyperus rotundus Cyperus esculentus Dactylis glomerata Cortaderia iubata Brachiaria mutica Phragmites spp. Agropyron repens Arundo donax Lolium perenne Polygonum coccineum Nuphar luteum Centaurea solstitialis Ipomoea pandurata Cvnara cardunculus Cirsium arvense Phleum pratense Panicum repens Scirpus acutus Paspalum urvillei Holcus spp. Eichornia crassipes Pistia stratiotes Ludwigia spp.

<sup>†</sup> Partial control.

<sup>11</sup> Partial control in southeastern states. See "Specific Weed Control Recommendations" below.

Agropyron smithii

#### Specific Perennial Weed Control Recommendations:

- Alligatorweed: Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.
- Bermudagrass: Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seedheads appear.

- 3. Bindweed, field / Silverleaf Nightshade / Texas Blueweed: Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.
- Brackenfern: Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.
- 5. Cattail: Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.
- 6. Cogongrass: Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.
- 7. Cordgrass: Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.
- 8. Cutgrass, glant: Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10-leaf stage prior to retreatment.
- 9. Dogbane, hemp / Knapweed / Horseradish: Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.
- 10. Fescue, tall: Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.
- 11. Guineagrass: Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.
- 12. Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth / Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western: Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.
- **13.** Lantana: Apply this product as a 3/4 to 1 percent solution with handheld equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.
- Loosestrife, purple: Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held

equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

- 15. Lotus, American: Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.
- 16. Maidencane / Paragrass: Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.
- 17. Milkweed, common: Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.
- 18. Nutsedge: purple, yellow: Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.
- **19.** Pampasgrass: Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.
- 20. Phragmites: For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer or fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.
- 21. Quackgrass / Kikuyugrass / Muhly, wirestern: Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3 to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.
- 22. Reed, giant / ice plant: For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.
- 23. Spatterdock: Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.
- 24. Sweet potato, wild: Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

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- 25. Thistle, Canada / artichoke: Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.
- 26. Torpedograss: Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.
- 27. Tules, common: Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.
- 28. Waterhyacinth: Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.
- 29. Waterlettuce: For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.
- 30. Waterprimrose: Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.
- 31. Other perennial weeds listed above: Apply 4 1/2 to 7 1/2 pints of Glypro per acre as a broadcast spray or apply as a 3/4 to 1 1/2 percent solution with hand-held equipment.

#### Woody Brush and Trees

**NOTE:** If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

#### **Application Rates and Timing**

When applied as a 5 to 8 percent solution as a directed application as described in the "Hand-Held and High-Volume Equipment" section, this product will control or partially control all wood brush and tree species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Specific Brush or Tree Control Recommendations: Numbers in parentheses "(-)" following the common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" which follow the species listing. See this section for specific application rates and timing for listed species.

For woody brush and trees, apply the recommended rate plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation. In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions. When applied as directed, Glypro plus nonionic surfactant will control the following woody brush plants and trees: (Numbers in parentheses "(-)" following common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" for that species which follow the species listing.)

#### Common Name

Alder (1) Ash <sup>†</sup>(20) Aspen, quaking (2) Bearclover, Bearmat (20) Birch (3) Blackberry (1) Broom, French (4) Broom, Scotch (4) Buckwheat, California 1(5) Cascara<sup>†</sup>(20) Catsclaw \*(6) Ceanothus (20) Chamise (17) Cherry, bitter (7) Cherry, black (7) Cherry, pin (7) Covote brush (8) Creeper, Virginia † (20) Dewberry (1) Dogwood (9) Elderberry (3) Elm <sup>†</sup>(20) Eucalyptus, bluegum (10) Hasardia<sup>†</sup>(5) Hawthorn (2) Hazel (3) Hickory (9) Holly, Florida (11) (Brazilian peppertree) Honeysuckle (1) Hornbeam, American (20) Kudzu (12) Locust, black † (20) Manzanita (20) Maple, red <sup>†</sup>(13) Maple, sugar (14) Maple, vine <sup>†</sup>(20) Monkey flower <sup>†</sup>(5) Oak, black <sup>†</sup>(20) Oak, northern pin (14) Oak, post (1) Oak, red (14) Oak, southern red (7)

Scientific Name Alnus spp. Fraxinus spp. Populus tremuloides Chamaebatia foliolosa Betula spp. Rubus spp. Cytisus monspessulanus Cytisus scoparius Eriogonum fasciculatum Rhamnus purshiana Acacia greggi Ceanothus spp. Adenostoma fasciculatum Prunus emarginata Prunus serotina Prunus pensylvanica Baccharis consanguinea Parthenocissus guinguefolia Rubus trivialis Cornus spp. Sambucus spp. Ulmus spp. Eucalyptus globulus Haplopappus squamosus Crataegus spp. Corylus spp. Carva spp. Schinus terebinthifolius

Lonicera spp. Carpinus caroliniana Pueraria lobata Robinia pseudoacacia Arctostaphylos spp. Acer rubrum Acer saccharum Acer circinatum Mimulus guttatus Quercus velutina Quercus velutina Quercus palustris Quercus stellata Quercus stalcata Page 182 of 416

Oak, white t (20) Persimmon<sup>+</sup>(20) Poison-ivy (15) Poison-oak (15) Poplar, yellow <sup>†</sup>(20) Prunus (7) Raspberry (1) Redbud, eastern (20) Rose, multiflora (16) Russian-olive (20) Sage: black (17), white Sagebrush, California (17) Salmonberry (3) Salt cedar 1(9) Saltbush, sea myrtle (18) Sassafras (20) Sourwood <sup>†</sup>(20) Sumac, poison <sup>†</sup>(20) Sumac, smooth <sup>†</sup>(20) Sumac, winged † (20) Sweetgum (7) Swordfern <sup>†</sup>(20) Tallowtree, Chinese (17) Thimbleberry (3) Tobacco, tree \* (5) Trumpetcreeper (2) Waxmyrtle, southern <sup>†</sup>(11) Willow (19)

Quercus alba Diospyros spp. Rhus radicans Rhus toxicodendron Liriodendron tulipifera Prunus spp. Rubus spp. Cercis canadensis Rosa multiflora Elaeagnus angustifolia Salvia spp. Artemisia californica Rubus spectabilis Tamarix spp. Baccharis halimifolia Sassafras aibidum Oxydendrum arboreum Rhus vernix Rhus glabra Rhus copallina Liquidambar styraciflua Polystichum munitum Sapium sebiferum Rubus parviflorus Nicotiana glauca Campsis radicans Myrica cerifera Salix spp.

<sup>†</sup>Partial control (See below for control or partial control instructions.)

#### **Specific Brush or Tree Control Recommendations:**

- Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry: For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
- Aspen, Quaking / Hawthorn / Trumpetcreeper: For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
- Birch / Elderberry / Hazel / Salmonberry / Thimbleberry: For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
- Broom, French / Broom, Scotch: For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.
- Buckwheat, California / Hasardia / Monkey flower / Tobacco, tree: For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
- Catsclaw: For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
- Cherry, bitter / Cherry, black / Cherry, pin / Oak, southern red / Sweetgum / Prunus: For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.
- Coyote brush: For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
- Dogwood / Hickory / Salt cedar: For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.

- Eucalyptus, bluegum: For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.
- **11.** Holly, Florida / Waxmyrtle, southern: For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.
- Kudzu: For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.
- 13. Maple, red: For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.
- 14. Maple, sugar / Oak: northern pin / Oak, red: For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
- 15. Poison-ivy / Poison-oak: For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.
- 16. Rose, multiflora: For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.
- 17. Sage, black / Sagebrush, California / Chamise / Tallowtree, Chinese: For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
- **18.** Saltbush, sea myrtle: For control, apply this product as a 1 percent solution with hand-held equipment.
- Willow: For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
- 20. Other woody brush and trees listed above: For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

#### Aquatic and other Noncrop Sites

Apply Glypro as directed and under conditions described to control or partially control weeds and woody plants listed in the "Weeds Controlled" section in industrial, recreational and public areas or other similar aquatic or terrestrial sites on this label.

#### **Noncrop Sites**

Glypro may be used to control the listed weeds in the following terrestrial noncrop sites and/or in aquatic sites within these areas:

Airports **Golf Courses** Habitat Restoration & Management Areas **Highways & Roadsides** Industrial Plant Sites Lumbervards **Parking Areas** Parks Petroleum Tank Farms Pipeline, Power, Telephone & Utility Rights-of-Way **Pumping Installations** Railroads Schools Storage Areas Similar Sites Page 183 of 416

#### **Aquatic Sites**

Glypro may be applied to emerged weeds in seeps, irrigation and drainage ditches, wildlife habitat restoration and management areas and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

- Glypro does not control plants which are completely submerged or have a majority of their foliage under water.
- There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.
- Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.
- NOTE: Do not apply this product directly to water within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made only in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.
- For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.
- Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.
- Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.
- When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

### Forestry Site Preparation and Utility Rights-of-Way

In forest and utility sites, Glypro is recommended for the control or partial control of woody brush, trees, and annual and perennial herbaceous weeds. Glypro is also recommended for use in preparing or establishing wildlife openings within these sites and for maintaining logging roads, and for side trimming along utility rights-of-way.

In forestry sites, Glypro is recommended for use in site preparation prior to planting any tree species, including Christmas trees and silvicultural nursery sites.

In utility sites, Glypro is recommended for use along electrical power, pipeline, and telephone rights-of-way, and in other utility sites associated with these rights-of-way, such as substations.

#### Application Rates \*:

Method of Application	Application Rate	Spray Volume (gal/acre)
Broadcast	1 E to 7 E at/aara	E to 20
Ground	1.5 to 7.5 qt/acre	10 to 60
Spray-to-Wet Handgun, Backpack Mistblower	0.75 to 2% by volume	spray-to-wet
Low Volume Directed Spray <sup>#</sup> Handgun, Backpack Mistblower	5% to 10% by volume	partial coverage

<sup>†</sup> Where repeat applications are necessary, do not exceed 8.0 quarts per acre per year.

\*\* For low volume directed spray applications, coverage should be uniform with at least 50 percent of the foliage contacted. For best results, coverage of the top one-half of the plant is important.

In forestry site preparation and utility rights-of-way applications, Glypro requires use with a nonionic surfactant. Use a nonionic surfactant containing greater than 80 percent active ingredient and labeled for use with herbicides. Use of this product without surfactant will result in reduced herbicidal performance. Refer to the "Mixing and Application Instructions" section of this label for more information.

Mix 2 or more quarts of nonionic surfactant per 100 gallons of spray solution (0.5% or more by volume). Use of surfactant concentrations greater than 1.5% by volume with handgun applications or 2.5% by volume with broadcast applications is not recommended.

Use higher rates of Glypro within the recommended rate ranges for control or partial control of woody brush, trees and hard-to-control perennial herbaceous weeds. For best results, apply to actively growing woody brush and trees after full leaf expansion and before fall color and leaf drop. Use increased rates within the recommended rate range to control of perennial herbaceous weeds from emergence up to the appearance of seedheads, flowers or berries appear. Use lower rates within the recommended rate range to control annual herbaceous weeds and actively growing perennial herbaceous weeds after seedheads, flowers or berries appear. Apply to foliage of actively growing annual herbaceous weeds anytime after emergence.

#### **Tank Mixtures**

Glypro may be used in tank mix combination with other herbicide products to broaden the spectrum of vegetation controlled. When tank mixing, read and observe applicable use directions, precautions and limitations on the respective product labels. Use according to the most restrictive precautionary statements for each product on the mixture. Any recommended rate of Glypro may be used in a tank mix. **Note:** For forestry site preparation, make sure the tank mix product is approved for use prior to planting the desired species. Observe planting interval restrictions. For side trimming treatments in utility rights-of-way, tank mixtures with Arsenal 2WSL herbicide are not recommended. For side trimming treatments, it is recommended that this product be used alone as recommended, or as a tank mix with Garlon.

Product	Broadcast Rate	Use Sites
Arsenal Applicators Concentrate	2 to 16 fl oz/acre	Forestry site preparation
Oust	1 to 4 oz/acre	Forestry site preparation, utility sites
Garlon 3A <sup>†</sup>	1 to 4 qt/acre	Forestry site preparation, utility sites
Garlon 4	1 to 4 qt/acre	Forestry site preparation, utility sites
Arsenal 2WSL	2 to 32 fl oz/acre	Utility sites
20 - 1	Spray-to-Wet Rates	CONCION LUCICIONS
Arsenal Applicators Concentrate	1/32% to 1/2% by volume	Forestry site preparation
Arsenal 2WSL	1/32% to 1/2% by volume	Utility sites
	Low Volume Directed Spray Rates	
Arsenal Applicators Concentrate	1/8% to 1/2% by volume	Forestry site preparation
Arsenal 2WSL	1/8% to 1/2% by volume	Utility sites

<sup>†</sup> Ensure that Garlon 3A is thoroughly mixed with water before adding Glypro. Agitation is required while mixing Glypro with Garlon 3A to avoid compatibility problems.

For control of herbaceous weeds, use the lower recommended tank mixture rates. For control of dense stands or difficult-to-control woody brush and trees, use the higher recommended rates.

#### Forestry Conifer and Hardwood Release

#### **Directed Sprays and Selective Equipment**

Glypro may be applied as a directed spray or by using selective equipment in forestry conifer and hardwood sites, including Christmas tree plantations and silvicultural nurseries. Mix 2 to 6 quarts of a nonionic surfactant per 100 gallons of spray solution (0.5 to 1.5 percent by volume) for all spray applications. Use a surfactant with greater than 80 percent active ingredient.

Tank Mixing: In hardwood plantations, tank mixtures with Oust may be used. In pine plantations, tank mixtures with Garlon 4 or Arsenal AC may be used. Comply with all site restrictions, forestry species limitations, and precautions on the tank mix product labels.

Avoid contact of spray drift, mist or drips with foliage, green bark or non-woody surface roots of desirable plant species. See "Application Equipment and Techniques" section of this label for specific recommendations and precautions.

Spray-to-Wet Applications: Use a 2 percent spray solution to control undesirable woody brush and trees. To control herbaceous weeds, use a 1 to 2 percent spray solution.

Low Volume Directed Spray Applications: Use a 5 to 10 percent spray solution. Coverage should be uniform with at least 50 percent of the foliage contacted. Coverage of the top one-half of the unwanted vegetation is important.

**Broadcast Applications:** For equipment calibrated for broadcast applications, use 1 1/2 to 7 1/2 quarts of Glypro per acre. Apply in 10 to 60 gallons of clean water per acre. Shielded application equipment may be used to avoid contact of the spray solution with desirable plants. Shields should be adjusted to prevent spray contact with the foliage of green bark of desirable vegetation.

**Wiper Application Equipment:** See the "Selective Equipment" section of this label for equipment and application rate recommendations.

#### **Broadcast Application**

Note: Except where specifically recommended below, make broadcast applications of Glypro only where conifers have been established for more than one year.

#### Broadcast application must be made after formation of final conifer resting buds in the fall or prior to initial bud swelling in the spring.

Injury may occur to conifers treated for release, especially where spray patterns overlap or the higher rates are applied. Damage can be accentuated if applications are made when conifers are actively growing, or are under stress from drought, flood water, improper planting, insects, animal damage or diseases.

Glypro may require use with a surfactant. Use a nonionic surfactant recommended for over-the-top foliar spray at the recommended labeled rate. Follow the instructions under "Mixing" portion of the "Mixing and Applications" section of this label.

# For release of the following conifer species outside the Southeastern United States:

Douglas fir (*Pseudotsuga menziesii*) Fir (*Abies* species) Hemlock <sup>#</sup> (*Tsuga* species) Pines <sup>†</sup> (*Pinus* species) Redwood, California <sup>#</sup> (*Sequoia* species)

- <sup>†</sup>Includes all species except loblolly pine, longleaf pine, shortleaf pine or slash pine.
- <sup>th</sup> Use of a surfactant is not recommended for release of hemlock species or California redwood. In mixed conifer stands, injury to these species may result if a surfactant is used.

Application Rate for Conifer Release: Apply 3/4 to 1 1/2 quarts per acre as a broadcast spray. In Maine and New Hampshire, up to 2 1/4 quarts per acre of Glypro may be used for the control and suppression of difficult-to-control hardwood species.

To release Douglas fir, and pine and spruce species at the end of the first growing season (except in California), apply 3/4 to 1 1/8 quarts per acre of Glypro. Make sure that all conifers are well hardened off.

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**Note:** For release of Douglas fir with Glypro or recommended tank mixtures, a nonionic surfactant recommended for over-the-top foliar spray may be used. To avoid possible conifer injury, nonionic surfactants may be used at 2 fluid ounces per acre at elevations above 1500 feet, or 1 fluid ounce per acre in the coastal range or at elevations below 1500 feet. Use of surfactant rates exceeding those listed above may result in unacceptable conifer injury and are not recommended. Make sure that the nonionic surfactant has been adequately tested for safety to Douglas fir before use.

Tank Mixtures with Oust: To release jack pine, white pine and white spruce, apply 3/4 to 1 1/2 quarts of Glypro with 1 to 3 ounces (1 to 1 1/2 ounces for white pine) of Oust per acre. Make applications to actively growing weeds as a broadcast spray over the top of established conifers. Applications at these rates should be made after formation of conifer resting buds in the late summer or fall.

Tank Mixtures with Arsenal Applicators Concentrate: Glypro may be tank mixed with Arsenal Applicators Concentrate for release of Douglas fir. Tank mix 3/4 to 1 1/8 quarts of Glypro with 2 to 6 fluid ounces of Arsenal Applicators Concentrate per acre. For release of balsam fir and red spruce, apply a mixture of 1 1/2 quarts of Glypro with 1 to 2 1/2 fluid ounces of Arsenal Applicators Concentrate per acre.

In Maine and New Hampshire for the release of red pine, balsam fir, red spruce, white spruce, Norway spruce, and black spruce with dense tough-to-control brush and where maples make up a large component of the undesirable trees, up to 2 1/4 quarts per acre of Glypro may be tank mixed with 1 to 2 1/2 fluid ounces per acre of Arsenal Applicators Concentrate herbicide and applied as a broadcast spray.

Tank mixtures with Arsenal Applicators Concentrate and Oust or

**Oust XP Herbicides:** In Maine and New Hampshire for release of red pine, balsam fir, red spruce, white spruce, Norway spruce and black spruce with heavy grass and herbaceous weed densities, tough-to-control brush and where maples make up a large component of the undesirable trees up to 2 1/4 quarts per acre of Glypro may be tank mixed with 1 to 2.5 fluid ounces per acre of Arsenal Applicators Concentrate and 1 to 3 oz of Oust XP herbicides and applied as a broadcast spray.

For release of the following conifer species in the Southeastern United States:

Loblolly pine (*Pinus taeda*) Eastern white pine (*Pinus strobus*) Shortleaf pine (*Pinus echinata*) Slash pine (*Pinus elliottii*) Virginia pine (*Pinus virginiana*) Longleaf pine (*Pinus palustris*)

Apply 1 1/8 to 1 7/8 quarts of Glypro per acre as a broadcast spray during late summer or early fall after the conifers have hardened off. For applications at the end of the first growing season, use 3/4 quart of Glypro alone or in a recommended tank mixture.

Tank Mixtures with Arsenal Applicators Concentrate: For conifer release, apply 3/4 to 1 1/2 quarts of Glypro with 2 to 16 fluid ounces of Arsenal Applicators Concentrate per acre as a broadcast spray. Use only on conifer species that are labeled for over-the-top spray for both products. Use the higher recommended rates for dense tough-to-control wood brush and trees.

Read and observe label claims, cautionary statements and all information on the labels of each product used in these tank mixtures. Use according to the most restrictive precautionary statements for each product in the mixture.

#### **Herbaceous Release**

When applied as directed, Glypro plus listed residual herbicides provides postemergence control of the annual weeds and control or suppression of the perennial weeds listed in this label, and residual control of the weeds listed in the residual herbicide label. Make applications to actively growing weeds as a broadcast spray over the top of labeled conifers.

**Tank Mixtures with Oust:** To release loblolly pines, tank mix 12 to 18 fluid ounces of Glypro with 2 to 4 ounces of Oust per acre.

To release slash pines, tank mix 9 to 12 fluid ounces of Glypro with 2 to 4 ounces of Oust per acre.

In Maine and New Hampshire for release of red pine, balsam fir, red spruce, white spruce, Norway spruce, and black spruce with heavy grass and herbaceous weeds infesting the site, up to 2 1/4 quarts per acre of Glypro may be tank mixed with 1 to 3 oz of Oust herbicide or Oust XP herbicide to control grass, herbaceous weeds and woody brush, and applied as a broadcast spray.

Mix up to 3.2 fluid ounces per acre of Entry II or equivalent surfactant with the recommended rate of Glypro plus Oust. Applications can be made over newly planted pines after emergence of herbaceous weeds in the spring or early summer. Best results are obtained from applications made in May and June.

Weed control may be reduced if water volumes exceed 25 gallons per acre for these treatments.

Tank Mixture with Atrazine: To release Douglas fir, apply 3/4 quart of Glypro with 4 pounds a.i. of atrazine per acre. Apply only over Douglas fir that has been established for at least one full growing season. Apply in the early spring, usually mid-March through early April. Injury will occur if applications are made after bud swell in the spring. For this use, do not add surfactant to the tank mixture.

Always read and follow the manufacturer's label for all herbicides and surfactants used.

#### Wetland Sites

Glypro may be used in and around water (aquatic areas) and wetlands found in forestry and in power, telephone and pipeline rights-of-way sites, including where these sites are adjacent to or surrounding domestic water supply reservoirs, supply streams, lakes and ponds. Read and observe the following before making applications in and around water.

Consult local public water control authorities before applying Glypro in and around public water. Permits may be required to treat in such areas.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

**Note:** Do not apply this product directly to water within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as a lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after application. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the application. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.

Do not spray open bodies of water where woody brush, trees and herbaceous weeds do not exist. The maximum application rate of 3 3/4 quarts per acre must not be exceeded in a single over-water broadcast application except as follows, where any recommended rate may be applied:

- · Stream crossings in utility right-of-way.
- Where applications will result in less than 20 percent of the total water area being treated.

#### Wildlife Habitat Restoration and Management Areas

Glypro is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Maintenance: When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl, and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots: Glypro may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness.

#### Wiper Applications

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weed Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results

#### **Cut Stump Application**

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting. Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will **control**, **partially control or suppress** most woody brush and tree species, some of which are listed below:

Common Name	Scientif
Alder	Alnus sp
Coyote brush <sup>†</sup>	Bacchar
Dogwood <sup>†</sup>	Cornus
Eucalyptus	Eucalyp
Hickory <sup>†</sup>	Carya s
Madrone	Arbutus
Maple <sup>†</sup>	Acer sp
Oak	Quercus
Poplar <sup>†</sup>	Populus
Reed, giant	Arundo
Salt cedar	Tamarix
Sweet gum <sup>†</sup>	Liquidar
Sycamore <sup>†</sup>	Platanu
Tan oak	Lithocar
Willow	Salix sp

ic Name op. ris consanguinea spp. tus spp. pp. menziesii D. s spp. spp. donax spp. nbar styraciflua s occidentalis pus densiflorus Salix spp.

<sup>†</sup> Glypro is not approved for this use on these species in the state of California.

#### Injection and Frill Applications

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment will control the following woody species:

Common Name Oak Poplar Sweet gum Sycamore Scientific Name Quercus spp. Populus spp. Liquidambar styraciflua Platanus occidentalis

#### This treatment will suppress the following woody species:

Common Name

Black gum<sup>†</sup> Dogwood Hickory Maple, red Scientific Name Nyssa sylvatica Cornus spp. Carya spp. Acer rubrum

<sup>†</sup>Glypro is not approved for this use on this species in the state of California.

#### Release of Bermudagrass or Bahiagrass on Noncrop Sites

#### Release Of Dormant Bermudagrass And Bahiagrass

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

#### Weeds Controlled

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

#### Weeds Controlled or Suppressed <sup>†</sup>

Note: C = Controlled; S = Suppressed

	Rate of Glypro (Fluid Ounces Per Acre)					
Weed Species	6	9	12	18	24	48
Barley, little Hordeum pusillum	S	С	С	С	С	С
Bedstraw, catchweed Galium aparine	S	С	С	С	С	С
Bluegrass, annual Poa annua	S	С	С	С	С	С
Chervil Chaerophyllum tainturieri	S	С	С	С	С	С
Chickweed, common Stellaria media	S	С	С	С	С	
Clover, crimson Trifolium incarnatum	•	S	S	С	С	С
Clover, large hop Trifolium campestre	•	S	S	С	С	С
Speedwell, corn Veronica arvensis	S	С	С	С	С	С
Fescue, tall Festuca arundinacea	•	•	•	•	S	S
Geranium, Carolina Geranium carolinianum	•	•	S	S	С	С
Henbit Lamium amplexicaule	•	S	С	С	С	С
Ryegrass, Italian Lolium multiflorum	•	•	S	С	С	С
Vetch, common Vicia sativa	•	•	S	С	С	С

<sup>†</sup> These rates apply only to sites where an established competitive turf is present.

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#### **Release Of Actively Growing Bermudagrass**

# NOTE: Use only on sites where bahiagrass or bermudagrass are desired for ground cover and some temporary injury or yellowing of the grasses can be tolerated.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass Dallisgrass Fescue (tall) Johnsongrass <sup>†</sup> Trumpetcreeper <sup>††</sup> Vaseygrass

<sup>†</sup>Johnsongrass is controlled at the higher rate. <sup>††</sup>Suppression at the higher rate only.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

#### Bahiagrass Seedhead and Vegetative Suppression

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence. Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

#### Annual Grass Growth Suppression

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

#### Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitations of Remedies.

#### Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

#### Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Crop injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

#### Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

- Refund of purchase price paid by buyer or user for product bought, or
- (2) Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses. The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

\*Trademark of Dow AgroSciences LLC Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

EPA-accepted 11-10-2003

Label Code: D02-077-003 Replaces Label: D02-077-0002 LOES Number: 010-00060

#### **Revisions:**

#### **Proposed Changes by Amendment:**

- Added Terms and Conditions of Use" section instructing the purchaser to return the unopened product to seller for refund of purchase price if Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable.
- 2. First aid statements updated in accordance with EPA PR Notice.
- Added pine straw plantations to listing of specific use sites that may be treated.
- Added grazing restrictions for lactating dairy animals on grazed areas on rights-of-way.
- Mixing and Application Instructions: Deleted limitation on use of nonionic surfactant at more than 1 qt/acre for broadcast applications. Forestry Conifer and Hardwood Release Section
- Added the state of New Hampshire to specific use recommendations and increased application rate up to 2 1/4 quarts per acre for difficult-to-control species in conifer release.
- Added three-way tank mix with Arsenal Applicators Concentrate and Oust or Oust XP for difficult-to-control brush or where maples make up a large component of undesirable trees.
- 8. Added tank mix with Oust herbicide or Oust XP herbicide to control grass, herbaceous weeds and woody brush in conifers.

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MATERIAL SAFETY DATA SHEET				
<b>Dow AgroSciences</b>	Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268			
GLYPRO* HERBICIDE	Effective Date: 3/23/04 Product Code: 74370 MSDS: 006694			
1. PRODUCT AND COMPANY IDENTIFICATION:	EXTINGUISHING MEDIA: Foam, CO <sub>2</sub> , Dry Chemical			
PRODUCT: Glypro* Herbicide COMPANY IDENTIFICATION: Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268-1189	FIRE AND EXPLOSION HAZARDS: Foam fire extinguishing system is preferred because uncontrolled water can spread possible contamination. Toxic irritating gases may be formed under fire conditions. FIRE-FIGHTING EQUIPMENT: Use positive-pressure, self-			
2. COMPOSITION/INFORMATION ON INGREDIENTS:	equipment.			
Glyphosate IPA: CAS # 038641-94-0 53.8% N-(phosphono-methyl)	6. ACCIDENTAL RELEASE MEASURES:			
glycine, Isopropylamine Salt Balance, Total 46.2%	ACTION TO TAKE FOR SPILLS: Absorb small spills with an inert absorbent material such as Hazorb, Zorball, sand, or dirt. Report large spills to Dow AgroSciences on 800- 1 992-5994			
3. HAZARDOUS IDENTIFICATIONS:				
EMERGENCY OVERVIEW Clear, pale yellow liquid. May cause eye irritation. Slightly toxic to aquatic organisms. EMERGENCY PHONE NUMBER: 800-992-5994	PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapors and spray mist. Handle concentrate in ventilated area. Wash thoroughly with soap and water after handling			
<b>EYE:</b> Flush eyes thoroughly with water for several minutes. Remove contact lenses after initial 1-2 minutes and continue flushing for several additional minutes. If effects	and before eating, chewing gum, using tobacco, using the toilet or smoking. Keep away from food, feedstuffs, and water supplies. Store in original container with the lid tightly closed. Store above 10°F (-12°C) to keep from crystallizing.			
	8. EXPOSURE CONTROLS/PERSONAL PROTECTION:			
SKIN: Wash skin with plenty of water. INGESTION: No emergency medical treatment necessary.	These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.			
<b>INHALATION</b> : Remove person to fresh air; if effects occur, consult a physician.	EXPOSURE GUIDELINES: None established			
<b>NOTE TO PHYSICIAN</b> : No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.	<b>ENGINEERING CONTROLS</b> : Good general ventilation should be sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.			
5. FIRE FIGHTING MEASURES:	RECOMMENDATIONS FOR MANUFACTURING,			
FLASH POINT: >214°F (>101°C) METHOD USED: Setaflash	WORKERS: EYE/FACE PROTECTION: Use safety glasses.			
FLAMMABLE LIMITS: LFL: Not applicable UFL: Not applicable	SKIN PROTECTION: No precautions other than clean body-covering clothing should be needed.			

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# **GLYPRO\* HERBICIDE**

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 3/23/04 Product Code: 74370 MSDS: 006694

RESPIRATORY PROTECTION: For most conditions, no respiratory protection should be needed; however, if discomfort is experienced, use a NIOSH approved air- purifying respirator. APPLICATIONS AND ALL OTHER HANDLERS: Please refer to the product label for personal protective clothing and equipment.	<ul> <li>SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: For a similar material, glyphosate, in animals, effects have been reported on the following organ: liver.</li> <li>CANCER INFORMATION: A similar material, glyphosate, did not cause cancer in laboratory animals.</li> <li>TERATOLOGY (BIRTH DEFECTS): For glyphosate IPA,</li> </ul>			
9. PHYSICAL AND CHEMICAL PROPERTIES:	available data are inadequate for evaluation of potential to cause birth defects. <b>REPRODUCTIVE EFFECTS</b> : For glyphosate IPA, available data are inadequate to determine effects on reproduction. <b>MUTAGENICITY</b> : For a similar material, glyphosate, in-			
APPEARANCE: Clear, pale yellow liquid DENSITY: 10.0 - 10.5 lbs/gal pH: 4.8 - 5.0 ODOR: None SOLUBILITY IN WATER: Miscible SPECIFIC GRAVITY: 1.21 gm/L				
FREEZING POINT: -7°F10°F (-21°C25°C)	12 ECOLOGICAL INFORMATION:			
10. STABILITY AND REACTIVITY:				
<ul> <li>STABILITY: (CONDITIONS TO AVOID) Stable under normal storage conditions.</li> <li>INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Galvanized or unlined steel (except stainless steel) containers or spray tanks may produce hydrogen gas which may form a highly combustible gas mixture.</li> <li>HAZARDOUS DECOMPOSITION PRODUCTS: None known.</li> <li>HAZARDOUS POLYMERIZATION: Not known to occur.</li> <li>11. TOXICOLOGICAL INFORMATION:</li> <li>EYE: May cause slight temporary eye irritation. Corneal injury is unlikely.</li> </ul>	<b>ECOTOXICOLOGY:</b> Material is practically non-toxic to aquatic organisms on an acute basis ( $LC_{50}$ or $EC_{50}$ is >100 mg/L in most sensitive species tested). Acute $LC_{50}$ for rainbow trout <u>(<i>Oncorhynchus mykiss</i>)</u> is >2500 mg/L. Acute immobilization $EC_{50}$ in water flea <u>(<i>Daphnia magna</i></u> ) is 918 mg/L. Material is practically non-toxic to birds on an acute basis ( $LD_{50}$ is >2000 mg/kg). Acute oral $LD_{50}$ in bobwhite <u>(<i>Colinus virginianus</i></u> ) is >2000 mg/kg. The $LC_{50}$ in earthworm Eisenia foetida is >1000 mg/kg. Acute contact $LD_{50}$ in honey bee ( <i>Apis mellifera</i> ) is >100			
injury is unlikely. <b>SKIN:</b> Essentially non-irritating to skin. Prolonged skin contact is unlikely to result in absorption of harmful amounts. The $LD_{50}$ for skin absorption in rabbits is >5000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.	μg/bee. Acute oral LD <sub>50</sub> in honey bee <u>(Apis mellifera)</u> is >100 μg/bee. Growth inhibition EC <sub>50</sub> in green alga <u>(Selenastrum</u> <u>capricornutum)</u> is 127 mg/L. Growth inhibition EC <sub>50</sub> in duckweed <u>(Lemna sp.)</u> is 24.4 mg/L.			
INGESTION: Very low toxicity if swallowed. Harmful effects	13. DISPUSAL CUNSIDERATIONS:			
INHALATION: Brief exposure (minutes) is not likely to cause adverse effects. The aerosol $LC_{50}$ for rats is >6.37 mg/L for 4 hours.	<b>DISPOSAL METHOD:</b> If wastes and/or containers cannot be disposed of according to the product label directions, disposal of this material must be in accordance with your local or area regulatory authorities.			



# **GLYPRO\* HERBICIDE**

This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations.

If the material as supplied becomes a waste, follow all applicable regional, national and local laws and regulations.

#### 14. TRANSPORT INFORMATION:

# U.S. DEPARTMENT OF TRANSPORTATION (DOT) INFORMATION:

For all package sizes and modes of transportation: This material is not regulated for transport.

### **15. REGULATORY INFORMATION:**

**NOTICE:** The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

### U.S. REGULATIONS

SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

Not to have met any hazard category

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 3/23/04 Product Code: 74370 MSDS: 006694

**STATE RIGHT-TO-KNOW:** This product is not known to contain any substances subject to the disclosure requirements of

New Jersey Pennsylvania

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

CATEGORY	RATING
Health	1
Flammability	1
Reactivity	0

### 16. OTHER INFORMATION:

MSDS STATUS: Revised Sections: 3,4,11,12,13,14 & 15 Reference: DR-0361-8028 Replaces MSDS Dated: 1/12/00 Document Code: D03-077-003 Replaces Document Code: D03-077-002

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

# Specimen Label





## **Specialty Herbicide**

<sup>®</sup>Trademark of Dow AgroSciences LLC

For the control of woody plants in forests, in rangeland and permanent pastures, and in non-crop areas including industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, road sides and railroads, fence rows, non-irrigation ditch banks and around farm buildings. Use on these sites may include application to grazed areas as well as establishment and maintenance of wildlife openings.



**Basal Bark** 



Active Ingredient:

triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic	
acid, butoxyethyl ester	13.6%
Inert Ingredients	86.4%
Total	100.0%

Acid Equivalent: triclopyr - 9.81% - 0.75 lb/gal

EPA Reg. No. 62719-176

# Keep Out Of Reach Of Children CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

#### **Precautionary Statements**

#### Hazard to Humans and Domestic Animals

Harmful If Swallowed • Prolonged Or Frequently Repeated Skin Contact May Cause Allergic Reactions In Some Individuals

### **Personal Protective Equipment (PPE)**

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selections chart.

#### Applicators and other handlers must wear:

- · Long-sleeved shirt and long pants
- Chemical-resistant gloves such as Barrier Laminate, Nitrile Rubber, Neoprene Rubber, or Viton
- · Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

#### **User Safety Recommendations**

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

#### First Aid

**If swallowed:** Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

#### **Environmental Hazards**

This pesticide is toxic to fish. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Notice: Read the entire label. Use only according to label directions. Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.

In case of emergency endangering hereigenties of with ment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

#### **Directions for Use**

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

#### Ready-To-Use, No Mixing Required.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

#### Agricultural Use Requirements (For Ground Application Only)

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves such as Barrier Laminate, Nitrile Rubber, Neoprene Rubber, or Viton
- Shoes plus socks

#### Non-Agricultural Use Requirements (For Ground Application Only)

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for Agricultural Pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Entry Restrictions for Non-WPS Uses: Do not enter or allow others to enter the treated area until sprays have dried.

#### Storage and Disposal

Do not contaminate water, food or feed by storage and disposal. Open dumping is prohibited.

Pesticide Storage: Store above 28°F or agitate before use. Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Container Disposal: Triple rinse (or equivalent) with 10 drops or more of a liquid hand soap and water or an oil basal product such as kerosene or diesel fuel and spray rinsate on undesirable vegetation, in target area. Offer containers for recycling or reconditioning where allowed, or puncture and dispose of in a sanitary landfill, or by incineration if approved by state and local procedures.

Container Disposal for Refillable Containers: Close all openings which have been opened during use and replace all caps. Return the empty container to a collection site designated by Dow AgroSciences. If the container has been damaged and cannot be returned according to the recommended procedures, contact the Dow AgroSciences Customer Service Center at 1-800-258-3033 to obtain proper handling instructions. General: Consult federal, state, or local disposal authorities for approved alternative procedures.

#### **General Information**

Pathfinder<sup>®</sup> II specialty herbicide is a ready-to-use product which is recommended for the control of woody plants through the use of basal bark application techniques in forests, in rangeland and permanent pastures, and in non-crop areas including industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, road sides and railroads, fence rows, non-irrigation ditch banks and around farm buildings. Use on these sites may include application to grazed areas as well as establishment and maintenance of wildlife openings.

#### **General Use Precautions and Restrictions**

The state of Arizona has not approved Pathfinder II for use on plants grown for commercial production; specifically forests grown for commercial timber production, or on designated grazing areas.

Apply this product only as specified on this label.

Chemigation: Do not apply this product through any type of irrigation system.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands, flood plains, deltas, marshes, swamps, bogs, and transitional areas between upland and lowland sites. Do not apply to open water (such as lakes, reservoirs, rivers, streams, creeks, salt water bays or estuaries) nor to water present in fresh water wetlands, deltas, marshes, swamps, bogs or potholes, or to salt water marshes below the mean high water mark. Do not apply Pathfinder II directly to, or otherwise permit it to come into direct contact with, grapes, tobacco, cotton, vegetable crops, flowers or other desirable broadleaf plants, and do not permit spray mists containing it to drift onto them.

#### **Grazing and Haying Restrictions**

Except for lactating dairy animals, there are no grazing restrictions following application of this product.

- Grazing Lactating Dairy Animals: Do not allow lactating dairy animals to graze treated areas until the next growing season following application of this product.
- Do not harvest hay for 14 days after application.
- Grazed areas of non-cropland and forestry sites may be spot treated if they comprise no more than 10% of the total grazable area.

Slaughter Restrictions: During the season of application, withdraw livestock from grazing treated grass at least 3 days before slaughter.

#### Avoiding Injurious Spray Drift

Applications should be made only when there is little or no hazard from spray drift. Very small quantities of spray, which may not be visible, may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants near enough to be injured.

Spray drift can be reduced by using spray pressures no greater than are required to obtain adequate coverage; by using large droplet producing nozzle tips; and by spraying when wind velocity is low. Do not apply with nozzles that produce a fine droplet spray. Do not apply with an orchard type mist blower.

Do not apply on snow or frozen ground.

Untreated trees occasionally can be affected by movement of the herbicide through root grafting with the treated trees.

Since this herbicide moves within the treated plant, do not use Pathfinder II on parts of a multiple stem plant if injury to the untreated portions (cut or standing stems) cannot be tolerated.

Do not apply on ditches used to transport irrigation water. Do not apply where runoff or irrigation water may flow onto agricultural land as injury to crops may result.

Be sure that use of this product conforms to all applicable regulations.

#### Woody Plant Species Controlled by Pathfinder II

ailanthus alder, red alder, speckled ash, green ash, white aspent Australian pine basswood beech, American birch, black birch, gray birch, paper blackberry blackgum boxelder bois d'arc briar, green Brazilian pepper cherry, black<sup>1</sup> cherry, choke cherry, pin cottonwood dogwood, flowering dogwood, red-osier elbow bush elm, American elm, winged<sup>†</sup> gallberry greenbriart guava hackberry hawthorne

hazel hedge hercules club hickory, mockernut hickory, pignut honeylocust hornbeam (blue beach) huisache locust, black<sup>†</sup> lotebush madrone. Pacific manzanita, greenleaf maple, bigleaf<sup>t</sup> maple, mountain maple, red maple, silver maple, striped maple, sugar maple, vine mesquite<sup>t, ttt</sup> mountain-laurel oak, blacktt oak, blackjack<sup>tt</sup> oak, chestnut oak, post" oak, red oak, scarlet oak, water oak, white olive, autumn olive, Russian osage orange

pecan persimmon, common pine, jack pine, loblolly pine, ponderosa pine, red pine, white plum (Prunus spp.) plum, sand plum, wild poison ivy poison oak poplar, balsam privet redcedar, eastern rose, multiflora salt cedar<sup>†</sup> sassafrast sumac, smooth<sup>†</sup> sumac, staghorn<sup>†</sup> sweetgum sycamore tallowtree, Chinese tamarack tanoak walnut waxmvrtle willow yaupon yellow poplar yucca

<sup>†</sup>Some resprouting may occur.

<sup>th</sup>Not recommended for streamline basal treatment.

\*\*\*Suppression only with streamline basal bark treatment.

#### Application Methods

#### Maximum Use Rates:

- Apply no more than 2.7 gallons (2 lb ae) per acre per year on rangeland and permanent pastures.
- Apply no more than 8 gallons (6 lb ae) per acre per year on forestry sites.
- Apply no more than 10.7 gallons (8 lb ae) per acre per year on non-crop areas.

# Application in Forests, in Rangeland and Permanent Pastures, and in Non-Crop Areas

#### Low Volume Basal Bark Treatment

To control susceptible woody plants with stems less than 6 inches in basal diameter, apply Pathfinder II with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Spray the basal parts of brush and tree trunks in a manner which thoroughly wets the lower 12 to 15 inches of stems, including the root collar area, but not to the point of runoff. Herbicide concentration should vary with size and susceptibility of species treated. Apply at any time, including the winter months, except when snow or water prevent spraying to the ground line.

#### **Treatment of Cut Stumps**

To control resprouting, apply undiluted Pathfinder II to wet the area adjacent to the cambium and bark around the entire circumference and the sides of cut stumps. Sides of stumps should be thoroughly wetted down to the root collar area, but not to the point of runoff. Treatments may be applied throughout the year, except when snow or water prevent spraying to the ground line. Control may be reduced with treatment during periods of moisture stress as in late summer.

#### Streamline Basal Bark Treatment (Southern States)

To control or suppress susceptible woody plants for conifer release or in rangeland and pasture, apply Pathfinder II with a backpack or knapsack spraver using equipment which provides a directed straight-stream sprav. Apply sufficient spray to one side of stems less than 3 inches in basal diameter to form a treated zone that is 6 inches in height. When the optimum amount of spray mixture is applied, the treated zone should widen to encircle the stem within approximately 30 minutes. Treat both sides of stems which are 3 to 4 inches in basal diameter. Direct the spray at bark that is approximately 12 to 24 inches above ground. Pines (loblolly, slash, shortleaf, and Virginia) up to 2 inches in diameter breast height (dbh) can be controlled by directing the spray at the point approximately 4 feet above ground. Best results are achieved when applications are made to young vigorously growing stems that have not developed the thicker bark characteristic of slower growing, understory trees in older stands. This technique is not recommended for scrub and live oak species, including blackjack, turkey, post, live, bluejack and laurel oaks. Apply from approximately 6 weeks prior to hardwood leaf expansion in the spring until approximately 2 months after leaf expansion is completed. Do not apply when snow or water prevent spraying at the desired height above ground level.

### Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitations of Remedies.

### Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

### Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

### Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

- 1. Refund of purchase price paid by buyer or user for product bought, or
- 2. Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use, and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

<sup>®</sup>Trademark of Dow AgroSciences LLC Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-104-008 Replaces Label: D02-104-007 Loes Number: 010-00087

EPA Accepted 03/28/06

#### Revisions:

- 1. Added pictures for basal bark and cut stump treatments.
- 2. Changed grazing and haying restrictions.
- Added bois d'arc, Chinese tallowtree, green briar, elbow bush, greenbriar, hawthorne, hedge, huisache, lotebush, multifora rose, osage orange, pecan, plum, privet, sand plum, wild plum, and yucca to woody plant species controlled.



# **PATHFINDER\* II HERBICIDE**

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 2/11/02 Product Code: 41753 MSDS: 004778

1. PRODUCT AND COMPANY IDENTIFICATION:	<b>INGESTION:</b> Low toxicity if swallowed. The oral LD <sub>50</sub> for		
PRODUCT: Pathfinder* II Herbicide	rats was 2389 mg/kg (males) and 1000 mg/kg (females). Small amounts swallowed incidental to normal handling		
COMPANY IDENTIFICATION: Dow AgroSciences 9330 Zionsville Road Indianapolis, IN 46268-1189	swallowing larger amounts may cause injury, however, swallowing larger amounts may cause injury. Aspiration into the lungs may occur during ingestion or vomiting, causing lung damage or even death due to chemical pneumonia.		
2. COMPOSITION/INFORMATION ON INGREDIENTS:	<b>INHALATION:</b> The $LC_{50}$ for rats is >5.0 mg/L for 4 hours. Excessive exposure may cause irritation to upper respiratory		
Triclopyr: ((3,5,6-trichloro-2- pyridinyl)oxy)acetic acid, butoxyethylester Inert Ingredients, Total, Including: 86.4%	tract (nose and throat) and lungs. May cause central nervous system effects. Symptoms of excessive exposure may be anesthetic or narcotic effects; dizziness and drowsiness may be observed.		
This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard	SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: For triclopyr butoxy ether ester, in animals, effects have been reported on the following organs: blood, kidney and liver.		
may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.	<b>CANCER INFORMATION:</b> Triclopyr butoxyethyl ester did not cause cancer in laboratory animals.		
3. HAZARDOUS IDENTIFICATIONS:	<b>TERATOLOGY (BIRTH DEFECTS):</b> For triclopyr butoxyethyl ester, birth defects are unlikely. Exposures having no effect on the mother should have no effect on the fetus. Did not cause birth defects in animals; other effects were seen in the fetus only at doses which caused toxic effects to the mother.		
<b>EMERGENCY OVERVIEW</b> Hazardous Chemical. Yellow to amber liquid. May cause eye and skin irritation. $LD_{50}$ for skin absorption in rabbits is >2000 mg/kg. Oral $LD_{50}$ for rats is 2389 mg/kg (males) and 1000 mg/kg (females). $LC_{50}$ for rats is >5.0 mg/L for 4			
hours. Toxic to aquatic organisms. EMERGENCY PHONE NUMBER: 800-992-5994	<b>REPRODUCTIVE EFFECTS:</b> For triclopyr butoxyethyl ester, in laboratory animal studies, effects on reproduction have been seen only at doses that produced significant toxicity to the neuron enimely		
POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is			
not handled in the recommended manner.	4. FIRST AID:		
<b>EYE:</b> May cause slight temporary eye irritation. Corneal injury is unlikely. Vapor may cause eye irritation experienced as mild discomfort and redness.	<b>EYES:</b> Flush eyes thoroughly with water for several minutes. Remove contact lenses after initial 1-2 minutes and continue flushing for several additional minutes.		
SKIN: Prolonged contact may cause skin irritation with local	SKIN: Wash skin with plenty of water.		
redness. Repeated exposure may cause irritation, even a burn. Repeated contact may cause drying or flaking of the skin. Prolonged skin contact is unlikely to result in absorption	<b>INGESTION:</b> Do not induce vomiting. Call a physician and/or transport to emergency facility immediately.		
of harmful amounts. The $LD_{50}$ for skin absorption in rabbits is >2000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.	<b>INHALATION:</b> Move person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.		
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# **PATHFINDER\* II HERBICIDE**

**NOTE TO PHYSICIAN:** The decision of whether to induce vomiting or not should be made by a physician. If lavage is performed, suggest endotracheal and/or esophageal control. Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach. If burn is present, treat as any thermal burn, after decontamination. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

### 5. FIRE FIGHTING MEASURES:

FLASH POINT: 350°F, 177°C METHOD USED: SFCC

#### FLAMMABLE LIMITS

LFL: Not determined UFL: Not determined

EXTINGUISHING MEDIA: Water fog, foam.

FIRE & EXPLOSION HAZARDS: May emit toxic, irritating vapors if involved in a fire.

**FIRE-FIGHTING EQUIPMENT:** Use positive pressure selfcontained breathing apparatus and full protective clothing.

### 6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS/LEAKS: Dike large spills. Keep out of streams and domestic water supplies. Absorb small spills in inert material such as dry sand. Eliminate all ignition sources. Report large spills to Dow AgroSciences at 800-992-5994.

#### 7. HANDLING AND STORAGE:

#### PRECAUTIONS TO BE TAKEN IN HANDLING AND

**STORAGE:** Keep out of reach of children. Harmful if swallowed, inhaled, or absorbed through skin. Avoid contact with skin, eyes, and clothing. Avoid breathing vapor or spray mist. Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Store in the original container with the lid tightly closed.

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

Effective Date: 2/11/02 Product Code: 41753 MSDS: 004778

#### 8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where a potential for exposure exists. Emergency conditions may require additional precautions.

#### EXPOSURE GUIDELINE(S):

3,5,6-trichloro-2-pyridinyloxyacetic acid, Dowanol EB ester: Dow AgroSciences Industrial Hygiene Guide is 2 mg/M3 as acid equivalent, Skin.

A "skin" notation following the exposure guideline refers to the potential for dermal absorption of the material. It is intended to alert the reader that inhalation may not be the only route of exposure and that measures to minimize dermal exposures should be considered.

**ENGINEERING CONTROLS:** Provide general and/or local exhaust ventilation to control airborne levels below the exposure guideline.

#### RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

**RESPIRATORY PROTECTION:** Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use a NIOSH approved air-purifying respirator.

**SKIN PROTECTION:** When prolonged or frequently repeated contact could occur, use chemically protective clothing resistant to this material. Selection of specific items such as faceshield, gloves, boots, apron or full-body suit will depend on operation.

**EYE/FACE PROTECTION:** Use safety glasses. If exposure causes eye discomfort, use a NIOSH approved full-face respirator.

APPLICATORS AND ALL OTHER HANDLERS: Refer to the product label for personal protective clothing and equipment recommendations.

# Dow AgroSciences

# **PATHFINDER\* II HERBICIDE**

Emergency Phone: 800-992-5994 Dow AgroSciences LLC Indianapolis, IN 46268

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9. PHYSICAL AND CHEMICAL PROPERTIES:         BOILING POINT: 425°F (218.5°C) @ 20mmHg         VAPOR PRESSURE: Not determined         VAPOR DENSITY: Not determined         SOLUBILITY IN WATER: Insoluble         SPECIFIC GRAVITY: 0.920 at 20°C (68°F)         APPEARANCE: Yellow to amber liquid         ODOR: Minimal         FREEZING POINT: -10°C, 13°F         10. STABILITY AND REACTIVITY:	DEGRADATION & PERSISTENCE:         Based largely or completely on information for triclopyr butoxyethyl ester.         Based on the stringent OECD test guidelines, this material cannot be considered as readily biodegradable; however, these results do not necessarily mean that the material is not biodegradable under environmental conditions.         The photolysis half-life in water is 6.6 days.         ECOTOXICOLOGY:         Based largely or completely on information for triclopyr butoxyethyl ester.         Material is highly toxic to aquatic organisms on an acute basis (LC <sub>50</sub> /EC <sub>50</sub> between 0.1 and 1 mg/L in most sensitive species.)		
<b>STABILITY:</b> (CONDITIONS TO AVOID) Stable under normal storage and handling conditions. Product will burn; keep away from heat and open flame.			
	13. DISPOSAL CONSIDERATIONS:		
<b>INCOMPATIBILITY:</b> (SPECIFIC MATERIALS TO AVOID) Acids, bases, and strong oxidizers.	<b>DISPOSAL METHOD:</b> Product, spray mixture, or rinsate that cannot be used according to label instructions must be disposed of according to applicable federal, state, or local procedures.		
HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, nitrogen oxides, hydrogen chloride, and			
phosgene may be formed if product is involved in	14. TRANSPORT INFORMATION:		
HAZARDOUS POLYMERIZATION: Not known to occur.	U.S. DEPARTMENT OF TRANSPORTATION (DOT) INFORMATION:		
11. TOXICOLOGICAL INFORMATION:	This material is not regulated for transportation.		
<b>MUTAGENICITY:</b> For triclopyr butoxyethyl ester, in-vitro	15. REGULATORY INFORMATION:		
	<b>NOTICE:</b> The information herein is presented in good faith		
12. ECOLOGICAL INFORMATION:	and believed to be accurate as of the effective date shown		
ENVIRONMENTAL DATA MOVEMENT & PARTITIONING: Based largely or completely on information for triclopyr butoxyethyl ester. Bioconcentration potential is moderate (BCF between 100 and 3000 or Log Pow between 3 and 5).	above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.		
	U.S. REGULATIONS		
	SARA 313 INFORMATION: To the best of our knowledge,		

this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.



# **PATHFINDER\* II HERBICIDE**

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

**STATE RIGHT-TO-KNOW:** This product is not known to contain any substances subject to the disclosure requirements of

New Jersey Pennsylvania

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

Category	Rating
Health	1
Flammability	1
Reactivity	0

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

#### 16. OTHER INFORMATION:

MSDS STATUS: Revised Sections: 3, 4, 7, 8, & 14 Reference: DR-0298-9448 Replaces MSDS dated: 12/9/99 Document Code: D03-104-003 Replaces Document Code: D03-104-002

The Information Herein Is Given In Good Faith, But No Warranty, Express or Implied, Is Made. Consult Dow AgroSciences for Further Information.

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### Literature Cited

BASF Corporation. 2006. Arsenal AC Specimen Label NVA 2006-04-104-0264. <<u>http://www.cdms.net/LabelsMsds/LMDefault.aspx?pd=69</u>> Accessed 18 Nov 2007.

BASF Corporation. 2006. Arsenal AC Material Safety Data Sheet. <<u>http://www.cdms.net/LabelsMsds/LMDefault.aspx?pd=69></u> Accessed 18 Nov 2007.

Dow AgroSciences. 2002. Pathfinder II Material Safety Data Sheet D03-104-003. <<u>http://www.cdms.net/manuf/1prod.asp?pd=2392&lc=0</u>> Accessed 18 Nov 2007.

Dow AgroSciences. 2006. Accord Concentrate Specimen Label D02-145-003. <<u>http://www.cdms.net/manuf/1prod.asp?pd=5095&lc=0</u>> Accessed 18 Nov 2007.

Dow AgroSciences. 2006. Glypro Specimen Label D02-077-003. <<u>http://www.cdms.net/manuf/1prod.asp?pd=4272&lc=0</u>> Accessed 18 Nov 2007.

Dow AgroSciences. 2004. Accord Concentrate Material Safety Data Sheet C03-145-002. <<u>http://www.cdms.net/manuf/1prod.asp?pd=5095&lc=0</u>> Accessed 18 Nov 2007.

Dow AgroSciences. 2004. Glypro Material Safety Data Sheet D03-077-003. <<u>http://www.cdms.net/manuf/1prod.asp?pd=4272&lc=0</u>> Accessed 18 Nov 2007.

Dow AgroSciences. 2007. Pathfinder II Specimen Label D02-104-008. <<u>http://www.cdms.net/manuf/1prod.asp?pd=2392&lc=0</u>> Accessed 18 Nov 2007.

Ezell, A.W. and A.J. Londo. 2000. Forest herbicide Safety: Environmental Concerns and Proper Handling. Mississippi State University Extension Service 1874. <<u>http://msucares.com/pubs/publications/p1874.htm</u>> Accessed 18 Sept 2007.

Ferrell, J.A., W.M. Stall and G.E. MacDonald. 2007. Diagnosing Herbicide Injury – 2007. University of Florida/Institute of Food and Agricultural Sciences (IFAS) Extension SS-AGR-15. <a href="http://edis.ifas.ufl.edu/WG053">http://edis.ifas.ufl.edu/WG053</a> Accessed 10 Oct 2007.

Howard, S.W. and R. Parker. 1995. Chemical Control for Woody Plants, Stumps and Trees. Washington State University Cooperative Extension EB1551. <<u>http://cru.cahe.wsu.edu/CEPublications/eb1551/eb1551.html</u>>18 Sept 2007.

Jackson, D.R. and J.C. Finley. 2005. Herbicides and Forest Vegetation Management: Controlling Unwanted Trees, Brush and Other Competing Forest Vegetation. Agricultural Research and Cooperative Extension, Pennsylvania State University College of Agricultural Sciences, University Park, Pennsylvania, USA. McGinty, A., C.W. Hanselka, R.K. Lyons, C.R. Hart and J.F. Cadenhead. 2005. Brush Busters: Sprayer Calibration Guide. Texas Cooperative Extension L-5465, the Texas A&M University System. <<u>http://tcebookstore.org/pubinfo.cfm?pubid=2027</u>> Accessed 25 Oct 2007.

McGinty, A., J. Ansley, J.F. Cadenhead, W. Hamilton, W.C. Hanselka, C. Hart and D.N. Ueckert. 2005. Chemical Weed and Brush Control-Suggestions for Rangeland. Texas Cooperative Extension B-1466, the Texas A&M University System. <<u>http://tcebookstore.org/pubinfo.cfm?pubid=2451</u>>Accessed 25 Oct 2007

McGinty, A., J. Ansley, J.F. Cadenhead, W. Hamilton, W.C. Hanselka, C. Hart and D.N. Ueckert. 2007. Chemical Weed and Brush Control-Suggestions for Rangeland 2007 Update. Texas Cooperative Extension B-1466A, the Texas A&M University System. <<u>http://tcebookstore.org/pubinfo.cfm?pubid=57></u> Accessed 25 Oct 2007

Texas Department of Agriculture. 2007. Pesticide Applicator. <<u>http://www.agr.state.tx.us/agr/program\_render/0,1987,1848\_5325\_0\_0,00.html?channelId=5325</u>> Accessed 10 Oct 2007.

Texas Department of Agriculture. 2007. Pesticide Applicator Recordkeeping Form . <<u>http://www.agr.state.tx.us/vgn/tda/files/1848/6506\_6506\_applicatorrecq527.pdf</u>> Accessed 10 Oct 2007.

Texas Department of Agriculture. 2007. Regulated Herbicides. <<u>http://www.agr.state.tx.us/agr/program\_render/0,1987,1848\_5539\_0\_0,00.html?channelId=5539</u> > Accessed 10 Oct 2007.

Texas Department of Agriculture. 2007. Spray Permit. <<u>http://www.agr.state.tx.us/vgn/tda/files/1848/6736\_6736\_spraypermitq820.pdf</u>> Accessed 10 Oct 2007.

Texas Secretary of State. 2007. Texas Administrative Code, Title 4, Chapter 7, Subchapter E, Section 7.50: General Requirements for Regulated Herbicide Applicators.

<<u>http://info.sos.state.tx.us/pls/pub/readtac\$ext.TacPage?sl=R&app=9&p\_dir=&p\_rloc=&p\_plo\_c=&pg=1&p\_tac=&ti=4&pt=1&ch=7&rl=50}</u> Accessed 10 Oct 2007.

GREAT TRINITY FOREST

# **Invasive Plant Species**

Descriptions of the major invasive plant species found within the forest and methods of management and control.

# **Great Trinity Forest Management Plan**

# **Invasive Plants**

# Plant Descriptions

(Major invasive plants found in the forest)

# Ailanthus

Ailanthus altissima (Mill.) Swingle

### **Other Common Names:**

Tree-of-heaven, Chinese sumac, paradise-tree, stinking sumac, paradise-tree, and copal-tree.

### **Brief Description:**

A rapid growing, thicket forming, introduced species that has become widely naturalized across its range. Leaves have a unique odor when crushed and are unusually large. It has been used as an ornamental planting in harsh environments. The seeds are eaten by a number of birds and browsing by deer has been noted to occur occassionaly.

### Habitat:

Introduced from China to Pennsylvania in 1784, it has now established itself throughout the United States. It is somewhat drought hardy and is flood intolerant. It is primarily found growing in untended lots around urban.

### Life History:

The species can produce seed beginning at about 2 to 3 years of age. Flowers appear from mid-April to July. The species is dioecious and male flowers emit a foul odor. The seeds ripen from September to October. Seeds are well adapted to wind dispersal which can occur anytime after ripening, but typically seeds persist over winter. Seedling growth is vigorous and studies have shown that survival is high until the first winter. The species is intolerant of shade, however, and therefore reproduction in forested areas is sparse and erratic. The species sprouts prolifically. Allelopathic effects from the leaves of ailanthus have been noted in the literature.

### Ailanthus and the Great Trinity Forest:

This species has been reported as invading the forest. A concerted effort needs to be made to remove all invasive species. Injection, basal bark, and foliar applications of herbicides are the most effective means of control due to its sprouting nature.

# Ailanthus altissima (Mill.) Swingle

# Ailanthus

### Simaroubaceae -- Quassia family

### James H. Miller

Ailanthus (*Ailanthus altissima*), also called tree-of-heaven, Chinese sumac, paradise-tree, and copal-tree (fig. 1), is an introduced species that has become widely naturalized across the continent. Ailanthus has found an extremely wide variety of places to establish itself, from urban areas to reclaimed surface-mined lands. Its successful reproduction on impoverished soils and in harsh environments results from its ability to sprout from the roots and to seed prolifically. Ailanthus is found as an upper-canopy component, with varying frequency, in the eastern hardwood forests, apparently spreading by sprouting after harvest disturbance.

# Habitat

## **Native Range**

Ailanthus, a native of China, was first introduced into the United States from England to Philadelphia, PA, in 1784. Extensive plantings in cities during the 1800's has resulted in its naturalization across the United States. An eastern range extends from Massachusetts, west to southern Ontario, southwest to Iowa, south to Texas, and east to northern Florida. It is found in less abundance from New Mexico west to California and north to Washington.

## Climate

Because of its wide distribution, ailanthus grows under a variety of climatic conditions. Within the naturalized range of the species, the climate can be temperate to subtropical and humid to arid. In arid regions bordering the Great Plains, low precipitation, from 360 to 610 mm (14 to 24 in) annually with 8 dry months, can be tolerated (7), whereas in humid localities in the southern Appalachians rainfall can exceed 2290 mm (90 in) annually (15). Annual maximum and minimum temperatures are -9° and 36° C (15° and 97° F). Extreme cold and prolonged snow cover restricts the elevational range to the lower slopes of the Rocky Mountains and prolonged cold temperatures have reportedly caused dieback, but resprouting occurs (1,7).

## Soils and Topography

Ailanthus grows best in loamy, moist soils but tolerates a wide range of textures, stoniness, and pH. On the dry end of the moisture spectrum it is drought hardy, and on the wet end it cannot tolerate flooding. The species is widely recognized by the urban populace since it frequently

occupies and covers untended areas in cities. The species' tolerance of harsh sites led to testing for strip mine reclamation; a study in eastern Kentucky found ailanthus better adapted to acid spoil than to calcareous spoil and capable of growing on spoils with low to moderate phosphorus (17). Soils on which ailanthus is most commonly found are within the orders Ultisols, Inceptisols, and Entisols.

## **Associated Forest Cover**

Because of ailanthus' scattered and disjunct occurrence over a wide geographical range, a listing of associated species would have little significance. Forest stands around cities are common areas of invasion and establishment, but it may be an occasional or minor component of forests following disturbance anywhere within its naturalized range.

# Life History

## **Reproduction and Early Growth**

**Flowering and Fruiting-** The yellowish-green flowers of ailanthus appear from mid-April to July, south to north, depending on latitude. The flowers are arranged in large panicles at the ends of new shoots. A dioecious species, it bears male and female flowers on different trees, with male trees producing three to four times more flowers than are usually found on female trees (11). Male flowers are more conspicuous than female ones, emitting a disagreeable odor that attracts numerous insects. The foul odor of the male flowers makes the tree less favored for ornamental plantings in cities.

**Seed Production and Dissemination-** Pollination occurs in the spring and clusters of seed ripen from September to October. The fruit is a samara with the seed in the center of a thin, oblong wing, well adapted for wind dispersal. The ripe samaras are greenish yellow or reddish brown. The seed usually persists on the female tree through the winter, characterizing their appearance, but can be dispersed any time from October to the following spring. The species is a prolific seeder; the most abundant seed production is from trees that are 12 to 20 years.

After collection, seeds should be spread to air-dry. Number of seeds per kilogram averages from 27,000 to 33,000 (12,235 to 14,970lb) and germination after cold stratification averages 65 to 85 percent (7,18). Seeds should be stored dry in sealed containers. The recommended cold stratification is 50 C (410 F) in moist sand for 60 days.

**Seedling Development-** Seeds, can be sown immediately upon ripening or stratified until spring. In nurseries, seeds are usually sown in the spring and seedlings transplanted early the following spring. Germination is epigeal. Vigorous first-year seedling growth of 1 to 2 m (3.3 to 6.6 ft) has been reported (1,11). Average survival on 11 different plantings in Indiana strip mines was 74 percent after the first growing season and then decreased to 58 percent after the first winter (5). This illustrates the winter damage and mortality frequently reported (1,7).

Because ailanthus is intolerant of shade, reproduction in natural stands appears sparse and erratic except by sprouting.

**Vegetative Reproduction-** The dense thickets of ailanthus reproduction on disturbed soils of road cuts and city building sites develop from root sprouts. Prolific root and stump sprouting has discouraged use of ailanthus as an ornamental species. After death or injury of the main stem the wide-spreading shallow root system can give rise to an abundance of sprouts. Sprouts have shown first-year height growth of 3 to 4 m (10 to 13 ft) (*19*). Thus, the species can be easily propagated from either root cuttings or from coppicing.

## Sapling and Pole Stages to Maturity

**Growth and Yield-** Information on the growth and yield of ailanthus in the United States at this time is lacking. Maximum heights are often reported as 17 to 27 m (56 to 90 ft) and a maximum d.b.h. as 100 cm (40 in) (10,12). A short-lived species, it lives 30 to 50 years (20). On arid sites, 15 m (50 ft) or more of height growth can be reached in 25 years, with a straight bole for 10 to 12 m (33 to 40 ft) (7). At a New England location, trees reached a 10 to 15 m (33 to 49 ft) height and 9 to 11 cm (3.7 to 4.3 in) d.b.h. in 30 years (11).

**Rooting Habit-** Ailanthus roots are shallow spreading, often apparent at the soil surface, and roots near the trunk thicken into enlarged storage structures. These large rounded structures are assumed to be for water storage, contributing to the drought hardiness of the species (4). There is a general absence of a taproot with most roots present in the upper 46 cm (18 in) of soil. Within this zone, the deeper roots send numerous small roots to the surface. Adventitious shoots may arise from any of the surface roots.

**Reaction to Competition-** Ailanthus is a successional pioneer species, intolerant of shade (8). It competes successfully in mixed stands of hardwoods throughout its range, indicating that it was present at the start of stand establishment.

Allelopathic effects on over 35 species of hardwoods and 34 species of conifers have been demonstrated for water extracts of ailanthus leaves (14). Only white ash (*Fraxinus americana*) was not adversely affected. Germination and growth of slash and Monterey pines (*Pinus elliottii* and *P radiata*) were inhibited by scattering leaves of ailanthus collected in June and July on the seed bed surface, while leaves collected in October stimulated germination and growth (22). Such studies point to a strong allelopathic role for ailanthus in forest succession.

**Damaging Agents-** The species is relatively resistant to insect predation (7). Three insect species are known to feed on ailanthus foliage, however (2). Most noted of the foliage feeders in the eastern range, especially in the South, is the ailanthus web-worm (*Atteva punctella*). Larvae from this insect feed on leaves enclosed in a frail, silken web. Another larval feeder, imported from Asia, is the cynthia moth (*Samia cynthia*). Ailanthus is the preferred host for this insect, but wild cherry and plum can also become infested. The Asiatic garden beetle (*Maladera castanea*) feeds on numerous plants during night flights, including ailanthus.

Although many fungi have been reported on the leaves and twigs of ailanthus, the tree suffers little from disease, and its pathology need rarely be a consideration in its culture (9). If ailanthus can be said to be subject to a major disease it would be Verticillium wilt (*Verticillium albo*-

*atrum*). Many trees were killed by this soil-borne wilt in Philadelphia in 1936. Shoestring root rot (*Armillaria mellea*) has been reported in trees in New York (16).

While this tree is rated moderately susceptible to Phymatotrichum root rot (*Phymatotrichum omnivorum*) in Texas, it is considered most satisfactory for planting in the southern parts of Texas root rot belt (20,23).

In Texas, seeds are eaten by a number of birds, including the pine grosbeak and the crossbill (21). Occasional browsing by deer has also been reported.

Wind, snow, and hard freezes are damaging to tops of seedlings, while mature trees are resistant to ice breakage (3). Resprouting usually occurs, although repeated damage leads to a reduction in seedling survival.

# **Special Uses**

Ailanthus's main importance remains in urban forestry, the original purpose of its importation into the United States. The species, tolerance of noxious emissions of gases and various dusts assures its continued use for plantings in industrial environments. Tolerance of poor soils and low soil moisture dictates its selection for city plantings in arid climates as well as shelterbelt plantings and on strip mine reclamation projects, although its unfavorable traits (odor and root sprouting) have decreased city plantings.

Root sprouting into fields is also a problem in shelterbelt plantings.

Pollinating insects are attracted by the male flowers. Honey from ailanthus has been reported as having an initial foul taste that disappears with aging, resulting in an exceptionally good tasting honey (13).

# Genetics

In the two centuries since its introduction into North America, ailanthus has probably become differentiated into genetically different subpopulations based on seed traits. Seed characteristics of ailanthus have been identified as traits that differentiate varieties and geographical strains. Ailanthus with bright red samaras compared to the more common greenish yellow has been named *Ailanthus altissima* var. *erythrocarpa* (Carr.) Rehd. A study of 11 seed sources from California and Eastern States found that seed width and weight were correlated with latitude (6). Northern sources have wider, heavier seed than the more southern sources.

# **Literature Cited**

- 1. Adamik, K., and F. E. Brauns. 1957. *Ailanthus glendulosa* (Tree-of-heaven) as a pulpwood. Part II. TAPPI 40:522-527.
- 2. Baker, Whiteford L. 1972. Eastern forest insects. U.S. Department of Agriculture, Miscellaneous Publication 1175. Washington, DC. 642 p.

- 3. Croxton, W. C. 1939. A study of the tolerance of trees to breakage by ice accumulation. Ecology 20:71-73.
- 4. Davies, P. A. 1944. The root system of *Ailanthus altissima*. Transactions of the Kentucky Academy of Sciences 1 1(34):33-35.
- 5. DenUyl, Daniel. 1962. Survival and growth of hardwood plantations on strip mine spoil banks in Indiana. Journal of Forestry 60:603-606.
- 6. Feret, Peter P., R. L. Bryant, and J. A. Ramsey. 1974. Genetic variation among American seed sources of *Ailanthus altissima* (Mill.) Swingle. Scientia Horticulturae 2:405-411.
- 7. Goor, A. Y., and C. W. Barney. 1968. Forest tree planting in arid zones. Ronald Press, New York. 409 p.
- 8. Grime, J. P. 1965. Shade tolerance in flowering plants. Nature 208(5006):161-163.
- 9. Hepting, George H. 1971. Diseases of forest and shade trees of the United States. U.S. Department of Agriculture, Agriculture Handbook 386. Washington, DC. 658 p.
- 10. Hottes, Alfred Carl. 1952. The book of trees. 3d ed. A. T. De La Mare, New York. 440 p.
- 11. Hu, Shiu-Ying. 1979. Ailanthus. Arnoldia 39(2):29-50.
- 12. Illick, Joseph S., and E. F. Brouse. 1926. The ailanthus tree in Pennsylvania. Pennsylvania Department of Forestry and Water Bulletin 38:1-29.
- 13. Melville, R. 1944. Ailanthus, source of peculiar London honey. Nature 134:640.
- Mergen, F. 1959. A toxic principle in the leaves of *Ailanthus*. Botanical Gazette 121:32-36.
- 15. Patterson, D. T. 1976. The history and distribution of five exotic weeds in North Carolina. Castanea 41(2):177-180.
- 16. Pirone, P. P. 1959. Tree maintenance, 3d ed. Oxford University Press, New York. 436 p.
- Plass, W. T. 1975. An evaluation of trees and shrubs for planting surface-mine spoils. USDA Forest Service, Research Paper NE-137. Northeastern Forest Experiment Station, Upper Darby, PA. 8 p.
- 18. Schopmeyer, C. S., tech. coord. 1974. Seeds of woody plants in the United States. U.S. Department of Agriculture, Agriculture Handbook 450. Washington, DC. 883 p.
- 19. Swingle, W. T. 1916. The early European history and the botanical name of the tree-ofheaven, *Ailanthus altissima*. Journal of the Washington Academy of Sciences 6:409-498.
- 20. U.S. Department of Agriculture. 1949. Trees. Yearbook of Agriculture 1949. Washington, DC. 944 p.
- 21. Vines, Robert A. 1977. Trees of East Texas. University of Texas Press, Austin and London. 538 p.
- 22. Voigt, G. W., and F. Mergen. 1962. Seasonal variation in toxicity of *Ailanthus* leaves on pine seedlings. Botanical Gazette 123(4):262-265.
- 23. Wright, Ernest, and H. R. Wells. 1948. Tests on the adaptability of trees and shrubs to shelterbelt planting on certain *Phymatotrichum* root rot infested soils in Oklahoma and Texas. Journal of Forestry 46:256-262.

# Chinaberry

Melia azedarach L.

### **Other Common Names:**

Persian lilac, white cedar, cape lilac, bead tree

### **Brief Description:**

Chinaberry was introduced in the mid-1800s from Asia. It has been widely used as an ornamental planting in the United States since then. Its fruit, leaves, and other parts can be poisonous to humans and livestock. To a limited extent birds feed and disseminate the fruit. It is studied for its medicinal properties.

### Habitat:

This species is common on roadsides, urban areas, homesites, and forest margins. It is rare at high elevations. It is cold hardy and drought tolerant. Chinaberry can be found growing on a variety of soils.

### Life History:

Purple flowers appear from March to May. The yellow poisonous berries mature in July and persist into January. It sprouts readily.

### Chinaberry and the Great Trinity Forest:

This species has been reported as invading the forest. A concerted effort needs to be made to remove all invasive species. Injection, basal bark, and foliar applications of herbicides are the most effective means of control due to its sprouting nature. It is probably less aggressive than other invasive trees in the area.



## Chinaberry Tree Melia azedarach L.

**Common Names:** chinaberry, Indian lilac, lelah, paraiso, pride of India, white cedar, China tree, bead tree, Persian lilac

**Native Origin:** Southeast Asia and Northern Australia; introduced in mid-1800s as an ornamental.

**Description:** A deciduous small to medium-sized tree in the mahogany family (Meliaceae), growing to a height of 50 feet and diameter of 2 feet with spreading crown and branched trunk with multiple boles. Stems are stout, glossy olive green to brown with numerous lighter dots (lenticels) and three-lobed leaf scar. Buds are small, round and fuzzy light brown. Bark is dark chocolate brown becoming increasingly fissured with age. Wood is soft and white. Lacy, dark-green leaves are alternately whorled, bi-pinnately compound, 1 to 2 feet long and 9 to 16 inches wide with a musky odor.

Each leaflet is lanceolate with tapering tips, 1 to 3 inches long and 0.5 to 1.2 inches wide. Glossy dark green with light-green mid-vein above and pale green with lighter-green mid-vein beneath, becoming golden yellow in fall. Long loose clusters of pinkish-lavender to whitish flowers are produced in spring, March to May. Fragrant clusters of flowers yield yellow-brown berries July to January. Berrylike spherical drupes contain a stone with one to six seeds. This fruit is poisonous to humans and livestock.



**Habitat:** This species is commonly found on roadsides, forest margins, open areas, clearings, and near dwellings, in low elevations (below 1000'). It is tolerant dry soils and semi-shade. Chinaberry forms colonies from root sprouts or sprouts from root collars, and spreads by abundant seeds that are dispersed by birds.



# **Distribution:** This species is reported from states shaded on Plants Database map. It is reported invasive in AL, AR, FL, GA, HI, LA, MS, NC, OK, SC, TX, UT, and VA.

**Ecological Impacts**: It invades disturbed areas and is commonly found along roads and forest edges. It has the potential to grow in dense thickets, restricting the growth of native vegetation. Seeds are dispersed by birds, although they are toxic to humans and livestock.

### Control and Management:

- **Manual**-. Manual and mechanical methods of control may therefore be ineffective in controlling the spread and extent of chinaberry because of its ability to send root and stem suckers from underground storage organs.
- **Chemical** It can be effectively controlled using any of several readily available general use herbicides such as glyphosate or tricloyr. Apply herbicides at the base of the trunk or use the cut-stump treatment. Foliar treatment can be used but high volumes of the solution are required. Follow label and state requirements.

References: http://plants.usda.gov, www.invasive.org,

http://enature.com/native\_invasive/invasives\_top.asp,

Nonnative Invasive Plants of Southern Forests, USDA. Miller, James H. p. 8-9, Virginia Tech Dept. of Forestrywww.cnr.vt.edu/dendro/dendrology/syllabus/mazedarach.htm,

http://tncweeds.ucdavis.edu/esadocs/documnts/meliaze. www.georgiainvasives.org/weeds/chinaberry.html
**MELIA AZEDERACH** L. <u>Meliacae/Mahogany Family</u>

Common Names:	Chinaberry, pride-of-India
Synonymy:	M. australis Sweet; M. japonica G. Don; M. sempervirens Sw.
Origin:	Asia

**Botanical Description**: Deciduous tree to 15 m (50 ft) tall. Twigs stout with purplish bark, dotted with buff-colored lenticels. Leaves alternate, large, long-petioled, 2 or 3 times compound (odd-pinnate), up to 0.5 m (1.5 ft) long; leaflets pungent when crushed, dark green above, often with sparse pubescence along veins; lighter green below, generally glabrous; margins serrate; blade bases often oblique. Inflorescences showy, loose, stalked panicles from leaf axils. Flowers small, fragrant, with 5 lilac petals; stalks of stamens united into dark purple tube. Fruit a stalked, thinly fleshy, subglobose, single-seeded drupe, yellow or yellowish green at maturity.

**Ecological Significance:** Introduced around 1830 as an ornamental in South Carolina and Georgia (Gordon and Thomas 1997) and widely planted in southern states. Occurs primarily in disturbed areas such as road right-of-ways and fencerows, but has also invaded floodplain hammocks and marshes and upland woods, particularly in north Florida (Clewell 1985, Godfrey 1988). Reported by land managers as infesting parks in 23 counties (EPPC 1996).

**Distribution**: Most abundantly naturalized in north and west Florida, but often escaping cultivation in peninsular counties, south to the Keys (Nelson 1994, Wunderlin 1982). Naturalized also in tropical America and planted in temperate and subtemperate areas around the world (Bailey and Bailey 1976). Reported as a prominent roadside and shoreline weed in Cape Province, South Africa (Henderson 1991). In the U.S., naturalized from eastern Virginia, southward to south Florida, and westward to eastern half of Texas and Oklahoma (Godfrey 1988).



Flowers

**Life History**: Often shrubby and root-suckering, forming thickets. Frequently flowers and fruits at shrub size. Produces flowers in spring, usually March and April; its fruits long-maturing, prolific, and commonly persistent after leaf fall. Fruits poisonous to humans and some other mammals, but seeds dispersed by a variety of songbirds, who relish the drupes and sometimes gorge themselves to the point of temporary intoxication (Nelson 1994).



**Compound leaf** 

Fruits

# **Chinese Tallow Tree**

Sapium sebiferum L.

#### **Other Common Names:**

Popcorntree and Florida aspen

#### **Brief Description:**

Chinese tallow tree is a fast growing and popular ornamental that has escaped cultivation. From 1920 to 1940 it was recommended for seed oil planting by the U.S. Department of Agriculture. The waxy seeds were traditionally used to make candles.

#### Habitat:

First introduced from China into South Carolina in the 1700s it has now moved across the South and the Gulf Coast. It invades wet areas such as stream and river banks as well as drainage ditches. It can also thrive on upland sites. Chinese tallow tree is shade tolerant, flood tolerant, and allelopathic to other plants.

#### Life History:

The tree flowers from April to June and the seeds mature in August to persist on the tree over winter or be dispersed by birds. It also sprouts prolifically. It is shade and flood tolerant.

#### Chinese tallow tree and the Great Trinity Forest:

This species has been observed invading the forest. A concerted effort needs to be made to remove all invasive species. Injection, basal bark, and foliar applications of herbicides are the most effective means of control due to its sprouting nature. Control of this species should be a high priority item.



## Chinese Tallow Tree Sapium sebiferum (L.) Roxb.

Synonym: Triadica sebifera(L.) Small

Common Names: Chinese tallow-tree, chicken tree, Florida aspen, popcorn tree, vegetable tallow, white wax berry, candleberry

**Native Origin**: Native to Japan and to several provinces of central China; Introduced to America for making candles, soap, cloth dressing, and fuel from the seed tallow.

Description: A deciduous tree in the spurge family (Euphorbiaceae) that reaches approximately 50 feet in height and 3 feet in diameter at maturity. Its bark is

reddish-brown with wide fissures and narrow ridges, and it often peels off vertically in narrow strips. The branches, which begin relatively low on the trunk, are typically long and drooping. The twigs are slender and waxy. Semicircular leaf scars become raised with age. The simple heart-shaped leaves are alternately whorled and dark-green with light-green mid- and lateral veins and turning yellow to red in fall. When freshly injured, the leaves exude a milky sap. The flowers are dangling yellowish-green 8-inch spikes which yield small clusters of three-lobed fruit that split to reveal popcorn-like seeds in fall and winter. It spreads by bird- and water-dispersed seeds and prolific surface root sprouts.

Habitat: It is adapted to a variety of disturbed sites and a wide range of soil conditions (alkaline, saline, or acidic soils). It invades low, swampy or sub-marshy places, shores of streams, ponds, lakes and impoundments, sometimes on floating islands; also in upland well-drained places, especially near human habitations stream banks. It



does best in alluvial forests, on low alluvial plains, and on rich leaf-molds, preferring well-drained clay-peat soils.

Distribution: It has been reported in the following states: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas and Virginia. It is reported invasive in AL, FL, GA, LA, MS, NC, SC, TX, and VA.

Ecological Impacts: It can invade wild-land areas and swiftly replace natural communities with nearly mono-specific stands. It alters natural soil conditions, creating an inhospitable environment for many native species. In Texas, invasion by S. sebiferum marked a dramatic transformation of community structure from graminoids (grasses) and forbs to trees and shrubs as S. sebiferum shaded out herbaceous species. The milky, white sap may also be a skin irritant or diarrheic in humans.

#### **Control and Management:**

- Manual- Mechanical control is not recommended because plants re-sprout vigorously from roots. Controlled burns can be effective during the growth season.
- Chemical- It can be effectively controlled using any of several readily available general use herbicides such as triclopyr, imazapyr, hexazinone. There are many possible ways to apply such herbicides, e.g., on foliage, on cut stems, as an injection, or as a basal spray directed to the bark of uncut stems. Repeat applications may be necessary to reduce densities. Follow label and state requirements. Managers should evaluate the specific circumstances of each infestation, seek professional advice and guidance if necessary, and use the herbicide in a manner that is consistent with the product label and other state requirements.

References: www.invasivespeciesinfo.gov/profiles/chtallow.shtml, www.invasive.org/eastern/eppc/SASE.html, http://tncweeds.ucdavis.edu/esadocs/documnts/sapiseb.html

Miller, James H. 2003. Nonnative Invasive Plants of Southern Forests: a field guide for identification and control. Gen. Tech. Rep. SRS-62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. P. 10-11, http://edis.ifau.ufl.edu/AG148, Godfrey, R.K. 1988. Trees, Shrubs, and Woody Vines of Northern Florida and Adjacent Georgia and Alabama. The University of Georgia Press, Athens, GA.

Produced by the USDA Forest Service, Forest Health Staff, Newtown Square, PA. WOW 02-02-06 Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive\_plants









# NATURAL AREA WEEDS: Chinese Tallow (Sapium sebiferum L.)<sup>1</sup>

K. A. Langeland<sup>2</sup>

#### Introduction

Florida's natural areas--a great source of pride and enjoyment to its citizens--provide recreation, protect biodiversity and fresh water supplies, buffer the harmful effects of storms, and significantly contribute to the economic well-being of the state (Jue et al. 2001). Natural areas are protected in almost nine million acres (nonsubmerged) of state, federal, local and private managed conservation lands in Florida (Jue et al. 2001). Unfortunately, many of these natural areas can be adversely affected when they are invaded by nonnative invasive plant species. An estimated 25,000 plant species have been brought into Florida for use as agricultural crops or landscape plants. While only a small number of these have become invasive, those that do can adversely affect native plant communities by competing for space and resources, disrupting hydrologic and fire regimes, or hybridizing with native species. They must be managed for the protection of native communities in natural areas. Chinese tallow (Sapium sebiferum L.) is one of these invasive plant species.



**Figure 1.** Chinese tallow tree (*Sapium sebiferum* L.) can be identified by its simple, alternate leaves with broadly rounded bases that taper to a slender point and dull white seeds that remain attached after leaves have fallen.

### How to Recognize Chinese Tallow

Chinese tallow is a deciduous tree with a milky sap that commonly grows to 30 ft tall. Leaves are simple, alternate, 1-2.5 inches wide, with broadly rounded bases and tapering to a slender point (Figure 1). Leaf stalks are 1-2 inches long. Small yellow flowers that are borne on spikes to 8 inches long occur in spring (Figure 2). The fruit is a 0.5 inch

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<sup>1.</sup> This document is SS-AGR-45, one of a series of the Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First Published February 2002. Revised February 2006. Please visit the EDIS Web site at http://edis.ifas.ufl.edu.

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wide, 3-lobed capsule that turns brown at maturity to reveal 3 dull white seeds (Figure 1). The seeds, which often remain attached to the tree through the winter, resemble popcorn, suggesting the other common name of popcorn tree.



Figure 2. In Spring, Chinese tallow tree displays spikes to 8 inches of small yellow flowers.

#### Distribution

The first record of Chinese tallow introduction into the United States is found in a letter from Benjamin Franklin written in 1772 to Dr. Noble Wimberly Jones of the Georgia colony. Franklin wrote: "I send also a few seeds of the Chinese Tallow Tree, which will I believe grow & thrive with you. "Tis a most useful plant" (Bell 1966). As early as 1803, Chinese tallow was spreading into coastal forests according to the noted French botanist Andre Michaux. Since Franklin's time, Chinese tallow has been introduced repeatedly to the United States as an ornamental and potential oil crop species. It is now naturalized from Richmond County North Carolina south through Central Florida, extending west into Texas and northwest Arkansas (McCormick 2005). Within Florida, Chinese tallow was naturalized in 57% of the counties in 1993 (Jubinsky and Anderson 1996) and found as far south as Dade County (Wunderlin et al. 2003).

#### Invasiveness

Chinese tallow has been recognized as a pest plant in the Carolinas since the 1970s (Langeland and Burks 1998). Within Florida, it has been reported from 46 natural areas (Florida Exotic Pest Plant Council Occurrence Database (http://www.fleppc.org)), and it is a target for removal from 12 natural areas in the Florida Department of Environmental Protection's Upland Invasive Exotic Plant Management Program (DEP Uplands Plant Control Summary, unpublished). Payne's Prairie State Preserve, south of Gainesville, Florida, once contained over 10,000 Chinese tallow trees (Jubinsky and Anderson 1996). Chinese tallow has been extensively used for ornamental planting and is a common plant on landscaped property. These trees present a constant source of seed for infestation of natural areas because the seeds are transported by birds such as pileated woodpeckers, cardinals, yellow-rumped warblers, American robins, and grackles, as well as by water (Jubinsky and Anderson 1996). While the length of time needed to deplete the seedbank is unknown, indications are that seeds remain viable for many years (Jubinsky and Anderson 1966). Zhang and Lin (1994) speculate that seeds may remain dormant for up to 100 years with little or no loss in viability.

The Florida Exotic Pest Plant Council included Chinese tallow on its 1993 List of Florida's Most Invasive Species. Chinese tallow was added to the Florida Department of Agriculture and Consumer Services Noxious Weed List (5b-57.007 FAC) in 1998. Plants on the Florida Noxious Weed List may not be introduced, possessed, moved, or released without a permit.

#### **Remove and Replace**

Homeowners can help mitigate the problem of Chinese tallow trees in Florida's natural areas by removing them from their property. Mature trees should be felled with a chain saw by the property owner or a professional tree service. The final cut should be made as close to the ground as possible and as level as possible to facilitate application of a herbicide to prevent sprouting. Stumps that are not treated with a herbicide will sprout to form multiple-trunked trees (Figure 3).

Homeowners with only one or a few trees should use Brush-B-Gon or Brush Killer herbicide. These diluted herbicide products (8.0% and 8.8% triclopyr amine, respectively) are available in quart-size containers from retail nursery supply stores. Property owners with large numbers of trees can use the more



Figure 3. Stumps of felled Chinese tallow trees that are not treated with a herbicide will sprout to form multiple-trunked trees.

concentrated Garlon 3A or Garlon 4 (44.4% triclopyr amine and 61.6% triclopyr ester, respectively), which are available only in 2.5-gallon or larger containers from farm supply stores. Renovate 3 is available in 1-quart containers and can be applied to trees that are standing in water. These products must be diluted before use. If it is not objectionable for dead trees to be left standing, Garlon 4 can be diluted at a rate of 1 part herbicide to 5 parts oil and applied to the bark at the base of trees with stems less than 6 inches in diameter. Oil manufactured for this purpose is available from farm supply stores. Pathfinder II (13.6% triclopyr ester) is a pre-diluted, ready to use product that can be used for basal bark application. The herbicide container will have a label with instructions for applying the herbicide. See Table 1.

If trees are cut at a time when seeds are attached, make sure that the material is disposed of in such a way the seeds will not be dispersed to new areas where they can germinate and produce new trees. Seedlings should be continually pulled by hand before they reach seed-bearing maturity.

Space in a landscape left after removal of Chinese tallow can be used to plant a new native or noninvasive non-native tree for shade, or some other landscape purpose. Tree species recommended in Table 2 are similar in size to Chinese tallow. Blackgum, maples, dogwood, and crepe myrtles provide fall color similar to Chinese tallow. Fact sheets that provide additional information on landscape plants can be viewed at http://hort.ifas.ufl.edu/trees/index.htm. For information on the availability of native landscape plant species contact the Association of Florida Native Nurseries (877/352-2366 or http://www.afnn.org). The Cooperative Extension Service Office in your county can help you identify plants appropriate to your property conditions, the ecosystems on and near your site, and your aesthetic preferences.

#### **Literature Cited**

Bell, M. 1966. Some notes and reflection upon a letter from Benjamin Franklin to Noble Wimberly Jones October 7, 1772. Privately printed at The Ashantilly Press, Darien, Georgia. 10 pp.

Jubinsky, G. and L. C. Anderson. 1996. The invasive potential of Chinese tallow-tree (*Sapium sebiferum* Roxb.) in the Southeast. Castanea 61:226-231.

Jue, S., C. Kindell, and J. Wojcik. 2001. Florida Conservation Lands 2001. Florida Natural Areas Inventory, Tallahassee, Florida. 165 pp.

Langeland, K. A. and K. C. Burks. 1998. Identification and Biology of Non-Native Plants in Florida's Natural Areas. University of Florida, Gainesville. 165 pp.

McCormick, C. M., Task Force Chair. 2005. Chinese Tallow Management Plan for Florida. http://www.fleppc.org/Manage\_Plans/ Tallow\_Plan.pdf

Wunderlin, R. P., and B. F. Hansen. 2003. Atlas of Florida Vascular Plants (http://www.plantatlas.usf.edu/). [S. M. Landry and K. N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa.

Zhang, K. and Y. Lin. 1994. Chinese Tallow. China Forestry Press. Beijing, China. 460 pp.

Herbicide	Application method	Dilution	Availability
Brush-B-Gon	Cut stump	Undiluted	Retail garden suppliers
Brush Killer	Cut stump	Undiluted	Retail garden suppliers
Garlon 3A	Cut stump	1 herbicide:5-10 water	Agriculture suppliers
Renovate	Cut stump	1 herbicide:5-10 water	SeaPro Corporation
Garlon 4	Cut stump	1 herbicide:5-10 oil	Agriculture suppliers
Garlon 4	Basal bark	1 herbicide:5 oil	Agriculture suppliers
Pathfinder II	Basal bark	Undiluted	Agriculture suppliers

Table 1. Herbicides for cut stump or basal bark application to control Chinese tallow trees.

 Table 2. Some suggested tree species for replacing Chinese tallow.

Native	Florida Hardiness Zones
American Hornbeam (Carpinus caroliniana)	North, Central
Blackgum (Nyssa sylvatica var. sylvatica)	North, Central
Cedar Elm (Ulmus crassifolia)	North, Central
Eastern Hophornbeam (Ostrya virginiana)	North, Central
Eastern Redbud (Cercis canadensis)	North, Central
Flatwoods Plum (Prunus umbellata)	North, Central
Florida Maple (Acer saccharum ssp. floridanum)	North, Central
Flowering Dogwood (Cornus floridana)	North, Central
Fringe Tree (Chionanthus virginicus)	North, Central
Geiger Tree (Cordia sebestena)	South
Paradise Tree (Simarouba glauca)	South
Red Bay (Persea barbonia)	Throughout
Red Maple (Acer rubrum)	Throughout
Red Stopper (Eugenia confusa)	South
River Birch (Betula nigra)	North, Central
Satin Leaf (Chrysophyllum oliviforme)	South
Silverbell (Halesia diptera)	North, Central
Swamp Bay (Persea palustris)	Throughout
Turkey Oak <i>(Quercus laevis)</i>	North, Central
White Ash (Fraxinus americana)	North
Winged Elm (Ulmus alata)	North, Central
Non-native	
Crepe Myrtle (Lagerstroemia indica)	Throughout
Queens Crepe Myrtle (Lagerstroemia speciosa)	South
Trumpet Tree (Tabebuia argentea)	South



## **Chinese Tallow: Invading the Southeastern Coastal Plain**

Chinese tallow is an ornamental tree with colorful autumn foliage that can survive full sunlight and shade, flooding, drought, and in some cases fire. To horticulturists this kind of tree sounds like a dream, but to ecologists, land managers, and land owners this kind of tree can be a nightmare, especially when it invades an area and takes over native vegetation. Chinese tallow (*Triadica sebifera*), a nonnative tree from China, is currently transforming the southeastern Coastal Plain.

Over the last 30 years, Chinese tallow has become a common tree in old fields and bottomland swamps of coastal Louisiana. Several studies at the U.S. Geological Survey's National Wetlands Research Center (NWRC), Lafayette, Louisiana, are aimed at understanding the factors that contribute to Chinese tallow growth, spread, and management.

When tallow invades, it eventually monopolizes an area, creating a forest without native animal or plant species. This tree exhibits classic traits of most nonnative invaders: it is attractive so people want to distribute it, it has incredible resiliency, it grows quickly and in a variety of soils, and it is resistant to pests.

In the coastal prairie of Louisiana and Texas, Chinese tallow can grow up to 30 feet and shade out native sun-loving prairie species. The disappearing of prairie species is troublesome because less than 1% of original coastal prairie remains, and in Louisiana, less than 500 of the original 2.2 million acres still exist.

Tallow reproduces and grows quickly and can cause large-scale ecosystem modification (fig. 1). For example, when it completely replaces native vegetation, it has a negative effect on birds by degrading the habitat. Besides shading out grasses that cattle like to eat, it can also be potentially harmful to humans and animals because of its berries (fig. 2) and plant sap that contain toxins. There is some concern its leaves may shed toxins that change the soil chemistry and make it difficult for other plants to grow.

## How did Chinese tallow come to America?

Chinese tallow was reportedly introduced to the United States by Benjamin Franklin in 1772. It was also introduced to South Carolina in the late 1700's. Because of the large amount of vegetable tallow found in the seed, the U.S. Department of Agriculture introduced it to the Gulf of Mexico Coast region in the 1900's to help establish local soap industries.

## What other products can be created with Chinese tallow?

Tallow has been cultivated as a seed-oil crop in China for at least 14 centuries. Candles, soap, cloth dressing, and fuel are made from the tallow. Chinese vegetable tallow is a solid fat that is in the outer covering of the seeds. The kernels produce an oil called stillingia oil that is used in machine oils, as a crude lamp oil, and in making varnishes and paints. It can also be converted to charcoal, ethanol, and methanol. Potentially, oil from the seeds can be a substitute for petroleum.



Figure 1. Chinese tallow, also called chicken tree and popcorn tree, is an aggressive, nonnative invader that reproduces quickly, creating a forest without native plant or animal species.



Figure 2. The fruit of Chinese tallow can be carried by birds and water runoff to invade areas.

**USGS ES-154-00** 

October 2000

## How far has Chinese tallow spread in the United States?

It has spread from South Carolina all the way down to Florida, west into Texas, and has now been located in California.

# How do Chinese tallow's characteristics make it such an aggressive invader?

Chinese tallow has the ability to reach reproductive age in as little as 3 years and to remain productive for at least 60 years. It does not seem to have a preference for disturbed areas over undisturbed areas and can grow in a variety of places. It can also grow in both full sunlight and shade. It is more tolerant of salinity and flooding than quite a few other native species. It grows in subtropical to warm climates but is hardy and able to withstand a few degrees of frost. It is able to thrive in the United States and is resistant to native insects. In addition, it is somewhat resistant to fire.

# Once Chinese tallow is established, is it hard to get rid of?

Chinese tallow is very hard to get rid of. Trees are chopped down, roots are dug up and removed, and herbicides are used, but the aggressive seedlings continue to return, sometimes for years. Fire can hold the tallow at bay when the tree density is low, but since tallow can suppress fuel species, fire can go up to a stand and then go out from lack of fuel, leaving the tallow relatively unharmed. Tallow can resprout if topkilled as well as root at some distance from the original stem.

## How can I control tallow on my property?

Tallow is susceptible to herbicides. Effective control of tallow can be achieved through the intensive use of chemical herbicides, mowing, or cutting; however, these methods are expensive for largescale control.

#### How is Chinese tallow spread?

Chinese tallow has been cultivated in nurseries and sold as an ornamental tree used for landscaping; however, it is now classified as a nuisance species in some locations and can no longer be sold. It has separate pollen and seed-bearing flowers, and seeds can be spread by birds and by moving water.

#### How is the USGS National Wetlands Research Center studying Chinese tallow?

In the Jean Lafitte National and Historical Park and Preserve, Louisiana, NWRC researchers use models that simulate tallow invasion in bottomland hardwood areas of the Mississippi River delta to better understand how Chinese tallow spreads. They also monitor the rate and extent of its invasion as well as assess the fate of native trees once tallow has invaded.

In the coastal prairie of Louisiana and Texas, researchers are also trying to determine the distribution of Chinese tallow and conditions that contribute to its growth. Because fire is an important natural process that maintains prairie, they are also evaluating the effectiveness of prescribed burning, specifically for the control of Chinese tallow.

Researchers have found that tallow is not restricted to moist conditions and established trees can tolerate severe drought, though growth can be reduced by arid conditions. Also, they have found that tallow can be damaged by fire and under certain circumstances, may be controlled by prescribed burning (fig. 3). On the other hand, tallow inhibits the spread of fire, which suggests that it could possibly escape from fire control if left untreated for several years.

Identifying how Chinese tallow is dispersed is crucial to controlling it. NWRC researchers are studying how tallow is distributed by migrating versus resident birds in South Carolina and Louisiana. In order to do this, they are studying which bird species eat tallow seeds. In addition, they are studying to see if some bird species may actually benefit from the presence of tallow, whereas others may suffer because of the change to their habitat.

Additionally, researchers at NWRC use aerial photography and satellite images to monitor landscape changes to detect and



Figure 3. The USGS National Wetlands Research Center, Lafayette, is currently researching the role of fire in controlling Chinese tallow.

track Chinese tallow invasion (fig. 4). These remote-sensing techniques can also be used to assess the impact of fire on tallow. A collaborative study with NASA is mapping Chinese tallow occurrences.

#### For more information, contact:

U.S. Geological Survey/National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA 70506; 337-266-8500; Fax: 337-266-8541; http://www.nwrc.usgs.gov



Figure 4. USGS National Wetlands Research Center researchers are exploring the uses of color-infrared photography to map Chinese tallow occurrences. One of the challenges of this research is being able to discern not only different types of vegetation but also leaf color changes of Chinese tallow. Chinese tallow mapping was carried out when the leaves were turning red (shown here in yellow) and provided a high contrast with the native forest, prairie, and marsh vegetation.

# **Chinese Privet**

Ligustrum sinense L.

#### **Other Common Names:**

Pivet

#### **Brief Description:**

Chinese privet is an invasive shrub that forms dense thickets in bottomlands and along fencerows. It is still used as an ornamental planting in the south. The seeds are spread by birds and other animals. Deer occasionally browse young shoots. The fruit is toxic to humans.

#### Habitat:

Privet occupies a variety of sites across the site, but may not tolerate dry and droughty sites. By invading bottomlands and fencerows, it can further can access to other sites such as fields and right-of-ways. Once established it is difficult to eradicate and can modify whole ecosystems over time.

#### Life History:

Privet flowers from April to June. It develops drupes of many berries that are then disseminated by birds and other animals. It sprouts profusely and is also considered shade tolerant.

#### Chinese privet and the Great Trinity Forest:

This species has been reported in the understory of the forest and occurring in thickets. A concerted effort needs to be made to remove all invasive species. Injection, basal bark, and foliar applications of herbicides are the most effective means of control due to its sprouting nature. Control of this species should be a high priority item. Basal bark would be the most effective means of control on plants with individual stems. Foliar sprays should be used when leaves are accessible for total coverage. An application rate that would ensure a thorough coating of the leaves should be favored in this case due to the dense foliar nature of the plant.

# USDANRCS Plant Guide

### exotic weed species

### CHINESE PRIVET Ligustrum sinense Lour. plant symbol = LISI

Contributed By: USDA, NRCS, National Plant Data Center & Louisiana State University-Plant Science; partial funding from the US Geological Survey and the US National Biological Information Infrastructure



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#### Uses

Weed (very invasive in the southern US), ornamental

#### Noxiousness

Chinese privet was introduced into the United States from China for ornamental planting. Having escaped from cultivation, it is now naturalized throughout the southeastern United States. The greatest threat posed by this species is large-scale ecosystem modification due to its ability to successfully compete with and displace native vegetation. Chinese privet plants mature rapidly and are prolific seed producers. They also reproduce vegetatively by means of root suckers. Once established, Chinese privet is difficult to eradicate because of its reproductive capacity.

Impact/Vectors: Ligustrum sinense is native to China and was introduced into the United States in 1852 for use as an ornamental shrub. It is used for hedge and mass plantings, and sometimes as single specimens for its foliage and its profusion of small white flowers (Dirr 1990; Wyman 1973). It continues to be widely sold in the nursery and gardening industry. The foliage of Chinese privet is also used, presumably, for cut-flower arrangements. This horticultural introduction has been cultivated for a relatively long time in the United States. Wyman (1973) reports that this species is still growing as a hedge on the old Berkman's Nursery grounds in Augusta, Georgia, where it was planted in the early 1860's. It was planted on the Chickamauga and Chattanooga National Military Park after it came under the control of the Secretary of War in 1890. Present day plants are descendants of those early plantings (Faulkner et al. 1989). According to Small (1933), the species was escaping from cultivation in southern Louisiana by the 1930's. A survey of appropriate herbaria reveals collection records from Georgia as early as 1900. Based on herbarium records the species has become naturalized and widespread in the southeast and eastern U.S. during the 1950's, 60's, and 70's. Taylor et al. (1996) notes the rapid, recent spread of Ligustrum sinense in Oklahoma.



The species is a major threat to natural landscapes. An example of Chinese privet's ability to push a native species closer to extinction is noted in the recovery plan for Schweintz's sunflower (*Helianthus schweinitzii*). This endangered species is known from about 16 populations on the piedmont of the Carolinas. Residential and commercial development and the invasion of aggressive exotics, such as *Ligustrum sinense*, represent the greatest threats for this species (U.S. Fish and Wildlife Service 1992). Similar observations about the competitive characteristics of Chinese privet have been noted in various Nature Conservancy reports in the Southeast. Removal of Chinese privet from natural areas is problematic and essential for their restoration (News from Volunteers of the Nature Conservancy, North Carolina Chapter and the Louisiana Chapter, pers. comm. 1997).

In addition to the privet's impact on natural landscapes, it can be directly harmful to humans. All introduced species of *Ligustrum* produce fruit toxic to humans that cause such symptoms as nausea, headache, abdominal pain, vomiting, diarrhea, weakness, and low blood pressure and body temperature. Where Chinese privet occurs in abundance, floral odors may cause respiratory irritation (Westbrooks & Preacher 1986). Chinese privet is sold in nurseries and is often included on recommended planting lists or other literature produced by cooperative extension services without mention of its invasive nature. Named cultivar selections have been developed (Bailey and Bailey 1976).

Chinese privet grows in a wide variety of habitats and can tolerate a wide range of soil and light conditions, but it grows best in mesic soils and abundant sunlight but can tolerate lower light conditions (Thomas 1980; Bailey & Bailey 1976). Few woody plants offer an easier test of gardeners' skills.



Leaves with developing fruit.

© L. Urbatsch

The species persists on abandoned home sites and can readily invade abandoned lots and farmlands where it forms impenetrable thickets. It becomes especially abundant along fencerows, stream, bayou, and forest margins, and it has the ability to invade forests (Godfrey 1988). Chinese privet reproduces by sexual and vegetative means. Seeds, produced in great abundance, are spread by birds (McRae 1980). Landscape plantings provide seed sources for establishment in disturbed habitats. Soil disturbances of all sorts such as forest clearing, abandoned agricultural lands, and fence construction provide opportunities for colonization by Chinese privet. Natural disturbances for example tree falls, erosion, animal excavations, etc. provide similar colonization opportunities. The plants also have the ability to reproduce vegetatively from root suckers. Once established, Chinese privet is difficult to control because of the huge seedbank and the need to remove underground parts as well. Because of these characteristics, the major impact of Chinese privet is its ability to displace native species and disrupt various terrestrial ecosystems.

#### Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

#### Description

*General*: Olive Family (Oleaceae). Chinese privet is a shrub or small tree that may grow to as much as 30

feet tall although its typical height ranges from 5 to 12 feet. If flowering, its blossoms are very aromatic. Its root system is shallow but extensive. Suckers are readily produced and the plants can spread vegetatively in this fashion. The plants branch abundantly and the branches typically arch gently downward. Its twigs are usually densely



© L. Urbatsch Petiole, axillary bud, stem with spreading hairs

hairy (pubescent) when young, and the plant hairs (trichomes) spread at right angles from the twig surface. Raised, tan-colored lenticels are also evident on the twig's surface. Chinese privet leaves are evergreen to semi-deciduous and are oppositely arranged (two leaves per node) along the stem on nodes that are usually less than one inch apart. The leaf stalk (or petiole, shown below) is about oneeighth inch long and covered with hairs. Leaf blades are elliptical in shape and are up to one inch wide and about two inches long. Leaf margins lack teeth (entire). The upper leaf blade surfaces are glabrous (without hairs) at maturity. Hairs occur along the midvein (see photo below) and sometimes on branch veins of the lower surfaces. The flowers occur in numerous, coneshaped, branching clusters (panicles) two to four inches long that profusely cover the shrub when flowering. A short, slender stalk (pedicel)



© L. Urbatsch Developing fruit & cuplike calyx of fused petals.

supports each flower. The green calyx consists of four sepals fused to form a small, cup-like structure. Four white to off-white petals that are basally fused to one another make-up the corolla. Each flower has two stamens attached to the corolla, and they project beyond the corolla throat (exserted stamens). The

flowers produce a somewhat disagreeable aroma. The single pistil in each flower matures into a blue-black, berrylike fruit. The fruit are ellipsoidal to nearly globose and are produced abundantly in persistent, pyramidal clusters.



© L. Urbatsch Midvein of lower leaf surface showing hairs.

Chinese privet is similar to Common Privet (*Ligustrum vulgare*), a European species that is naturalized in more temperate areas of the eastern United States. <u>Chinese privet has evergreen to semi-evergreen leaves</u>, <u>densely hairy twigs and petioles</u>, <u>pubescent midveins on its lower leaf surfaces</u>, and <u>exserted stamens</u>. In contrast, common privet is

deciduous to somewhat evergreen with sparsely pubescent twigs, glabrous midveins, and included stamens (the tips of the anthers are shorter than the extended corolla lobes) (Gleason 1952).



© L. Urbatsch Petiole, leaf base & margin.

*Distribution*: A survey of herbarium records shows that its present distribution includes an area extending from Florida to southern New England and westward to the eastern parts of Kansas, Oklahoma, and Texas. Chinese privet thrives in wet to dry habitats. It persists around old home sites and flourishes along fencerows, and stream and forest margins where it forms impenetrable, monocultural thickets. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

#### Control

It is recommended that you contact your local agricultural extension specialist and/or county weed specialist for control measures pertinent to your area.

Various control measures have been reported for Chinese privet. For small areas and for relatively small plants, hand removal is effective. Digging tools such as a mattock are useful for removing underground parts. Broken root fragments need to be removed because of their ability to re-sprout. Repeated mowing and cutting will control the spread of privet, but will not eradicate it. For such treatment, stems should be cut as close to the ground as possible (Bartlow et al. 1997). Mechanical removal is especially effective in the early stages of an invasion when the numbers of plants are relatively small.

For larger natural areas where the use of chemical herbicides is inadvisable, enlisting numerous helpers to mechanically remove Chinese privet may be required. Using heavy equipment for large-scale removal may be appropriate in some locations, but the negative effects of soil disturbance and the potential for erosion need to be considered.

Herbicide treatments properly applied can selectively remove invasive species with minimal soil disturbance. Even slight soil disturbance may offer opportunities for re-invasion. When considering chemical control, local laws affecting herbicide use must be observed. Appropriate precautions in various habitats may be needed. Kline & Duquesnel (1996) point out that not all herbicides are appropriate for all areas. Some may damage nontarget species. Herbicides will behave differently in different environments and under different conditions (Neal et al. 1986). For example, they may degrade more slowly in wetter, more anaerobic soils or move downward in sandier soils. A careful monitoring program is essential for evaluating herbicide use.

Randall & Marinelli (1996) report effective control of Chinese privet with glyphosate herbicides stating that foliage treatment is best for actively growing plants. Foliar spray methods should be used only where risk to non-target species is minimal. A 2% solution of glyphosate or 2% triclopyr with a one-half percent of non-ionic surfactant is reportedly effective for treating Chinese privet (Bartlow et al. 1997).

Kline & Duquesnel (1996) discuss various treatments for woody species including Brazilian pepper, Australian pine, Chinese tallow, and other tree-like species. They note that within mixed stands single stem treatments consisting of basal-bark treatments, cut-surface treatments (injection, cut-stump, or girdle), or direct foliar applications may be effective. A typical basal or cut-surface treatment consists of a 10-50% mixture of one of the following types of herbicides (glyphosate, hexazinone, imazapyr, or triclopyr) with an oil dilutant. They provide a table for use as a guide for selecting application methods and herbicides for various invasive plant species.

Brian Bowen, President of the Tennessee Exotic Pest Plant Council, reports success in controlling privet using 25% glyphosate/75% horticulture oil applied as a cut-surface treatment (personal communication, 1997). He advises against using this application as the plants break dormancy because upward movement of the sap reduces the treatment's effectiveness. The same herbicide preparation is effective when applied to cut stumps as long as the ground isn't frozen (Bartlow et al. 1997). For the basal bark method, applying a mixture of 25% triclopyr/75% horticultural oil to the basal parts of the shrub is reported (Bartlow et al. 1997). W. N. Kline, Senior Scientist, Dow Elanco, Duluth, Georgia, also favors basal-bark or cut-surface treatment over foliar application (pers. comm. 1997). The latter causes such rapid leaf drop that translocation of the herbicide in the plants is reduced, thereby lowering its effectiveness. Furthermore, he reports that disturbance (e.g., fire or mechanical) should be avoided for about one year following basal-bark or cut-surface treatments to allow translocation of herbicides. Disturbance of the plants or root system too soon after treatment may disrupt translocation and result in resprouting.

Fire is a naturally occurring phenomenon that is essential for certain native plant communities to exist. Its use in exotic pest plant control is being investigated. Faulkner et al. (1989) reported its effectiveness as a management tool in the Chickamauga and Chattanooga National Military Park for controlling *Ligustrum sinense* and other pest plants. Fire had the benefit of killing large privet stems, but the vigorous resprouting that followed burning offset this gain. Fall and winter burns had desirable aesthetic effects by considerably reducing the biomass of privet, but no long-term benefits were achieved since the species still remained.

Fire was also used as a herbicide pretreatment (Faulkner et al. 1989). In the spring following the fall and winter burns, foliar application of glyphosate damaged or killed a majority of the Chinese privet shoots. Burning facilitated foliar application of herbicide by reducing biomass. However, it did not increase the effectiveness of the herbicide compared to the unburned controls.

Privet has no known biological controls. A foliagefeeding insect native to Europe, *Macrophya punctumalbum*, is a known pest. Privet is also susceptible to a fungal leaf spot, *Pseudocercospora ligustri*, and a common root crown bacteria, *Agrobacterium tume-faciens* (Bartlow et al. 1997).

#### **Illustrations and Photographs:**

Auburn University 1999. *Dendrology: Chinese privet*. Version: 000330. <http://sofserv.forestry.auburn.edu/samuelson/dendro logy/oleaceae\_pg/chinese\_privet.htm>. Department of Forestry, Auburn, Alabama.

Gleason, H. A. 1952. Illustrated flora of the northeastern United States and adjacent Canada. Lancaster Press, Inc., Lancaster, PA. (line drawing, vol 3, p. 53.)

Godfrey, R. K. 1988. *Trees, shrubs, and woody vines of northern Florida and adjacent Georgia, and Alabama*. The University of Georgia Press, Athens. 734 pp. (excellent line drawing showing flower and fruit in detail, p. 518).

Radford, A. E., H. E. Ahles, & C. R. Bell 1968. *Manual of the vascular flora of the Carolinas*. University of North Carolina Press, Chapel Hill, North Carolina. (small line drawing, p 831).

Randall, J. M. & J. Marinelli 1996. *Invasive plants, weeds of the global garden*. Brooklyn Botanic Garden, Handbook #149, Brooklyn, New York. 99 p. (photograph, plants in flower, p. 58)

Schopmeyer, C. S. 1974. Seeds of woody plants in the United States. USDA, Forest Service, Agricultural Handbook No. 450. (illustration of *L.* sinense seeds and seedlings of *L.* vulgare, a similar species, p. 500, 502).

#### References

Bailey, L. H., & E. Z. Bailey 1976. *Hortus third: A concise dictionary of plants cultivated in the United States and Canada*. Macmillan Publishing Company, New York, New York. 1186 p.

Bartlow, J., K. Johnson, M. Kertis, T. Remaley, S. Ross, E. Simet, T. Smith, D. Soehn, & G. Taylor 1997. *Tennessee exotic plant management manual*. 119 pp. (http://webriver.com/tn-eppc).

Dirr, M. 1990. *Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation, and uses.* 4th Edition. Stipes Publishing Co., Champaign, Illinois. 826 pp.

Gleason, H. A. 1952. *Illustrated flora of the northeastern United States and adjacent Canada*. Vol. 3. Lancaster Press, Lancaster, Pennsylvania.

Godfrey, R. K. 1988. *Trees, shrubs, and woody vines* of northern Florida and adjacent Georgia, and *Alabama*. The University of Georgia Press, Athens, Georgia. 734 pp.

James, T. K. & J. Mortimer 1983. *Control of privet*. Pg 206-209. IN *Proceedings of the 37th New Zealand weed and pest control conference*, Christ Church, New Zealand.

Kline, W. N. & J. G. Duquesnel 1996. *Management* of invasive exotic plants with herbicides in Florida. Down to Earth. Vol 51. No. 2.

McRae, W. A. 1980. Unusual bobwhite foods on abandoned Piedmont farmlands, Georgia. Georgia Journal of Science 38(1):49-54.

Miller, J.H. 1998. Primary screening of forestry herbicides for control of Chinese privet (Ligustrum sinense), Chinese wisteria (Wisteria sinensis), and trumpetcreeper (Campsis radicans). IN Proceedings, 51st annual Southern Weed Science Society meeting, January 26-28, Birmingham, Alabama. <http://www.srs.fs.fed.us/pubs/viewpub.asp?ID=836 >. USDA, FS, Southern Research Station, Ashville, North Carolina.

Neal, J. C., W. A. Skroch, & T. J. Monaco 1985. Effect of plant growth stage on glyphosate absorption and transport in Ligustrum and blue Pacific juniper. Weed Science 34(1):115-121.

Randall, J. M. & J. Marinelli 1996. *Invasive plants, weeds of the global garden*. Brooklyn Botanic Garden, Handbook #149, Brooklyn, New York. 99 p.

Westbrooks, R. G. & J. W. Preacher 1986. Poisonous plants of eastern North America. University of South Carolina Press, Columbia, South Carolina. 172 p.

Small, J. K. 1933. *Manual of the southeastern flora*. The University of North Carolina Press, Chapel Hill, North Carolina. 1499 p.

Taylor, C. E., K. L. Magrath, P. Folley, P. Buck, & S. Carpenter 1996. *Oklahoma vascular plants: Additions and distributional comments*. Proceedings of the Oklahoma Academy of Science 76:31-34.

Thomas, E. H. 1980. *The New York Botanical Garden illustrated encyclopedia of horticulture*. Garland STPM Press, New York, New York.

USDA, NRCS 2000. *The PLANTS database*. Version: 000330. <http://plants.usda.gov>. National Plant Data Center, Baton Rouge, Louisiana.

USDI, Fish and Wildlife Service 1992. *Endangered and threatened species of the Southeastern United States (The Red Book).* USFWS, Southeastern Region, Atlanta, Georgia.

Wyman, W. 1973. *Shrubs and vines for American* gardens. MacMillan Publishing Co., Inc., New York, New York. 613 pp.

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Edited 05dec00 jsp;03feb03ahv

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# Privet is a Plague: You Can Help Stop It

and

By James H. Miller Southern Research Station, USDA Forest Service *Tim Albritton* USDA Natural Resources <u>Conservation Service</u>

ave you noticed how privet appears to be exploding across the landscape? Privet is that rampant small-leaved shrub that stays green in winter and can be seen along many fencerows and forest edges, as well as invading interior forests. What at one time was considered the staple farm house shrub is now completely out of control. It has become a plague. In fact, it is spreading through our most precious forests - bottomland hardwoods and forest preserves. What was once considered beauty to grace our homes has turned against us to rapidly spread along roadsides and stream-sides to infiltrate our forests.

Landowners and managers can either stand by and watch the takeover or start the process to battle this plant plague. To begin, we want to tell you how to identify the different species of privet that are invading our forests, and then explain how you can combat them.

While a few flowering privet shrubs in spring was once a beautiful sight, thousands of plants have now become hideous and dominating. The dense stands prevent forest regeneration by displacing native trees and plants, and also deny management and recreational access. Recent surveys show that there is even more privet now in southern forests than kudzu. This explosive occupation by privet has been documented by a Natural Resources Conservation Service survey of privet shown in Figure 1. This figure shows the increasing invasion of only one species of privet - Chinese privet. Actually there are more than three different species that are causing us increasing problems.

#### How to Identify Privets

The most invasive non-native privet is Chinese privet (*Ligustrum sinense*) or what we often call "common privet." It was introduced into the United States from China in 1852. Like many introduced plants of that time, it was actually imported here from England after being transported there from China. Figure 1 shows how Chinese privet remained docile for about 100 years, occurring in only a few counties in the Southern US; then for some unexplained reason, it began to spread rapidly in the 1950's and continues to do so today.

Chinese privet is the smallest leaved privet (0.5 to1.5 inches long). It is termed semi-evergreen to evergreen, meaning it retains mostly green leaves during the winter. All privets have leaves that are opposite to one another along the branches. The other two species of privet that are increasingly invading our forests are truly evergreen, thick-leaved species, mainly glossy privet (Ligustrum lucidum) and Japanese privet (L. japonicum). Their leaves range from 2 to 6 inches long. As the name implies, Japanese privet came from Japan (through England), with introduction in about 1845, while glossy privet originated in China and was introduced way back in 1794. Only Japanese privet is still widely sold as an ornamental, while sales have stopped for the most part for Chinese and glossy privet because of their extremely invasive nature.



Figure 1. Spread of Chinese privet in the Southern US by counties.

Page 230 of 416 Spring 2004 There are at least two other species of ornamental privet escaping into southern forests: European privet (*L. vulgare*), which closely resembles Chinese privet, and border privet (*L. obtusifolium*), which resembles glossy and Japanese privet. All of these species can occur in the same infestation. Thus, the privet plague will be gaining new recruits. The good news is that all these privet species are controllable.

Because privets retain their foliage during fall and winter, they have the competitive advantage over native plants that go dormant. During warm sunny days in fall and winter, privets can produce and store sugars from photosynthesis while native plants sleep. Another big advantage is their abundant fruity seeds, just perfect for spread by birds and animals. Privets are in the olive family and just like the olives we buy in a jar, there is a thin fleshy fruit covering a hard seed in the center. These dark-purple or blackish fruit often dangle in huge clusters on privet branches in winter and early spring when most birds are migrating north. Birds are the main means of spread and are the most probable cause of the privet explosion since the 1950's. Birds have learned to count on privets during their northern migration. Another factor for the explosion has been the removal of so much southern lands from cultivation during this period, a prime invitation for invasion.

Deer is another species of wildlife that browse seedling plants of Chinese privet, often on the expanding edges of privet patches. Of course, the rapid growth of Chinese privet soon puts the tender twigs out of reach. It does not take but a few years for privets to reach their maximum heights of 20 to 35 feet. Chinese privet has multiple stems from a base that will eventually lean and arch. Glossy and Japanese privets grow more as central upright stems. The prolific root sprouting of Chinese privet yields thousands of sprouts per acre that spread and intensify a patch, along with a horde of seedlings.

Regardless of the use by birds and deer, many more species of wildlife are denied suitable habitat by privet infestations and the infested lands become worthless for timber production, recreation, and native plant conservation.

#### **Successful Privet Control**

Privets can be controlled with concerted efforts and by using methods that have proven to be effective. A combination of treatments in an integrated manner usually will provide the most effective strategy for successful eradication. Many forms of treatment can be used such as: prescribed burning; tractors with rootrakes and shredder-mulcher heads; brushsaws; pulling and digging plants; and safe and effective herbicides. The right combination depends on the extent of your privet infestation, the size of the privet, your objectives, and your budget.

The usual objective is to first eradicate the privets and then facilitate native plant re-establishment. Selective removal of privets before they become an infestation is the best situation to address, using treatments that have minimal impact on associated native plants. But large infestations can be eradicated with a more concerted effort.

For multi-acre infestations of large privet, tractors with rootrakes or mower heads are often the best approach. Some of the over-sized bush hogs or mulchershredders used on utility right-of-ways can grind large privet shrubs to chip mulch. Another approach would be to chainsaw or brushsaw large privet. Of course, all stumps should be immediately treated with Garlon 3A or a glyphosate herbicide as a 20% solution (2.5 quarts per 3-gallon mix) in water with a surfactant to prevent resprouting. If safety to surrounding trees is not an issue, then Arensal AC, Chopper, or Velpar L as a 10% solution (1 quart per 3-gallon mix) can be used, staying mindful of soil activity. With all cut stump treatments, sawdust and chips should be swept from the stump before herbicide application to prevent de-activation. Applications can be made with a backpack sprayer or utility spray bottle, or a wick applicator, dropper bottle, or paintbrush.

Tree injection, hack-and-squirt, and basal stem sprays are other methods for treating privet stems larger than one inch in diameter. Privet injection and hackand-squirt are difficult because of the multiple stems and the need to treat each one. The long tube of an E-Z-ject injector permits easier treatment of the multistemmed base while a machete and squirt bottle will aid with treating each stem.

(Continued on page 26)



Chinese Privet Up to 30 feet in height. Leaves: thin, 0.5 to 1.5 inches long, tip often indented.



*Glossy Privet* Up to 35 feet in height. Leaves: thick, 3 to 6 inches long, yellowish rimmed.



Japanese Privet Up to 20 feet in height. Leaves: thick, 2 to 4 inches long, under veins protrude. Alabama's TRage 33(10) 446 rests / 21

### **Privet is a Plague**

(Continued from page 21)



A mulcher-shredder or "brush-hog" can be used to tackle large privet.

The herbicides and mixtures specified previously can be used with the same considerations for the safety of non-target plants.

Basal stem sprays using *Garlon 4* as a 20% solution (2.5 quarts in 3-gallon mix) in commercially available basal oil, diesel fuel, or kerosene with a penetrant (check with herbicide distributor) are effective on stems up to 3 inch diameter. Some herbicides, such as *Pathfinder II* and *Pathway*, are sold ready-to-use with these ingredients. Thoroughly wet the lower one foot of each privet stem with this mixture.

Foliar spray treatments are the most cost-effective way to eradicate privets and should be used whenever the foliage can be reached using spray applicators. Resprouts of privet that are topkilled by burning or brush mowing can be more easily treated with foliar sprays. A test of forest herbicides as foliar sprays was conducted in resprouted Chinese privet near Auburn, Alabama using September applications. The results shown in Table 1 reveal that glyphosate herbicides (such as Accord) were the most effective with Arsenal AC being next most effective at the rates tested. Additional tests have shown that glyphosate used during warmer days of winter and spring are even more effective than September, while treatments during summer dry periods are least effective.

For Chinese privet control, thoroughly wet all leaves with one of the following herbicides in water with a surfactant (April or October to January): a glyphosate herbicide as a 3% solution (12 ounces per 3-gallon mix); or *Arsenal AC* as a 1% solution (4 ounces per 3-gallon mix). Remember that *Arsenal* can injure or kill desirable plants having roots in the treated area and is not advisable for use under desirable hardwoods and pines.

For the waxy-leaved glossy and Japanese privet, thoroughly wet all leaves with one of the following herbicides in water with a surfactant: August through January — Arsenal AC as a 1% solution (4 ounces per 3-gallon mix), or Garlon 4 as a 3% solution (12 ounces per 3-gallon mix); and March to June or October to January — a glyphosate herbicide as a 3% solution (12 ounces per 3-gallon mix).

Depending on the area to be treated, foliar sprays can be applied using a backpack sprayer or sprayers mounted on tractors, ATVs, or helicopters. Directed foliar sprays are applications that are directed towards the target plant with care to minimize spray to desirable neighboring plants.

With any invasive plant control strategy, one to many treatments will be required to be successful. In addition, follow-up surveillance and treatment of new arrivals will be a must. It may be necessary to coordinate your treatments with your neighbors to prevent re-entry.

#### **Getting Assistance**

The Environmental Quality Incentives Program (EQIP) is sponsoring a special project this year to address invasive species. Privet is one of the seven invasive species listed in the Invasive Plants Management Project. For more information about this project and how to apply for assistance contact your local NRCS office.

The Alabama Agricultural and Conservation Development Commission Program (AA&CDC) can provide cost share assistance for landowners interested in forestry improvement practices. However, funding may be limited. There are two elements within the forestry improvement section that apply:

1) One practice authorizes cost sharing for clearing land occupied largely by scrubby brush of no economic value (this would include privet), and reforesting the site with a desirable species.

2) If privet is invading where there is already a stand of desirable trees, another cost share practice authorizes a herbicide release treatment of desirable seedlings and young trees.

Additional information on EQIP programs is available at this website: http:// www.al.nrcs.usda.gov/programs/costshare/EQIP/index.html.

#### Rehabilitation

Rehabilitation is the most important final phase of an integrated invasive plant eradication and reclamation program. This phase requires establishment and/or release of fast-growing native plants (such as loblolly pine, waxmyrtle, and sweetgum) that can out-compete and outlast any surviving invasive plant while stabilizing and protecting the soil. Recommendations for preventing and managing plant invasions like privets on a specific site include maintaining forest vigor with minimal disturbance, constant surveillance, treatment of new unwanted arrivals, and finally, rehabilitation following eradication.

#### **Cautions and Disclaimer**

Registered herbicides are deemed safe by the US Environmental Protection Agency (EPA) for treating invasive plants when used properly. Herbicides used improperly can be injurious to humans, animals, and plants. Special precautions should be exercised when using herbicides in wetlands and around water. Always carefully read and follow label instructions. Follow recommended practices for the disposal of surplus herbicides and pesticides and their containers.

Use of trade names is for reader's information and does not constitute official endorsement or approval by the US Department of Agriculture to the exclusion of any suitable product or process.

Herbicide	Rate per Acre	% Control
Accord	1.5 gal	97
Arsenal AC	24 fl. oz	80
Escort	3.3 oz	70
Garlon 4	1.5 gal	24
Oust	6 oz	22
Vanquish	1.5 gal	5
Tordon K	0.5 gal	5
Transline	21 fl. oz	0

Table 1. Third-year Privet Control with Forestry Herbicides.

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by James H. Miller, USDA Forest Service, Southern Research Station, Auburn, AL 36849

hinese privet (Ligustrum sinense Lour.) is probably the most problematic alien shrub in the 13-states of the southern region, widely invading forests, parks and preserves, pastures, and right-of-ways (Haragan 1996, Miller 1997, Matlack 2002). After a century of planting as an ornamental shrub following introduction in 1852 (Dirr 1998), range expansion has been rapid and far-reaching since about 1960 (NRCS website). This rapid invasion has occurred as birds feed upon abundant fruits produced in early spring and disperse seed during northern migrations. It is widely observed that the habitats most under siege are disturbed areas and bottomland forests (Dirr 1998), while upland forests and pasture margins are steadily being invaded as well. Site dominance occurs through Chinese privet's production of abundant root suckers and clump sprouts, as well as carpets of seedlings in infested areas.

Chinese privet is but one of at least eight nonnative privet species within the region that have escaped into natural habitats. Other widely occurring privet invaders are European privet (*L. vulgare* L.), glossy privet (*L. lucidum* Ait. f.), and Japanese privet (*L. japonicum* Thunb.). Those locally problematic are Amur privet (*L. amuense* Carr.), border privet (*L. obtusifolium* Sieb. & Zucc.), California (originally from Japan) privet (*L. ovalifolium* Hassk.), and waxyleaf privet (*L. quihoui* Carr.), including several varieties of each. Japanese, glossy, and border privet are evergreen while the others are semi-evergreen and retain foliage depending on the severity of the winter and locale. All have opposite leaves, with white flower clusters in spring that yield black to blue-black drupes in fall and winter to spring. The fleshy one-seeded fruit characterize these members of the olive family (Oleaceae).

Herbicides are one tool that can be used to control privets as part of an integrated vegetation management approach. The objective of this investigation was to compare foliar sprays of most herbicides registered for forest use in the southern region for their effectiveness on Chinese privet.

#### Methods

The study site was located along a riparian area of a perennial stream in east-central Alabama. A uniformly dense stand of Chinese privet had been brush mowed on a 3-year cycle for 9 years before study initiation. The infestation had one year of regrowth, being 4 to 10 ft tall. Sixty-four, 10 x 20-ft plots were established in four blocks. Seven herbicide treatments and a nontreated control were randomly assigned to plots in each block and tested at two intervals, August and September. The first treatment was planned for July, but due to the absence of rainfall for 3 months during the summer, it was applied in August after rainfall commenced with 2 inches in 2 weeks preceding treatment.

Near maximum labeled rates were tested for each herbicide using formulations with a single active ingredient (Table 1). This approach aimed to identify the most effective active ingredients for treating Chinese privet in late-summer and early fall. Applications were by a CO<sub>2</sub>-powered backpack sprayer with a Table 1. Herbicide tests on Chinese privet.

Herbicide active ingredient (ai)	Rate' per Acre Ibs ai <sup>2</sup>	1 Year After Treatment	2 Years After Treatment	3 Years After Treatment
Accord glyphosate	1.5 gal <i>6.0</i>	99a³	98a	97a
Arsenal AC imazapyr	24 fl oz <i>0</i> .75	94a	89a	79ab
Escort metsulfuron	3.3 oz <i>0.12</i>	81ab	79a	69ab
Garlon 4 triclopyr	1.5 gal <i>6.0</i>	64ab	44ab	22abc
Oust sulfometuron	6.0 oz <i>0.28</i>	31abc	32abc	21abc
Vanquish <i>dicamba</i>	1.5 gal <i>6.0</i>	27abc	25abc	04abcd
Tordon K <i>picloram</i>	0.5 gal <i>1.0</i>	12abcd	09abcd	05abcd
Transline clopyralid	21 fl oz 0.5	00abcd	00abcd	00abcd

<sup>1</sup>Product per acre. <sup>2</sup>Pounds active ingredient per acre. <sup>3</sup>Results of Tukey's HSD, where values with different letters are significantly different at the 5% level of probability.



Spraying Systems XR 8003 flat-fan nozzle swiveled downward on a 4-foot extended wand. A total spray mixture of 40 gallons per acre (gpa) in water was used except with Accord, which was tested with 30 gpa per label recommendations. A surfactant (Entry II) was added at 0.5 percent to all mixtures except Accord, which contains surfactant. The applicator stood in the middle of half plots and rotated about to uniformly cover all plants, while a guide outside the plot gave directions to assure uniformity (shown above).

Plots were rated 1, 2, and 3 years after treatment using visual estimates of percent volume reduction of standing shrubs. Untreated control plots in each block were used as height references during ratings, while before treatment volumes (average height X cover) were used as co-variants in the analysis. There were no significant differences between

the August and September applications and thus these data were combined. According to standard procedures, percent reductions (control) were arsine square root transformed and data were analyzed using Tukey's HSD Test.

#### Findings

Privet control exceeded 90 percent with Accord (glyphosate) and Arsenal AC (imazapyr) the first year and did not statistically differ from Escort, which averaged 81 percent control (Table 1). Accord gave near complete control for the 3-year post-treatment period to exceed 97 percent with minimal resprouting and seedlings. Garlon 4, Oust, Vanquish, Tordon K, and Transline provided less than 65 percent control. Transline was completely ineffective on privet at these timings and rates.

The most effective herbicide, Accord, is a foliar active herbicide that is deactivated when it reaches the soil and thus presents safety to nearby unsprayed plants. This offers a treatment option to prevent harm to native cohort plants when care in application restricts spray to privet foliage only. The wand extension used in this research permitted effective treatment for privet that was 10 ft tall. The wand could be fitted with a longer extension and a projecting spray tip to treat taller privet.

The active ingredient in Accord is glyphosate, which is available in many formulations including aquatic labeled products permitted for spraying around and over water. The aquatic formulations could be used to eradicate the extensive privet infestations that occur along streamside areas and



partially flooded wetlands. Further tests of aquatic formulations of glyphosate are required since they contain no surfactants, which may lessen control.

#### Conclusions

Resprouted Chinese privet can be effectively controlled or even eradicated with Accord treatments or other herbicides with similar glyphosate formulations. This offers a treatment option that can be safe to applicators as well as flora and fauna when used according to label directions. Subsequent tests have shown that lower rates are equally effective, as low as 1 quart per acre. Treatments in December are most effective while those in April are only slightly less effective (Harrington and Miller 2005). Arsenal AC and Escort were less effective in this trial, but provided enough control for use in particular locations. All treatments will need to be repeated to achieve eradication, and native plant revegetation fostered to obtain restoration.

#### Literature

Dirr, M.A. 1998. Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation, and uses. Stipes Publication, Champaign, IL. 1187 p.

Haragran, D.P. 1996. Ligustrum vulgare, L. sinense, L. japonicum. p 58-59. In: Randall, J.M and Marinelli, J (Eds.) Invasive plants: weeds of the global garden. Brooklyn Botanic Garden, NYC, 111 p.

Harrington, T. and Miller, J.H. 2005. Effects of application rate, timing, and formulation of glyphosate and triclopyr for control of Chinese privet (Ligustrum sinense). Weed Technology 19:47-54.

Matlack, G.R. 2002. Exotic plant species in Mississippi, USA: critical issues in management and research. Natural Areas Journal 22:241-247.

Miller, J.H. 1997. Exotic invasive plants in southeastern forests. p 97-105. In: K.O. Britton (Ed.), Proceedings of Exotic pests of eastern forests. USDA Forest Service and Tennessee Exotic Pest Plant Council. 198 p.



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#### The mission of the Florida Exotic Pest Plant Council is to support the management of invasive exotic plants in Florida's natural areas by providing a forum for the exchange of scientific, educational and technical information.

An **exotic plant** has been introduced to Florida, either purposefully or accidentally, from a natural range outside of Florida. A **naturalized exotic plant** is one that sustains itself outside of cultivation (it is still exotic; it has not "become" native). An **invasive exotic plant** not only has become naturalized, but it is expanding its range in Florida plant communities.

Wildland Weeds (ISSN 1524-9786) is published quarterly by the Florida Exotic Pest Plant Council (FLEPPC) and the Southeast Exotic Pest Plant Council (SE-EPPC) to provide a focus for the issues and for information on exotic pest plant biology, distribution and control.

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Design by JS Design Studio. Printing by StorterChilds, Gainesville, FL.

**On the Cover:** Melapaleuza turned into Mudapaleuza when 3 inches of rain fell two days prior to the event in the Everglades buffer strip near Holiday Park. Five swamp buggies got bogged down in the mud. See article on page 9. (*Photo by Ken Langeland*)

#### Effects of Application Rate, Timing, and Formulation of Glyphosate and Triclopyr on Control of Chinese Privet (*Ligustrum sinense*)<sup>1</sup>

TIMOTHY B. HARRINGTON and JAMES H. MILLER<sup>2</sup>

Abstract: Chinese privet is a nonnative shrub that has invaded mesic forests throughout the southeastern United States during the past century. Foliar sprays of glyphosate and triclopyr were tested in three factorial experiments that included wide ranges of application rate, timing, and formulation to refine methods for controlling Chinese privet. For spring (April) and fall (October and December) applications, percentage control of privet cover averaged 93 to 100% and 49 to 70% for glyphosate and triclopyr treatments, respectively, whereas for summer (June and August) applications, control averaged 67 to 69% and 14 to 26%, respectively (study 1). However, privet control was not influenced by variation in herbicide rates of 1.7, 3.4, 5.0, or 6.7 kg ae/ha compared with each of the five application timings. No differences were found in August comparisons of liquid vs. dry glyphosate products or water-soluble vs. oil-soluble triclopyr products for each of the four rates (study 2). In a comparison of low rates of glyphosate applied in August with or without trenching of plot perimeters to isolate privet clumps (study 3), control increased from 12 to 65% as rate increased from 0 to 0.8 kg ae/ha, suggesting that rate responses may occur at lower values than those tested in studies 1 and 2. Isolation of privet clumps by trenching did not have a statistically detectable effect on privet susceptibility to glyphosate. Low rates of glyphosate (1.7 kg ae/ha or possibly lower) will provide effective control of privet when applied in the spring or fall.

Nomenclature: Glyphosate; triclopyr; Chinese privet, Ligustrum sinense Lour.

Additional index words: Bottomland hardwoods, crown cover, invasive weeds, response surface analysis.

#### INTRODUCTION

Chinese privet is a rapidly encroaching plant that continues to invade disturbed sites, fencerows, and bottomland and upland forests in the Southeast (Dirr 1998; Haragan 1996; Miller 2003). This shade-tolerant, perennial shrub or small tree grows to a height of 9 m and has multiple stems (Miller 2003). Its foliage is evergreen to semievergreen, becoming deciduous in cold climates (Dirr 1998). Once liberated from their fleshy fruit, privet seeds will germinate promptly without cold stratification (Burrows and Kohen 1986; Young and Young 1992). The spread of its seeds by birds and other animals and abundant production of root sprouts enable the species to invade new areas and form dense thickets (Dirr 1998; Miller and Miller 1999). Because of the species' shade tolerance and abundant regeneration, privet is able to spread and thrive under dense forest canopies. As an additional layer of understory vegetation, privet may be an important factor limiting hardwood regeneration, wildlife habitat, biodiversity, and recreational activities.

Introduced from China in 1852 as a woody ornamental, Chinese privet has escaped and now dominates understories of mesic forests throughout the southeastern United States (Haragan 1996) and is moving into New England and the Midwest (USDA-NRCS 2003a). During the period of 1950 to 1980, Chinese privet distribution expanded at an exponential rate, and today it is present in over 40% of southeastern U.S. counties (USDA-NRCS 2003b). In a survey conducted by the USDA Forest Service, the Forest Inventory and Analysis Program estimated that *Ligustrum* spp. occupied approximately 5% of forestland area along the eastern seaboard from Virginia to Florida (Rudis and Jacobs 2002). Chinese privet is ranked among the top 10 exotic pest plants of Georgia (Georgia Exotic Pest Plant Council 2003) and Mississippi (Matlack 2002).

Herbicides are an important tool for controlling *Li*gustrum spp., although comprehensive comparisons of application rate and timing are not available in the pub-

<sup>&</sup>lt;sup>1</sup>Received for publication September 23, 2003, and in revised form May 18, 2004.

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lished literature. In primary screening work, Miller (1998) observed 89 to 90% control of Chinese privet after 1 yr with high rates of glyphosate, imazapyr, or metsulfuron applied as foliar sprays in August, whereas control averaged only 60% after triclopyr. James and Mortimer (1984) successfully controlled privet with cutstump applications of picloram plus 2,4-D or picloram plus triclopyr and with foliage applications of metsulfuron (spring or autumn) or glyphosate (spring only). Similarly, Little (1982) achieved control of 97% of privet plants by cut-stump application of picloram plus 2,4-D. Mowatt (1981) found consistently high levels of control when privet was injected with triclopyr or hexazinone but variable control when injected with glyphosate or dicamba.

Of the herbicides tested, glyphosate and triclopyr have no soil activity at registered rates (WSSA 1994) and pose little risk to associated vegetation when applied to privet as a directed foliar application. Other herbicides, such as picloram, imazapyr, and metsulfuron, have soil-activated phytotoxic effects on many hardwood tree species and therefore have restrictions when used for privet control in bottomland forests. To identify optimum application rates and timings of herbicides for a given target species, controlled studies are needed in which these factors are varied systematically and plant responses are quantified with objective measurements (Borders and Shiver 1989; Knowe et al. 1995). Therefore, the objective of this research was to compare control of Chinese privet abundance and height 2 yr after various application rates, timings, and formulations of glyphosate and triclopyr. Because a herbicide dose applied to privet in a small plot might be subject to excessive dilution within the creeping root system, we conducted a separate study in which privet control after low rates of glyphosate was compared in the presence vs. absence of trenching to sever the root system from nearby plants.

#### MATERIALS AND METHODS

**Study Site and Treatments.** The research was conducted in the understory of a 1.2-ha bottomland hardwood stand located at the confluence of McNutts and Barber creeks in Oconee County near Athens, GA (lat 33°57'N, long 83°19'W). Soils are gravelly sandy loams of the Madison series (fine, kaolinitic, thermic Typic Kanhapludults) and gravelly loams of the Louisa series (loamy, micaceous, thermic, shallow Ruptic-Ultic Dystrudepts) (USDA-NRCS 2003c). The upper canopy of the forest included, in decreasing order of abundance, river birch (*Betula nigra* L.), green ash (*Fraxinus penn*- sylvanica Marsh.), boxelder (*Acer negundo* L.), red maple (*Acer rubrum* L.), yellow-poplar (*Liriodendron tulipifera* L.), American hornbeam (*Carpinus caroliniana* Walt.), water oak (*Quercus nigra* L.), and sweetgum (*Liquidambar styraciflua* L.). In spring 1999, a dense stand of privet, 2 to 4 m in height, was cut to a 15-cm height by the Georgia Department of Transportation in preparation for a stump application of the triethylamine salt of triclopyr in water. However, the herbicide treatment was delayed for several weeks, and no signs of plant injury were visually detectable at study initiation (spring 2000). Triclopyr entry into the privet stumps probably was prevented by blockage of the xylem vessels, which can occur within 2 h after cutting the stem of a woody plant (Newton and Knight 1981).

In April 2000, the study site was dominated by a uniform stand of 1-yr-old privet sprouts about 1 m in height. A total of 218 plots, each 3 by 6 m in dimension, were located in a contiguous grid. Three studies were initiated to compare privet control subsequent to a variety of treatment specifications (Table 1). Study 1 compared four application rates (kg ae/ha) and five timings of glyphosate and triclopyr. Study 2 compared two formulations and four rates of glyphosate and triclopyr applied in August 2000. Studies 1 and 2 had randomized complete block designs with four replications of each treatment. Blocks ran parallel to McNutts Creek and were assigned according to distance from the creek because flooding can limit privet growth (Brown and Pezeshki 2000). Four of the plots (one per block) were randomly assigned as nontreated checks. Using the remaining plots, study 3 compared three application rates of glyphosate applied in August 2000 with or without trenching of plot perimeters to a depth of 50 cm with a Ditch Witch<sup>3</sup> to isolate privet clumps. Study 3 had a completely randomized design with three replications of each treatment because plot locations did not conform to the blocked designs of studies 1 and 2. Plots for the three studies were randomly interspersed. To evaluate control resulting from a nonherbicide treatment, four plots were designated for manual uprooting of privet in June (one plot per block). The time required to manually uproot the privet on a given plot was recorded (min/m<sup>2</sup>). Seedlings and small clumps were uprooted by hand, whereas larger clumps were uprooted with a winch puller.<sup>4</sup>

Herbicide treatments for study 1 were applied on the following dates in 2000: April 20, June 19, August 23,

<sup>&</sup>lt;sup>3</sup> Model 1230, walk-along trencher, Ditch Witch, 4501 East Second, Edmond, OK 73034-7500.

 $<sup>^4</sup>$  Model 144, winch puller, Ben Meadows Co., P.O. Box 5277, Janesville, WI 53547-5277.

		Herbicide		
Study	Factors (levels) tested	Common name	Commercial name <sup>a</sup>	
1 <sup>b</sup>	Herbicides (2), application rates (4), and application timings $(5)^{c}$	Glyphosate Triclopyr	Accord <sup>®</sup> SP Garlon <sup>®</sup> 3A	
2	Herbicides (2), formulations (2), and application rates (4)	Glyphosate	Accord®SP Roundup®Pro Dry	
		Triclopyr	Garlon <sup>®</sup> 3A Garlon <sup>®</sup> 4 <sup>d</sup>	
3	Rates (3), trenching levels (2)	Glyphosate	Accord <sup>®</sup> SP	

Table 1. Experimental design features of studies 1, 2, and 3 for control of Chinese privet. Four additional plots (one per block) were designated as nontreated checks, and four additional plots (one per block) were designated for manual uprooting of privet in June.

<sup>a</sup> Accord®SP (isopropylamine salt of glyphosate), Garlon®3A (triethylamine salt of triclopyr), and Garlon®4 (butoxyethyl ester of triclopyr) are products of Dow AgroSciences LLC, Indianapolis, IN, and Roundup®Pro Dry (ammonium salt of glyphosate) is a product of the Monsanto Company, St. Louis, MO.

<sup>b</sup> Study 1 had a total of 160 plots (four replications of 40 treatments), study 2 had a total of 64 plots (four replications of 16 treatments) of which 32 were shared from study 1 (those for the August timing of the Accord®SP and Garlon®3A treatments), and study 3 had a total of 18 plots (three replications of six treatments).

<sup>c</sup> Herbicide application rates were 1.7, 3.4, 5.0, and 6.7 kg ae/ha for studies 1 and 2, and 0, 0.4, and 0.8 kg ae/ha for study 3. Application timings were April, June, August, October, and December 2000 for study 1 and August 2000 for studies 2 and 3.

<sup>d</sup> Improved JLB®Oil Plus (Brewer International, P.O. Box 690037 Vero Beach, FL 32969) was used as a spray carrier for Garlon®4, whereas water was used as the spray carrier for all other herbicides.

October 16, and December 7. Rainfall in the month before each treatment was, respectively, 58, 21, 45, 117, and 111% of the long-term average. Treatments for studies 2 and 3 occurred on August 23, 2000. Air temperatures during the December treatment ranged from 11 to 14 C; temperatures during all other application timings were well above freezing. All treatments were applied with a CO<sub>2</sub>-pressurized backpack sprayer<sup>5</sup> with a fournozzle boom that created a uniform 1.8-m band of spray. The sprayer was calibrated with 8002VS flat-fan spray nozzles<sup>6</sup> with a pressure of 200 kPa for an output rate of 187 L/ha to ensure complete coverage of the privet canopy within a 1.8-m band centered across the 6-m length of each plot (approximately 60-cm bands on either side remained nontreated as plot buffers). Boom height was kept about 50 cm above the top of the privet canopy for each application timing.

**Vegetation Measurements.** Just before each application timing, the following variables were measured on privet rooted within each of three square, 1-m<sup>2</sup> subplots centered at pin flags placed permanently 1, 3, and 5 m along the centerline of the 6-m dimension of each plot: cover (visually estimated percentage of area occupied by plant crowns), stem density (stems/m<sup>2</sup>), and height (cm, tallest stem per subplot). All vegetation measurements were repeated in October 2002, an average of two growing seasons after the various application timings.

To provide an index of overstory forest density, total stem cross-sectional area of trees (stand basal area;  $m^2/$ 

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ha) was measured as follows. At each of 26 systematically located points within the study area, stem diameter (cm) at 1.37 m height (diameter breast height, dbh) was measured on each tree (dbh > 2.5 cm) whose center was rooted within 6 m of a given point (sample area = 0.01 ha). The total cross-sectional area (m<sup>2</sup>) of stems measured around each point was divided by sample area to equal stand basal area. Each treatment plot was assigned the value of stand basal area from the closest point.

**Statistical Analysis.** Control (%) of privet cover, density, and height was calculated by subtracting posttreatment (2002) values for each subplot from their respective pretreatment (2000) values, expressing this difference as a percentage of the mean posttreatment value for the nontreated check plots (26.8%, 20.8 stems/m<sup>2</sup>, and 177 cm for cover, density, and height, respectively), and then averaging the percentages by plot. Note that this numerical expression of control could exceed 100% for individual plots and that negative values for control indicated that privet abundance or height increased during the study.

Data from each study were subjected to stepwise linear regression (SAS 1999a) to fit response surface models (Petersen 1985) with the minimum number of variables needed to account for significant ( $\alpha = 0.05$ ) effects of the various experimental factors (see model equations below). This analytical approach is appropriate for herbicide trials that test quantitative factors because it enables identification of optimum application rates and timings (Borders and Shiver 1989). Stand basal area of overstory trees and the time interval between pre- and posttreatment measurements (days) were tested as poten-

<sup>&</sup>lt;sup>5</sup> Model GS, CO<sub>2</sub> backpack sprayer with four-nozzle spray boom, R&D Sprayers Inc., 419 Highway 104, Opelousas, LA 70570.

<sup>&</sup>lt;sup>6</sup> Nozzle 8002VS, Visiflo flat spray tip, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

representation of privet control vs. application timing.							
Variable	Application timing	Glyphosate			Triclopyr		
		Pretreatment	Posttreatment	Control (%) <sup>a</sup>	Pretreatment	Posttreatment	Control (%)
Cover (%)	April	26.8 (0.5)	1.8 (2.7)	93.2 (10.1)	27.9 (3.3)	14.9 (1.7)	49.4 (11.4)
	June	22.6 (1.2)	4.0 (2.3)	69.3 (10.8)	27.8 (3.3)	20.7 (2.6)	26.4 (15.0)
	August	20.7 (1.1)	2.8 (1.3)	66.9 (6.4)	19.9 (2.8)	16.1 (2.2)	14.2 (9.9)
	October	26.9 (0.1)	0.3 (3.2)	99.4 (11.9)	29.8 (2.9)	13.3 (2.3)	61.6 (12.1)
	December	28.0 (0.1)	0.3 (3.0)	103.5 (11.0)	23.4 (1.2)	4.5 (1.7)	70.3 (6.2)
Density (stems/m <sup>2</sup> )	April	22.9 (0.5)	1.9 (2.3)	100.9 (10.8)	27.0 (2.5)	13.4 (1.9)	65.4 (10.5)
•	June	16.8 (1.3)	4.5 (1.6)	59.2 (8.6)	21.2 (2.3)	14.5 (3.2)	32.4 (15.7)
	August	21.1 (1.1)	3.6 (1.3)	83.8 (7.2)	16.5 (1.6)	11.3 (1.4)	24.8 (8.8)
	October	25.6 (0.2)	0.6 (4.3)	119.9 (20.9)	28.4 (2.2)	11.9 (2.9)	79.0 (11.3)
	December	21.3 (0.2)	0.5 (2.4)	100.0 (11.4)	22.4 (1.4)	5.5 (3.4)	81.3 (12.6)
Height (cm)	April	111.8 (7.2)	25.4 (7.8)	48.7 (5.8)	111.3 (16.1)	100.1 (7.0)	6.3 (7.5)
0 ( )	June	116.2 (8.7)	43.3 (5.0)	41.1 (6.7)	113.6 (12.1)	99.1 (7.4)	8.2 (6.3)
	August	134.1 (6.9)	32.0 (7.9)	57.6 (6.3)	126.5 (15.1)	109.6 (8.2)	9.5 (7.5)

*Table 2.* Average pre- and posttreatment values and percentage control values of Chinese privet cover, density, and height (standard errors in parentheses) for various application timings of glyphosate and triclopyr (study 1). Averages have been computed across all application rates. Figure 1 provides a graphical representation of privet control vs. application timing.

<sup>a</sup> Privet control was calculated by subtracting posttreatment values from respective pretreatment values and expressing this difference as a percentage of the mean posttreatment value for the nontreated check plots (26.8%, 20.8 stems/m<sup>2</sup>, and 177 cm for cover, density, and height, respectively).

69.8 (5.3) 72.7 (5.7)

8.3 (9.0)

9.6 (10.0)

132.0 (2.6)

138.5 (4.4)

tial covariates in the response surface models. Proc RSREG was used to test model lack of fit and the overall significance of the application rate, timing, and formulation variables (SAS 1999b). Scatter plots of the residuals from each regression against predicted values indicated that the residual variances were relatively homogenous and that transformations of the dependent variables were not necessary. Other expressions of woody plant response to herbicide treatments (absolute abundance and height and the proportionate change estimators of Knowe et al. [1990]) were tested for privet and rejected because they did not provide homogeneous distributions of the residuals. The following is the full-regression model tested for study 1:

October

December

$$Y = B_0 + B_1(Y_i) + B_2(BA) + B_3(t) + B_4(r_2) + B_5(r_3)$$
  
+  $B_6(r_4) + B_7(H) + B_8(A) + B_9(M) + B_{10}(A^2)$   
+  $B_{11}(M^2) + B_{12}(H)(A) + B_{13}(H)(M) + B_{14}(A)(M)$   
[1]

where *Y* is the percentage control of privet cover, density, or height;  $B_0$  to  $B_{14}$  are regression coefficients to be estimated;  $Y_i$  is pretreatment cover, density, or height; *BA* is overstory stand basal area (m<sup>2</sup>/ha); *t* is the time interval (days) between pre- and posttreatment measurements;  $r_2$  to  $r_4$  are indicator variables specified to represent blocks 2, 3, and 4, respectively (Sokal and Rohlf 1981); *H* is an indicator variable specified to represent herbicide (H = 1 if glyphosate, and H = 0 if triclopyr); *A* is herbicide rate (kg ae/ha); and *M* is application timing specified as a numerical designation of month (i.e., 4, 6, 8, 10, or 12).

73.3 (10.7)

45.8 (8.8)

35.5 (8.9)

42.9 (5.8)

136.2 (12.5)

121.9 (9.9)

The following is the full regression model tested for study 2:

$$Y = C_0 + C_1(Y_i) + C_2(BA) + C_3(r_2) + C_4(r_3) + C_5(r_4)$$
  
+  $C_6(H) + C_7(F) + C_8(A) + C_9(A^2) + C_{10}(H)(F)$ 

+ 
$$C_{11}(H)(A)$$
 +  $C_{12}(F)(A)$  [2]

where *Y*, *Y<sub>i</sub>*, *BA*, *r*<sub>2</sub> to *r*<sub>4</sub>, *H*, and *A* are as described above for model [1]; *C*<sub>0</sub> to *C*<sub>12</sub> are regression coefficients to be estimated; and *F* is an indicator variable specified to represent the alternative formulation for either glyphosate (*F* = 1 if glypohosate dry formulation, and *F* = 0 if glyphosate liquid formulation) or triclopyr (*F* = 1 if in oil, and *F* = 0 if in water).

The following is the full regression model tested for study 3:

$$Y = D_0 + D_1(Y_i) + D_2(BA) + D_3(A) + D_4(T) + D_5(A)(T) + D_6(A^2)$$
[3]

where *Y*, *Y<sub>i</sub>*, *BA*, and *A* are as described above for model [1];  $D_0$  to  $D_6$  are regression coefficients to be estimated; and *T* is an indicator variable specified to represent presence (T = 1) or absence (T = 0) of trenching of plot perimeters to isolate privet clumps.

#### **RESULTS AND DISCUSSION**

**General Information.** Pretreatment cover, density, and height of Chinese privet averaged 25%, 22 stems/m<sup>2</sup>, and



*Figure 1.* Average values ( $\pm$  standard error) and response surface predictions (fitted curves) for 2-yr (2000 to 2002) control of Chinese privet (A) cover, (B) density, and (C) height as influenced by application timing of glyphosate and triclopyr (study 1). Numerical values are provided in Table 2. Response models (fitted curves) have been adjusted for mean values of pretreatment cover, density, or height and stand basal area of overstory trees.

124 cm, respectively, across all application rates and timings for study 1. Lack of fit for each of the response surface models was not significant. In each model, pretreatment abundance (i.e., cover or density) or height was a significant variable; however, indicator variables for blocks were not significant. The time interval between pre- and posttreatment measurements also was not a significant variable in the regression models for study 1. Stand basal area of overstory trees was a significant variable in the models for studies 1 and 2. For example, the average overstory basal area of 6.5 m<sup>2</sup>/ha was associated with 4% of additional control of privet cover in study 1. In general, decreases in light intensity and increases in humidity have been associated with increased glyphosate absorption for a variety of herbaceous species (Hess 1987). A similar response may have occurred for privet growing in the shade and elevated humidity of the forest understory.

**Study 1: Comparison of Herbicide Application Rates** and Timings. Herbicide rate did not have a statistically detectable effect on control of Chinese privet. Control of privet cover (averaged across rates) after spring (April) and fall (October and December) applications averaged 93 to 100% and 49 to 70% for glyphosate and triclopyr, respectively (Table 2). However, control was substantially less after summer (June and August) applications (averages of 67 to 69% and 14 to 26% control for glyphosate and triclopyr, respectively). Droughty conditions that preceded the June and August timings may have limited herbicide efficacy; however, drought is common during this period. Severe moisture stress limited absorption and translocation of glyphosate in several common herbaceous (Lauridson et al. 1983; Moosavi-Nia and Dore 1979) and woody species (D'Anieri et al. 1990). Severe moisture stress also limited translocation of triclopyr to stems and roots of water oak and southern red oak (Quercus falcata Michx.) (Seiler et al. 1993) and red maple (Bollig et al. 1995). In addition, late spring and summer are the periods when shoot growth (Stromayer et al. 1998) and flowering (Miller 2003) are most active for Chinese privet and translocation of photosynthates is likely to be primarily upward and therefore less able to transport herbicides to the roots.

The relationships for control of privet cover and density to application timing had similar curvilinear shapes (Figures 1A and 1B). Regression models explained 66 to 75% of the total variation in these variables, and they included the quadratic term for application timing listed in model [1],  $M^2$  (Table 3). The regression coefficient for the *H* parameter in model [1] indicated that control of cover and density was 42 to 44 percentage points greater after glyphosate than after triclopyr. The parallel nature of the relationships for glyphosate and triclopyr suggests that similar factors of plant physiology (e.g., plant water stress) were operating to limit efficacy of the two herbicides during summer.

Japanese privet (Ligustrum japonicum Thunb.), a Li-

	Independent variables <sup>b</sup>	Regression coefficients	Fit statistics <sup>a</sup>			
Dependent variable			$R^2$	$\Delta R^2$	$S_{y \cdot x}$	n
Cover (% control)	$B_0$	9.21	0.655		30.1	160
	$Y_i$	3.05		0.386		
	BA	0.686		0.020		
	Н	43.6		0.189		
	M	-17.6		0.031		
	$M^2$	1.29		0.029		
Density (% control)	$B_0$	-6.27	0.754		28.1	160
<b>,</b>	Y,	3.94		0.564		
	BA	0.570		0.013		
	Н	41.7		0.140		
	M	-12.9		0.023		
	$M^2$	0.994		0.014		
Height (% control)	$B_0$	-39.5	0.592		22.6	160
	Y,	0.326		0.229		
	BA	0.711		0.029		
	Н	35.3		0.252		
	$M^2$	0.223		0.082		

*Table 3.* Regression coefficients and fit statistics from study 1 response surface analyses for 2-yr (2000–2002) control of Chinese privet cover, density, and height after various application timings and rates of glyphosate and triclopyr. Coefficients in each model were significant at  $P \leq 0.05$ . Models are illustrated graphically in Figure 1.

<sup>a</sup>  $R^2$  is the coefficient of determination,  $\Delta R^2$  is the proportion of total variation in the dependent variable explained by a given independent variable,  $s_{y,x}$  is the standard error of estimate, and *n* is the sample size.

<sup>b</sup>  $B_0$  is the regression intercept,  $Y_i$  is pretreatment cover (%), density (stems/m<sup>2</sup>), or height (cm), *BA* is stand basal area of overstory trees (m<sup>2</sup>/ha), *H* is an indicator variable for herbicide (H = 1 if glyphosate and H = 0 if triclopyr), and *M* is application timing (numerical designation of month).

gustrum species having greater stature and waxier leaves than Chinese privet, was most sensitive to glyphosate when laboratory applications were made at budbreak, when absorption and transport of the herbicide was greatest (Neal et al. 1985). In general, incomplete development or relative absence of the waxy cuticle on a leaf surface will enable greater absorption of water-soluble herbicides (Hess 1987). In this experiment, perhaps the less waxy leaves of Chinese privet, compared with Japanese privet, and the downward translocation of photosynthates resulted in greater glyphosate susceptibility in the fall as found for deciduous fruit trees (Putnam 1976; Weller and Skroch 1983).

The relationship between control of privet height and application timing (Figure 1C) was not as curvilinear as that observed for control of cover and density (Figures 1A and 1B). Instead, control of height increased in a relatively linear fashion as application timing varied from April to December. The response surface model explained 59% of the total variation in control of height, and it included a quadratic term for application timing (Table 3). The regression coefficient for the *H* parameter in model [1] indicated that control of height averaged 35 percentage points greater after glyphosate than after triclopyr.

**Response to Manual Uprooting.** Manual uprooting of Chinese privet in June resulted in 57, 56, and 38% control of cover, density, and height, respectively. These lev-

els of privet control were similar to the average of those reported for the triclopyr treatments (Table 2). Privet regrowth originated primarily from root sprouts. The average time required for one person to conduct manual uprooting of privet was 14 min/m<sup>2</sup>. Small seedlings were relatively easy to uproot by hand, whereas the larger clumps had to be uprooted with the leverage provided by a winch puller. Clearly, the size of privet plants and the depth of their rooting greatly affected the production rate of this treatment.

**Study 2: Comparison of Herbicide Formulations and** Rates. Control of cover, density, and height of Chinese privet did not differ significantly between the two formulations of glyphosate (liquid formulation vs. dry formulation) or triclopyr (water soluble vs. oil soluble) when applied in August (Figure 2). As found in study 1, rate did not have a significant influence on privet control in study 2. The regression coefficient for the H parameter in model [2] indicated that control of privet cover, density, and height averaged 41 to 51 percentage points greater after glyphosate than after triclopyr treatments. Because study 2 was conducted only in August, when droughty conditions may have limited herbicide uptake and translocation, this comparison of herbicide formulations cannot identify whether differences would exist for other application timings.

Study 3: Susceptibility of Isolated vs. Stand-Grown Privet to Glyphosate. Average control of privet cover



*Figure 2*. Average values ( $\pm$  standard error) for 2-yr (2000 to 2002) control of Chinese privet (A) cover, (B) density, and (C) height as influenced by application rate and formulation of glyphosate and triclopyr applied in August (study 2). Herbicide rate and formulation had no statistically detectable effects on privet control (P > 0.05).

increased from 12 to 65% as glyphosate rate increased from 0 to 0.8 kg ae/ha (Figure 3). Similar responses were observed for control of density and height ( $R^2 = 0.56$  to 0.91; data not shown). Although control from glyphosate averaged much greater for isolated (trenched) (91%) than for stand-grown privet (36%), differences were not statistically significant because of high variability among



*Figure 3.* Average values ( $\pm$  standard error) for 2-yr (2000 to 2002) control of Chinese privet cover as influenced by glyphosate rate and presence vs. absence of trenching of plot perimeters to isolate privet clumps (study 3). Trenching did not have a statistically detectable effect on privet control (P > 0.05). The response model (fitted lines) has been adjusted for mean pretreatment cover.

plots. However, results from study 3 indicate that glyphosate rates less than 1.7 kg ae/ha provided a significant degree of privet control, and this may explain the observed absence of herbicide rate effects in studies 1 and 2. In study 3, privet was susceptible to glyphosate rates lower than those tested in studies 1 and 2, even in August when control was lowest. Therefore, each of the glyphosate rates tested in studies 1 and 2 probably exceeded the dose needed to provide the maximum control possible for a given application timing.<sup>7</sup>

#### ACKNOWLEDGMENTS

This research was funded by the Georgia Department of Transportation, Atlanta, GA. We are grateful to J. Gatch, M. Murphy, G. Ahuja, and D. Marshall for assistance with plot establishment, treatment application, and vegetation measurements. We are also thankful to L. Priestley for logistical support and to E. Cole, S. Knowe, and S. Zedaker for manuscript reviews. In addition, we thank Dow AgroSciences LLC and the Monsanto Com-

<sup>&</sup>lt;sup>7</sup> USDA/Forest Service Disclaimers: The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service. This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate state or federal agencies, or both, before they can be recommended. CAUTION: Pesticides can be injurious to humans, domestic and wild animals, and desirable plants if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

pany for providing technical advice and donating herbicides.

#### LITERATURE CITED

- Bollig, J. J., J. R. Seiler, S. M. Zedaker, J. W. Thompson, and D. Lucero. 1995. Effect of plant moisture stress and application surface on uptake and translocation of triclopyr with organosilicone surfactant in red maple seedlings. Can. J. For. Res. 25:425–429.
- Borders, B. E. and B. D. Shiver. 1989. Herbicide field studies in forestry: statistical and other considerations. Can. J. For. Res. 19:768–772.
- Brown, C. E. and S. R. Pezeshki. 2000. A study on waterlogging as a potential tool to control *Ligustrum sinense* populations in western Tennessee. Wetlands 20:429–437.
- Burrows, F. J. and J. Kohen. 1986. Inhibition of germination of privet. Plant Prot. Q. 1:107–108.
- D'Anieri, P., S. M. Zedaker, J. R. Seiler, and R. E. Kreh. 1990. Glyphosate translocation and efficacy relationships in red maple, sweetgum, and loblolly pine seedlings. For. Sci. 36:438–447.
- Dirr, M. A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation, and Uses. 5th ed. Champaign, IL: Stipes. P. 563.
- Georgia Exotic Pest Plant Council. 2003. Top Ten Exotic Pest Plants in Georgia: Web page: www.gaeppc.org. Accessed: January 12, 2004.
- Haragan, P. D. 1996. Privet (*Ligustrum vulgare, L. sinense, L. japonicum*). In J. M. Randall and J. Marinelli, eds. Invasive Plants: Weeds of the Global Garden. Brooklyn, NY: Brooklyn Botanic Garden. Pp. 58–59.
- Hess, F. D. 1987. Relationship of plant morphology to herbicide application and absorption. *In* C. G. McWhorter and M. R. Gephardt, eds. Methods of Applying Herbicides. Monograph 4. Champaign, IL: Weed Science Society of America. Pp. 19–35.
- James, T. K. and J. Mortimer. 1984. Control of privet. Proceedings of New Zealand Weed and Pest Control Conference 37:206–209.
- Knowe, S. A., E. C. Cole, and M. Newton. 1995. Response surface analysis of control of red alder and vine maple with glyphosate-imazapyr and triclopyr-imazapyr. West. J. Appl. For. 10:127–132.
- Knowe, S. A., B. D. Shiver, and B. E. Borders. 1990. Evaluation of four estimators of herbicide treatment efficacy for woody competition control studies. For. Sci. 36:201–211.
- Lauridson, T. C., R. G. Wilson, and L. C. Haderlie. 1983. Effect of moisture stress on Canada thistle (*Cirsium arvense*) control. Weed Sci. 31:674– 680.
- Little, C. 1982. How to control privet. N. Z. J. Agric. 145:15.
- Matlack, G. R. 2002. Exotic plant species in Mississippi, USA: critical issues in management and research. Nat. Areas J. 22:241–247.
- Miller, J. H. 1998. Primary screening of forestry herbicides for control of Chinese privet (*Ligustrum sinense*), Chinese wisteria (*Wisteria sinensis*), and trumpetcreeper (*Campsis radicans*). Proc. South. Weed Sci. Soc. 51: 161–162.
- Miller, J. H. 2003. Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. Gen. Tech. Rep. SRS-62. Asheville,

NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Pp. 20–21.

- Miller, J. H. and K. V. Miller. 1999. Forest Plants of the Southeast and Their Wildlife Uses. Champaign, IL: Southern Weed Science Society. P. 360.
- Moosavi-Nia, H. and J. Dore. 1979. Factors affecting glyphosate activity in *Imperata cylindrica* (L.) Beauv. and *Cyperus rotundus* L. I. Effect of soil moisture. Weed Res. 19:137–143.
- Mowatt, J. 1981. Control of large-leaved privet (*Ligustrum lucidum*) and small-leaved privet (*L. sinense*) in urban bushland. Proceedings of the Sixth Australian Weeds Conference 1:165–168.
- Neal, J. C., W. A. Skroch, and T. J. Monaco. 1985. Effects of plant growth stage on glyphosate absorption and transport in Ligustrum (*Ligustrum japonicum*) and blue Pacific juniper (*Juniperus conferta*). Weed Sci. 34: 115–121.
- Newton, M. and F. B. Knight. 1981. Handbook of Weed and Insect Control Chemicals for Forest Resource Managers. Beaverton, OR: Timber. P. 67.
- Petersen, R. G. 1985. Design and Analysis of Experiments. New York: Marcel Dekker. Pp. 252–301.
- Putnam, A. R. 1976. Fate of glyphosate in deciduous fruit trees. Weed Sci. 24:425–430.
- Rudis, V. A. and D. M. Jacobs. 2002. Selected noxious non-native plants species invading forests of the eastern United States. *In* The 7th Annual Janet Meakin Poor Research Symposium: Invasive Plants—Global Issues, Local Challenges. Glencoe, IL: Chicago Botanic Garden. Pp. 15– 16.
- [SAS] Statistical Analysis Systems. 1999a. SAS/STAT User's Guide. Version 8. Cary, NC: Statistical Analysis Systems Institute. Pp. 2875–2907, 3031–3043.
- [SAS] Statistical Analysis Systems. 1999b. SAS Procedures Guide. Version 8. Cary, NC: Statistical Analysis Systems Institute. Pp. 624–633.
- Seiler, J. R., B. H. Cazell, W. G. Schneider, S. M. Zedaker, and R. E. Kreh. 1993. Effect of plant moisture stress on absorption and translocation of triclopyr in oak seedlings. Can. J. For. Res. 23:2213–2215.
- Sokal, R. R. and J. F. Rohlf. 1981. Biometry. 2nd ed. San Francisco, CA: W. H. Freeman. Pp. 499–509.
- Stromayer, K.A.K., R. J. Warren, and T. B. Harrington. 1998. Managing Chinese privet for white-tailed deer. South. J. Appl. For. 22:227–230.
- [USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2003a. PLANTS National Database: Web page: http://plants.usda.gov/. Accessed: January 12, 2004.
- [USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2003b. Plant distribution, *Ligustrum sinense*, Chinese Privet: Web page: http://www.nationalatlas.gov/wdligum.html. Accessed: January 12, 2004.
- [USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2003c. Official Descriptions for Madison and Louisa Soil Series: Web page: http://ortho.ftw.nrcs.usda.gov/osd/ osd.html. Accessed: January 12, 2004.
- Weller, S. C. and W. A. Skroch. 1983. Toxicity of glyphosate to peach trees as influenced by application timing. Hortic. Sci. 18:940–941.
- [WSSA] Weed Science Society of America. 1994. Herbicide Handbook. 7th ed. Champaign, IL: Weed Science Society of America. Pp. 149–152, 292–294.
- Young, J. A. and C. G. Young. 1992. Seeds of Woody Plants in North America. Portland, OR: Dioscorides. Pp. 204–205.

# White Mulberry

Moras alba L.

#### **Other Common Names:**

Common mulberry

#### **Brief Description:**

White mulberry globally is used for silk production. In the United States it can be found as a cultivated ornamental species and as planting in windbreaks. Its fruit is edible and slightly more insipid than the other mulberry species. This plant is credited with the fastest plant movement of all other plants. Pollen is released from the plant at half the speed of sound. Altogether though, white mulberry should be considered an unwanted exotic plant because of its propensity to spread. It possesses a poisonous white milky sap.

#### Habitat:

White mulberry has naturalized in the urban interface across much of eastern North America. It occurs in every state except Arizona and Nevada. Originally it was introduced from northern China, but is now found cultivated across the globe. It is somewhat drought and wind hardy which has led to its use in shelterbelt plantings. Typically they like full sun and deep well drained loamy soils. White mulberry can tolerate extended flooding and clay alkaline soils. It can be found growing in shrub and tree forms.

#### Life History:

White mulberry flowers from May to June. Its fruit is ripe soon afterwards and seeds are disseminated by birds and other animals. It exhibits fast growth and readily inhabits fencerows and invades fields in some areas. It can sprout readily. Overall it is a short plant though. White mulberry also hybridizes with red mulberry. It can be distinguished from red mulberry by its smaller, thinner, shinier leaves; its bark is more orange and yellow; and its fruit is typically white or pink.

#### White mulberry and the Great Trinity Forest:

This species has been reported as invading the forest. A concerted effort needs to be made to remove all invasive species. Injection, basal bark, and foliar applications of herbicides are the most effective means of control due to its sprouting nature. There will be considerable difficulty in distinguishing between this tree and its relative, the native red mulberry.





## White Mulberry Morus alba

Common Names: Common mulberry, white mulberry

**Native Origin**: *Morus alba* was introduced during colonial times in an effort to establish a silkworm industry in the United States. It comes from Asia. It was widely cultivated in Europe during the 18<sup>th</sup> and 19<sup>th</sup> centuries for silkworms. It is still cultivated in China, India, Bangladesh and Pakistan.

**Description**: A deciduous shrub or tree, 30 to 50 feet in height and approximately 1.5 feet in diameter. It has low branches and a wide spreading crown. Bark is orange-brown with lenticels when young, becoming gray with long narrow irregular ridges. Glossy green leaves that turn yellow in autumn are 3 to 6 inches long, alternate, stipulate, and variable in shape. Unisex flowers are small, greenish-yellow, with dense spikes. The blackberry-like aggregate fruits, 1 to 1 1/4 inch long, turn from green to white to red to black as they ripen, May to August.

**Habitat:** White mulberry occurs naturally in sparse forests on hillsides at a wide range of elevations. It grows in part shade to full sun. It can grow in clay, loam, sand, acidic, alkaline, and well-drained soils. It tolerates extended flooding or droughty conditions.

Distribution: The seeds are spread by wildlife that feed on the



fruits. It expands locally by producing new plants from its roots. It occurs throughout the US with exception of Alaska, Arizona and Nevada.





**Ecological Impacts**: Impacts include hybridization with and replacement of native mulberry. It transmits a harmful root disease to red mulberry and invades natural areas including fields, forest edges and roadsides.

#### **Control and Management:**

- Manual- Hand pull seedlings, cut trees, grind stumps, girdle large trees
- Chemical- Paint stumps with glyphosate

Diseases: Leaf spot, bacterial blight, powdery mildew, and cankers may infect this tree.

**Natural Enemies**: Fifty four species of fungi infect white mulberry; approximately 263 arthropods occur on this species

#### References:

http://plants.usda.gov, www.hort.uconn.edu/plants/m/moralb/moralb1.html, www.hort.purdue.edu/newcrop/duke\_energy/Morus\_alba.html, http://hort.ifas.ufl.edu/TREES/MORALBA.pdf, http://www.duke.edu/~cwcook/trees/moal.html, Plant Invaders of Mid-Atlantic Natural Areas, p. 59, Invasive Plants of Asian Origin Established in the United States and their Natural Enemies p. 110

WOW 07-22-05





## WHITE MULBERRY

Morus alba

Other Names | Origin & Distribution | Plant Description | Similar Species | Biology | Toxicity | Facts & Folklore



Family: Mulberry Family (Moraceae)

Other Names: mulberry, Russian mulberry, silkworm mulberry..

**Origin and Distribution:** White mulberry is native to China and has long been cultivated in Europe. The British introduced it to North America prior to the American Revolution in a failed attempt to establish a silkworm industry, since the leaves are the primary food of silkworm caterpillars. Several varieties of this species have been widely planted in North America and have become naturalized. White mulberry is common in the eastern U.S., and is found in over three-fourths of the counties of Ohio, mostly along fencerows of unattended areas and in other open rural and urban habitats. It is not tolerant of shade and rarely grows in forested sites. But it is relatively tolerant of drought, salt, pollution and poor soils. This species is increasingly found in no-till corn or soybean fields where it may interfere with harvest.

**Plant Description:** White mulberry is a small- to medium-sized, fast-growing, deciduous tree with a short, thick trunk that branches into numerous limbs to form a bushy, spreading crown. Several varieties exist, and they may have erect or weeping branches. This species is characterized by its furrowed orangish-brown bark, slender light orange twigs, shiny variously-lobed leaves and white to pink to purple berry-like fruit. In field crops, young trees are cut off annually by harvesting equipment and sprout new branches each spring, resulting in a highly branched shrub with a large trunk close to the ground. Twigs and leaves exude a milky juice (latex). The wood is light, soft and coarse-grained. White mulberry reproduces by seeds

- Root system White mulberry produces wide-spreading, aggressive roots that are known to clog drains.
- Stems The trunk is short, thick (8 to 16 inches in diameter, sometimes up to 5 feet) and multi-branched, resulting in a full, spreading crown. Central stems can grow 20 to 50 feet tall (sometimes up to 80 feet), but as a weed of roadsides and crop fields, it seldom grows over 15 feet tall. The bark is gray at first, turning an orangish- or yellowish-brown, with shallow furrows or ridges and an orange inner layer that is visible through the furrows. Secondary branches are generally slender and, depending on the variety, may be upright or hang casually toward the ground. Twigs are slender, erect and initially slightly hairy and reddish-brown, becoming smooth and light orange. Several shoots are produced from one node, giving the crown a branchy appearance.
- Leaves The thin, bright, light green leaves are alternate, broadly oval and 2 to 4 inches long, with toothed margins (triangular teeth). The upper surface is smooth and shiny. The lower leaf surface is pale green and generally smooth, with hairs only along the main veins. Leaves can be unlobed (common on older trees) or have 2 to 5 unequal lobes (common on young trees and sprouts from older trees). The petiole (leaf stalk) is smooth.
- *Flowers* Clusters of small petalless flowers are borne in a dense hanging spike. Male and female flowers are usually produced on separate plants (dioecious), but sometimes are produced on the same plant (monoecious). The male flower cluster is narrow and somewhat elongated and the female flower cluster is more oval.
- Fruits & Seeds The berry-like 'fruit' is a tight, elongated cluster of white to pink (sometimes violet) smaller fruits. There are several horticultural varieties, some with dark fruit.

**Similar Species:** Red mulberry (*Morus rubra*) is a larger native version of its cousin, growing to heights of 50 to 70 feet with trunk diameters of 2 to 3 feet. It produces a light soft wood and rough brown bark. The red mulberry is indigenous to the eastern United States, and grows best in rich, river bottom woods and floodplains. Red mulberry is distinguished from white mulberry by the following: its leaves are larger, thicker, less shiny and have a downy lower surface; the bark and twigs are less orange or yellow; the fruits are longer and red to blackish but never white or pink; and it occurs in more natural, shaded habitats such as floodplain forests.

**Biology:** White mulberry flowers from April to June. Flowers are wind-pollinated. The fruits are very attractive to birds and mammals, which are probably responsible for its spread along fencerows and in fields. The plant has strong rooting ability and cut stems buried in soil are able to regenerate.

White mulberry is a fast-growing, short-lived plant that is becoming a problem in no-till fields. Once established, the roots will continue to produce sprouts even if the plant is cut back every year. White mulberry hybridizes with other *Morus* species through cross-pollination. This has raised concerns for the native red mulberry, because 'genetic swamping' could eliminate the native species.

**Toxicity:** All parts of white mulberry, except for the ripe fruit, contain a milky sap (latex) that is toxic to humans. Although humans may consume ripe mulberry fruit, ingestion of unripe fruit can result in stomach upset, stimulation of the nervous system and hallucinations. The sap is also an irritant, and contact with leaves and stems may result in varying degrees of skin irritation. White mulberry pollen is highly allergenic and contributes to hayfever.

#### Facts and Folklore:

- The genus name, *Morus*, is Latin for 'delay', referring to the formation of winter buds late in the season after the weather has turned cold. The species name, *alba*, means 'white', referring to the whitish color of the buds.
- The silkworm is thought to prefer mulberries over all other plants due to a unique fragrance given off by the mulberry and to special organs in the caterpillar that respond to the taste of mulberry leaves. Silk proteins (fibroin and sericin) are derived only from mulberry leaves.
- White mulberry fruits vary greatly in sweetness, some being very sweet and others dry and tasteless. They lack the tartness of other mulberry species.
# MULBERRY

Morus spp.

Moraceae

Common Names: Mulberry.

**Species:** White Mulberry (*Morus alba* L.), Black Mulberry (*M. nigra* L.), American Mulberry, Red Mulberry (*M. rubra* L.). Hybrid forms exist between *Morus alba* and *M. rubra*.

**Related Species:** Korean Mulberry (*Morus australis*), Himalayan Mulberry (*M. laevigata*).



**Distant Affinity:** Breadfruit (*Artocarpus altilis*), <u>Jackfruit</u> (*A. heterophyllus*), <u>Fig</u> (*Ficus* spp.), Che (*Cudrania tricuspidata*), African Breadfruit (*Treculia african*).

**Origin:** The white mulberry is native to eastern and central China. It became naturalized in Europe centuries ago. The tree was introduced into America for silkworm culture in early colonial times and naturalized and hybridized with the native red mulberry. The red or American mulberry is native to eastern United States from Massachusetts to Kansas and down to the Gulf coast. The black mulberry is native to western Asia and has been grown for its fruits in Europe since before Roman times.

**Adaptation:** The white mulberry, and to a lesser extent the red mulberry, are quite tolerant of drought, pollution and poor soil. The white mulberry is considered a weed tree in many parts of the country including urban areas. The black mulberry is more fastidious, faring less well in cold climates or areas with humid summers. The white mulberry is the most cold-hardy of the three species, although this varies from one clone to another. Some are damaged at 25° F, while others are unfazed at -25° F. Red mulberries are hardy to sub-zero temperatures. The black mulberry is the least cold-hardy of the three, although again cold tolerance seems to depend on the clone. In general it is limited to USDA Hardiness Zone 7 (0° to 10° F average minimum) or warmer. They have been planted only to a limited extent in America, mostly on the Pacific Coast. The mulberry makes a good town tree which will grow well in a tub.

# DESCRIPTION

Growth Habit: All three mulberry species are deciduous trees of varying sizes. White Page 250 of 416

mulberries can grow to 80 ft. and are the most variable in form, including drooping and pyramidal shapes. In the South on rich soils the red mulberry can reach 70 ft. in height. The black mulberry is the smallest of the three, sometimes growing to 30 ft. in height, but it tends to be a bush if not trained when it is young. The species vary greatly in longevity. Red mulberry trees rarely live more than 75 years, while black mulberries have been known to bear fruit for hundreds of years. The mulberry makes an attractive tree which will bear fruit while still small and young.

**Foliage:** The white mulberry is so-named for the color of its buds, rather than the color of its fruit. The thin, glossy, light green leaves are variously lobed even on the same plant. Some are unlobed while others are glove-shaped. Leaves of the red mulberry are larger and thicker, blunt toothed and often lobed. They are rough on their upper surfaces and pubescent underneath. The smaller black mulberry leaves are similar to those of the red mulberry, but with sturdier twigs and fatter buds. The species vary in the time of year they begin to leaf-out. White mulberries generally come out in early spring, almost two months before black mulberries.

**Flowers:** Mulberry trees are either dioecious or monoecious, and sometimes will change from one sex to another. The flowers are held on short, green, pendulous, nondescript catkins that appear in the axils of the current season's growth and on spurs on older wood. They are wind pollinated and some cultivars will set fruit without any pollination. Cross-pollination is not necessary. In California mulberries set fruit without pollination.

**Fruit:** Botanically the fruit is not a berry but a collective fruit, in appearance like a swollen loganberry. When the flowers are pollinated, they and their fleshy bases begin to swell. Ultimately they become completely altered in texture and color, becoming succulent, fat and full of juice. In appearance, each tiny swollen flower roughly resembles the individual drupe of a blackberry. The color of the fruit does not identify the mulberry species. White mulberries, for example, can produce white, lavender or black fruit. White mulberry fruits are generally very sweet but often lacking in needed tartness. Red mulberry fruits are usually deep red, almost black, and in the best clones have a flavor that almost equals that of the black mulberry. Black mulberry fruits are large and juicy, with a good balance of sweetness and tartness that makes them the best flavored species of mulberry. The refreshing tart taste is in some ways reminiscent of grapefruit. Mulberries ripen over an extended period of time unlike many other fruits which seem to come all at once.

# CULTURE

**Location:** Mulberries need full sun and also adequate space. The distance between trees should be at least 15 ft. The trees should not be planted near a sidewalk. The fallen fruit will not only stain the walkway, but are likely to be tracked indoors. The trees are quite wind-resistant with some cultivars used as windbreaks in the Great Plains region.

**Soil:** Mulberries like a warm, well-drained soil, preferably a deep loam. Shallow soils such as those frequently found on chalk or gravel are not recommended.

**Irrigation:** Although somewhat drought-resistant, mulberries need to be watered in dry seasons. If the roots become too dry during drought, the fruit is likely to drop before it has fully ripened.

**Fertilization:** Mulberries generally thrive with minimal fertilization. An annual application of a balanced fertilizer such as 10:10:10 NPK will maintain satisfactory growth. In California mulberries usually need only nitrogen.

**Pruning:** No special pruning techniques are needed after the branches have been trained to a sturdy framework, except to remove dead or overcrowded wood. A mulberry tree can be kept to a tidy form by developing a set of main branches, and then pruning laterals to 6 leaves in July in order to develop spurs near the main branches. It is not advisable to prune the trees heavily since the plant is inclined to bleed at the cuts. Cuts of more than two inches in diameter generally do not heal and should be avoided at all cost. The bleeding will be less severe if the tree is pruned while it is dormant.

**Propagation:** Mulberries can be grown from seed, although the plants can take 10 years or more to bear. Seed should be sown as soon as extracted from the fruit, although white mulberry seeds germinate better after stratifying one to three months before planting.

Sprig budding is the most common method for grafting mulberries. A T-cut is made in the rootstock and a smooth, sloping cut is made on the lower end of the scion. The scion is then inserted into the T and wrapped and sealed. Other types of grafts are also usually successful, although there may be incompatibility between white and black mulberries. Hardwood, softwood and root cuttings also are suitable methods for propagating mulberries. Softwood cuttings of white mulberries root easily when taken in midsummer and treated with rooting hormone. Red mulberries are less easily rooted. Black mulberries are also somewhat difficult to propagate since they tend to bleed a lot.

**Pests and Diseases:** Mulberries are generally free of pests and diseases, although cankers and dieback can occur. In some areas "popcorn disease" is an occasional problem, in which fruits swell to resemble popped corn. *M. alba/M. rubra* hybrids are particularly prone to this condition. The disease carries on from one season to the next, so collecting and burning infected fruits help control it. The ripe fruit is very attractive to birds, but there is usually enough fruit left over for harvesting.

**Harvest:** White and red mulberry fruits (and hybrid fruits) are ready for harvest in late spring. The fruit of black mulberries ripen in summer to late summer. The fruits of white mulberries

are often harvested by spreading a sheet on the ground and shaking the limbs. A surprising quantity can be gathered from a comparatively small and young tree. Black mulberry fruits are more difficult to pick. As the berries are squeezed to pull them loose, they tend to collapse, staining the hands (and clothing) with blood red juice. Unwashed the berries will keep several days in a refrigerator in a covered container. The ripe fruits of the black mulberry contain about 9% sugar with malic and citric acid. The berries can be eaten out of hand or used in any way that other berries are used, such as in pies, tarts, puddings or sweetened and pureed as a sauce. Slightly unripe fruits are best for making pies and tarts. Mulberries blend well with other fruits, especially pears and apples. They can also be made into wine and make an excellent dried fruit, especially the black varieties.

# CULTIVARS

# Black Persian

*M. nigra.* Large black fruit, over an inch long and almost as wide. Juicy with a rich, subacid flavor. The tree is fairly drought-resistant once established.

## Collier

*M. alba* X *M. rubra.* Medium-sized, purplish-black fruit, 1-1/8 inches long and 3/8 inch in diameter. Flavor sweet, with just a trace of tartness. Quality very good, on par with Illinois Everbearing. Ripens over a long period. Tree of medium size, spreading , relatively hardy, very productive.

## Downing

The original Downing was a *M. alba* var. *multicaulis* plant grown fromseed sown about 1846. The fruit was black with excellent flavor and ripened from June to September. Other varieties have subsequently been sold under the same name.

## **Illinois Everbearing**

*M. alba* X *M. rubra.* Originated in White County, Illinois. Introduced in 1958. Black, nearly seedless fruit large and very long, averaging 12 per ounce. Flavor good to very good, very sweet, considered best by by many. Matures over along season. Tree vigorous and somewhat dwarfed, extremely hardy and productive.

## Kaester

*M. nigra.* Originated in Los Angeles. Introduced in 1971 by Nelson Westree. Large black or deep purple, elongated fruit, 1-1/2 inches long and 1/2 inch in diameter. Flavor very sweet, with good sweet/tart balance. Tree bears heavily.

## Pakistan

Originated in Islamabad, Pakistan. Extremely large ruby-red fruit 2-1/2 to 3-1/2 inches long and 3/8 inch in diameter. Flesh firmer than most other named cultivars. Sweet with a fine balance of flavors. Quality excellent. Tree spreading with large heart-shaped leaves. Recommended for the deep South and mild winter areas such as southern California, but usually performs satisfactorily in cooler areas.

## Riviera

Originated in Vista, Calif. Elongated, deep purple-black fruits, 1 to 1-1/2 inches in

length, 1/2 inch in diameter. Flesh slightly juicy and very sweet. Very good dessert quality. Ripens over a long period, from April to June.

## Russian (Tatarica)

Introduced into Europe from China about 1,500 years ago. Fruit reddish-black, of good quality when completely ripe. Tree bushy, to 35 ft. tall, very hardy and drought resistant. Planted widely for windbreaks and wildlife food.

## Shangri-La

Originated in Naples, Fla. Large, black fruit. Good mulberry for the Deep South and other areas. Hardy in U.S.D.A. Zones 7-9. Tree has very large, heart-shaped leaves.

# Tehama (Giant White)

Originated in Tehama County, Calif. Very large, white-colored, plump fruit, 2-3/4 inches in length and 1/2 inch wide. Very sweet, succulent, melting flesh. Attractive, large-leaved tree. Probably best adapted to mild winter areas.

## Wellington

Originated in Geneva, N.Y. Reddish-black medium-sized fruit, 1-1/4 inches long, 3/8 inch in diameter. Form long, slender and cylindrical. Flesh soft, of good flavor. Ripens over a period of several weeks. Tree is heavy producer. May be the old cultivar New American, which was also sold many years ago as Downing.

# FURTHER READING

- Everett, T. H., ed. *New Illustrated Encyclopedia of Gardening. vol. 7.* Greystone Press, 1960. p. 1190.
- Facciola, Stephen. *Cornucopia: a Source Book of Edible Plants.* Kampong Publications, 1990. pp. 391-392.
- Johns, Leslie and Violet Stevenson, *Fruit for the Home and Garden*. Angus and Robertson, 1985. pp. 173-176
- Reich, Lee. Uncommon Fruits Worthy of Attention. Addison-Wesley, 1991. pp 173-183.

See <u>Index of CRFG Publications</u>, <u>1969</u> - <u>1989</u> and annual indexes of <u>Fruit Gardener</u> for additional articles on the mulberry.

Here is the list of additional CRFG Fruit Facts.

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# **CHINESE LESPEDEZA** Lespedeza cuneata (Dum. Cours.) G. Don

Plant Symbol = LECU

Contributed by: USDA NRCS Plant Materials Program



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## **Caution: This plant may become highly** invasive. Check for its status in your area.

**Alternate Names** Sericea lespedeza

## Uses

Chinese lespedeza is used for hay, pasture, erosion control, cover crops, and wildlife food and cover.

## Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

## Weediness

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or

# Plant Fact Sheet

agriculture department regarding its status and use. Weed information is also available from the PLANTS Web site at plants.usda.gov.

## Description

Chinese lespedeza has light green stems 3-5 feet tall having few branches. New growth arises from the crown each year. A plant two or three years old may have 20-30 stems. New shoots are succulent and tender until they reach 12 to 18 inches, when they become woody and fibrous. Roots are widely branched and penetrate the soil more than three feet. A high percentage of seeds produced may be hard seed. These seeds, which may comprise 20%-30% of the seed lot need to be scarified to germinate. There are approximately 372,000 seeds per pound of unscarified and 335,000 seeds per pound of the scarified seed.

## **Adaptation and Distribution**

Chinese lespedeza is adapted to the southern portions of Ohio, Pennsylvania, and central New Jersey southward into the southeast states. It is best suited to areas receiving at least 30 inches of rainfall annually. It can survive short periods of subzero temperatures when fully established, but prolonged freezing will contribute to winter kill. It grows best on deep, well-drained, medium to coarse textured soils. Chinese lespedeza is tolerant of low pH(4.5)and infertile soils. Optimum pH range is 6.0-6.5. On some sites it has been very competitive and hindered the re-colonization of native species.

For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

## Establishment

Chinese lespedeza should be seeded in the early spring (two to three weeks before normal corn planting time) in a firm seedbed free of weed pressures. Because stand establishment is slow, it is best seeded with a quick establishing grass such as weeping lovegrass. Seed may be drilled or broadcast. Use 10-12 lbs./ac. if using hulled and scarified seed; 10-15 lbs./ac. if seed is unhulled or unscarified. Inoculate with the appropriate rhizobia.

## Management

Chinese lespedeza responds to regular applications of lime and fertilizer according to soil test

Plant Materials <a href="http://plant-materials.nrcs.usda.gov/">http://plant-materials.nrcs.usda.gov/</a> Plant Fact Sheet/Guide Coordination Page <a href="http://plant-materials.nrcs.usda.gov/intranet/pfs.html">http://plant-materials.nrcs.usda.gov/intranet/pfs.html</a> National Plant Data Center <a href="http://npdc.usda.gov">http://npdc.usda.gov</a>>

recommendations. Since it is a legume, nitrogen is not necessary, however phosphorus and potassium may need to be applied every two to three years. Fertility helps maintain stand density and palatability. Chinese lespedeza may be mowed or grazed frequently if well fertilized. Graze or cut when plants are 12 inches tall. Leave a three inch growth after each harvest. On critical areas, mow at least once every two years if competing vegetation is to be controlled.

# Cultivars, Improved, and Selected Materials (and area of origin)

Commercially available cultivars adapted to the northeast include 'Interstate', 'Serala', 'Caricea', and 'Appalow' (Japan). 'Appalow' is a prostrate form developed at the Quicksand Plant Materials Center in Kentucky.

## Control

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

## Prepared By & Species Coordinator:

USDA NRCS Plant Materials Program

Edited: 05Feb2002 JLK; 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<<u>http://plants.usda.gov</u>> or the Plant Materials Program Web site <<u>http://Plant-Materials.nrcs.usda.gov</u>>

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Fact Sheet –01-87

# ARUNDO DONAX

Giant Reed Invades Southern Nevada Maria Ryan Area Extension Specialist

A giant reed is invading the rivers and streams of Southern Nevada. *Arundo donax,* or Giant Reed, is a tall, perennial reed-like grass (Poaceae family) that is used as a landscaping plant for shade, privacy, and a windbreak. Recently it has been found along riparian areas (areas along rivers and streams) outcompeting the native vegetation, altering the natural physical and biological processes of these riparian ecosystems, and forming pure stands of this invasive plant. *Arundo donax* threatens streams, rivers, and the habitats of animals that use these important areas.

## History



Arundo is a genus of very tall reeds that resemble bamboo. Arundo species are native to tropical, subtropical, and warm temperate climates and *Arundo donax* is probably native to the Indian sub-continent. *Arundo donax*, the tallest of six species, was probably first introduced into the United States in California from Eastern Asia (Fornell 1990.) It has been widely cultivated around the world for centuries for a multitude of purposes, including measuring rods, walking sticks, fishing poles, musical instruments, baskets, mats, roof thatching, paper and recently, in the manufacturing of rayon for garments (Duke 1983.) It easily reproduces and has very high production rates which makes it a very useful plant throughout the year.

Arundo donax has been used as a folk medicine to treat dropsy and various other conditions (Duke and Wain 1981.) It has also been analyzed as a potential energy source because of its tremendous production potential (Duke 1983.) It has little use as livestock forage as its leaves mature quickly and become unpalatable quickly.



Concerns

## Biology

Arundo donax is a tall (6 to 30 feet), perennial reed that grows well in warm climates with wet soils. It reproduces mainly from its branching, knotty, thick rhizomes or roots. It has long (12 to 27 inches), broad, linear leaf blades and has two cultivated varieties that show variegations (striping) or are glaucous (bluish-gray.) Its stems are 3/4" to 1-1/2" wide, smooth and hollow with many nodes. It produces a tall, plume-like flower that is whitish brown or whitish with a purple hue (Hitchcock 1950.) Its seeds are most likely sterile.

What concerns ecologists most about the spread of Arundo donax in Southern Nevada, is that the plant is very competitive and can crowd out native plants in their natural environments. Arundo quickly becomes the dominant plant species in riparian areas, replacing native plant communities of willows, cottonwoods and mesquite (Salix, *Populus, Prosopsis*) (Bell 1997). In a very short time, Arundo forms thick, dense monocultures (stands of only Arundo plants) and has displaced large percentages of the native riparian plant communities in California. For example, Arundo donax was estimated to dominate 68 percent of the riparian vegetation along the Santa Ana River (Douthit 1994). These stands of the Giant Reed have little or no value for wildlife species that are dependent on these riparian areas for protection, feeding, nesting, and burrowing habitat. There are a number of bird species of concern that are negatively affected by Arundo stands because they rely on native plant communities (Frandsen and Jackson 1994). Arundo donax uses large amounts of water causing reduced groundwater availability (Iverson 1994). The upright growth form of Arundo provides little shading and subsequent cooling of the in-stream habitats necessary for many native fish and invertebrate animals.

Arundo has enormous production potential (8000 lbs/ac.). The Giant Reed is highly flammable most of the year and may be adapted to extreme fires (Scott 1994). The high productivity rates and increased flammability throughout the year increases the probability of unseasonable and higher intensity fires. Arundo is adapted to fire in that it sprouts quickly after a fire and leaves little opportunity for the native plants to be established. This sets up the undesirable situation where Arundo outcompetes the native plants, then forms very thick stands of only *Arundo donax* plants (monoculture), decreasing overall biological diversity (Bell 1997).

These thick stands of Arundo that become established are alter the regular flows of the streams and rivers because of its very thick root masses that hold the banks and terraces more so than native plant communities. This inhibits the movement of the water and sediments that naturally move and change in the flood plain area and invertebrates. This decreases the chances for native populations to survive as well as decreases overall biological diversity.



## Control

An integrated approach that considers use and efficacy of mechanical, chemical, and biological control is best when determining timing and methods. It is important to consider the density of the *Arundo donax* plants in a given area as well as the presence or absence of desired native plants. Age of the Arundo and its height are important as well as the terrain and season (Bell 1997).

Since *Arundo donax* can reproduce from pieces of roots and stem nodes, it is important to consider that any mechanical methods of removal might cause more plants to appear with stem and root material that is dropped or left behind. Mechanical removal is an effective way to begin control of

very large, solid stands of Arundo. Harvesting or chopping to remove large vegetation is appropriate if the material will not present a threat of debris-damming downstream and if the material can be removed or burned. Chipping of cut material presents a problem of regrowth from broken stems and roots and is not recommended. Subsequent application of herbicides after the cut material has been removed is most effective after about three to six weeks so the plants have a chance to regrow to about three feet in height.

The most effective herbicide treatment on the market today is Rodeo<sup>®</sup> (glyphosate), as it is the only herbicide that is labeled for use in wetland and aquatic areas. However, this systemic herbicide that translocates to the roots is labeled for control of both monocots (grasses like *Arundo donax*) and dicots (broadleaf plants). Care should be used and the herbicide targeted only at Arundo plants, unless there are other undesirable plants in the area such as Tamarix species. Other herbicides are available that will target grass species, however they are currently not labeled for use in wetland areas.

The most effective treatment using Rodeo<sup>®</sup> is by foliar application of a two-to-five percent (2-5%) solution that is applied after flowering and before dormancy (Monsanto 1989), which is the time when the plants are actively moving nutrients into their roots to prepare for winter. A preliminary trial on the Santa Margarita River in California resulted in an almost 100 percent control (Omori 1996).

Another method is the cut stem treatment that requires mechanical removal of the top portion of the plant followed by herbicide application within one or two minutes of the cutting to ensure adequate uptake of the chemical (Monsanto 1989). This method is most effective after flowering and is highly effective, but is labor intensive and the cut stem pieces that are left behind can regrow.

## Summary

The giant reed *Arundo donax* is a non-native plant to the United States and has invaded many rivers and streams in California and now Southern Nevada. This plant is very aggressive and can easily outcompete the native, more desirable plants that live along these waterways. *Arundo donax* forms dense stands that are highly flammable with roots systems that can change the natural water course and affect the ecological balance of these riparian systems. It spreads quickly through a tremendous root system that can resprout from a small piece of root or stem. These stands crowd out all desirable vegetation and provide little useful habitat for the native animals, birds and fishes that make these river systems home for at least part of their life cycle. The most effective control of *Arundo donax* must be controlled in Southern Nevada as it poses a serious threat to the physical and biological functioning of our riparian ecosystems.

Photographs courtesy of J. Giessow, Santa Margarita and San Luis Rey Weed Management Area

## Bibliography

Bell, G.P. (1997). Ecology and management of *Arundo donax,* and approaches to riparian habitat restoration in Southern California. In Wade, J.H.,Pysek, P., and Green, D. (eds.), Plant Invasions: Studies from North America and Europe. Blackhuys Publishers, Leiden, The Netherlands, pp. 103-113.

Douthit. S. 1994. *Arundo donax* in the Santa Ana River Basin. In: Jackson, N. *Arundo donax* workshop. p. 7-10.

Duke, J.A. 1983. *Arundo donax*. <u>http://newcrop.hort.purdue.edu/newcrop/duke\_engery/Arundo\_donax.html</u>. October 30, 2001

Duke, J.A. and Wain, K.K. 1981. Medicinal plants of the world. Computer index with more than 85,000 entries. 3 vols.

Frandsen, P. and N. Jackson. 1994. Impact of *Arundo donax* in flood control and endangered species. In: Jackson, N. et al. *Arundo donax* workshop. p. 13-16.

Fornell, T.C. 1990. Widespread adventive plants in Catalunia. In DiCastri, F., Hansen, A.J., Debussche, M. (eds.) Biological invasions in Europe and the Mediterranean Basin. Kluwer Academic Publishers, Boston, MA, pp 85-104.

Hitchcock, A. S. and A. Chase. 1950. Manual of the Grasses of the United States. Misc. Publ. 200. U.S. Dept. of Agriculture, Washington, D.C. pp. 184-185.

Iverson, M. 1994. In: Jackson, N. et al. Arundo donax workshop. p.19-26.

Monsanto. 1989. Label for Rodeo<sup>®</sup> aquatic herbicide. Monsanto Company, St. Louis, MO.

Omori, G. 1996. Eradicating the giant reed (*Arundo donax*) in riparian areas in Marine Corps Base, Camp Pendleton, California. Report to Environmental Security, Marine Corps Base, Camp Pendleton, California and the Nature Conservancy. Oceanside, CA, 7 pp.

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Bugwood Network

BW-2006-03

December 2006

# Invasive Plant Responses to Silvicultural Practices in the South

C. W. Evans, D. J. Moorhead, C. T. Bargeron and G. K. Douce



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## Acknowledgements

The authors wish to thank Dr. John Taylor, USDA Forest Service, for his support of this project and Dr. Larry Nelson, Clemson University, and Dr. James Miller, USDA Forest Service, for their review and helpful comments on this publication.

Funding for development of this publication was provided by USDA Forest Service, State and Private Forestry, Forest Health Protection, Region 8.

The authors dedicate this publication to the memory of Dr. Larry Nelson (1950-2006). Larry recognized the problems posed by invasive plants in our forested, agricultural and urban landscapes and was proactive in developing research and outreach programs. Through his efforts countless professional foresters, natural resource managers, students, and the public, across the South, developed an awareness of invasive plant management. We hope this publication can serve to further his work.

## Citation

Evans, C.W., D.J. Moorhead, C.T. Bargeron, and G.K. Douce. 2006. Invasive Plant Responses to Silvicultural Practices in the South. The University of Georgia Bugwood Network, Tifton GA, BW-2006-03. 52 p.

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## How to use this guide

This guide is intended to aid foresters and managers in the southeastern United States in developing management plans and managing forests threatened by invasive plants. This guide integrates identification of invasive plants, potential mechanisms for spread (natural seed or vegetative production, or human induced spread by cultural practices) and a suite of silvicultural management/control practices. The first section of the guide includes simple descriptions of common silvicultural practices and how they alter the habitat. General guidelines for reducing the risk and impact of invasive plants are included in a bulleted list format. Profiles for thirteen common invasive plants give detailed information on identification and ecology as well as how they are expected to respond to the habitat alterations resulting from silvicultural practices. Quick reference tables summarizing the information in this book and allow the user to quickly find information and recommendations for each of these common invasive plant species are included in the back of this publication.

## **Pesticide Precautionary Statement**

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all label precautions.

Store pesticides in the original containers under lock and key—out of reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dust; wear protective clothing and equipment if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed them. If a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

# Dispose of empty pesticide containers promptly and in accordance with all applicable Federal, State, and local laws.

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# Invasive Plant Responses to Silvicultural Practices in the South

## C. W. Evans, D. J. Moorhead, C. T. Bargeron and G. K. Douce

## **Executive Summary**

Many forest managers are unknowingly introducing and spreading invasive plants on their lands through management practices they implement. These practices, ranging from traditional silvicultural management to wildlife enhancement and land-use conversion practices, all influence invasive plant growth, reproduction, and dispersal. Recognizing and predicting the response of individual species to these practices will enable managers to take steps to prevent or reduce the impact of invasive plants on their land. Many of these species eliminate all productive uses on infested sites and are very expensive to control and/or eradicate. Knowing which invasive plants are common in your region and being able to identify them aids in quickly responding to new threats. Monitoring disturbed areas and proper sanitation of equipment helps prevent new infestations. Issues such as when and how to use prescribed fire and how different invasive plants will respond can be confusing and overwhelming. This publication integrates vegetation management guidelines and control techniques with silvicultural practices, such as prescribed fire, harvest techniques, site preparation, timber stand improvement, and wildlife plantings, in a format that will help the manager understand the relationship of management practices and invasive plants.

## General Principles to Reduce the Impact of Invasive Plants

- 1. Learn to identify invasive plants and incorporate their management into any land-use plan.
- Prevent introduction of invasive plants to uninfested sites: This critical component is one of the most cost-effective methods of management.
- Contain and treat new invasive plants or those not yet well established: Controlling small infestations is more effective and economical than trying to control well-established, rapidly spreading infestations.
- Minimize transport of invasive plants from infested to uninfested areas: Cleaning vehicles and equipment is the most effective method of prevention.
- Minimize soil disturbance: Invasive plants often prefer disturbed ground, don't disturb soil unless it is necessary.
- 6. Maintain desirable species: Establishing and maintaining competitive, desirable plants along roadsides and disturbed areas prevents or slows establishment of invasive plants.

Keywords: Silviculture, invasive plants, sanitation, monitoring, herbicides, management, disturbance

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## Section I: Management Practices

## Harvest Activities

Harvest activities include practices in which trees are harvested, such as regeneration cuts (for example, shelterwood, seed tree, and group selection), thinning operations, or clear cuts.

#### Habitat Alterations:

- Soil disturbance
- Increased light to understory or forest floor
- Mechanical damage
- Use of off-site equipment

## **Prescribed Fire**

Prescribed fire is the practice of using fire, intentionally set, to obtain certain management objectives. Often prescribed fire is used to inhibit establishment of undesirable species or to set back succession. The use of prescribed fire also includes creation and maintenance of fire breaks.

## Habitat Alterations:

- · Creation of bare soil
- · Initial release of nutrients
- Kill or top kill of under and midstory vegetation
- Increased light to understory or forest floor
- Soil disturbance (fire breaks)
- · Use of off-site equipment

## Internal Road Construction

Roads are often built within a parcel of land to enable the owner/manager to move equipment and reach remote areas. Included within this category is the creation and maintenance of internal roads and stream crossings.

## Habitat Alterations:

- · Soil disturbance
- Increased light to understory or forest floor
- · Open canopy
- Off-site material
- Use of off-site equipment
- Mechanical damage (Limited after initial creation)
- · Potential wetland disturbance



Figure 1 - Skidding can spread invasives across the harvest tract.



Figure 2 - Prescribed fire can be used to control certain invasive species and spread others.



Figure 3 - Road construction introduces off-site materials which may contain invasives.



Figure 4 - Straw mulch may harbor seeds of invasive plants

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## **Mechanical Site Preparation**

The practice of site preparation (or site prep) manipulates the ground layer to achieve a better microclimate for seedling establishment and growth. Site prep often follows a clearcut treatment and precedes planting. Common mechanical site prep treatments are: bedding, chopping, and disking.

#### Habitat Alterations:

- Exposes bare mineral soil
- Increased light to understory or forest floor
- Use of off-site equipment
- · Removal of native vegetation
- Damage and alteration to root zone (compaction, rutting, drainage)

#### Tree Planting

Tree planting includes the practices involved in planting of seedlings. Seed bed preparation treatments, such as scalping and sub-soiling, and seedling planting are included within this category.

## Habitat Alterations:

- · Soil disturbance
- · Mechanical damage
- · Use of off-site equipment
- Off-site material

## Release Treatments (Intermediate Treatments)

Release treatments are used to free small trees from competition from undesirable vegetation. Treatments include herbicide, mowing, cutting, and fire.

## Habitat Alterations:

- Increased light to understory or forest floor
- Midstory removal/thinning
- Understory damage/disturbance
- · Soil disturbance



Figure 5 - Site preparation creates bare soil and high light environment conducive to invasive establishment and spread.



Figure 6 - Tree planting equipment may harbor invasive seeds or plant material.



Figure 7 - This scalper could carry plant roots and rhizomes across sites.



Figure 8 - Release treatments create high light environments condusive **396** 2000 invasives.

## Special Considerations

#### **Pine Straw Production**

Many pine stands are managed for pine straw production. The needles that are naturally shed from pine trees are raked, baled, and sold as pine straw mulch. Pine straw production involves managing stands for optimum straw production, removing understory vegetation with herbicide and/or fire, collecting (raking) the straw, and making bales. Often practices such as prescribed fire, mowing, and herbicide treatments are used in production areas. Stand alterations include soil disturbance, removal of understory and midstory, and increased light to the forest floor. **Bales and equipment from infested stands can foster the widespread distribution of invasive plants.** 

#### Wildlife Enhancement

Wildlife enhancement involves any practice that can improve or enhance the wildlife habitat on a land, such as food plot installation, fertilization, and selective thinning and planting. This is a varied category but can include aspects of other silvicultural practices. Wildlife enhancement practices are a common avenue for invasive plant introductions, either via contaminated equipment or intentional planting. Areas to monitor for any invasive plants are camps, food plots, and other areas used.

#### Streamside Management Zones (SMZ)

These areas are protected because of water quality and erosion concerns. **They can be** *refuges for invasive plants which can spread into adjacent lands.* Since SMZs are adjacent to drainages, streams, or rivers, invasive plants that favor wet areas, streamsides, or bottomlands are likely to be present.

#### Land Use Conversion

This category covers practices used when converting lands previously under cultivated agriculture or pasture into trees. A different suite of invasive plants can become problems in areas undergoing land use conversion. Established invasive plant populations or viable seedbanks may exist in agricultural fields or pastures. Fencerows may serve as a harbor for these invasives. A plant that was a minor pest in the previous land use may not be inhibited by the current management practices and suddenly expand its population drastically.



Figure 9 - Pine straw production



Figure 10 - Wildlife food plot



Figure 11 - Forest stream



Figure12 - Newly planted pine stand invaded by kudzu

## Section II: General Guidelines for Risk Reduction Early Detection Through Monitoring

- Monitor disturbed habitats for newly established invasive plants.
- Sites to monitor include food plots, cut-over lands, roadsides, stream sides, recently flooded areas, storm damaged areas, internal roads and trails, firebreaks, burned areas rights-of-way, and fencerows.
- Mark known infestations on a map and flag them in field for easy re-location.
- Search the surrounding areas for any "satellite" infestations and mark them as well.



Figure13 - Harvest tract with SMZs and fencerows



Figure14 - Resource map showing land-use and invasive plant infestations

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## Best Management Practices for Activities Involving Soil Disturbance

- Before starting ground-disturbing activities, inventory invasive plant infestations both on-site and in the adjacent area.
- Begin activities in uninfested areas before operating in infested areas.
- Use uninfested areas for staging, parking and cleaning equipment. Avoid or minimize all types of travel through infested areas, or restrict to those periods when spread of seed or propagules are least likely.
- When possible, to suppress growth of invasive plants and prevent their establishment, retain relatively closed canopies.
- Minimize soil disturbance and retain desirable vegetation in and around area to the maximum extent possible.
- Monitor infested areas for at least three growing seasons following completion of activities. Provide for follow-up treatments based on inspection results.
- Do not blade roads or pull ditches where new invaders are found, if possible.
- When it is necessary to conduct soil work in infested roadsides or ditches, schedule activity when seeds or propagules are least likely to be viable and to be spread.
- Quarantine soil from infested area to prevent off-site spread.





Figure 16 - Road maintainence

## Best Management Practices Involving Off-site Material and Equipment

- Invasive plants can be introduced and spread by moving infested equipment, sand, gravel, borrow, fill and other off-site material.
- Determine the need and identify sites where equipment can be cleaned. Seeds and plant parts need to be collected when practical and incinerated. Remove mud, dirt, and plant parts from project equipment before moving it into a project area and clean all equipment before leaving the project site, if operating in infested areas.
- Inspect material sources at site of origin to ensure that they are free of invasive plant material before use and transport. Treat infested sources for eradication, and strip and stockpile contaminated material before any use.
- Inspect and document the area where material from treated infested sources is used annually for at least three years after project completion to ensure that any invasive plants transported to the site are promptly detected and controlled.
- Maintain stockpiled, uninfested material in a weed-free condition.
- Incorporate invasive plant prevention into road work layout, design, and decisions.
- Minimize roadside sources of seed that could be transported to other areas.
- Periodically inspect system roads and rights-of-way for invasion. Inventory and mark infestations and schedule them for treatment.
- Avoid working in infested areas if possible. Postpone work until invasive plants have been eliminated from the site.
- Perform road maintenance such as road grading, brushing, and ditch cleaning from uninfested to infested areas to help prevent moving seeds and plant material from infested areas into adjacent uninfested areas.
- Clean road graders and other equipment immediately after operating in infested areas. Clean all dirt and plant parts from the top and underside of mower decks.



Figure 17 - Food plot equipment with plant material that can be transported to other sites



Figure 18 - Cogongrass seeds on radiator screen

## **Best Management Practices for Re-Vegetation**

- Re-vegetate all disturbed soil, except on surfaced roads, in a manner that
  optimizes plant establishment for that specific site, unless ongoing disturbance at
  the site will prevent establishment of invasive plants.
- Use local seeding guidelines and appropriate mixes, but realize that many species previously recommended for this purpose are now presenting invasive problems.. Use native material where appropriate and available. Re-vegetation may include planting, seeding, fertilization, and mulching.
- Monitor and evaluate success of re-vegetation in relation to project plan.
- When re-vegetating areas that were previously dominated by invasive plants, try to achieve at least 90% control of the invasive before attempting restoration.



Figure 19 - Applying mulch for soil stabilization



Figure 20 - Seeding



Figure 21 - Native longleaf wiregrass stand

## Invasive Plants of Concern in Forested Landscapes in the South

Across the South, foresters and resource managers can encounter numerous invasive plants that can impact silvicultural practices and management goals. The following is a list of common invasive plants in the South. This publications highlights and provides information on the response of thirteen invasive plants to common silvicultural practices (highlighted in bold).

## Trees

Tree of Heaven - Ailanthus altissima Mimosa, Silktree - Albizia julibrissin Paper mulberry - Broussonetia papyrifera Russian Olive - Elaeagnus angustifolia Chinaberrytree - Melia azedarach Paulownia, Princesstree - Paulownia tomentosa Tallow tree - Triadica sebifera

## Shrubs

Thorny Olive - Elaeagnus pungens Autumn Olive - Elaeagnus umbellata Winged Burning Bush - Euonymus alata Privet - Ligustrum spp. Bush Honeysuckles - Lonicera spp. Nandina - Nandina domestica Multiflora rose - Rosa multiflora

## Vines

Oriental Bittersweet - Celastrus orbiculatus Purple crownvetch Coronilla varia Climbing Yams - Dioscorea spp. Winter Creeper - Euonymus fortunei English Ivy - Hedera helix Japanese Honeysuckle - Lonicera japonica Japanese Climbing Fern - Lygodium japonicum Kudzu - Pueraria montana Vincas, Periwinkles - Vinca minor/V. minor Nonnative Wisterias - Wisteria sinensis/W. floribunda

## Grasses

Giant Reed - Arundo donax **Cogongrass** - Imperata cylindrica Tall Fescue - Lolium arundinaceum **Nepalese Browntop** - Microstegium vimineum Chinese Silvergrass - Miscanthus sinensis Golden bamboo - Phyllostachys aurea Johnsongrass - Sorghum halepense

## Forbs

Garlic Mustard - Alliaria petiolata Exotic Lespedezas - Lespedeza bicolor/L. cuneata Tropical Soda Apple - Solanum viarum Japanese knotweed - Polygonum cuspidatum

## Section III: Invasive Plant Profiles Tree of Heaven - Ailanthus altissima

### Identification

Tree of heaven is a rapidly growing small tree but can reach up to 80 feet in height and 6 feet in diameter. It has pinnately compound leaves that are 1-4 feet in length with 10-41 leaflets (Figure 22). Tree of heaven resembles the sumacs and hickories, but is easily recognized by the glandular, notched base on each leaflet (Figure 23). The thick twigs are light brown in color with large lenticels, and have large, heart-shaped leaf scars. Young twigs emit a strong odor, somewhat like peanut butter, when broken. The small yellow flowers occur in terminal clusters on female plants (Figure 24). The winged fruit can be from yellow to brilliant orange in color, turning dry and brown when ripe (Figure 25). Thickets of tree of heaven tend to be circular in shape.

### Habitat and Distribution

Tree of heaven, native to Asia, was first introduced into America in 1748 by a Pennsylvania gardener. It was widely planted in cities because of its ability to grow in adverse conditions. Quickly escaping cultivation, tree of heaven has spread throughout the eastern United States, with the exception of the coastal plain areas.

Tree of heaven is extremely tolerant of poor soil conditions and has been known to grow even in cement cracks. Acidic, compacted, or nutrient poor conditions do not inhibit colonization. It commonly invades urban areas, roadsides, rights-of-way, fencerows, forest edges, savannas, open forests, canopy gaps, and other disturbed areas (Figure 26). It is very drought and flood tolerant but cannot grow in shaded conditions. The light, winged seeds can travel distances of 300 feet or more. Most reproduction is asexual, via cloning.

#### Impact

The ability to reproduce both by seeds and by sprouts allows tree of heaven to spread and quickly dominate disturbed areas. Dense clonal thickets displace native species and can rapidly take over fields and meadows, restricting light to the understory. Tree of heaven has alleopathic properties which aids it in displacing other species.





Figure 22





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Figure 25

#### **Response to Disturbance**

Promoted by high light environments Promoted by soil disturbance Re-sprouts vigorously after being cut Establishes easily after disturbance

#### Reproduction

Primary means – Seed and clonal growth Mature after 10 years from seed Mature within two years from sprout Abundant seed production (greater than 300,000/plant) Insect pollinated No significant seed banking Dioecious - male and female flowers on separate plants

#### Seed Dispersal

Wind blown seeds

### **Growth Habits**

Tree Shade intolerant (although it can persist somewhat until disturbance) Flood tolerant Poor soil tolerant Drought tolerant Prefers disturbed areas Cold hardy Alleopathic

### **Response to Prescribed Fire**

Not a control option Not a fire hazard Re-sprout from roots after fire



Figure 26

### **Control Recommendations**

*Large trees.* Make stem injections and apply Garlon 3A, Pathfinder II, or Arsenal AC in dilutions to cut spacings specified on the herbicide label (midsummer best, late winter somewhat less effective). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.

*Saplings.* Apply Garlon 4 as a 20-percent solution in commercially available basal oil, vegetable oil, or crop oil (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray.

Seedlings and saplings. Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC as a 1-percent solution (4 ounces per 3-gallon mix), Krenite S as a 15-percent solution (3 pints per 3-gallon mix), Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix), or Escort XP at 1 ounce per acre. (See Herbicide Quick Reference page 40-42) Page 275 of 416

## Paulownia - Paulownia tomentosa

## Identification

Paulownia or Princesstree is a deciduous tree, growing up to 60 feet in height and 2 feet in diameter. The bark is light gray to tan, often somewhat shiny, with white lenticels, becoming rough and slightly fissured with age (Figure 27). The twigs are stout with large, circular leaf scars and chambered or hollow piths. Leaves are opposite, fuzzy, large (6 to 12 inches long), and heart-shaped (Figure 29). Flowers are showy, erect, and pale-violet in color (Figure 30). The pecan-shaped fruits occur in erect terminal clusters, leaving behind the split, thin fruit capsule well into winter (Figure 28, 29). The abundant seeds are minute and winged.

### Habitat and Distribution

Paulownia is native to eastern Asia and was first introduced into America in the early 1800s for ornamental purposes and as a potential export for carving wood (Figure 31). Paulownia can invade a variety of different habitats including roadsides, cliffs, riparian areas, open woods, highway embankments, stream banks, forest edges, landslides, burned-over areas, rocky out-croppings, mine spoils, old home sites, and other disturbed sites (Figure 32). It can tolerate infertile, shallow, rocky, alkaline to acidic, or very dry soils. It can even invade nearly vertical rock walls and cracks in concrete. Paulownia readily invades after fire or other types of soil disturbance. It is found throughout the Eastern United States. In the South, it is most problematic in the mountainous regions.

#### Impact

The tiny, winged seeds of paulownia are easily dispersed long distances via the wind. Once, established it is difficult to remove due to its ability to resprout vigorously and the prolific seed production. Its ability to colonize rocky or infertile sites, make paulownia a threat to some rare plants that require these marginal habitats. Its ability to resprout or colonize by seed quickly after a fire creates problems when managing species such as table mountain pine that require fire for regeneration.





Figure 27

Figure 28





Figure 30

Figure 29

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## **Response to Disturbance**

Promoted by high light environments Promoted by soil disturbance Promoted by fire Re-sprouts vigorously after being cut Invades readily after disturbance Rapid growth (roots sprouts can grow over 15 feet a year) Invades quickly after fire or disturbance

## Reproduction

Primary means – seed Time to maturity – 8-10 years Abundant seed production (20 million/ plant) Insect pollinated Clonal from root sprouts **Seed Dispersal** Wind-blown and water-dispersed seeds

## Growth Habits

Tree Not very shade tolerant Poor-soil tolerant Flood tolerant Drought tolerant Prefers highly disturbed areas

#### **Response to Prescribed Fire**

Not a control option Not a fire hazard Colonizes quickly after fire (particularly spring fires)



Figure 31



Figure 32

#### **Control Recommendations**

*Large trees.* Make stem injections using Arsenal AC or a glyphosate herbicide in dilutions and cut spacings specified on the herbicide label (anytime except March and April). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.

*Saplings.* Apply Garlon 4 as a 20-percent solution in commercially available basal oil, vegetable oil, or crop oil (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray.

Resprouts and seedlings. Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC as a 1-percent solution (4 ounces per 3-gallon mix); a glyphosate herbicide, Garlon 3A, or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).

(See Herbicide Quick Reference page 40-42)

## Tallow Tree - Triadica sebifera

## Identification

Tallow tree, also called popcorn tree, is a deciduous tree reaching 60 feet in height and 3 feet in diameter. The alternate leaves, which turn yellow or red in the fall, are heart-shaped with a long pointed tip (Figure 33, 34). The bark is light gray to tan, becoming fissured with age. The sap is a milky white color. The noticeable male flowers are yellowish and occur on long, dangling spikes (Figure 35). Three-lobed fruit are found in clusters at the end of branches. The fruit turn from green to black and split to reveal three waxy popcorn-like seeds (Figure 36).

#### Habitat and Distribution

Tallow tree is a native of China and was first introduced into America in South Carolina during the 1700s. The USDA recommended planting this tree for seed oil from 1920 to about 1940. It is currently still being sold as an ornamental. Tallow tree invades wet areas such as stream banks, ditches, wetlands, coastal prairies, and swamps, but can also invade drier upland sites such as forests, fields, pastures, and pine plantations (Figure 37). It can tolerate salty soils, flooding, and shady environments. Tallow tree readily invades disturbed areas but does not require disturbance to invade, and can invade high-quality mature forests. It is currently found throughout the southeastern United States in the Coastal Plain and lower Piedmont regions, from Texas to North Carolina. It has also been found in California.

#### Impact

Tallow tree is s serious threat because of its ability to invade high quality, undisturbed forests. Seed is dispersed both by birds and by water. It can displace native vegetation by forming dense monocultural stands. Tallow tree can also alter soil conditions due to the high amount of tannins present in the leaf litter. It has alleopathic properties which help it exclude other vegetations from infested sites. Open areas, such as fields and wet meadows, are quickly dominated, altering water and light regimes. It is a major threat to coastal prairies and forests on both the Gulf and Atlantic coasts. Forest regeneration in infested areas is difficult due to the quick dispersal and rapid growth of tallow tree.







Figure 35



Figure 34



Figure 36

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## **Response to Disturbance**

Promoted by high light environments Promoted by soil disturbance Discouraged by fire Re-sprouts vigorously after being cut Establishes well after disturbance

## Reproduction

Primary means – seed Can mature within three years Seed production – 100,000/plant Moderate seed bank (some survival possible up to 7 years) Does not self pollinate Wind pollinated

### Seed Dispersal

Bird and water dispersed seeds

#### **Growth Habits**

Tree Shade tolerant Full sun tolerant Flood tolerant Salt tolerant Can grow in varied habitat types Not cold hardy Able to invade undisturbed habitats

#### **Response to Prescribed Fire**

Dormant season burning may be an effective control option Not a fire hazard Re-growth after fire possible



Figure 37

## **Control Recommendations**

*Large trees.* Make stem injections using Arsenal AC, Garlon 3A, or Pathfinder II in dilutions and cut spacings specified on the herbicide label (anytime except March and April). For felled trees, apply herbicides to stem and stump tops immediately after cutting (at least a 10-percent solution for Garlon 3A). For treatment of extensive infestations in forest situations, apply Velpar L to the soil surface within 3 feet of the stem (one squirt of spot gun per 1-inch stem diameter) or in a grid pattern at spacings specified on the herbicide label.

*Saplings.* Apply Garlon 4 as a 20-percent solution in commercially available basal oil, vegetable oil, or crop oil (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray.

*Seedlings and saplings.* Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC as a 1-percent solution (4 ounces per 3-gallon mix), Krenite S as a 20-percent solution (2 quarts per 3-gallon mix), or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).

(See Herbicide Quick Reference page 40-42)

## Autumn Olive - Elaeagnus umbellata

## Identification

Autumn olive is a deciduous shrub from 3 to 20 feet in height. Bark is gray-brown and smooth with small white lenticels. Scattered thorns occur on many plants but may be absent. Leaves are alternate, elliptical and 2-3 inches in length, with silvery, dotted undersides (Figure 38). The whitish-yellow flowers occur in axillary clusters, giving way to red, juicy fruits (Figure 39, 40).

### Habitat and Distribution

Autumn olive is native to China and Japan and was introduced into America in 1830. Since then it has been widely planted for wildlife habitat, mine reclamation, and shelterbelts (Figure 41). Autumn olive invades old fields, woodland edges, forest openings, pastures, road sides, rights-of-way, and other disturbed areas. It can grow in sandy, loamy, and somewhat clayey soils with slightly acidic to neutral pH, but does best on sandy, dry soils. It is drought tolerate and can thrive in very infertile and dry soil. Plants cannot tolerate wet conditions. Autumn olive is somewhat shade tolerant but cannot grow in moderate or deeply shaded environments. Because the fruits are readily eaten by birds and small mammals, this plant has the ability to spread rapidly. It is found throughout the eastern United States, from Maine to Iowa and south to Florida. In the South, it is a problematic invader in the Piedmont region and farther north usually spreading from older plantings.

#### Impact

Both its rapid growth and prolific fruiting allow autumn olive to disperse rapidly. It can form large dense thickets, creating a monocultural shrub layer. These thickets can displace native species, reducing biodiversity and altering successional states. Meadows and forest openings can quickly become dominated and the canopy closed, restricting light availability to the understory layer. Autumn olive is a nitrogen-fixing plant, which could potentially alter soil nitrogen availability, greatly alter ecosystems that are adapted to infertile soils. Autumn olive re-sprouts vigorously, making any control work difficult and allowing it to re-grow rapidly after disturbance.





Figure 39

Figure 40

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Response to Disturbance Good initial colonizer (post fire and post disturbance) Promoted by soil disturbance Promoted by fire Promoted by high light environments Sprouts vigorously after cutting

Reproduction Primary means – seed Matures in 3-5 years on good sites High seed production (20,000-54,000 per year) High rate of germination (>90% with cold stratification, ~70% with no cold stratification) Flowers April to May Insect pollinated Seed Dispersal Bird and small mammal dispersed seeds

#### **Growth Habits**

Shrub/tree Rapid growth Somewhat shade tolerant Flood intolerant Drought tolerant Open habitats Grows on infertile soils Nitrogen fixer Early spring emergence

### **Response to Prescribed Fire**

Not a control option Not a significant fire hazard Sprouts quickly after fire Colonizes quickly after fire



Figure 41

## **Control Recommendations**

Thoroughly wet all leaves with Arsenal AC, Vanquish or Garlon 4 as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (April to October).

For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in commercially available basal oil, vegetable oil, or crop oil (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix). (See Herbicide Quick Reference page 40-42)

## Privet - Ligustrum spp.

#### Identification

Although several species of privet occur in the Southeast, they are often hard to distinguish. In general, privet is a thick, evergreen to semi-evergreen shrub up to 30 feet in height. Bark is light gray to tan in color and very smooth. Trunks usually occur as multiple stems with many long, leafy branches. The opposite leaves are thick, somewhat waxy, oval and 0.5 to 1.5 inches long. White flowers are very abundant and occur in clusters at the end of branches (Figure 42). Fruit ripen to a dark purple to black color and persist into winter (Figure 43).

## Habitat and Distribution

Privet was introduced into the United States in the early 1800s. It is commonly used as an ornamental shrub and for hedgerows. Privet can invade a wide variety of habitats including floodplains, stream sides, upland and bottomland forests, old fields, road sides, rights-of-way, fencerows, windbreaks, pastures, savannas, wetlands, and most any other habitat (Figure 44). It prefers moist open lands but can be found in highly shaded or dry areas. Privet readily invades both pine and hardwood forests, where it is often found as thickets in the understory. Privet is a generalist and can invade areas with a wide variety of soil types, nutrient availability, moisture, and pH. It is widespread and common throughout the southeast and scattered elsewhere in the U.S.

### Impact

Privet is one of the most widespread and problematic invasive plants in the Southeast. It reproduces both by sprouts and by seeds, which are bird and mammal dispersed. It spreads quickly and once established can form dense almost impenetrable thickets. These thickets shade and displace many native understory and shrub species. Mid-canopy trees and developing seedlings and saplings can be replaced or restricted from establishing by privet infestations. It is very difficult to remove and reinfestations are common because of the abundant seed source.



Figure 42



## **Response to Disturbance**

Promoted by soil disturbance Re-sprouts vigorously after being cut Establishes well in disturbed areas Can invade undisturbed forests in canopy gaps

#### Reproduction

Primary means - seed and asexual Seed production - 1000s/plant Seed bank less than one year High seed germination rates Asexual reproduction - suckering

#### Seed Dispersal

Bird and water dispersed seeds

#### Growth Habits

Evergreen to semi-evergreen Shrub/small tree Shade tolerant Full sun tolerant Flood tolerant Drought intolerant Prefers forested habitats Cold hardy depending on species

#### **Response to Prescribed Fire**

Repeated fires can control (depending on site) Not a fire hazard Re-sprouts after fire Readily establishes after fire



Figure 44

## **Control Recommendations**

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (August to December): a glyphosate herbicide as a 3-percent solution (12 ounces per 3-gallon mix), Arsenal AC as a 1-percent solution (4 ounces per 3-gallon mix), or Escort XP at 1 ounce/per acre plus 0.25 percent non-ionic surfactant).

During the dormant season (November through February) use a 3-5% glyphosate solution with water applied as a directed spray to completely wet the foliage of the privet. Use a glyphosate product that contains 41% or more active ingredient. With no soil activity and low impact on dormant (leafless) plants, glyphosate is a good option when desirable nontarget plants are growing in close proximity to privet.

For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in crop oil (2.5 quarts per 3-gallon mix) to young bark as a basal spray. Or, cut large stems and immediately treat the stumps with Arsenal AC or Velpar L as a 10-percent solution in water (1 quart per 3gallon mix) with a surfactant. Or, cut large stems and immediately treat the stumps with Krenite (Mixed 50-50 with water). When safety to surrounding vegetation is desired, immediately treat stumps and cut stems with Garlon 3A or a glyphosate herbicide as a 20percent solution in water (2.5 quarts per 3-gallon mix) with a sur pate 283 of 416 (See Herbicide Quick Reference page 40-42)

## Oriental bittersweet - Celastrus orbiculatus

## Identification

Oriental bittersweet is a deciduous, climbing, woody vine that can grow to lengths of 60 feet. Vines can grow to 4 inches in diameter and are gray to olive in color with whitish-gray, raised lenticels. The alternate, elliptical leaves are variable in shape, bluntly toothed, and light green in color, turning yellow in fall (Figure 45). Small, inconspicuous, axillary flowers give way to round green fruit which ripen and split to reveal showy scarlet berries that persist into winter (Figure 46). It closely resembles American bittersweet (*Celastrus scandens*) but can be distinguished from it because American bittersweet has flowers and fruits in terminals rather than axillary along the stem (Figure 47).

### Habitat and Distribution

Oriental bittersweet was introduced from China around 1860 as an ornamental. It can be dispersed widely and quickly due to the berries being eaten and spread by birds. It can invade a variety of habitats including open and young forests, meadows, glades, savannas, roadsides, fencerows, old home sites, and other disturbed areas (Figure 48). It is generally found in areas of hardwood forests but has been reported in coniferous forests as well (Figure 49). Oriental bittersweet is widely spread and problematic throughout the Northeastern United States as far west as Iowa and sporadically to Louisiana. It has not been widely reported in the lower Piedmont or Coastal Plain. It is a major pest in areas of the southern Appalachians, especially the Asheville, NC region.

#### Impact

Prolific vine growth allows Oriental bittersweet to encircle trees and girdle them. It also can completely cover other vegetation and shade, out-compete and kill even large trees. The added weight to the trees increases susceptibility to ice storms and wind damage. Oriental bittersweet can shade and restrict growth of native understory species, shrubs, tree seedlings, and some native vines. It has also been shown to hybridize with American bittersweet, potentially leading to a loss of genetic identity.



Figure 45



Figure 46



Figure 47

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## **Response to Disturbance**

Promoted by soil disturbance Re-sprouts vigorously after being cut Damage encourages sprouting Establishes rapidly after disturbance Colonizes gaps well

#### Reproduction

Primary means - seed Can produce seed in second year Seed production (>350 fruits/plant and 3-6 seeds/fruit) Fruit remain on vine well into winter Seed bank less than 1 year High germination rate (90%) Dioecious - male and female flowers on separate plants Insect (primarily bee) pollinated. Some wind pollination as well Oak litter may inhibit establishment Asexual reproduction - runners, root and root fragment sprouts, and root crown sprouting Hybridizes

### Seed Dispersal

Seed primarily dispersed by birds but also by animals, humans and water movement



Figure 48

## Growth Habits

Vine Rapid growth (greater than 10 feet/year) Shade tolerant (20% full sun has no affect on seed germination) Grows best in partial to full sun Flood intolerant Drought intolerant Prefers open woods/disturbed areas Cold hardy Deciduous Can climb supports of various sizes (does not require small diameter vertical structure to climb)

## **Response to Prescribed Fire**

Not a control option Not a fire hazard Post-fire regeneration very possible Fire may only top-kill plants, with resprouting following shortly after Post fire flush of growth possible (nutrient and light availability increased due to fire)



Figure 49

#### **Control Recommendations**

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 4, Garlon 3A, or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix).

For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in commercially available basal oil, vegetable oil, or crop oil (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to the lower 16 inches of stems. Or, cut large stems and immediately treat the cut surfaces with one of the following herbicides in water with a surfactant: Garlon 4 or a glyphosate herbicide as a 25-percent solution (32 of age 285 of g416) n mix).

(See Herbicide Quick Reference page 40-42)
### Japanese honeysuckle - Lonicera japonica

#### Identification

Japanese honeysuckle is an evergreen to semi-evergreen vine that can be found either trailing along the ground or climbing to heights of over 80 feet. Vines are slender, woody, and become fissured with age. It has opposite, oval shaped leaves that are entire to slightly lobed and 1 to 2.5 inches long (Figure 50). Showy, fragrant, tubular flowers that are whitishpink to yellow in color give way to small green berries that turn black when ripened (Figure 51).

#### Habitat and Distribution

A native of eastern Asia, Japanese honeysuckle was first introduced into America in 1806 in Long Island, NY and since has been planted widely throughout the United States as an ornamental, for erosion control, and for wildlife habitat (deer forage). It is the most common invasive plant in the southeastern United States forests. It invades a wide variety of habitats including forest floors, forest edges, shrub and small tree canopies, floodplains, roadsides, rights-of-way, fence rows, old fields, wetlands, and disturbed areas (Figure 52). Japanese honeysuckle can thrive under a mature, closed forest canopy, but is most prolific along edges and in openings (Figure 53). It currently occurs in at least 38 states and is abundantly found throughout the Southeast.

#### Impact

The long growing season, due to its evergreen tendencies, helps Japanese honeysuckle compete successfully with many native species for both above and below ground resources. It can girdle shrubs and small saplings by twining around them and can form dense mats in the canopies of shrubs and trees, shading everything below. Japanese honeysuckle can also form dense thickets on the forest floor, inhibiting growth of native understory species and establishment of tree seedlings. Forest canopy gaps can be quickly invaded and closed in and forest edges can grow into a "living wall" of vegetation Forest regeneration is difficult in infested areas, because of the reduced growth and survivorship of seedlings caused by Japanese honeysuckle.



Figure 50



Figure 51

Promoted by high light Promoted by soil disturbance Sprouts vigorously after cutting or fire Most successful in early successional stages with small diameter vertical structure Thinning activities stimulate growth Seeds and re-sprouts can vigorously grow after site-prep or clear cutting activities, to the point of out-competing the trees. Fast growth in a single season if conditions are favorable Remains at low densities in mature forest until clearing or thinning, when it spread rapidly Evergreen (somewhat semi-evergreen)

Cold tolerant

#### Reproduction

Primary means – Asexual and seed High seed production (222 g seeds/plant) Seed bank potential very low (less than one year) High seed viability (85%) and germination rates (63%) Insect and hummingbird pollinated

Perennial



Figure 52

#### Seed Dispersal

Bird and animal dispersed seed Readily eaten by deer

#### **Growth Habits**

Vine Shade tolerant Flood tolerant Drought tolerant Can grow in varied habitat types

#### **Response to Prescribed Fire**

Not a control option (returns to pre-burn levels within a few years) Not a fire hazard Rapid re-growth after fire



Figure 53

#### **Control Recommendations**

Apply Escort XP with a surfactant to foliage June to August—either by broadcast spraying 2 ounces per acre in water (0.6 dry ounces per 3-gallon mix - and apply a total of 10 gallons of spray mix per acre) or by spot spraying 2 to 4 ounces per acre in water (0.6 to 1.2 dry ounces per 3-gallon mix).

Or, treat foliage with one of the following herbicides in water with a surfactant (July to October or during warm days in early winter) keeping spray away from desirable plants: a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix) or Garlon 3A or Garlon 4 as a 3- to 5-percent solution (12 to 20 ounces per 3-gallon mix).

Or, cut large vines just above the soil surface and immediately treat the freshly cut stem with a glyphosate herbicide or Garlon 3A as a 20-percent solution (2.5 quarts per 3-gallon sprayer) in water with a surfactant July to October (safe to surrounding plants).

Prescribed burning in spring will reduce dense ground mats and sever climbing vines for more effective herbicide treatments to resprouting vines.

(See Herbicide Quick Reference page 40-42)

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### Japanese climbing fern - Lygodium japonicum

#### Identification

Japanese climbing fern is a perennial climbing fern with fronds that can reach lengths of 90 feet. Vines (rachises) are thin and wiry, and die back in winter (it remains evergreen in central and south Florida). The leaflets (pinnae) are compound and finely dissected. The overall leaflet has a triangular shape and is 3 to 6 inches in length (Figure 54). Spores occur on the fertile leaflets as a double row of dots under the margins (Figure 55). It is one of the few "vine-like" ferns that occur in the United States. It can be easily distinguished from the native American climbing fern (*Lygodium palmatum*) by leaflet (pinnae) shape. American climbing fern is palmately lobed, whereas Japanese climbing fern is pinnately compound.

#### Habitat and Distribution

Japanese climbing fern is native to eastern Asia and was first introduced into America during the early 1900s for ornamental purposes. Japanese climbing fern invades disturbed areas such as open forests, pine plantations, savannas, swamps, coastal hammocks, forest edges, streamsides, ditches, rights-of-way, and roadsides. It can grow in a wide range of light and moisture levels but cannot tolerate extreme drought or flooding. Fire appears to promote Japanese climbing fern abundance. While Japanese climbing fern readily invades after disturbance, it doesn't require any type disturbance before invading, and has been found in high-quality, undisturbed environments. Currently, it can be found throughout the Coastal Plain and lower Piedmont regions of the Southeastern United States. Japanese climbing fern appears to be currently expanding its range northward.

#### Impact

Japanese climbing fern forms dense tangled mats, which cover the ground and shrubs, shading and killing understory vegetation and tree seedlings. It can also form "walls" of fern which block any available sunlight, reducing biodiversity (Figure 56). The winter-killed vegetation creates fuel ladders, which can intensify and carry fires into the tree crowns (Figure 57). The minute spores can spread, undetected, by wind and on contaminated equipment and plant material. Contaminated pine straw bales are a major avenue of spread, causing some states to regulate the industry (Figure 58).





Figure 54

Figure 55

Promoted by soil disturbance Promoted by fire Re-grows well after being cut Readily invades disturbed areas Does not require disturbance before invading

#### Reproduction

Primary means – spore Has the ability to self pollinate Long spore viability

#### Spore dispersal

Human, wind, water, and animal dispersed Pine straw is a major method of dispersal

#### Growth Habits

Vine/fern Shade tolerant Flood tolerant Drought intolerant Can grow in varied habitat types Not cold hardy Evergreen/semi-evergreen

#### **Response to Prescribed Fire**

Not a control option Fire hazard Rapid re-growth after fire



Figure 56



Figure 57



Figure 58

#### **Control Recommendations**

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Escort XP at 1 to 2 ounces per acre in water (0.3 to 0.6 dry ounces per 3-gallon mix) OR Arsenal AC as a 1-percent solution (4 ounces per 3-gallon mix) OR Garlon 3A, Garlon 4, or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix)

#### (See Herbicide Quick Reference page 40-42)

#### Cogongrass - Imperata cylindrica

#### Identification

Cogongrass is a perennial colony-forming grass up to six feet tall. The clumps of grass arise from the ground, with no apparent stem. The leaf sheaths overlap near the base. The leaves have an off-center midrib that is whitish in color, but this is a variable trait (Figure 59). Leaf margins are finely serrated giving it a sharp texture. Ligules are fringed membranes. The sharp, branched, white rhizomes are concentrated in a dense layer in the top six inches of soil (Figure 60). Flowers and seeds are in a large fuzzy panicle, giving the flowering plant a cottony or silky look. Cogongrass rarely is found as a single plant but quickly forms patches or infestations, often circular in outline (Figure 61).

#### Habitat and Distribution

Cogongrass is native to Southeast Asia and was first introduced into the southeast United States in the early 1900s. Initially cogongrass was planted for forage and erosion control; however it is unpalatable for livestock and not well suited for erosion control due to its aggressive behavior. Cogongrass can invade a wide variety of sites including road sides and rights-of-way, forests, pine plantations, ditches, pastures, field edges, orchards, levees, sand dunes, and waste areas (Figure 62). Cogongrass will not grow in saturated soils, but tolerates periodic flooding reasonably well. It can also tolerate saline environments and drought. It can grow in both deep shade and full sunlight. It cannot successfully invade areas that are annually cultivated. Fire stimulates growth and flower production. Cogongrass can grow in moderately cold weather, being found as far north as the Tennessee border inland and to Connecticut along the coast. Cogongrass is widespread and extremely problematic in Mississippi, Alabama, and Florida. It is currently sparsely located in Louisiana, Georgia, and South Carolina. Cogongrass' introduced range in the United States is expected to continue to expand.

#### Impact

Cogongrass can form dense mats that exclude all other understory vegetation (Figure 63). Cogongrass has little or no value for wildlife either as food or habitat. Desirable species are displaced and new species are prevented from establishing. Dense infestations restrict tree and shrub establishment. Cogongrass is very flammable and creates fire hazards especially in winter. The thick thatch layer dries quickly and burns very hot. Prescribed and wild fires in infested areas are more intense than in native vegetation (Figure 64), and trees can be damaged or even killed during these fires. Wildlife, including gopher tortoises and indigo snakes, and game species such as bobwhite quail and wild turkey, are negatively impacted by cogongrass and habitats may be completely lost due to heavy infestations.





Figure 60



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Figure 59

Promoted by high light environments Establishes quickly on disturbed sites Regrows quickly after soil disturbance Promoted by fire Re-grows after being cut Possibly alleopathic Resistant to most herbicides Unpalatable

#### Reproduction

Primary means – seed and rhizome
Matures in less than one year
Abundant seed production (3,000/plant)
High seed germination (90%)
Low seed viability (viability declines sharply after 3 months)
Seed bank less than 6 months
Low seedling survivorship (20% in first year)
Does not self pollinate
Rhizomatous (rhizome biomass up to 16 tons/acre)
Grows well from rhizome fragments (soil transferred)



**Control Recommendations** 

Figure 62

#### Seed Dispersal

Wind and soil contaminate Seed dispersed (up to 15 miles via wind)

#### Growth Habits

Grass Perennial Full sun and deep shade tolerant Drought tolerant Not flood tolerant (saturated soil conditions, especially in early establishment) Cold tolerant (as low as 7 degrees Fahrenheit) Can grow in varied habitat types

#### **Response to Prescribed Fire**

Not a control option, but may be used to reduce thatch before chemical treatment Fire hazard Fire stimulates flowering



Figure 63



Figure 64

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant: Arsenal AC as a 2-percent solution (8 ounces per 3-gallon mix), a glyphosate herbicide as a 2percent solution (8 ounces per 3-gallon mix), or combination of the two herbicides. Apply before flowering in spring to suppress seed production. Apply 32 ounces per acre of Arsenal AC or 64 ounces per acre of Chopper herbicide in late fall for eradication. Mowing or careful prescribed burning of the thatch in late winter can aid herbicide treatments.

(See Herbicide Quick Reference page 40-42)

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#### Nepalese browntop - Microstegium vimineum

#### Identification

Nepalese browntop, also called Japanese stiltgrass, is a delicate, sprawling, annual grass that is 0.5 to 3 feet in height (Figure 65). Alternate leaves are short, flat, and lance-shaped and are pale green with off-center veins (Figure 66). Stems are wiry and often multi-branched. Flowers are in delicate spikes that emerge from slender tips. Seeds are prolific and can persist into winter. Dieback begins in early fall, causing the plants to turn brown, giving it the common name, browntop.

#### Habitat and Distribution

Nepalese browntop is native to Asia and was accidentally introduced into America in Knoxville, Tennessee sometime around 1920. It has been used as packing material for porcelain, possibly explaining its accidental introduction. Most commonly an invader of forested floodplains, Nepalese browntop is also found in ditches, wastelands, forest edges, forested wetlands, fields, shaded roadsides, and trails (Figure 67). Floodplains along major rivers, semi-permanent streams, and wet draws are common places to find this plant. In mountainous regions, it is found below elevations of 4000 feet, and is often associated with areas of natural (e.g., flood scouring) or artificial (e.g., mowing, tilling) disturbance. Partial to deep shade is preferred and it can thrive in very low light conditions. Invaded sites often have moist, sandy or loamy soils with mildly acidic or neutral pH. Nepalese browntop can also invade drier, upland sites, but cannot tolerate periodic standing water.

Nepalese browntop is found throughout the Eastern United States, from Florida to New York. In the South, it is widespread and problematic from Kentucky, Tennessee, Virginia, North Carolina, and northern Georgia.

#### Impact

Nepalese browntop is capable of invading high-quality, mature floodplain forest and is very difficult to remove once established. It can disperse and invade new areas very quickly. Infestations form thick monocultural stands that alter communities, replacing the native herbaceous vegetation within three to five years after introduction. Alterations in the litter composition, pH levels, and organic soil horizon have been reported after infestations. Nepalese browntop can also negatively effect silvicultural practices by reducing growth in establishing seedlings.

It is dispersed chiefly by flood waters, but can be dispersed by animals and hikers carrying seeds on their fur/clothing. It is a prolific seeder, producing 100-1000 seeds per plant. It is very shade tolerant and can displace vegetation native to floodplains.





Figure 66

Figure 65

Promoted by high light environments Promoted by soil disturbance Discouraged by fire Establishes after fire on bare soil conditions Does not sprout well after cutting (annual), but can regrow top portions of plant if cut early in season

#### Reproduction

Primary means – seed High seed production (>1000 seeds per plant) Low seed viability (33%) Seed bank 3-5 years Can self-pollinate even before flowers open Small root system

#### Seed Dispersal

Animal, water, wind (short distances), human, and soil contaminate spread

#### **Growth Habits**

Grass Annual Very shade tolerant Saturated soil tolerant (doesn't do well with extended flooding) Drought intolerant Prefers moist forested habitats C<sup>4</sup> photosynthetic pathway Cold hardy High light tolerant (grows best ~35% full sunlight) Does not establish well with deep litter layer

**Response to Prescribed Fire** Late season fire may help in control Not a fire hazard Establishes after fire on bare soil conditions



Figure 67

#### **Control Recommendations**

Apply a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant in summer. Or, apply Vantage (see label) for situations that require more selective control and less impact on associated plants.

Repeat treatments for several years to control abundant germinating seeds. Mowing or pulling just before seed set will prevent seed buildup.

#### (See Herbicide Quick Reference page 40-42)

#### Garlic Mustard - Alliaria petiolata

#### Identification

Garlic mustard is an herbaceous biennial forb that is an aggressive invader of wooded areas throughout the eastern and middle United States. First-year plants are basal rosettes with green heart-shaped leaves (1-6 inches tall) (Figure 68). Second-year plants produce a 1-4 feet tall flowering stalk with small, white flowers (Figure 69). Fruits are long seeds pods (siliques) with small, hard, black seeds (Figure 70). Just below the surface, the root system often has a characteristic S-curve. Garlic mustard is most easily recognized by a garlic odor present on actively growing parts of the plant when crushed and the strongly toothed, triangular leaves in the second-year plants (Figure 71).

#### Habitat and Distribution

Garlic mustard invades hardwood forests, savannas, woodlots, forest edges, and roadsides. It has been reported as invading coniferous forest, but infrequently. Disturbed forests are most often invaded, but high-quality, undisturbed forests can also be invaded. Stream sides and bottomland forest are the most common habitat invaded, but slope and upland sites are also vulnerable. Garlic mustard does best in partial light but can tolerate deep shade and full sun. It grows in a variety of soils with limestone or sandstone substrates and neutral to basic pH. Infestations usually start along an edge, trail or stream and spread throughout the remaining forest.

Garlic mustard is a major invasive of northeastern and midwestern United States and southeastern Canada. It is also found in areas of the Rocky Mountains and the Pacific Northwest, from Oregon to Alaska. In the South, it occurs mostly along the major river systems, and has been recorded as far south as Marietta, Georgia.

#### Impact

Once introduced, garlic mustard can form dense stands that shade and compete with native understory flora, lowering native species diversity. It can quickly become the dominate vegetation once introduced. It emerges early in the growing season, competing with and shading the spring ephemerals. Garlic mustard is notable because a high shade tolerance allows it to invade high-quality mature forests, once thought to be relatively resistant to invasion. It has little or no value as a wildlife food and white-tailed deer preferentially avoid garlic mustard to feed upon the other species, possibly aiding in the dominance of garlic mustard in the landscape. It may also interfere with the larval development of two rare butterflies. Once established, garlic mustard is very difficult to remove and spreads rapidly.



Figure 68



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Discouraged by high light environments Promoted by soil disturbance Promoted by deer as they forage on its competition Does not re-sprout well Establishes well after disturbance Can establish in undisturbed sites Unpalatable to most wildlife Rapid growth in early spring/late fall

#### Reproduction

Primary means – seed
Time to maturity – 2 years
No vegetative reproduction
Early spring emergence (Especially for 2<sup>nd</sup> year plants)
Abundant but variable seed production (>10,000 seeds/sq. ft. or up to 7,900 seeds/plant)
Seed bank 4-6 years, but most (88%) germinate in 1<sup>st</sup> year
Seed drop in late summer/early fall
Germinates in February or March after 50 to 105 days of cold stratification
High seedling mortality in first winter
Can self-pollinate

Insect pollinated



Figure 70

**Control Recommendations** 

**Seed Dispersal** Animal, human, and water dispersed

#### Growth Habits

Herbaceous forb Flood tolerant Shade tolerant Sun tolerant Grows best in 50% full sun Drought intolerant Prefers shaded forests Alleopathic Obligate Biennial

#### **Response to Prescribed Fire**

Can be a control option Fire (growing season) reduces density of existing stand Not a fire hazard Potential for rapid colonization following fire



Figure 71



Figure 72

To control two generations, thoroughly wet all leaves with a glyphosate herbicide as a 2percent solution in water (8 ounces per 3-gallon mix) during flowering (April through June). Include a surfactant unless plants are near surface waters.

In locations where herbicides cannot be used, pull plants before seed formation. Repeated annual prescribed burns in fall or early spring will control this plant, while "flaming" individual plants with propane torches has also shown preliminary success (Figure 72).

(See Herbicide Quick Reference page 40-42)

#### Exotic lespedezas - Lespedeza cuneata and L. bicolor

#### Identification

Two species of lespedeza are serious invaders in the Southeast; Chinese or sericea lespedeza (*L. cuneata*) and shrubby or bicolor lespedeza (*L. bicolor*). Chinese lespedeza is an upright semi-woody forb, 3 to 6 feet in height with one to many slender stems. Shrubby lespedeza is very similar but usually displays more branching and is 3 to 10 feet in height. Both species have alternate, abundant, three-parted leaves. Chinese lespedeza leaflets are slender and 0.4 to 0.8 inches long whereas shrubby lespedeza leaflets are more elliptical to oval and 1-2 inches long (Figures 73 & 74 respectively). Flowers are small and whitish-yellow (Chinese) or purple (shrubby). Fruits are single-seeded, round (Chinese) or flattened (shrubby) legume pods.

#### Habitat and Distribution

Native to Asia and introduced into the Unites States in the late 1800s, lespedeza has been widely planted for wildlife habitat, erosion control, and mine reclamation. It grows well in meadows, prairies, pastures, old fields, roadsides, mine spoils, savannas, open forests, fence rows, ditches, highway embankments, orchards, and other disturbed habitats (Figure 75). It is resistant to drought and can tolerate moderate flooding. Because of its ability to fix nitrogen, lespedeza thrives on disturbed or nutrient poor sites. Sandy or sandy-loam soils are preferred but it can grow in a variety of soil types ranging from sandy to clayey. It can invade areas with strongly acidic to neutral pH. It currently is found throughout the eastern United States and in the South, is primarily a problem in the upper coastal plain and areas north.

#### Impact

Lespedeza is an extremely aggressive invader of open areas. Dense monocultural thickets are formed due to its ability to sprout from root crowns. It displaces native vegetation and, once established, is very difficult to remove due to the seed bank, which can remain viable for decades. Open areas can be quickly dominated by lespedeza, altering species diversity, wildlife suitability, and management plans. Lespedeza is fire promoted, potentially forcing managers to alter planned fire regimes in fire-adapted environments such as prairies and pine savannas (Figure 76). Tannins and other alleopathic chemicals are produced, which can inhibit growth of other plant species. On a strip mine reclamation site, lespedeza completely dominated a disturbed areas and compromised 100% aerial cover in three years.



Figure 73



Figure 74

Promoted by high light environments Promoted by soil disturbance Fire encouraged Re-sprouts vigorously after being cut Does not fair well in absence of disturbance Mowing promotes growth Responds well to disturbance Difficult to remove once established



Figure 75

#### Reproduction

Primary means – Seed and root crowns Seed production – 300 million seeds/acre Long seed bank (20+ years) Can self-pollinate Seeds usually do not remain on plant through winter Fire scarification of seeds, increases germination rates Insect pollinated

#### Seed Dispersal

Animal and human dispersed seeds

#### **Growth Habits**

Semi-woody shrub Perennial Somewhat shade tolerant Full sun tolerant Flood intolerant Drought tolerant Prefers open woods/grasslands Cold tolerant Above ground portions dieback in winter

#### **Response to Prescribed Fire**

Not a control option Not a fire hazard Fire scarification of seeds, increases germination rates



Figure 76

#### **Control Recommendations**

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to September): Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix), Escort XP at three-fourths of an ounce per acre (0.2 dry ounces per 3-gallon mix), Transline as a 0.2-percent solution (1 ounce per 3-gallon mix), a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix), or Velpar L as a 2-percent solution (8 ounces per 3-gallon mix). Mowing 1 to 3 months before herbicide applications can assist control.

(See Herbicide Quick Reference page 40-42)

#### Japanese knotweed - Polygonum cuspidatum

#### Identification

Japanese knotweed is a dense growing semi-woody shrub that can reach heights of 10 feet. The hollow, simple or little-branched stems are smooth and shiny with enlarged nodes. The alternate leaves are variable in shape, but are generally large and triangular with a flat or rounded base and pointed tip (Figure 77). Flowers are minute and greenish-white and appear in loose clusters in the axils (Figure 78). Fruit are small, dry achenes. Above ground portions of the plant die back in winter. Japanese knotweed is easily recognized by its extremely dense growth form, often occurring in large monocultural thickets (Figure 79, 80).

#### Habitat and Distribution

Japanese knotweed is native to eastern Asia and was first introduced into America in the 19<sup>th</sup> Century. It commonly invades disturbed areas with high light, such as road sides, ditches, wetlands, rights-of-way, open hillsides, wet meadows, yards, sandbars, islands, and stream banks. It doesn't appear to be able to invade low-light areas, such as forested understories. Japanese knotweed can grow in moist sites with a variety of soil types, salinity levels, pH, and nutrient availabilities. It is often associated with some type of soil disturbance. Japanese knotweed is found scattered throughout the United States and Canada. It is most problematic in the northeastern and Pacific northwestern United States. It is also a problem in the Mid-South and appears to be spreading its range into the upper Piedmont regions.

#### Impact

Reproduction occurs both by vegetative cuttings and seeds, making this plant extremely hard to eradicate. The dense patches, which emerge early in the growing season, shade and displace other plant life and reduce wildlife habitat. It doesn't appear to be a major threat to shaded environments, such as a forest understory, but could quickly invaded forest gaps created by natural or human-aided disturbance. Infestations along stream banks increase susceptibility to erosion (Figure 81). Open areas can be quickly invaded and completely dominated by Japanese knotweed (Figure 82). Control and restoration is difficult and very expensive.



Figure 77



Figure 79





Figure 80

Promoted by high light environment Promoted by soil disturbance Re-sprouts vigorously after cutting Invades readily after disturbance Does not invade undisturbed sites

#### Reproduction

Primary means - Asexual Vegetative reproduction (roots and shoots) Minimal sexual reproduction Can hybridize with giant knotweed

#### Seed dispersal

Wind and water dispersed seeds Plant material water and human spread (soil contaminate)

#### Growth Habits

Semi-woody shrub Perennial Cold hardy Full sun tolerant Shade intolerant Saturated soil and flood tolerant Somewhat drought tolerant Prefers open habitats Above ground portions die-back in winter

#### **Response to Prescribed Fire**

Not known if fire works as a control Not a fire hazard



Figure 81

#### **Control Recommendations**

Treat foliage with one of the following herbicides in water with a surfactant, Garlon 3A, Garlon 4, or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix), the ideal time to spray is after surrounding vegetation has become dormant (October-November) to avoid affecting non-target species. surrounding vegetation has become dormant (October-November) to avoid affecting non-target species. A 0.5% non-ionic surfactant is recommended in order to penetrate the leaf cuticle, and ambient air temperature should be above 65°F.

Or, cut the stem 5 cm (2 in) above ground level. Immediately apply a 25% solution of Garlon 3A, Garlon 4, or glyphosate (32 ounces per 1-gallon mix) to the cross-section of the stem. A subsequent foliar application of glyphosate may be required to control new seedlings and resprouts. Use this method in areas where vines are established within or around non-target plants or where vines have grown into the canopy. This treatment remains effective at low temperatures as long as the ground is not frozen.

(See Herbicide Quick Reference page 40-42)



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#### Section IV: Quick Reference Tables Herbicide Quick Reference Guide Arsenal AC, Chopper (Imazapyr) Escort XP (Metsulfuron)

#### MODE OF ACTION

Plant protein production inhibitor Absorbed by both roots and foliage, and translocated throughout plant; accumulates in growing tissues and roots

#### SELECTIVITY

Selective; controls most hardwoods, most pines are tolerant

At higher application rates, pines will show epinasty and reduced growth

Controls some grasses except at very low application rates

#### SOIL ACTIVITY AND MOBILITY

Soil active; however, soil mobility is relatively low Imazapyr appears to bind loosely to clay particles and organic matter

Soil activity expresses itself during the period of spring leaf expansion; applications made from late June through mid-September produce little or no evidence of soil activity

Application after mid-September may yield soil activity during the following spring

#### PERSISTENCE AND BREAKDOWN

Moderately persistent; half-life is reported to be 19-34 days, but soil residues may persist significantly longer during periods of cold weather

Decomposition is primarily by photolysis **PRIMARY FORESTRY USES** 

Widely used for site preparation and release in pine management

Recommended for directed foliar application or injection; may be effectively tank-mixed with other herbicides such as triclopyr or glyphosate Tank mixes either have a broadened target spectrum or are more effective on target species than each component alone

Effects on treated vegetation appear very slowly; visual impact is low

#### APPLICATION TIMING

Avoid injection applications during rapid tree growth/green up in spring and early summer Directed foliar spray made in July or August when material washed off leaves tends not to be picked up by roots of non-target plants, allows for good selectivity

Fall treatments may result in winter "carry-over" and residual soil activity the following spring WEAKNESSES OR LIMITATIONS

Little control of blackgum, and locust; effectively releases blackberry

Broadcast applications of more than one ounce per acre will control most grasses, unless spray is intercepted by taller vegetation.

Grass control is not desirable in ROW applications

#### MODE OF ACTION

Rapid foliar and root absorption; systemic translocation Acts to inhibit cell division by disrupting amino

acid biosynthesis

#### SELECTIVITY

Somewhat selective; affects many broadleaved weeds and many annual grasses

#### SOIL ACTIVITY AND MOBILITY

Fairly mobile in soil; soil active PERSISTENCE AND BREAKDOWN

Broken down by chemical hydrolysis and soil microbes; rate of breakdown is influenced by soil temperature, pH, and levels of oxygen & moisture

Half-life in the South is 1 - 6 weeks (typically about 30 days)

#### APPLICATION TIMING

Best results achieved in early growing season with post-emergence application; best on actively growing weeds

Rapid growth enhances efficacy of the herbicide Also effective as a pre-emergent soil application

#### Garlon, Pathfinder II (Triclopyr)

#### MODE OF ACTION

Growth regulator, readily absorbed by foliage, with some stem uptake

Translocates up and down in plants; accumulates in growing tissues and the root collar

#### SELECTIVITY

Semi-selective; controls many woody and broadleaf species; grasses are tolerant

Pines are tolerant of the amine formulation after resting buds are formed in late summer; the ester formulations control pines as well as hardwoods

#### SOIL ACTIVITY AND MOBILITY

Generally non-mobile in soils; but, gross applications (spills) or misapplication of Garlon 3A may show some mobility and non-target root uptake and may contaminate ground water

#### PERSISTENCE AND BREAKDOWN

Moderately short half-life of 10-46 days with an average 30 day half-life; degraded both by soil microbes and by photolysis

Breakdown in water is photolytic and extremely rapid (10 hr half-life at  $25^{\circ}$  C)

#### PRIMARY FORESTRY USES

Garlon 3A is used as an injection or cut-surface treatment in site preparation and release, and as a foliar spray in rights-of-way or for hardwood control in conifer plantations

Efficacy of Garlon 3A is increased, and application rate reduced, by tank mixing with imazapyr Some tank mixes with Glyphosate are also effective Garlon 4 is used as a basal bark (streamline application) treatme**Frage 3200 tof 416** rol of

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individual stems in either pine or hardwood management

It may also be used as an emulsion in a water-based foliar spray for control of either pines or hardwoods

Efficacy of Garlon 4 may be enhanced and rates reduced by tank mixing with imazapyr [Chopper] Pathfinder II is used primarily in right-of-way applications, but may also be used as a selective basal bark treatment (streamline application) in forestry applications

#### APPLICATION TIMING

Broadcast or directed foliar sprays may be done any time during the full-leaf season Injection and cut-surface treatments may be done

at any time other than during spring sap-flow Basal bark treatments must generally be done during the leaf-off season to avoid contact with leaves of desirable vegetation and resultant damage

#### WEAKNESSES OR LIMITATIONS

Little or no control of sourwood, blackgum, and persimmon. Red maple displays top-kill, but often resprouts from the roots after 1-2 years Currently formulated with a flammable carrier (kerosene)

Some grazing and hay harvest restrictions apply, depending upon product and application rate

#### glyphosate

#### MODE OF ACTION

Growth inhibitor; absorbed by foliage, translocates throughout the plant eventually accumulating in the roots

#### SELECTIVITY

Semi-selective; pines show limited tolerance if application is made after they form resting buds late in the summer

Controls most, but not all, grasses In aquatic applications, effective only on emerged

plants or shoreline vegetation

#### SOIL ACTIVITY AND MOBILITY

Not soil active; not mobile in soil

Glyphosate is strongly adsorbed to soil particles and organic matter; deactivated rapidly by muddy water or water with a high calcium content

#### PERSISTENCE AND BREAKDOWN

Decomposed by microbial activity; moderate halflife of about 60 days

#### APPLICATION TIMING

Glyphosate formulations generally give poor control of ash and hickory, and are weak on dogwood, sourwood, and yellow poplar Foresters is generally considered a "fall" chemical; it is generally applied after pine resting buds are formed, but before leaf coloration (early summer applications often produce top-kill followed by resprouting) Injection may be done at any time the trees are actively growing, except in the spring during rapid sap flow

Aquatic treatments and wildlife opening rehabilitation should be done when the target vegetation is actively growing, but even here, late season application is generally best

#### WEAKNESSES OR LIMITATIONS

Aquatic treatments and wildlife opening rehabilitation should be done when the target vegetation is actively growing, but even here, late season application is generally best Use caution when tank mixing glyphosate and triclopyr formulations, they may deactivate each other; make a test mix in a jar to check compatibility before attempting to tank mix these products

Glyphosate is not generally effective against submerged plants (binds to suspended soil and organic matter)

Glyphosate is not generally considered suitable for right-of-way application because it kills the grasses and leaves soil vulnerable to erosion

#### CAUTION

Do not mix or store glyphosate in unlined steel or galvanized containers; hydrogen gas will be produced, and may build up in dangerous quantities

#### Krenite (Fosamine)

#### MODE OF ACTION

Bud inhibitor; absorbed slowly by leaves While laboratory testing indicates that it translocates throughout the target plant, only treated portions of the plant are affected in field applications

(An explanation for this apparently inconsistent behavior is still lacking)

When applied in the fall plants do not re-leaf the following spring - no obvious brownup results from its use

#### SELECTIVITY

Limited selectivity; controls both pines and hardwoods but not grasses

#### SOIL ACTIVITY AND MOBILITY

Not soil active; little or no movement in soil primarily due to its short half-life in soil (7-10 days)

PERSISTENCE AND BREAKDOWN

Relatively short half-life (7-10 days); breakdown is by soil microbes

#### APPLICATION TIMING

Generally applied in late summer/early fall; autumn leaf coloration masks treatment effects WEAKNESSES OR LIMITATIONS

Absorption by leaf surfaces is slow; rainfall within 6 hours after application may make treatment ineffective

"S" formulation works best; the "S"urfactant aids leaf surface penetration

Works better in cooler climates; not very effective in long growing seasons of the deep South

#### Transline (Clopyralid)

#### MODE OF ACTION

Plant growth regulator

#### SELECTIVITY

Selective; controls composites, legumes, and smartweeds, while pines, most hardwoods, and grasses are tolerant

#### SOIL ACTIVITY AND MOBILITY

Although soil application is not recommended, clopyralid is absorbed by the roots or foliage, and soil activity from spills or misapplication can occur Soil mobility is relatively high, especially if percolating water is present

#### PERSISTENCE AND BREAKDOWN

Low to moderate in persistence; aerobic half-life is 12 to 70 days

Breakdown is by soil microbes

#### APPLICATION TIMING

Apply when plants are actively growing One or two applications per year for two to four years may be required to completely control old, well-established kudzu

#### WEAKNESSES OR LIMITATIONS

Forestry application formerly was restricted to sites adjacent to rights-of-way, wildlife openings and certain types of tree plantations.

May cause needle curling or leaf burning when used in over-the-top release sprays. This effect is made worse by surfactants

#### Vanquish (Dicamba)

#### MODE OF ACTION

Growth regulator; readily absorbed by roots and leaves Translocates through xylem and accumulates in mature leaves

#### SELECTIVITY

Somewhat selective; controls most annual or perennial broadleaved weeds (including hardwoods) but may damage or kill pines Does not control grasses

#### SOIL ACTIVITY AND MOBILITY

Soil active; relatively mobile if percolating water is present

#### PERSISTENCE AND BREAKDOWN

Relatively short half-life (2 weeks)

Breakdown, primarily by soil microbes, is strongly affected by both soil temperature and soil moisture

#### TOXICITY TO HUMANS AND WILDLIFE

Relatively low toxicity and Rat oral  $\rm LD_{50}$  (technical dicamba) is 1,707 mg/kg; for Vanquish it is 3,512 mg/kg

#### PRIMARY FORESTRY USES

May be used for forest site preparation and rightsof-way maintenance

#### APPLICATION TIMING

Generally applied in spring or early summer

#### Velpar (Hexazinone)

#### MODE OF ACTION

Photosynthetic inhibitor; readily absorbed through the roots and, to a lesser degree, through foliage (liquid formulations)

Foliar absorption can be greatly enhanced by the addition of a nonionic surfactant

Translocates upward via the xylem

#### SELECTIVITY

Generally selective, controlling most hardwoods White pines are susceptible to hexazinone; loblolly pine is somewhat more susceptible than the other, generally resistant, southern yellow pines Controls some grasses

#### SOIL ACTIVITY AND MOBILITY

Soil active; tends to be highly mobile in soil, especially porous soils with percolating water Mobility is strongly influenced by soil texture; high clay or organic matter content retards movement and reduces efficacy

Application rates must be adjusted to suit soil texture

Do not apply to saturated or poorly drained soils **PERSISTENCE AND BREAKDOWN** 

Moderate half-life (1 - 6 months; typical = 90 days); breakdown is by soil microbes

**TOXICITY TO HUMANS AND WILDLIFE** Low toxicity; rat oral LD<sub>20</sub> is 1,690 mg/kg for the

Low toxicity; rat oral  $LD_{50}$  is 1,690 mg/kg for the technical product

Velpar L has a  $LD_{50}$  of 4,120 mg/kg **APPLICATION TIMING** 

Used for site preparation and release in pine management, by broadcast (ULW) or soil spot (Velpar L, DF) treatment

May be used as a foliar spray or for injection (Velpar L, DF)

Hexazinone is a "spring" chemical, and is most effective when applied during periods of rapid plant growth and of frequent rainfall **APPLICATION TIMING** 

Soil treatments in the South are generally ineffective after mid-June

#### WEAKNESSES OR LIMITATIONS

Do not use where mobility in soil is likely to result in off-site movement (hillsides, etc.)

Creates a fairly rapid "brownup" which may be visually unacceptable

Broadcast treatments may cause some mortality in loblolly pine

Do not use on or under white which are very susceptible

Gives poor control of ash, yellow poplar, sourwood, hornbeam, and persimmon Velpar L is formulated with an alcohol carrier which can cause permanent eye injury Herbicide Quick Reference Guide

					Herbici	des				
Invasive Species	Arsenal AC	Escort XP	Garlon 3A	Garlon 4	glyphosate	Krenite S	Pathfinder II	Transline	Vanquish	Velpar
Tree of Heaven	B,O		С	C,K	C,O	F				
Paulownia	B,O		С	C,K	C,O					
Tallow tree	B,O		0	C,K		Н	0			
Autumn Olive	B,L			B,K	М				В	
Privet	В	Н	М	К	E,M	Ъ				
Oriental Bittersweet			С	C,K,N	C,N					
Japanese Honeysuckle		ſ	D	D,M	C,M					
Japanese Climbing Fern	В	I	С	С	С					
Cogongrass	С				С					
Nepalese Browntop					С					
Garlic Mustard					С					
Exotic Lespedezas		9		С	С			V		С
Japanese Knotweed			C,N	C,N	C,N					

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**9**<sub>A</sub> 0.2% foliar B 1% foliar C 2% foliar D 3-5% foliar

G 3/4 ounce/acre foliar H 1 ounce/acre foliar F 15-20% foliar

E 3-5% foliar (dormant season only)

 J 2 ounces/acre foliar
 K 20% basal bark with oil and penetrant
 L 10% cut stump/injection I 1-2 ounces/acre foliar

M 20% cut stump/injection
N 25% cut stump/injection
O 20-50% cut stump/injection
P 50% cut stump/injection







Species Distribution

~						Stat	es and Pl	nysiograp	hic regions					
	mivasive opecies	AL	AR	FL	GA	KY	$\mathbf{LA}$	MS	NC	OK	SC	ΛL	ΤX	ΥΛ
	Tree of Heaven	A,I,P,R	O,Z		B,P,R	A,C,I			B,P	O,Z	B,P	A,C,I,R		A, B, P, R
	Paulownia	A,R	O,Z		B,R	Α			В		В	A,R		A,B,R
	Tallow tree	C	С	С	С		C	С	С		C		С	
•	Autumn Olive	A,I,P,R	O,Z		B,P,R	A,I			B,P	O,Z	B,P	A,I,R		A,B,P,R
	Privet	A,C,I,P,R	C,O,Z	С	C,B,P,R	A,C,I	С	С	B,C,P	C,O,Z	B,C,P	A,C,I,R	С	A,B,C,P,R
	Oriental Bittersweet	A,P,R	O,Z		B,P,R	A,C,I			B,P	O,Z	B,P	A,C,I,R		A,B,P,R
	Japanese Honeysuckle	A,C,I,P,R	C,O,Z	С	C,B,P,R	A,C,I	С	С	B,C,P	C,O,Z	B,C,P	A,C,I,R	С	A,B,C,P,R
·	Japanese Climbing Fern	C,P		С	C,P		С	С	С		С		С	
-	Cogongrass	C,P	С	С	C,P		С	С	C,P	С	C,P	С	С	
	Nepalese Browntop	A,I,P,R	O,Z		B,P,R	A,I			B,P	O,Z	B,P	A,I,R		A,B,P,R
Pa	Garlic Mustard	A,I,P,R	O,Z		B,P,R	A,C,I			B,P	0,Z	P,B	A,C,I,R		A, B, P, R
age 3	Exotic Lespedezas	A,C,I,P,R	C,O,Z	С	C,B,P,R	A,C,I	С	С	B,C,P	C,O,Z	B,C,P	A,C,I,R	С	A,B,C,P,R
05 o	Japanese Knotweed	A,R			B,R	$\Lambda,I$			B,P		В	A,I,R		A,B,P,R
416 416	<ul> <li>A - Appalachian/Cumber</li> <li>B - Blue Ridge Mountains</li> <li>C - Coastal Plain</li> <li>- Interior Low Plateau</li> </ul>	fand Plateau	Odwn	<ul> <li>Ouachita</li> <li>Piedmont</li> <li>Ridge anc</li> <li>Ozark Pla</li> </ul>	. Mountains t 1 Valley ateau									

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	R	esponse to I	Disturbanc	e
Invasive Species	High Light	Soil Disturbance	Fire	Re-sprout/ re-grow
Tree of Heaven	Promoted	Promoted	Negligible	Yes
Paulownia	Promoted	Promoted	Promoted	Yes
Tallow tree	Promoted	Promoted	Discouraged	Yes
Autumn Olive	Promoted	Promoted	Promoted	Yes
Privet	Promoted	Promoted	Negligible	Yes
Oriental Bittersweet	Negligible	Promoted	Negligible	Yes
Japanese Honeysuckle	Promoted	Promoted	Negligible	Yes
Japanese Climbing Fern	Negligible	Promoted	Promoted	Yes
Cogongrass	Promoted	Promoted	Promoted	Yes
Nepalese Browntop	Promoted	Promoted	Discouraged	No
Garlic Mustard	Discouraged	Promoted	Discouraged	No
Exotic Lespedezas	Promoted	Promoted	Promoted	Yes
Japanese Knotweed	Promoted	Promoted	Negligible	Yes

		Seed Dis	spersal	
Invasive Species	Wind	Water	Bird	Soil contaminate
Tree of Heaven	Yes	No	No	No
Paulownia	Yes	No	No	No
Tallow tree	No	Yes	Yes	No
Autumn Olive	No	No	Yes	No
Privet	No	Yes	Yes	No
Oriental Bittersweet	No	Yes	Yes	No
Japanese Honeysuckle	No	No	Yes	No
Japanese Climbing Fern	Yes	Yes	No	Yes
Cogongrass	Yes	No	No	Yes
Nepalese Browntop	No	Yes	No	Yes
Garlic Mustard	No	Yes	No	Yes
Exotic Lespedezas	No	No	Yes	Yes
Japanese Knotweed	Yes	Yes	No	No

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		Gro	owth Ha	bits	
Invasive Species	Form	Shade tolerant	Flood tolerant	Drought tolerant	Habitat
Tree of Heaven	Tree	Yes	Yes	Yes	Disturbed areas
Paulownia	Tree	No	Yes	Yes	Disturbed areas
Tallow tree	Tree	Yes	Yes	No	Varied
Autumn Olive	Shrub/tree	Somewhat	No	Yes	Open
Privet	Shrub/tree	Yes	Yes	No	Forests
Oriental Bittersweet	Vine	Yes	No	No	Open woods / Disturbed Areas
Japanese Honeysuckle	Vine	Yes	Yes	Yes	Varied
Japanese Climbing Fern	Vine	Yes	Yes	No	Varied
Cogongrass	Grass	Yes	No	Yes	Varied
Nepalese Browntop	Grass	Yes	Yes	No	Moist forests
Garlic Mustard	Herbaceous	Yes	Yes	No	Forests
Exotic Lespedezas	Semi-woody shrub	No	No	Yes	Open woods / Grasslands
Japanese Knotweed	Semi-woody shrub	No	Yes	Somewhat	Open

Incoming Comparing		Prescrib	ed Fire	
Invasive Species	Control option	Hazard	Post-fire	
Tree of Heaven	No	No	Rapid re-growth	
Paulownia	No	No	Colonizes quickly	
Tallow tree	Yes	No	Re-growth possible	
Autumn Olive	No	No	Colonizes quickly	
Privet	Yes	No	Rapid re-growth	
Oriental Bittersweet	No	No	Re-growth possible	
Japanese Honeysuckle	No	No	Rapid re-growth	
Japanese Climbing Fern	No	Yes	Rapid re-growth	
Cogongrass	No	Yes	Stimulates flowering	
Nepalese Browntop	No	No	Establishes on bare soil	
Garlic Mustard	Yes	No	Seed bank survival	
Exotic Lespedezas	No	No	Scarifies seeds, high rates of germination	
Japanese Knotweed	Not Available	No	Not Available	

		R	eproducti	on	
Invasive Species	Primary means	Time to Maturity	Max seeds	Seed Bank	Reproductive system
Tree of Heaven	Seed and Clonal	10 Years	300,000/plant	< 1year	Perennial
Paulownia	Seed	8-10 Years	20 million/plant	Not Available	Perennial
Tallow tree	Seed	3 Years	100,000/plant	7 years	Perennial
Autumn Olive	Seed	3-5 Years	66000/plant	Not Available	Perennial
Privet	Seed and Asexual	Not Available	100s/plant	< 1year	Perennial
Oriental Bittersweet	Seed	2 Years	2200/plant	< 1year	Perennial
Japanese Honeysuckle	Asexual and Seed	Not Available	222 g seeds/plant	< 1year	Perennial
Japanese Climbing Fern	Spore	Not Available	Not Available	Not Available	Perennial
Cogongrass	Seed and Rhizome	1 Year	3000/plant	< 6 months	Perennial
Nepalese Browntop	Seed	1 Year	1000/plant	3-5 Years	Annual
Garlic Mustard	Seed	2 Years	7900/plant	4-6 years	Biennial
Exotic Lespedezas	Seed and roor crowns	Not Available	300 million / acre	20+ years	Perennial
Japanese Knotweed	Asexual (mainly)	N/A	N/A	N/A	Perennial

Management Recommendations

vasive Species						
	Harvest Activities	<b>Prescribed Fire</b>	Internal Road Construction	Mechanical Site Prep	Tree Planting	Release Treatments (Intermediate Treatments)
of Heaven	b,d,e	q	d,e	b,d,e	d,e	b,d,e
ownia	a,b,d,f	d,f,i	d,f	b,d,f	d,f	b,d,f
ow tree	b,d,f,j	c,d	d,f,j	d,f,j	d,f	b,d,f,j
ımn Olive	d,h	b,h	d,h	Ч	h	b,d,h
et	d,h,j	c,d,h	d,h,j	d,h,j	d,h	b,d,h,j
ntal Bittersweet	b,d,h	d,h	d,h	b,d,h	d,h	b,d,h
nese Honeysuckle	d,h	c,d,h	d,h,j	c,h,j	d,h	b,d,h,j
nese Climbing Fern	d,f	b,f,g	d,f,j	d,f,j	d,f	b,d,f,j
ngrass	a,b,e,f	b,e,f,g	d,e,f	d,e,f	d,e,f	b,d,e,f
alese Browntop	d,f,j	c,f	d,f,j	f,j	f	b,d,f,j
ic Mustard	d,f	c,d,f	d,f	c,f	c,d,f	b,d,f
tic Lespedezas	b,d,h	a,b,d,h	d,h	b,d,h	d,h	b,d,h
nese Knotweed	d,e,j	р	d,e,j	b,e,j	ə	d,e,j
onduct control measu pecies is promoted by ceatment can reduce s ollow-up treatment by lean any equipment th	tres before initiating si r treatment, follow-up species population leve y monitoring site for r hat contacts soil (plant	llviculture treatmer control measures i els ew infestations : is rhizome spread	t nay be needed <b>g</b> - Clea. <b>h</b> - Mor <b>i</b> - Resp <b>j</b> - Spec	n all equipment thoroug form with caution, special nitor fencerows, edges, a onse of invasive depends u ies may be found in wet	hly (plant is seed es increases fire ri nd SMZs for new pon timing of trea land, see herbicid	or spore spread) sk infestations (bird dispersed) tment, see species page for details e table for label information

#### References

- Batcher, M.S. 2000. Element Stewardship Abstract for *Ligustrum* spp. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/ligu\_sp.html.
- Bogler, D.J and M.S. Batcher. 2000. Element Stewardship Abstract for Sapium sebiferum. The Nature Conservancy (TNC) Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/sapiseb.html.
- Burns, J.H. and T.E. Miller. 2004. Invasion of Chinese Tallow (*Sapium sebiferum*) in the Lake Jackson area, Northern Florida. American Midland Naturalist. 152:410-417.
- Byers, D.L. and J.A. Quinn. 1998. Demographic Variation in *Alliaria* (Brassicaceae) in Four Contrasting Habitats. Journal of the Torrey Botanical Society. Vol. 125. No. 2: 138-149.
- Cole, P.G. and J.F. Weltzin. 2004. Environmental Correlates of the Distribution and Abundance of *Microstegium vimineum*, in East Tennessee. Southeastern Naturalist. 3(3):545-562.
- Dreyer, G.D. 1994. Element Stewardship Abstract for *Celastrus orbiculata*. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/celaorb.html.
- Ellsworth, J.W., R.A. Harrington, and J.H. Fownes. 2004. Seedling emergence, growth, and allocation of Oriental bittersweet: effects of seed input, seed bank, and forest floor litter. Forest Ecology and Management. 190: 255-264.
- Evans, C.W., D.J. Moorhead, C.T. Bargeron, and G.K. Douce. 2005. Identifying and Controlling Cogongrass in Georgia. The Bugwood Network, The University of Georgia. Tifton, GA BW-2005-04. http://www.cogongrass.org/cogongrasspub.pdf.
- Evans, C.W., D.J. Moorhead, C.T. Bargeron, and G.K. Douce. 2006. Invasive Plants of Georgia's Forests: Identification and Control. The Bugwood Network, The University of Georgia, BW-2006-02. http://www.gainvasives.org/pubs/gfcnew.pdf.
- Ferguson, L., C. Duncan, and K. Snodgrass. 2003. Backcountry Road Maintenance and Weed Management. Tech. Rep. 0371-2811-MTDC. Missoula, MT: USDA, Forest Service, Missoula Technology and Development Center, 22p.
- Fire Effects Information System. 2003. Online database at http://www.fs.fed.us/database/feis/
- FL-EPPC, Lygodium Task Force. 2001. Lygodium Management Plan for Florida. Florida Exotic Pest Plant Council. http://www.fleppc.org/Manage\_Plans/Lygo\_micro\_plan.pdf.
- Hobbs, R.J. and S.E. Humphries. 1995. an Integrated Approach to the Ecology and Management of Plant Invasions. Conservation Biology. 9(4):761-770.
- Horton, J.L. and H.S. Neufeld. 1998. Photosynthetic responses of *Microstegium vimineum* (Trin.) A. Camus, a shade-tolerant, C4 grass, to variable light environments. Oecologia (1998) 114:11-19.
- Hoshovsky, M.C. 1988. Element Stewardship Abstract for Ailanthus altissima. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/ailaalt.html.
- Luken, J.O., L.M. Kuddes, and T.C. Tholemeier. 1997. Response to Understory Species to Gap Formation and Soil Disturbance in *Lonicera maackii* Thickets. Restoration Ecology Vol. 5 No.3: 229-235.
- Meekins, J.F. and B.C. McCarthy. 2000. Responses of the biennial forest herb *Alliaria petiolata* to variation in population density, nutrient addition and light availability. Journal of Ecology 88: 447-463.

- Miller, J.H. and K.V. Miller. 1999. Forest Plants of the Southeast and Their Wildlife Uses. Revised Edition, In cooperation with the Southern Weed Science Society. The University of Georgia Press, Athens, GA. 454 pp.
- Miller, J. H. 2003. Nonnative invasive plants of southern forests: a field guide for identification and control. Gen. Tech. Rep. SRS–62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 93 p.
- Mistretta, P. 2003. Pesticide Applicator Training Course, USDA Forest Service Region 8. http://www.bugwood.org/PAT/index.html
- Morisawa, T. 1999. Weed Notes: Lespedeza bicolor. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/moredocs/lesbic01.html.
- Nuzzo, V. 1997. Element Stewardship Abstract for Lonicera japonica. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/lonijap.html
- Nuzzo, V. 1999. Invasion pattern of the herb garlic mustard (*Alliaria petiolata*) in high quality forests. Biological Invasions 1: 169-179.
- Nuzzo, V. 2000. Element Stewardship Abstract for Alliaria petiolata. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/allipet.html
- Preston, R. J. (1989). North American Trees. Ames: Iowa State University Press. 407 pp.
- Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill. 1183 pp.
- Remaley, T. 2000. Southeast Exotic Pest Plant Council Invasive Plant Manual. http://www.se-eppc.org/manual/index.html.
- Sather, N. and N. Eckardt. 1987. Element Stewardship Abstract for *Elaeagnus umbellata*. TNC Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/elaeumb.html
- Seiger, L. 1991. Element Stewardship Abstract for *Polygonum cuspidatum*. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/polycus.html.
- Stevens, S. 2002. Element Stewardship Abstract for Lespedeza cuneata (Dumont-Cours.) G. Don. TNC Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/lespcun.html.
- Swearingen, J., K. Reshetiloff, B. Slattery, and S. Zwicker. 2002. Plant Invaders of Mid-Atlantic Natural Areas. National Park Service and U.S. Fish & Wildlife Service, 82 pp.
- Tu, M. 2000. Element Stewardship Abstract for *Microstegium vimineum*. The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/esadocs/documnts/micrvim.html
- Tu. M. 2002. Weed Notes: Imperata cylindrica 'Red Baron' (Japanese Blood Grass). The Nature Conservancy Invasive Species Initiative. http://tncweeds.ucdavis.edu/moredocs/impcyl01.html
- USDA Forest Service. 2001. Guide to Noxious Weed Prevention Practices. http://www.fs.fed.us/rangelands/ftp/invasives/documentsGuidetoNoxWeedPrevPractices\_07052001.pdf.
- Van Driesche, R., et al., 2002, Biological Control of Invasive Plants in the Eastern United States, USDA Forest Service Publication FHTET-2002-04, 413 p.
- Weakley, A.S. 2006. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas: Working Draft of 17 January 2006. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC.
- Yates, E. D., D. F. Levia Jr., C. L. Williams. 2004. Recruitment of three non-native invasive plants into a fragmented forest in southern Illinois. Forest Ecology and MarRegereal 1 69(4)189-130.



The Bugwood Network *www.bugwood.org* 

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The University of Georgia and Ft. Valley State College, the U.S. Department of Agriculture and counties of the state cooperating. The Cooperative Extension, the University of Georgia College of Agricultural and Environmental Sciences and Warnell School of Forestry and Natural Resources offers educational programs, assistance and materials to all people without regard to race, color, national origin, age, sex or disability.

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# Nonnative Invasive Plants of Southern Forests

A Field Guide for Identification and Control





Forest Service Southern Research Station General Technical Report SRS-62



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# **Front Cover**

**Upper left**—Chinese lespedeza (*Lespedeza cuneata*) infestation that developed from dormant seed in the soil seed bank after a forest thinning operation.

Upper right—Kudzu (Pueraria montana) infestation on the urban-wildland interface.

*Lower left*—Chinese privet (*Ligustrum sinense*) and dormant kudzu invading and replacing a pine-hardwood stand.

Lower right—Cogongrass (Imperata cylindrica) infestation under mature slash pine (Pinus elliottii).

## **Back Cover**

**Upper left**—Stem injection using a hatchet and spray bottle to apply a hack-and-squirt treatment to control silktree (*Albizia julibrissin*).

Upper right—Hand pulling seedlings of Chinese privet (Ligustrum sinense).

Lower left-Prescribed burning can often assist in controlling garlic mustard (Alliaria petiolata).

*Lower right*—Containerized native plants for rehabilitation plantings.

Funding support for 2006 reprinting provided by the Eastern Forest Environmental Threat Assessment Center, Asheville, NC.

First Printed May 2003 Revised August 2003 Revised December 2004 Revised August 2006

Southern Research Station P.O. Box 2680 Asheville, NC 28802

# Nonnative Invasive Plants of Southern Forests

# A Field Guide for Identification and Control

James H. Miller

# **Acknowledgments**

The contributions of Erwin B. Chambliss, USDA Forest Service, Auburn, AL, have been invaluable in image management and layout. Kristine Johnson, Great Smoky Mountains National Park; Johnny Randall, North Carolina Botanical Gardens; Jack Ranney, University of Tennessee; and Fred Nations, Weeks Bay National Estuarine Research Reserve, made comprehensive reviews and provided invaluable recommendations for improvements. Reviews of control recommendations were made by Ron Cornish, Dow ArgroScience; Harry Quicke, BASF Corporation; Carroll Walls, UAP Timberlands; and Michael Link, DuPont Corporation. Their knowledgeable comments greatly strengthened content and clarity.

#### All Plant Images by the Author Except for the Contributions by:

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- Patrick Breen, Department of Horticulture, Oregon State University, Corvallis, OR
- Charles T. Bryson, USDA Agricultural Research Service, Southern Weed Science Research Unit, Stoneville, MS
- Thomas Ellis, Jr., Baldwin County Forestry Planning Committee, Bay Minette, AL
- Chris Evans, University of Georgia, Tifton, GA
- John W. Everest, Department of Agronomy & Soils, Auburn University, Auburn, AL
- Jerry Gibson, Deer Park, AL

Kristine Johnson, Great Smoky Mountains National Park, Gatlinburg, TN

Keith Langdon, Great Smoky Mountains National Park, Gatlinburg, TN

- John Meade, Department of Plant Science, Rutgers, The State University of New Jersey, New Brunswick, NJ
- Fred Nation, Weeks Bay National Estuarine Research Reserve, Fairhope, AL

John M. Randall, The Nature Conservancy, University of California, Davis, CA

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Susan Ross, Great Smoky Mountains National Park, Gatlinburg, TN

John Schwegman, Illinois Department of Natural Resources, Springfield, IL

Jody Shimp, Illinois Department of Natural Resources, Springfield, IL

Warner Park Nature Center, Metropolitan Board of Parks and Recreation, Nashville, TN

Hugh Wilson, Texas A&M University, College Station, TX

#### Plant Names and Plant Distribution Maps from:

- USDA Natural Resources Conservation Service's Plants Database: <u>http://plants.usda.gov</u>.
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#### ABSTRACT

Invasions of nonnative plants into forests of the Southern United States continue to go unchecked and unmonitored. Invasive nonnative plants infest under and beside forest canopies and dominate small forest openings, increasingly eroding forest productivity, hindering forest use and management activities, and degrading diversity and wildlife habitat. Often called nonnative, exotic, nonindigenous, alien, or noxious weeds, they occur as trees, shrubs, vines, grasses, ferns, and forbs. This book provides information on accurate identification and effective control of the 33 nonnative plants and groups that are currently invading the forests of the 13 Southern States, showing both growing and dormant season traits. It lists other nonnative plants of growing concern, control strategies, and selective herbicide application procedures. Recommendations for preventing and managing invasions on a specific site include maintaining forest vigor with minimal disturbance, constant surveillance and treatment of new unwanted arrivals, and finally rehabilitation following eradication.

**Keywords:** Alien plants, exotic plant control, exotic weeds, herbicide weed control, integrated vegetation management, invasive exotic plants, invasive nonindigenous plants, noxious plant control.

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# Explanation of Codes and Conventions Used in Species Descriptions





Broadcast treatment of herbicide spray to kudzu.

# Introduction

Invasions of nonnative plants into southern forests continue to go largely unchecked and only partially monitored. Invasive nonnative plants infest under and beside forest canopies and occupy small forest openings, increasingly eroding forest productivity, hindering forest use and management activities, and degrading diversity and wildlife habitat. Often called non-native, exotic, nonindigenous, alien, or noxious weeds, they occur as trees, shrubs, vines, grasses, ferns, and forbs. Some have been introduced into this country accidentally, but most were brought here as ornamentals or for livestock forage. These robust plants arrived without their natural predators of insects and diseases that tend to keep native plants in natural balance. Many have hybridized. Now they increase across the landscape with little opposition, beyond the control and reclamation measures applied by landowners and managers on individual land holdings.

The objective of this book is to provide information on accurate identification and effective control of the 33 plants or groups that are invading the forests of the 13 Southern States at an alarming rate, showing both growing and dormant season traits. It lists other nonnative invasive plants of growing concern and explains control recommendations and selective application procedures. The text and photographs were originally developed to assist in the first region-wide survey and monitoring of these invading species, conducted by the USDA Forest Service's Forest Inventory and Analysis Research Work Unit of the Southern Research Station in collaboration with State forestry management agencies. The four-number survey codes as well as the international plant codes are given for each species (see opposite page).

Integrated vegetation management programs are needed to combat invading nonnative plants. Strategies of surveillance and treatment of new arrivals will safeguard lands, and rehabilitation of existing infestations can be achieved by concerted control measures and reestablishment of native vegetation. Tree-of-Heaven

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#### Ailanthus altissima (P. Mill.) Swingle AIAL

Synonyms: ailanthus, Chinese sumac, stinking sumac, paradise-tree, copal-tree

**Plant.** Deciduous tree to 80 feet (25 m) in height and 6 feet (1.8 m) in diameter, with long pinnately compound leaves and circular glands under lobes on leaflet bases. Strong odor from flowers and other parts, sometimes likened to peanuts or cashews.

**Stem.** Twigs stout, chestnut brown to reddish tan, and smooth-to-velvety with light dots (lenticels) and heart-shaped leaf scars. Buds finely hairy, dome-shaped, and partially hidden by the leaf base. Branches light gray to dark gray, smooth and glossy, with raised dots becoming fissures with age. Bark light gray and rough with areas of light-tan fissures.

**Leaves.** Alternate, odd- or even-pinnately compound, 10 to 41 leaflets on 1- to 3-foot (30 to 90 cm) light-green to reddish-green stalks with swollen bases. Leaflets lanceolate and asymmetric and not always directly opposite, each 2 to 7 inches (5 to 18 cm) long and 1 to 2 inches (2.5 to 5 cm) wide. Long tapering tips and lobed bases with one or more glands beneath each lobe (round dots). Margins entire. Dark green with light-green veins above and whitish green beneath. Petioles 0.2 to 0.5 inch (5 to 12 mm) long.

**Flowers.** April to June. Large terminal clusters to 20 inches (50 cm) long of small, yellowish-green flowers, with five petals and five sepals. Male and female flower on separate trees.

**Fruit and seeds.** July to February. Persistent clusters of wing-shaped fruit with twisted tips on female trees, 1 inch (2.5 cm) long. Single seed. Green turning to tan then brown.

**Ecology.** Rapid growing, forming thickets and dense stands. Both shade and flood intolerant and allelopathic. Colonizes by root sprouts and spreads by prolific wind-and water-dispersed seeds. Viable seed can be produced by 2- and 3-year-old plants.

**Resembles** hickories, *Carya* spp., and sumacs, *Rhus* spp., but neither has glands at leaflet bases. Hickories distinguished by a braided bark, sumacs by shrub shape.

**History and use.** Introduced in 1784 from Europe, although originally from Eastern China. Ornamental.



# **Tree-of-Heaven**



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0341

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# Silktree, Mimosa













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#### *Albizia julibrissin* Durazz. **ALJU** Synonym: silky acacia

**Plant.** Deciduous leguminous tree 10 to 50 feet (3 to 15 m) in height with single or multiple boles, smooth light-brown bark, feathery leaves, and showy pink blossoms that continually yield dangling flat pods during summer. Pods persistent during winter.

**Stem.** Twigs slender to stout, lime green turning shiny grayish brown with light dots (lenticels). No terminal bud. Bark glossy, thin, light brown turning gray with raised corky dots and dashes.

**Leaves.** Alternate, bipinnately compound 6 to 20 inches (15 to 50 cm) long with 8 to 24 pairs of branches and 20 to 60 leaflets per branch, feathery and fernlike. Leaflets asymmetric, 0.4 to 0.6 inch (1 to 1.5 cm) long, dark green, with midvein nearer and running parallel to one margin. Margins entire.

**Flowers.** May to July (and sporadically to November). Terminal clusters at the base of the current year's twigs, each with 15 to 25 sessile flowers 1.4 to 2 inches (3.5 to 5 cm) long. Pom-pom like with numerous filaments, bright-pink feathery tufts with white bases. Fragrant.

**Fruits and seeds.** June to February. Legume pods in clusters, flat with bulging seeds, each pod 3 to 7 inches (8 to 18 cm) long, splitting in winter along the edges to release 5 to 10 oval seeds. Initially light green turning dark brown in fall and whitish tan in winter.

**Ecology.** Occurs on dry-to-wet sites and spreads along stream banks, preferring open conditions but also persisting in shade. Seldom found above 3,000 feet (900 m). Forms colonies from root sprouts and spreads by abundant animal- and water-dispersed seeds. Seeds remain viable for many years. Nitrogen fixer.

**Resembles** honeylocust, *Gleditsia triacanthos* L., which has longer leaflets— 1 inch (2.5 cm) long. Seedlings resemble partridge pea, *Chamaecrista fasciculata* (Michx.) Greene, an annual plant with once pinnately compound leaves.

**History and use.** A traditional ornamental introduced from Asia in 1745. Potential use for forage and biofuel.





# Silktree, Mimosa



# Princesstree, Paulownia















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#### *Paulownia tomentosa* (Thunb.) Sieb. & Zucc. ex Steud. **PATO2** Synonym: empresstree

**Plant.** Deciduous tree to 60 feet (18 m) in height and 2 feet (60 cm) in diameter with large heart-shaped leaves, fuzzy hairy on both sides, showy pale-violet flowers in early spring before leaves, and persistent pecan-shaped capsules in terminal clusters in summer to winter. Abundant flower buds present on erect stalks over winter.

**Stem.** Twigs and branches stout, glossy gray brown and speckled with numerous white dots (lenticels). No terminal bud. Lateral leaf scars raised, circular, and becoming larger, dark, and sunken. Bark light-to-dark gray, roughened, and becoming slightly fissured. Stem pith chambered or hollow and wood white.

**Leaves.** Opposite, heart-shaped and fuzzy hairy on both surfaces, 6 to 12 inches (15 to 30 cm) long and 5 to 9 inches (13 to 23 cm) wide. Leaves larger on resprouts, 16 to 20 inches (40 to 50 cm) across, with extra tips often extending at vein tips. Petioles rough hairy, 2 to 8 inches (5 to 20 cm) long.

**Flowers.** April to May. Covered with showy erect panicles of pale-violet flowers before leaves in early spring, tubular with five unequal lobes. Fragrant. Flower buds fuzzy, linear, and becoming ovoid in summer and persistent on erect stalks over winter.

**Fruit and seeds.** June to April. Terminal clusters of pecan-shaped capsules 1 to 2 inches (2.5 to 5 cm) long and 0.6 to 1 inch (1.5 to 2.5 cm) wide. Pale green in summer turning to tan in winter and eventually black and persistent into spring. Capsules splitting in half during late winter to release tiny winged seeds.

**Ecology.** Common around old homes, on roadsides, riparian areas, and forest margins in infested areas. Infrequently planted in plantations. Spreads by wind- and water- dispersed seeds. Invades after fire, harvesting, and other disturbances. Forms colonies from root sprouts.

**Resembles** southern catalpa, *Catalpa bignonioides* Walt., and northern catalpa, *C. speciosa* (Warder) Warder *ex* Engelm., which have leaves with sparsely hairy upper surfaces and rough hairy lower surfaces and long slender, persistent beans.

**History and use.** Introduced in the early 1800s from East Asia. Has been widely planted as an ornamental and grown in scattered plantations for speculative high-value wood exports to Japan.

States with suspected infestations are shown in gray.



## Princesstree, Paulownia



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# Chinaberrytree

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#### Melia azedarach L. MEAZ

**Plant.** Deciduous tree to 50 feet (15 m) in height and 2 feet (60 cm) in diameter, much branched with multiple boles, lacy dark-green leaves having a musky odor, and clusters of lavender flowers in spring yielding persistent, poisonous yellow berries.

**Stem.** Twigs stout, glossy greenish-brown with light dots (lenticels). No terminal bud. Numerous broad, V-shaped, raised leaf scars with three bundle scars below a domed fuzzy bud. Bark dark chocolate brown and becoming increasingly fissured with age. Wood soft and white.

**Leaves.** Alternately whorled, bipinnately compound, 1 to 2 feet (30 to 60 cm) long and 9 to 16 inches (23 to 40 cm) wide. Leafstalk lime green with base slightly clasping stem. Each leaflet lanceolate with tapering tips, 1 to 3 inches (2.5 to 8 cm) long and 0.5 to 1.2 inches (1 to 3 cm) wide. Margins varying from entire to coarsely crenate to serrate and wavy. Glossy dark green with light-green midvein above and pale green with lighter-green midvein beneath, becoming golden yellow in fall.

**Flowers.** March to May. Showy panicles from lower axils of new stems. Five pinkish-lavender to whitish petals, stamens united in dark-purple tube. Five green sepals. Fragrant.

**Fruit and seeds.** July to January. Berrylike spherical drupe 0.5 to 0.7 inch (1.2 to 1.8 cm) wide persisting through winter and containing a stone with one to six seeds. Light green turning yellowish green then yellowish tan. Poisonous to humans and livestock.

**Ecology.** Common on roadsides, at forest margins, and around old homesites but rare at high elevations. Semishade tolerant. Forms colonies from root sprouts or sprouts from root collars, and spreads by bird-dispersed abundant seeds.

**Resembles** common elderberry, *Sambucus canadensis* L., a spreading crowned shrub with once pinnately compound leaves, margins finely serrate, and green to dark-purple berries in flat-topped clusters.

**History and use.** Introduced in the mid-1800s from Asia. Widely planted as a traditional ornamental around homesites. Extracts potentially useful for natural pesticides.





# Chinaberrytree



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# Tallowtree, Popcorntree













#### Triadica sebifera (L.) Small TRSE6

Synonym: Chinese tallowtree, Sapium sebiferum (L.) Roxb.

**Plant.** Deciduous tree to 60 feet (18 m) in height and 3 feet (90 cm) in diameter, with heart-shaped leaves, dangling yellowish spikes in spring yielding small clusters of three-lobed fruit that split to reveal popcorn-like seeds in fall and winter.

**Stem.** Terminal clusters of flowers and fruits result in whorled branching from lateral buds below fruit clusters. Twigs lime green turning gray with scattered brownish dots (lenticels) later becoming striations. Numerous semicircular leaf scars becoming raised with age. Bark light gray and fissured. Sap milky.

**Leaves.** Alternately whorled, distinctively heart-shaped with a rounded wide-angled base and a short or long attenuate tip. Blades 2 to 3 inches (5 to 8 cm) long and 1.5 to 2.5 inches (4 to 6 cm) wide. Dark-green with light-green mid- and lateral veins and turning yellow to red in fall. Hairless, lime-green petioles 1 to 3 inches (2.5 to 8 cm) with two tiny glands on upper side of juncture between blade and petiole (requires magnification).

**Flowers.** April to June. Slender, drooping spikes to 8 inches (20 cm) long of tiny flowers. Yellowish-green sepals but no petals. Female flowers at base and males along the spike.

**Fruit and seeds.** August to January. Small terminal clusters of three-lobed capsules (occasionally four to five lobed), each 0.5 to 0.75 inch (1.2 to 2 cm) across. Dark green in summer becoming black and splitting to reveal three white-wax coated seeds 0.3 inch (0.8 cm) long and 0.2 inch (0.5 cm) wide. Resemble popcorn and remain attached until winter.

**Ecology.** Invades stream banks, riverbanks, and wet areas like ditches as well as upland sites. Thrives in both freshwater and saline soils. Shade tolerant, flood tolerant, and allelopathic. Increasing widely through ornamental plantings. Spreading by bird- and water-dispersed seeds and colonizing by prolific surface root sprouts.

**Resembles** cottonwoods, *Populus* spp., which have wavy margined leaves and flaking bark.

**History and use.** Introduced from China to South Carolina in the 1700s and then in significant numbers to the gulf coast in the early 1900s. Plantings for seed oil recommended by the U.S. Department of Agriculture during 1920 to 1940. Ornamentals still sold and planted. Waxy seeds traditionally used to make candles. Honey plant for beekeeping.

States with suspected infestations are shown in gray.



## **Tallowtree, Popcorntree**



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12



P. Breen

Fall

P. Breen

Winter

#### Elaeagnus angustifolia L. ELAN

Synonym: oleaster

**Plant.** Deciduous, thorny tree or shrub to 35 feet (10 m) in height with a single bole, many long narrow leaves, and many yellow fruit covered with minute silvery scales.

Stem. Twigs slender, thorny, and silver scaly becoming glossy and greenish. Branches smooth and reddish brown. Pith pale brown to orange brown. Bark dark brown and denselv fissured.

Leaves. Alternate, long lanceolate to oblanceolate measuring 1.5 to 4 inches (4 to 10 cm) long and 0.4 to 1.2 inches (1 to 3 cm) wide. Margins entire (rarely toothed). Green to slightly silvery above with dense silver scales beneath. Petioles short and silvery.

Flowers. April to July. Axillary clusters, each with 5 to 10 silvery-white to yellow flowers. Tubular with four lobes. Fragrant.

Fruit and seeds. August to October. Drupelike, hard fleshy fruit 0.5 inch (1.2 cm) wide and long, resembling an olive. Light green to yellow (sometimes tinged with red). One nutlet in each fruit.

Ecology. Found as scattered plants in forest openings, open forests, and along forest edges. Thrives in sandy floodplains. Shade intolerant. Spreads by bird- and other animal-dispersed seeds. A nonleguminous nitrogen fixer.

**Resembles** silverthorn or thorny olive, *E. pungens* Thunb., which is an evergreen with brown scaly and hairy twigs, flowers in late fall producing few reddish silverscaly drupes in spring. Also resembles autumn olive, E. umbellata Thunb., which has leaves with nonscaly upper surfaces in summer, flowers in early summer, and many reddish, rounded berries in fall and early winter.

History and use. Native to Europe and western Asia, a recent (early 1900s) arrival in the upper part of the Southeast. Initially planted as a yard ornamental, for windbreaks, surface mine reclamation, and wildlife habitat.



# **Russian Olive**



# Silverthorn, Thorny Olive





October

April Page 332 of 416

April

#### Elaeagnus pungens Thunb. ELPU2

**Plant.** Evergreen, densely bushy shrub 3 to 25 feet (1 to 8 m) in height, with long limber projecting shoots, scattered thorny branches. Thick leaves, silver-brown scaly beneath. Often found as escaped single plants from animal-dispersed seeds.

**Stem.** Multiple stems and densely branched. Twigs brown and dense with brown scales and hairy when young. Short shoots with small leaves becoming sharp-branched or unbranched thorns 0.4 to 1.6 inches (1 to 4 cm) long, and in second year producing leafy lateral branches, followed by flowers in fall. Lateral branches distinctly long, limber, and in late summer to spring extending beyond bushy crown and ascending into trees. Bark dark drab and rough with projecting thorns.

**Leaves.** Alternate, oval to elliptic and thick, 0.4 to 4 inches (1 to 10 cm) long and 0.2 to 2 inches (0.6 to 5 cm) wide. Irregular and wavy margins. Blade surfaces silver scaly in spring becoming dark green or brownish green above and densely silver scaly with scattered brown scales beneath. Petioles 0.1 to 0.2 inch (4 to 5 mm) long, grooved above.

**Flowers.** October to December. Axillary clusters, each with one to three flowers, 0.4 inch (1 cm) long, silvery white to brown. Tubular with four lobes. Fragrant.

**Fruit and seeds.** March to June. Oblong, juicy drupe, 0.3 to 0.6 inch (1 to 1.5 cm) long, containing one nutlet. Whitish ripening to red and finely dotted with brown scales. Persistent shriveled calyx tube at tip.

**Ecology.** Fast-growing, weedy ornamental. Tolerant to shade, drought, and salt. Spreads by animal-dispersed seeds and occurs as scattered individuals, both in the open and under forest shade. Increases in size by prolific stem sprouts. Can climb into trees.

**Resembles** autumn olive, *E. umbellata* Thunb., and Russian olive, *E. angustifolia* L., both of which are deciduous and are further described in this book. Autumn olive has thin leaves with silver scales (not silver brown) and abundant reddish rounded berries in fall and early winter. Russian olive has silver scaly twigs and leaf surfaces, and many yellow olives in fall and winter.

**History and use.** Introduced as an ornamental from China and Japan in 1830. Frequently planted for hedgerows and on highway right-of-ways and still used for landscaping.

States with suspected infestations are shown in gray.



## Silverthorn, Thorny Olive



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#### Elaeagnus umbellata Thunb. ELUM

Plant. Tardily deciduous bushy leafy shrub, 3 to 20 feet (1 to 6 m) in height, with scattered thorny branches. Leaves silvery scaly beneath, with many red berries in fall.

Stem. Twigs slender and silver scaly, spur twigs common, with some lateral twigs becoming pointed like thorns. Branches and main stems glossy olive drab with scattered thorns and many whitish dots (lenticels), becoming light gray to gray brown with age and eventually fissuring to expose light-brown inner bark.

Leaves. Alternate, elliptic 2 to 3 inches (5 to 8 cm) long and 0.8 to 1.2 inches (2 to 3 cm) wide. Margins entire and wavy. Bright green to gray green above with silver scaly midvein and densely silver scaly beneath. Petioles short and silvery.

Flowers. February to June. Axillary clusters, each with 5 to 10 tubular flowers with 4 lobes. Silvery white to yellow. Fragrant.

Fruit and seeds. August to November. Round, juicy drupe 0.3 to 0.4 inch (7 to 10 mm) containing one nutlet. Red and finely doted with silvery to silvery-brown scales.

Ecology. Prefers drier sites. Shade tolerant. Spreads by animal-dispersed seeds and found as scattered plants in forest openings and open forests, eventually forming dense stands. A nonleguminous nitrogen fixer.

**Resembles** silverthorn or thorny olive, *E. pungens* Thunb., and Russian olive, E. angustifolia L. Silverthorn is an evergreen that has brown scaly and hairy twigs, flowers in late fall, and few reddish-silver scaly drupes in spring. Russian olive has silver scaly twigs and leaves, flowers in early summer, and many yellow olives in fall and winter. Also resembles minniebush, Menziesia pilosa (Michx. ex Lam.) Juss. ex Pers., a Southern Appalachian native at high elevations, which is distinguished by glands, not scales, on the midvein and leaves with finely serrate margins.

History and use. Introduced from China and Japan in 1830. Widely planted for wildlife habitat, strip mine reclamation, and shelterbelts.



## **Autumn Olive**



# Winged Burning Bush













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#### Euonymus alatus (Thunb.) Sieb. EUAL8

Synonyms: wahoo, winged euonymus, burning bush

**Plant.** Deciduous, wing-stemmed, bushy shrub to 12 feet (4 m) in height, multiple stemmed and much branched. Canopy broad and leafy. Small and obovate leaves green and turning bright scarlet to purplish red in fall. Paired purple fruit in fall.

**Stem.** Four corky wings or ridges appearing along young lime-green squarish twigs and becoming wider with age. Numerous opposite branches, with bases encircled by corky rings. Larger branches and bark becoming light gray.

**Leaves.** Opposite, obovate, and thin, only 1 to 2 inches (2.5 to 5 cm) long and 0.4 to 0.8 inch (1 to 2 cm) wide. Tips tapering to an acute point. Margins finely crenate. Both surfaces smooth and hairless. Dark green with whitish midvein above and light green beneath turning bright crimson to purplish red in fall. Petioles 0.04 to 0.16 inches (1 to 4 mm) long.

**Flowers.** April to May. Axillary pairs of small flowers at the ends of a Y-shaped 1-inch (2.5-cm) stem. Flowers inconspicuous, 0.2 to 0.3 inch (6 to 8 mm) across, greenish-yellow, five-lobed, pistil elongating as fruit forms.

**Fruit and seeds.** August to January. Dangling paired (or single) reddish capsules in leaf axils turning purple and splitting in fall to reveal an orange fleshy-covered seed.

**Ecology.** Shade tolerant. Colonizes by root suckers and spreads by animal-dispersed seeds.

**Resembles** the larger leaved species of blueberry, *Vaccinium* spp., but their leaves are alternate. **Possibly resembles** rusty blackhaw, *Viburnum rufidulum* Raf., which also has opposite leaves, but distinguished by their larger size and leathery texture. Dormant twigs **may resemble** winged elm, *Ulmus alata* Michx., and sweetgum, *Liquidambar styraciflua* L., which are usually two-winged instead of four-winged.

**History and use.** Introduced from northeast Asia in the 1860s. Widely planted as an ornamental and for highway beautification.

States with suspected infestations are shown in gray.

# Winged Burning Bush



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# **Chinese/European Privet**









Chinese privet shown in all images









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#### Ligustrum sinense Lour./L. vulgare L. LISI/LIVU

**Plant.** Semievergreen to evergreen, thicket-forming shrubs to 30 feet (9 m) in height that are multiple stemmed and leaning-to-arching with long leafy branches. Essentially indistinguishable except at flowering. Chinese privet is the most widely occurring.

**Stem.** Opposite or whorled, long slender branching that increases upward with twigs projecting outward at near right angles. Brownish gray turning gray green and short hairy (rusty or grayish) with light dots (lenticels). Leaf scars semicircular with one bundle scar. Bark brownish gray to gray and slightly rough (not fissured).

**Leaves.** Opposite in two rows at near right angle to stem, thin, ovate to elliptic with rounded tip (often minutely indented), 0.8 to 1.6 inches (2 to 4 cm) long and 0.4 to 1.2 inches (1 to 3 cm) wide. Margins entire. Lustrous green above and pale green with hairy midvein beneath (European privet not hairy beneath). Petioles 0.04 to 0.2 inch (1 to 5 mm) long, rusty hairy. Leaves usually persistent during winter.

**Flowers.** April to June. Abundant, terminal and upper axillary clusters on short branches forming panicles of white flowers. Corolla four-lobed, tube 0.06 to 0.1 inch (1.5 to 2 mm) long and equal or shorter than the lobes, with stamens extending from the corolla on Chinese privet and within the corolla on European privet. Fragrant.

**Fruit and seeds.** July to March. Dense ovoid drupes hanging or projecting outward, 0.2 to 0.3 inch (6 to 8 mm) long and 0.16 inch (4 mm) wide, containing one to four seeds. Pale green in summer ripening to dark purple and appearing almost black in late fall to winter.

**Ecology.** Aggressive and troublesome invasives, often forming dense thickets, particularly in bottom-land forests and along fencerows, thus gaining access to forests, fields, and right-of-ways. Shade tolerant. Colonize by root sprouts and spread widely by abundant bird- and other animal-dispersed seeds.

**Resemble** Japanese privet, *L. japonicum* Thunb., which has larger leaves and is further described in this book. **Also resemble** upland swampprivet, *Forestiera ligustrina* (Michx.) Poir., which occurs mainly on rocky sites and has short twigs and sparse flowers and fruit.

**History and use.** Introduced from China and Europe in the early to mid-1800s. Traditional southern ornamentals. Deer browse Chinese privet sprouts.





# **Chinese/European Privet**



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# Japanese / Glossy Privet

July

22



December

June

June

#### Ligustrum japonicum Thunb./L. lucidum Ait. f. LIJA/LILU2

Plant. Evergreen to 20 feet (6 m) in height for Japanese privet and 35 feet (10 m) in height for glossy privet, with spreading crowns, thick opposite leaves, conical clusters of white flowers in spring, and green to purple-black fruit in summer and winter.

Stem. Twigs hairless and pale green becoming brownish to reddish tinged. Branches opposite and brownish gray with many raised corky dots (lenticels). Bark light gray and smooth except for scattered horizontal, discontinuous ridges.

Leaves. Opposite, leathery, ovate to oblong, bases rounded and tips blunt or tapering often with a tiny sharp tip. Two to four inches (5 to 10 cm) long and 1 to 2 inches (2.5 to 5 cm) wide. Margins entire and often vellowish rimmed and turned upward with glossy privet and slightly rolled under with Japanese privet. Upper blades lustrous dark green with 6 to 8 pairs of light-green veins with glossy privet and 4 to 6 pairs of indistinct veins with Japanese privet that protrude slightly from light green lower surfaces. Petioles 0.4 to 0.8 inch (1 to 2 cm) long for glossy privet and 0.2 to 0.4 inch (6 to 12 mm) long for Japanese privet, light green and glossy privet sometimes reddish tinged.

Flowers. April to June. Loosely branching, terminal- and upper-axillary, conical clusters of many small white four-petaled flowers. Fragrant.

Fruit and seeds. July to February. Conical-shaped, branched terminal clusters of ovoid drupes, each 0.2 to 0.5 inch (5 to 12 mm) long and 0.2 inch (5 mm) wide. Pale green in summer ripening to blue black in winter.

Ecology. Single plants or thicket-forming, occurring in the same habitats as Chinese privet, but generally not as abundant, depending upon location. Invade both lowland and upland habitats, but usually more prevalent in lowlands. Shade tolerant. Colonize by root sprouts and spread by abundant bird- and other animal-dispersed seeds.

**Resembles** Chinese privet, *L. sinense* Lour., which has smaller and thinner leaves, is further described in this book. Also resembles redtip, also named photinia, Photinia x fraseri Dress, an ornamental shrub that has similar but alternate leaves.

History and use. Introduced from Japan and Korea in 1845 and 1794, respectively. Widely planted as ornamentals and escaped.



## Japanese / Glossy Privet



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#### Amur honeysuckle, *Lonicera maackii* (Rupr.) Herder LOMA6 Morrow's honeysuckle, *L. morrowii* Gray LOMO2 Tatarian honeysuckle, *L. tatarica* L. LOTA Sweet-breath-of-spring, *L. fragrantissima* Lindl. & Paxton LOFR Bell's honeysuckle, *L. xbella* Zabel LOBE (hybrid Morrows and Tatarian)

**Plant.** Tardily deciduous, upright, arching-branched shrubs to small trees. Amur to 30 feet (9 m) in height and spindly in forests, Morrow's to 6.5 feet (2 m) in height, Tatarian and sweet-breath-of-spring to 10 feet (3 m) in height, and Bell's to 20 feet (6 m) in height. Much branched and arching in openings, multiple stemmed, dark-green opposite leaves, showy white to pink or yellow flowers, and abundant orange to red berries.

**Stem.** Opposite branched, light tan with braided-strand appearance. Bark often flaking. Older branches hollow.

**Leaves.** Opposite in two rows, ovate to oblong with rounded to subcordate bases, 1.2 to 4 inches (3 to 10 cm) long. Persistent into winter. Margins entire. Amur tapering to a long slender tip; Bell's to a medium tapering tip; and others with short pointed tips. Morrow's with wrinkled upper surface and both Amur and Bell's softhairy lower surface, others with hairless leaves. Petioles 0.1 to 0.4 inch (2.5 to 10 mm) long.

**Flowers.** February to June. Axillary, bracted short-stemmed clusters, each with one to several white to yellow (some pink to red) flowers. Petals tubular flaring to five lobes in two lips (upper lip four-lobed, lower lip single-lobed). Five extended stamen. Fragrant.

**Fruit and seeds.** June to February. Abundant spherical, glossy berries paired in leaf axils, each 0.2 to 0.5 inch (6 to 12 mm). Green becoming pink and ripening to red (sometimes yellow or orange). Usually persistent into winter.

**Ecology.** Often forms dense thickets in open forests, forest edges, abandoned fields, pastures, roadsides, and other open upland habitats. Relatively shade tolerant. Colonize by root sprouts and spread by abundant bird- and other animal-dispersed seeds. Seeds long-lived in the soil.

**Resemble** the woody vine, Japanese honeysuckle, *L. japonica* Thunb, as far as leaves and flowers. Also resemble the native shrub American fly honeysuckle, *L. canadensis* Bartr. ex Marsh., which has hairy margined leaves, blue fruit, and found at high elevations in mountains. Also resemble the native bush honeysuckles, *Diervilla* spp., which have similar leaves but terminal flowers in cymes and capsules for fruit.

**History and use.** All introduced from Asia in the 1700s and 1800s. Mistakenly used as ornamentals and wildlife plants.



# **Bush Honeysuckles**



louo n

Sacred Bamboo, Nandina















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#### Nandina domestica Thunb. NADO

**Plant.** Evergreen erect shrub to 8 feet (2.5 m) in height, with multiple bushy stems that resemble bamboo, glossy bipinnately compound green (or reddish) leaves, white to pinkish flowers in terminal clusters, and bright red berries in fall and winter.

**Stem.** Large compound leaves resembling leafy branches, woody leafstalk bases persisting as stubby branches, and overlapping sheaths encasing the main stem. Stubby branches whorled alternately up the stem and tightly stacked near terminals for a given year's growth. The overlapping sheaths on the main stem give the appearance of bamboo, thus, the common name. Stem fleshy and greenish gray near terminal, becoming woody barked and tan to brown with fissures towards the base. Wood bright yellow.

**Leaves.** Alternately whorled, bipinnately compound on 1.5 to 3 feet (0.5 to 1 m) slender leafstalks, often reddish tinged with joints distinctly segmented. Leafstalk bases clasping stems with a V-notch on the opposite side of attachment. Nine to eighty-one nearly sessile leaflets, lanceolate to diamond-shaped, 0.5 to 4 inches (1.2 to 10 cm) long and 0.4 to 1.2 inches (1 to 3 cm) wide. Glossy light green to dark green sometimes red tinged or burgundy.

**Flowers.** May to July. Terminal (or axillary) panicles of several hundred flowers, 4 to 10 inches (10 to 25 cm) long. Pink in bud, opening to three (two to four) lanceolate deciduous petals, white to cream, with yellow anthers 0.2 to 0.3 inch (6 to 8 mm) long. Fragrant.

**Fruit and seeds.** September to April. Dense terminal and axillary clusters of fleshy, spherical berries 0.2 to 0.3 inch (6 to 8 mm). Light green ripening to bright red. Two hemispherical seeds.

**Ecology.** Occurs under forest canopies and near forest edges. Shade tolerant. Seedlings frequent in vicinity of old plantings. Varying leaf colors in the various cultivars, some of which do not produce viable seeds. Colonizes by root sprouts and spreads by animal-dispersed seeds.

**History and use.** Introduced from eastern Asia and India in the early 1800s. Widely planted as an ornamental, now escaped and spreading from around old homes and recent landscape plantings. Sterile seeded reddish cultivars available.





# Sacred Bamboo, Nandina



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# **Nonnative Roses**



August





Multiflora rose shown in all images











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#### Multiflora rose, *Rosa multiflora* Thunb. ex Murr. ROMU Macartney rose, *R. bracteata* J.C. Wendl. ROBR Cherokee rose, *R. laevigata* Michx. ROLA

**Plant.** Evergreen except multiflora. Erect climbing, arching, or trailing shrubs to 10 feet (3 m) in height or length. Clump forming. Pinnately compound leaves, frequent recurved and straight thorns, clustered or single white flowers in early summer, and red rose hips in fall to winter.

**Stem.** Long arching or climbing by clinging using recurved or straight thorns. Green with leaf and branch scars linear and spaced like nodes. Flower buds of multiflora often red in winter. Bark dark brown with streaks of light brown or green.

**Leaves.** Alternate, odd-pinnately compound with three to nine elliptic to lanceolate leaflets, each 1 to 3 inches (2.5 to 8 cm) long. Margins finely and sharply serrate. Leafstalk bases clasping, channeled, and often bristled on margins with toothed hairs.

**Flowers.** April to June. Terminal or axillary branched clusters or single flowers. Five white petals. Many yellow anthers in center.

**Fruit and seeds.** July to December. Rose hip, spherical, and fleshy, 0.25 to 0.4 inch (0.6 to 1 cm). Green to yellow and ripening to glossy red.

**Ecology.** Form small-to-large infestations often climbing up into trees. Multiflora widely planted and often spreading along right-of-ways and invading new forests and forest margins. Colonize by prolific sprouting and stems that root, and spread by animal-dispersed seeds.

**Resemble** native Carolina rose, *R. carolina* L., swamp rose, *R. palustris* Marsh., and climbing rose, *R. setigera* Michx., all of which have pink flowers in spring and nonbristled leafstalk bases, but none forming extensive infestations except swamp rose in wet habitat.

**History and use.** Introduced from Asia. Traditionally planted as ornamentals, livestock containment, and wildlife habitat. Multiflora widely planted for "living fences" or screening.





# **Nonnative Roses**



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# **Oriental Bittersweet**









Octob











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#### Celastrus orbiculatus Thunb. CEOR7

Synonym: Asian bittersweet

**Plant.** Deciduous, twining and climbing woody vine to 60 feet (20 m) in tree crowns, forming thicket and arbor infestations. Elliptic to rounded leaves, axillary dangling clusters of inconspicuous yellowish flowers in spring, and green spherical fruit that split to reveal three-parted showy scarlet berries in winter.

**Stem.** Woody vine to 4 inches (10 cm) diameter, twining and arbor forming, with many alternate drooping branches growing at angles and eventually becoming straight. Olive drab with many raised whitish corky dots (lenticels) becoming tan to gray. Branch scars of fruit clusters semicircular, each with a tiny corky shelf projection.

**Leaves.** Alternate, 1.2 to 5 inches (3 to 12 cm) long. Variable shaped, long tapering tipped when young becoming larger and round tipped when mature. Margins finely blunt toothed. Dark green becoming bright yellow in late summer to fall. Base tapering into 0.4- to 1.2-inch (1- to 3-cm) petiole.

**Flowers.** May. Numerous tiny-branched axillary clusters (cymes), each with three to seven inconspicuous orange-yellow flowers. Five petals.

**Fruit and seeds.** August to January. Dangling clusters of spherical 0.5-inch (1.2-cm) capsules, tipped with a persistent pistil. Green turning yellow orange then tan. In winter, splitting and folding upward to reveal three fleshy scarlet sections, each containing two white seeds. Persistent in winter at most leaf axils.

**Ecology.** Occurs on a wide range of sites mainly along forest edges. Found as scattered plants to extensive infestations in forest openings, margins, and roadsides as well as in meadows. Shade tolerant but densest infestations along forest edges and in openings. Colonizes by prolific vine growth and seedlings, and spreads by bird- and other animal-dispersed seeds and humans collecting decorative fruit-bearing vines.

**Resembles** American bittersweet, *C. scandens* L., which has only terminal flowers and fruit, and leaves usually twice as large but absent among the flowers and fruit. Hybridization suspected between the two species. **Also resembles** grape vines, *Vitis* spp., in winter, but can be distinguished by persistent scarlet fruit versus grapes.

**History and use.** Introduced from Asia in 1736. Very showy ornamental with berried vines that are traditionally collected as home decorations in winter, which promotes spread when discarded.



# **Oriental Bittersweet**



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VINES

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#### Air yam, *Dioscorea bulbifera L.* DIBU Chinese yam, Cinnamon vine, D. oppositifolia L., formerly D. batatas Dcne. DIOP Water yam, *D. alata L.* DIAL2 Svnonvm: air potato

Plant. Herbaceous, high climbing vines to 65 feet (20 m) long, infestations covering shrubs and trees. Twining and sprawling stems with long-petioled heart-shaped leaves. Spreading by dangling potato-like tubers (bulbils) at leaf axils and underground tubers. Monocots.

Stem. Twining and covering vegetation, branching, hairless. Internode cross sections round for air yam to angled for Chinese and water yams. Water yam nodes winged and reddish. All stems dying back in winter leaving some small bulbils attached.

Leaves. Alternate (air) or combination alternate and opposite (Chinese and water). Heart-shaped to triangular with elongated tips, thin and hairless, 4 to 8 inches (10 to 20 cm) long and 2 to 6 inches (5 to 15 cm) wide. Long petioled. Basal lobes broadly rounded (air) or often angled (Chinese and water). Margins smooth. Veins parallel and converging at base. Dark green with slightly indented curved veins above (quilted appearing) and lighter green beneath. Chinese yam leaves turning bright yellow in fall.

Flowers. May to August. Rare, small, male and female flowers in panicles or spikes on separate plants, to 4.5 inches (11 cm) long in axils. Green to white. Fragrant, with Chinese yam having a cinnamon fragrance (thus the common name cinnamon vine).

Fruit and seeds. June to September (and year-round). Aerial tubers (bulbils) resembling miniature potatoes being the most notable fruit with 1 to 4 occurring at leaf axils that drop and sprout to form new plants. Shape spherical (air and Chinese) to oblong (water). Texture smooth (air) to warty (Chinese) to rough (water). Air yam to 5 inches (12 cm) long, Chinese yam to 1 inch (2.5 cm) long, and water yam to 1.2 inches (3 cm) long and 4 inches (10 cm) wide. Very rarely have capsules and winged seeds, which have questionable viability.

Ecology. Rapid growing and occurring on open to semishady sites: water yams in Florida, air vams extending from Florida to adjacent States, and Chinese vams in all States except Florida. All dying back during winter but able to cover small trees in a year, with old vines providing trellises for regrowth. Spread and persist by underground tubers and abundant production of aerial yams, which drop and form new plants and can spread by water.

Resemble greenbrier, Smilax spp., which has thorns and green-to-purple berries but no aerial potatoes. Also resemble several native Dioscorea species that do not form dense vine infestations nor have aerial tubers (bulbils): fourleaf yam, D. quaternata J.F. Gmel.; wild yam, D. villosa L., with hairy upper leaf surfaces; native Florida vam, D. floridana Bartlett; and, only in Florida, nonnative Zanzibar yam, D. sansibarensis Pax.

History and use. Introduced from Africa (air) and Asia (Chinese and water) as possible food sources in the 1800s. Ornamentals often spread by unsuspecting gardeners intrigued by the dangling yams. Presently cultivated for medicinal use.

States with suspected infestations are shown in gray.



# **Climbing Yams**



Winter Creeper





Lan











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#### *Euonymus fortunei* (Tursz.) Hand.-Maz. **EUFO5** Synonyms: climbing euonymus, gaity

**Plant.** Evergreen woody vine climbing to 40 to 70 feet (12 to 22 m) and clinging by aerial roots or rooting at nodes, or standing as a shrub to 3 feet (1 m) in height. Leaves thick and dark green or green-white variegated on green stems. Pinkish-to-red capsules splitting open in fall to expose fleshy orange seeds.

**Stem.** Twigs stout, lime green, and hairless becoming increasingly dusted and streaked with light-gray reddish corky bark. Patches or lines of protruding aerial roots underneath or along surfaces used for attachment. Branches opposite, leaf scars thin upturned white crescents, and branch scars jutting and containing a light semicircle. Older stems covered with gray corky bark becoming fissured and then checked.

**Leaves.** Opposite broadly oval, moderately thick, with bases tapering to petiole. One to 2.5 inches (2.5 to 6 cm) long and 1 to 1.8 inches (2.5 to 4.5 cm) wide. Margins finely crenate, somewhat turned under, to wavy. Blades smooth glossy, hairless, dark green with whitish mid- and lateral veins (or variegated green white above and light green beneath). Petioles 0.15 to 0.4 inch (0.4 to 1 cm) long.

**Flowers.** May to July. Axillary clusters of small greenish-yellow inconspicuous flowers at the ends of Y-shaped stems, each flower 0.1 inch (2 to 3 mm) wide. Five petals. Pistils soon elongating with fruit.

**Fruit and seeds.** September to November. Dangling paired or single pinkish-to-red capsules, 0.2 to 0.4 inch (5 to 10 mm) long, splitting to reveal a fleshy orange-to-red covered seed.

**Ecology.** Forms dense ground cover and can climb trees eventually overtopping them. Shade tolerant occurring under dense stands but avoiding wet areas. Colonizes by trailing and climbing vines that root at nodes, and spreads by bird-, other animal-, and water-dispersed seeds.

**Resembles** the larger leaved species of blueberry, *Vaccinium* spp., but their leaves are alternate. **Possibly resembles** the opposite- and thick-leaved rusty blackhaw, *Viburnum rufidulum* Raf., which is distinguished by dark buds in each axil.

History and use. Introduced from Asia in 1907. Ornamental ground cover.



## Winter Creeper



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# English Ivy

















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#### Hedera helix L. HEHE

**Plant.** Evergreen woody vine climbing to 90 feet (28 m) by clinging aerial roots and trailing to form dense ground cover. Thick dark-green leaves with whitish veins and three to five pointed lobes when juvenile. Maturing at about 10 years into erect plants or branches with unlobed leaves and terminal flower clusters that yield purplish berries. Toxic to humans when eaten and triggering dermatitis in sensitive individuals.

**Stem.** Woody slender vines when a ground cover and growing to 10 inches (25 cm) in diameter when climbing infested trees and rocks by many fine to stout aerial rootlets. Vines pale green (sometimes reddish tinged), rooting at nodes, becoming covered with gray-brown shiny bark, segmented by encircling and raised leaf scars, and roughened by tiny ridges. Bark light gray to brown, bumpy and gnarly, with aerial rootlets developing along the side where clinging to vertical structures. Aerial rootlets exuding a gluelike substance. Older vines sometimes grown together where crossed.

**Leaves.** Alternate, with shapes varying according to age—typical juvenile plants having three to five pointed lobes and mature plants broadly lanceolate and unlobed, 2 to 4 inches (5 to 10 cm) long and 2.5 to 5 inches (6 to 12 cm) wide. Thick and waxy, smooth and hairless, dark green with whitish veins radiating from the petiole and pale green beneath. Petioles to 6 inches (15 cm) long, pale green and often reddish tinged.

**Flowers.** June to October. Terminal hairy-stemmed umbel clusters of small greenishyellow flowers on mature plants. Five thick and pointed petals, 0.1 inch (3 mm) long. Each petal radiating from a five-sided domed green floral disk, 0.1 inch (3 mm) wide, tipped by a short pistil.

**Fruit and seeds.** October to May. Clusters of spherical drupes, 0.2 to 0.3 inch (7 to 8 mm). Pale green in late summer ripening to dark blue to purplish in late winter to spring.

**Ecology.** Thrives in moist open forests, but adaptable to a range of moisture and soil conditions, including rocky cliffs. Shade tolerance allowing early growth under dense stands, but becoming adapted to higher light levels with maturity. Avoids wet areas. Amasses on infested trees, decreasing vigor, and increasing chance of windthrow. Serves as a reservoir for bacterial leaf scorch that infects oaks (*Quercus* spp.), elms (*Ulmus* spp.), and maples (*Acer* spp.). Spreads by bird-dispersed seeds and colonizes by trailing and climbing vines that root at nodes. Drupes mildly toxic, discouraging over consumption by birds.

**Resembles** grape, *Vitis* spp., which has a leaf that is similarly shaped but not thick and often hairy.

**History and use.** Introduced from Europe in colonial times. Traditional ornamental and still widely planted as an ornamental. Source of varnish resin, dye, and tanning substances.

States with suspected infestations are shown in gray.



# **English Ivy**



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# Japanese Honeysuckle











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#### Lonicera japonica Thunb. LOJA

Plant. Semievergreen to evergreen woody vine, high climbing and trailing to 80 feet (24 m) long, branching and often forming arbors in forest canopies and/or ground cover under canopies and forming long woody rhizomes that sprout frequently.

Stem. Slender woody vine becoming stout to 2 inches (5 cm) in diameter, with cross section round and opposite branching. Brown and hairy becoming tan barked, fissured, and sloughing with age. Rooting at low nodes.

Leaves. Opposite, broadly ovate to elliptic to oblong, base rounded, tips blunt-pointed to round. Length 1.6 to 2.6 inches (4 to 6.5 cm) and width 0.8 to 1.5 inches (2 to 4 cm). Margins entire but often lobed in early spring. Both surfaces smooth to rough hairy, with undersurface appearing whitish.

Flowers. April to August. Axillary pairs, each 0.8 to 1.2 inches (2 to 3 cm) long, on a bracted stalk. White (or pink) and pale yellow. Fragrant. Thin tubular flaring into five lobes in two lips (upper lip four-lobed and lower lip single-lobed), with the longest lobes roughly equal to the tube. Five stamens and one pistil, all projecting outward and becoming curved. Persistent sepals.

Fruit and seeds. June to March. Nearly spherical, green ripening to black, glossy berry 0.2 inch (5 to 6 mm) on stalks 0.4 to 1.2 inches (1 to 3 cm) long. Two to three seeds.

Ecology. Most commonly occurring invasive plant, overwhelming and replacing native flora in all forest types over a wide range of sites. Occurs as dense infestations along forest margins and right-of-ways as well as under dense canopies and as arbors high in canopies. Shade tolerant. Persists by large woody rootstocks and spreads by rooting at vine nodes and animal-dispersed seeds.

Resembles yellow jassamine, Gelsemium sempervirens (L.) St. Hil., which has thinner leaves and hairless stems. Also resembles native honeysuckles, Lonicera spp., that usually have reddish hairless stems and hairless leaves and do not form extensive infestations.

History and use. Introduced from Japan in the early 1800s. Traditional ornamental, valued as deer browse, with some value for erosion control. Still planted in wildlife food plots.

States with suspected infestations are shown in gray.



## Japanese Honeysuckle



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# Kudzu



#### Pueraria montana (Lour.) Merr. PUMOL

Synonyms: *P. lobata* (Willd.) Ohwi, *P. montana var. lobata* (Willd.) Maesen & S. Almeida

**Plant.** Deciduous twining, trailing, mat-forming, ropelike woody leguminous vine, 35 to 100 feet (10 to 30 m) long with three-leaflet leaves. Large semiwoody tuberous roots reaching depths of 3 to 16 feet (1 to 5 m). Leaves and small vines dying with first frost and matted dead leaves persistent during winter.

**Stem.** Woody vines to 10 inches (25 cm) in diameter, round in cross section, with infrequent branching. Stems yellow green with dense erect golden hairs and upward matted silver hairs, aging to ropelike, light gray, and hairless. Frequent unswollen nodes that root when on the ground. Mature bark eventually rough, rigid, and usually dark brown.

**Leaves.** Alternate, pinnately compound three-leaflet leaves, each leaflet 3 to 7 inches (8 to 18 cm) long and 2.5 to 8 inches (6 to 20 cm) wide. Usually slightly lobed (unless in shade): a two-lobed symmetric middle leaflet and two one-lobed side leaflets, all petioles swollen near leaflets. Tips pointed. Margins thin membranous and fine golden hairy. Leafstalks 6 to 12 inches (15 to 30 cm) long, long hairy, base swollen, with deciduous stipules.

**Flowers.** June to September. Axillary slender clusters (racemes), 2 to 12 inches (5 to 30 cm) long, of pealike flowers in pairs (or threes) from raised nodes spiraling up the stalk, opening from the base to top. Petals lavender to wine colored with yellow centers.

**Fruit and seeds.** September to January. Clustered dry, flattened legume pods (bulging above the seeds) each 1.2 to 3 inches (3 to 8 cm) long and 0.3 to 0.5 inch (8 to 12 mm) wide. Green ripening to tan with stiff golden-brown hairs. Splitting on one to two sides to release a few ovoid seeds.

**Ecology.** Occurs in old infestations, along right-of-ways and stream banks. Forms dense mats over the ground, debris, shrubs, and mature trees forming dense patches by twining on objects less than 4 inches (10 cm) in diameter. Colonizes by vines rooting at nodes and spreads by wind-, animal-, and water-dispersed seeds. Seed viability variable. Leguminous nitrogen fixer.

**History and use.** Introduced from Japan and China in early 1900s with continued seed importation. Erosion control, livestock feed, and folk art.

States with suspected infestations are shown in gray.



### Kudzu



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3123

# Vincas, Periwinkles



Bigleaf periwinkle



Bigleaf periwinkle





Common periwinkle leaves and flower

Bigleaf periwinkle leaves and flower



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B. Rice

### Common periwinkle, *Vinca minor* ∟. VIMI2 Bigleaf periwinkle, *V. major* ∟. VIMA

**Plant.** Evergreen to semievergreen vines, somewhat woody, trailing or scrambling to 3 feet (1 m) long and upright to 1 foot (30 cm). Violet pinwheel-shaped flowers.

**Stem.** Slender (common periwinkle) to stout (bigleaf periwinkle), succulent becoming somewhat woody (tough to break) with flowering branches erect and jointed at axils. Hairless and smooth. Dark green at base to light green upward with a reddish tinge.

**Leaves.** Opposite. Glossy and hairless, somewhat thick, with margins slightly rolled under. Common periwinkle narrow elliptic, 0.8 to 1.8 inches (2 to 4.5 cm) long and 0.4 to 1 inch (1 to 2.5 cm) wide, with petioles 0.1 inch (1 to 3 mm) long. Bigleaf periwinkle heart-shaped to somewhat triangular to elliptic, 1.5 to 2.5 inches (4 to 6 cm) long and 1 to 1.5 inches (2.5 to 4 cm) wide, with petioles 0.2 to 0.4 inch (5 to 10 mm) long. Blades dark green with whitish lateral and midveins above and lighter green with whitish midveins beneath. Some varieties variegated.

**Flowers.** April to May (sporadically May to September). Axillary, usually solitary. Violet to blue lavender (to white), with five petals radiating pinwheel-like at right angles from the floral tube. Common periwinkle 1 inch (2.5 cm) wide with a 0.3- to 0.5-inch (8- to 12-mm) long tube. Bigleaf periwinkle 1.5 to 2 inches (4 to 5 cm) wide with a 0.6- to 0.8-inch (1.5- to 2-cm) long tube. Five sepals long lanceolate, about 0.4 inch (1 cm), hairy margined.

**Fruit and seeds.** May to July. Slender, cylindrical fruit to 2 inches (5 cm) long. Becoming dry and splitting to release three to five seeds.

**Ecology.** Found around old homesite plantings and scattered in open to dense canopied forests. Form mats and extensive infestations even under forest canopies by vines rooting at nodes, with viability of seeds yet to be reported.

**Resemble** partridgeberry, *Mitchella repens* L., which has cordate leaves, white twin flowers, and red berries. **Also, may resemble** yellow jasmine, *Gelsemium sempervirens* (L.) St. Hil., which has wider spaced leaves and reddish stems, often white waxy.

**History and use.** Introduced from Europe in 1700s. Ornamental ground cover, commonly sold and planted by gardeners.

States with suspected infestations are shown in gray.

# Vincas, Periwinkles



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# **Nonnative Wisterias**



Bodne

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I. Bodnei

# Chinese wisteria, *Wisteria sinensis* (Sims) DC. WISI Japanese wisteria, *W. floribunda* (Willd.) DC. WIFL

**Plant.** Deciduous high climbing, twining, or trailing leguminous woody vines (or cultured as shrubs) to 70 feet (20 m) long. Chinese and Japanese wisteria difficult to distinguish due to possible hybridization.

**Stem.** Woody vines to 10 inches (25 cm) in diameter with infrequent alternate branching. Twigs densely short hairy. Older bark of Chinese wisteria tight and dark gray with light dots (lenticels) compared to white bark of Japanese wisteria.

**Leaves.** Alternate, odd pinnately compound 4 to 16 inches (10 to 40 cm) long, with 7 to 13 leaflets (Chinese) or 13 to 19 leaflets (Japanese), and stalks with swollen bases. Leaflets oval to elliptic with tapering pointed tips 1.6 to 3 inches (4 to 8 cm) long and 1 to 1.4 inches (2.5 to 3.5 cm) wide. Hairless to short hairy at maturity but densely silky hairy when young. Margins entire and wavy. Sessile or short petioled.

**Flowers.** March to May. Dangling and showy, stalked clusters (racemes) appearing when leaves emerge, 4 to 20 inches (10 to 50 cm) long and 3 to 3.5 inches (7 to 9 cm) wide. All blooming at about the same time (Chinese) or gradually from base (Japanese). Pealike flowers, corolla lavender to violet (to pink to white). Fragrant.

**Fruit and seeds.** July to November. Flattened legume pod, irregularly oblong to oblanceolate, 2.5 to 6 inches (6 to 15 cm) long and 0.8 to 1.2 inches (2 to 3 cm) wide. Velvety hairy, greenish brown to golden, splitting on two sides to release one to eight flat round brown seeds, each 0.5 to 1 inch (1.2 to 2.5 cm) in diameter.

**Ecology.** Form dense infestations where previously planted. Occur on wet to dry sites. Colonize by vines twining and covering shrubs and trees and by runners rooting at nodes when vines covered by leaf litter. Seeds water-dispersed along riparian areas. Large seed size a deterrent to animal dispersal.

**Resemble** native or naturalized American wisteria, *W. frutescens* (L.) Poir., which does not form extensive infestations, occurs in wet forests, flowers in June to August after leaves developed, and has 6-inch (15-cm) flower clusters, 9 to 15 leaflets, hairless pods, and slender old vines. **Also may resemble** trumpet creeper, *Campsis radicans* (L.) Seem. ex Bureau, which has leaflets with coarsely toothed margins.

**History and use.** Introduced from Asia in the early 1800s. Traditional southern porch vines.

States with suspected infestations are shown in gray.

# **Nonnative Wisterias**



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#### Arundo donax L. ARDO4

**Plant.** Giant reed grass, cornlike stems, thicket forming in distinct clumps to 20 feet (6 m) in height, with gray-green and hairless stems, long-lanceolate leaves alternately jutting from stems and drooping at the ends, and large plumelike terminal panicles. Seed infertile. Spreading from tuberous rhizomes. Dried grass remaining standing in winter and spring.

**Stem.** Somewhat succulent and fibrous, with round cross section to 1 inch (2.5 cm). Solid jointed every 1 to 8 inches (2.5 to 20 cm) and covered by overlapping leaf sheaths. Gray to yellowish green. Initially white pithed and becoming hollow between joints. Old stems sometimes persistent into the following summer.

**Leaves.** Alternate, cornlike, long lanceolate with both surfaces hairless, and clasping stem with conspicuous whitish base. Eighteen to thirty inches (45 to 76 cm) long and 1 to 4 inches (2.5 to 10 cm) wide near base. Margins and ligule membranous (about 1 mm). Midvein whitish near base becoming inconspicuous towards tip. Veins parallel. Sheaths overlapping, hairless, and semiglossy.

**Flowers.** August to September. Terminal erect dense plumes of whorled stemmed flowers to 36 inches (1 m) long. Husks hairy, membranous with several veins, and greenish to whitish to purplish.

**Seeds.** October to March. Dense terminal plume, spindle-shaped, densely hairy. Grain never appears.

**Ecology.** Occurs mainly on upland sites as scattered dense clumps along roadsides and forest margins, migrating from old home plantings by displaced rhizome fragments. Persistent infestations by dense branching tuberous rhizome growth. Probable spread by movement of stem parts in soil or by road shoulder grading. Plants believed to be sterile and not producing viable seeds.

**Resembles** golden bamboo, *Phyllostachys aurea* Carr. ex A.& C. Rivière, another large grasslike plant that is woody in character. **Closely resembles** common reed, *Phragmites australis* (Cav.) Trin. ex Steud., which has similar large hairy seed heads, but not erect and fanned in a loose plume, and which occurs mainly near swamps, marshes, and wet habitats.

**History and use.** Introduced from western Asia, northern Africa, and southern Europe in the early 1800s. Ornamental.

States with suspected infestations are shown in gray.



# **Giant Reed**



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4008

Tall Fescue

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Bodne

Мау

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#### Lolium arundinaceum (Schreb.) S.J. Darbyshire LOAR10

Synonyms: *Festuca arundinacea* Shreb., *F. elatior* L., meadow fescue, Kentucky 31 fescue, *Schedonorus phoenix* (Scop.) Holub

**Plant.** Erect, tufted cool-season perennial grass 2 to 4 feet (60 to 120 cm) in height, green in winter and spring, during which it is the most common green bunchgrass. Dark-green leaves appearing in late winter, usually flowering in spring (infrequently in late summer). Semidormant during heat of summer, with whitish seedstalks persisting. Growth resuming in fall and continuing into early winter.

**Stem.** Moderately stout, unbranched, hairless with round cross section and one to three swollen light-green nodes widely spaced near the base.

**Leaves.** Mostly basal and a few alternate, flat and long-lanceolate, 4 to 18 inches (10 to 45 cm) long and 0.1 to 0.3 inch (3 to 8 mm) wide. Whitish to yellow-green flared collars, with collar backs often at an angle to the stem. Blades smooth to rough, with one to two leaves along the stem becoming smaller upward. Midvein not apparent. Ligule a tiny white membrane.

**Flowers.** March to June (to October). Loosely branched terminal panicles, 4 to 12 inches (10 to 30 cm) long, that are erect or nodding at tips, narrow then spreading in spring, and then narrow again in summer. Spindle-shaped clusters along branches. Branches shorter upward, with four to seven flowers per branch. Flowers greenish white and shiny becoming purplish. Spikelets hairless, ellipsoid with a pointed tip.

**Seeds.** May (to November). Husked grain, spindle-shaped, 0.1 to 0.2 inch (3 to 5 mm) long. Whitish straw-colored husks, usually tipped with a short hair.

**Ecology.** The predominant cool-season bunchgrass. Occurs as tufted clumps or small to extensive colonies along forest margins and right-of-ways, and widely escaped to invade new forest plantations, roads, openings, and high-elevation balds. Grows on wet to dry sites. Spreads by expanding rootcrowns and less by seeds. Replaces warm season grassland communities and prairies to the detriment of unique plants and birds. Certain varieties poisonous to livestock and wildlife by infecting them with an endophytic fungus.

**Resembles** other grasses, especially other fescues and ryegrasses (*Lolium* spp.) but distinguished by forming extensive colonies and infestations, growing green in late winter, and having long rounded stems with lower swollen nodes and whitish-flared collars at the base of leaves. Ryegrasses distinguished by producing alternate seed heads on opposite sides of seedstalks in spring.

**History and use.** Introduced from Europe in the early to mid-1800s. Recognized as a valuable forage grass in 1930s when the ecotype Kentucky 31 was discovered. Now widely distributed most everywhere in the World. Established widely for turf, forage, soil stabilization, and wildlife food plots.

States with suspected infestations are shown in gray.



# **Tall Fescue**



4051

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### Imperata cylindrica (L.) Beauv. IMCY

Synonyms: japgrass, bloodroot grass (red varieties), Red Barron (red varieties)

Plant. Aggressive, colony-forming dense perennial grass 1 to 6 feet (30 to 150 cm) in height, often leaning in mats when over 3 feet (90 cm) in height. Stemless tufts of long leaves, blades yellow green, with off-center midveins and silver-plumed flowers and seeds. Plants arising from branching sharp-tipped white-scaly rhizomes.

**Stem.** Upright to ascending, stout, not apparent, and hidden by overlapping leaf sheaths.

Leaves. Mainly arising from near the base, long lanceolate, 1 to 4 feet (30 to 120 cm) long and 0.5 to 1 inch (12 to 25 mm) wide, shorter upward. Overlapping sheaths, with outer sheaths often long hairy and hair tufts near the throat. Blades flat or cupped inward, bases narrowing, tips sharp and often drooping. Most often yellowish green. White midvein on upper surface slightly-to-mostly off center (varies in an area). Margins translucent and minutely serrated (rough). Ligule a fringed membrane to 0.04 inch (1.1 mm).

Flowers. February to May (or year-round in Florida). Terminal, silky spikelike panicle, 1 to 8 inches (2.5 to 20 cm) long and 0.2 to 1 inch (0.5 to 2.5 cm) wide, cylindrical and tightly branched on a reddish slender stalk. Spikelets paired, each 0.1 to 0.2 inch (3 to 6 mm) long, obscured by silky to silvery-white hairs to 0.07 inch (1.8 mm).

Seeds. May to June. Oblong brown grain, 0.04 to 0.05 inch (1 to 1.3 mm) long, released within silvery hairy husks for wind dispersal.

Ecology. Grows in full sunlight to partial shade, and, thus, can invade a range of sites. Often in circular infestations with rapidly growing and branching rhizomes forming a dense mat to exclude most other vegetation. Aggressively invades right-of-ways, new forest plantations, open forests, old fields, and pastures. Absent in areas with frequent tillage. Colonizes by rhizomes and spreads by wind-dispersed seeds and promoted by burning. Highly flammable and a severe fire hazard, burning extremely hot especially in winter.

Resembles Johnsongrass, Sorghum halepense (L.) Pers.; purpletop, Tridens flavus (L.) A.S. Hitchc.; silver plumegrass, Saccharum alopecuroidum (L.) Nutt.; and sugarcane plumegrass, S. giganteum (Walt.) Pers.-all having a stem and none having an off-center midvein.

History and use. Introduced from Southeast Asia into Florida and southern Louisiana, southern Alabama, and southern Georgia in the early 1900s. Initially for soil stabilization. Expectations for improved forage unrealized. A Federal listed noxious weed.





# Cogongrass



4055

# Nepalese Browntop













#### *Microstegium vimineum* (Trin.) A. Camus MIVI

Synonyms: Japanese stilt grass, Mary's grass, basketgrass

Plant. Sprawling, annual grass, 0.5 to 3 feet (15 to 90 cm) in height. Flat short leaf blades, with off-center veins. Stems branching near the base and rooting at nodes to form dense and extensive infestations. Dried whitish-tan grass remains standing in winter.

Stem. Ascending to reclining, slender and wiry, up to 4 feet (120 cm) long, with alternate branching. Covered by overlapping sheaths with hairless nodes and internodes. Green to purple to brown. Aerial rootlets descend from lower nodes.

**Leaves.** Alternate (none basal) projecting out from stem, lanceolate to oblanceolate, 2 to 4 inches (5 to 10 cm) long and 0.07 to 0.6 inch (2 to 15 mm) wide. Blades flat, sparsely hairy on both surfaces and along margins. Midvein whitish and off center. Throat collar hairy. Liqule membranous with a hairy margin.

Flowers. July to October. Terminal, thin and spikelike raceme, to 3 inches (8 cm) long. Unbranched or with one to three lateral branches on an elongated wiry stem. Other thin racemes of self-pollinating flowers enclosed or slightly extending from lower leaf sheaths. Spikelets paired, with the outer stemmed and inner sessile.

Seeds. July to December. Husked grain, seed head thin, grain ellipsoid, 0.1 inch (2.8 to 3 mm) long, with seedstalks partially remaining during winter.

Ecology. Flourishes on alluvial floodplains and streamsides, mostly colonizing floodscoured banks, due to water dispersal of seed and flood tolerance. Also common at forest edges, roadsides, and trailsides, as well as damp fields, swamps, lawns, and along ditches. Occurs up to 4,000 feet (1200 m) elevation. Very shade tolerant. Consolidates occupation by prolific seeding, with each plant producing 100 to 1,000 seeds that can remain viable in the soil for 3 years. Spreads on trails and recreational areas by seeds hitchhiking on hikers' and visitors' shoes and clothes.

**Resembles** crabgrass, *Digitaria* spp., and nimblewill, *Muhlenbergia schreberi* J.F. Gmel., both having broad short leaves, but distinguished from Nepalese browntop by branching seed heads and stout stems. Also resembles whitegrass, Leersia *virginica* Willd., which is a perennial with flat, compressed seed heads.

History and use. Native to temperate and tropical Asia, and first identified near Knoxville, TN, around 1919. Ground cover with little wildlife food value.

States with suspected infestations are shown in gray.



### **Nepalese Browntop**



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#### Miscanthus sinensis Anderss. MISI

**Plant.** Tall, densely bunched, perennial grass, 5 to 10 feet (1.5 to 3 m) in height. Long-slender upright-to-arching leaves with whitish upper midveins. Many loosely plumed panicles in late summer turning silvery to pinkish in fall. Dried grass standing with some seed heads during winter, but seed viability spotty.

**Stem.** Upright-to-arching, originating in tufts from base and unbranched. Covered with overlapping leaf sheaths until stem appears with flower plume in late summer.

**Leaves.** Alternate, long linear, upright-to-arching (persisting and curly tipped when dried) to 40 inches (1 m) long and less than 0.8 inch (2 cm) wide. Blades green to variegated (light green striped) with whitish collars. Midvein white above and green ridged beneath. Tufted hairs at throat, sheath margins, and ligule, but otherwise hairless. Margins rough.

**Flowers.** August to November. Much branched and drooping terminal plumed panicles, 4 to 15 inches (10 to 38 cm) long and 2 to 8 inches (5 to 20 cm) wide. Silvery to pinkish, showiest in fall. Stalk appressed rough hairy.

**Seeds.** September to January. Grain hidden, husks membranous, yellowish brown to slightly reddish, sparsely hairy, with twisted tip.

**Ecology.** Forms extensive infestations by escaping from older ornamental plantings to roadsides, forest margins, and adjacent disturbed sites, especially after burning. Shade tolerant. Highly flammable and a fire hazard.

**History and use.** Introduced from eastern Asia. Still widely sold and increasingly planted as an ornamental. Several varieties imported and sold. Cultivars vary widely in fertility and percent of seed viability.



### **Chinese Silvergrass**



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# Bamboos











Golden bamboo shown in all images





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# Golden bamboo, *Phyllostachys aurea* Carr. ex A.& C. Rivière PHAU8 and other invasive bamboos, *Phyllostachys* spp. and *Bambusa* spp.

**Plant.** Perennial infestation-forming bamboos, 16 to 40 feet (5 to 12 m) in height, with jointed cane stems and bushy tops of lanceolate leaves in fan clusters on grass-like stems, often golden green. Plants arising from branched rhizomes.

**Stem.** Solid jointed canes 1 to 6 inches (2.5 to 15 cm) in diameter. Hollow between joints. Golden to green to black. Branches wiry and grasslike from joints. Lower shoots and branches with loose papery sheaths that cover the ground when shed.

**Leaves.** Alternate, grasslike, often in fan clusters. Blades long and lanceolate, 3 to 10 inches (8 to 25 cm) long and 0.5 to 1.5 inches (1.3 to 4 cm) wide. Veins parallel. Often golden, sometimes green or variegated. Hairless except for large hairs at base of petiole, which shed with age. Sheaths encasing stem.

Flowers. Flowers very rarely.

Seeds. Seeds very rarely.

**Ecology.** Common around old homesites and now escaped. Colonize by rhizomes with infestations rapidly expanding after disturbance. General dieback periodically after flowering and seeding (about every 7 to 12 years) resulting in standing dead canes and new shoots.

**Resemble** switchcane, *Arundinaria gigantea* (Walt). Muhl., the only native bamboolike cane in the South, distinguished by its lower height—usually only 6 to 8 feet (2 to 2.5 m)—and its persistent sheaths on the stem and absence of long opposite branches. **Also resemble** giant reed, *Arundo donax* L., also described in this book.

**History and use.** All native to Asia. Widely planted as ornamentals and for fishing poles.



# Bamboos



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# Japanese Climbing Fern





FERNS





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### Lygodium japonicum (Thunb. ex Murr.) Sw. LYJA

**Plant.** Perennial viney fern, climbing and twining, to 90 feet (30 m) long, with lacy finely divided leaflets along green to orange to black wiry vines, often forming mats of shrub- and tree-covering infestations. Tan-brown fronds persisting in winter, while others remain green in Florida and in sheltered places further north. Vines arising as branches (long compound leaves) from underground, widely creeping rhizomes that are slender, black, and wiry.

**Stem.** Slender but difficult to break, twining and climbing, wiry. Green to strawcolored or reddish. Mostly deciduous in late winter.

**Leaves (fronds).** Opposite on vine, compound once- or twice-divided, varying in appearance according to the number of divisions, generally triangular in outline. Three to 6 inches (8 to 15 cm) long and 2 to 3 inches (5 to 8 cm) wide. Highly dissected leaflets, appearing lacy. Light green turning dark to tan brown in winter.

**Flowers.** Fertile fronds usually smaller segments with fingerlike projections around the margins, bearing sporangia (spore producing dots) in double rows under margins.

Seeds. Tiny, wind-dispersed spores.

**Ecology.** Occurs along highway right-of-ways, especially under and around bridges, invading into open forests, forest road edges, and stream and swamp margins. Scattered in open timber stands and plantations, but can increase in cover to form mats, smothering shrubs and trees. Persists and colonizes by rhizomes and spreads rap idly by wind-dispersed spores. Dies back in late winter in the more northern areas, with dead vines providing a trellis for reestablishment.

**Resembles** Old World climbing fern, *L. microphyllum* (Cav.) R. Br., and American climbing fern, *L. palmatum* (Bernh.) Sw., both of which are distinguished by five to seven palmately lobed, finger-like fronds. American climbing fern—a native occurring in swamps, stream beds, and ravines—does not spread beyond small areas to form extensive infestations. Old World climbing fern, also introduced, is a major invasive pest in southern Florida.

**History and use.** Native to Asia and tropical Australia and introduced from Japan in 1930s. An ornamental still being spread by unsuspecting gardeners.



# Japanese Climbing Fern



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# FORBS





H. Wilson







J. Shimp

**Garlic Mustard** 

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### Alliaria petiolata (Bieb.) Cavara & Grande ALPE4

**Plant.** Cool-season biennial forb with a slender taproot found in small to extensive colonies. Basal rosettes of leaves in the first year remaining green during winter and producing one to several 2- to 4-foot (60- to 120-cm) tall flower stalks in the second year, and then dying after seed formation in midsummer. Dead plants remain standing after June as long slender seedstalks with many upturned thin seed capsules and a characteristic crook at the stalk base. A faint to strong garlic odor emitted from all parts of the plant when crushed, becoming milder as fall approaches.

Stem. Erect, slightly ridged, light green, hairless above and hairy below. One to several stems from the same rootstock.

Leaves. Early basal rosette of kidney-shaped leaves and later alternate heart-shaped to triangular leaves, 1.2 to 3.6 inches (3 to 9 cm) long and 1 to 4 inches (2.5 to 10 cm) wide. Margins shallow to coarsely wavy toothed. Tips elongated on stem leaves. Petioles 0.4 to 3 inches (1 to 8 cm) long and reduced upward.

Flowers. April to May. Terminal, tight clusters of small white four-petaled flowers, each 0.2 to 0.3 inch (5 to 7 mm) long and 0.4 to 0.6 inch (10 to 14 mm) wide. Flowering progressing upward as seedpods form below.

Fruit and seeds. May to June. Four-sided, erect-to-ascending, thin pod, 1 to 5 inches (2.5 to 12 cm) long and 0.06 inch (1.5 mm) wide. Initially appearing to be stem branches that are alternately whorled along the stalk. Green ripening to tan and papery, exploding to expel tiny black seeds arranged in rows.

Ecology. Occurs in small to extensive colonies on floodplains, under forest canopies, and at forest margins and openings. Shade tolerant. Capable of ballistic seed dispersal of up to 10 feet (3 m). Spreads by human-, animal-, and water-dispersed seeds, which lie dormant for 2 to 6 years before germinating in spring. Experiences vear to vear variations in population densities. Allelopathic, emitting chemicals to kill surrounding plants and microbes.

History and use. Introduced from Europe in the 1800s and first sighted as an escaped weed in 1868 on Long Island, NY. Originally cultivated for medicinal use, but no known value now.

States with suspected infestations are shown in gray.



# **Garlic Mustard**



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Shrubby Lespedeza











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#### Lespedeza bicolor Turcz. LEBI2

Synonyms: bicolor lespedeza, bicolor, shrub bushclover

**Plant.** Perennial much branched, leguminous forb or ascending shrub, 3 to 10 feet (1 to 3 m) in height with three-leaflet leaves, many small purple-to-white pea flowers, and single-seeded pods from a woody rootcrown. Dormant brown plants remain upright most of the winter.

**Stem.** Arching branched, upright-to-ascending stems, 0.2 to 0.8 inch (0.5 to 2 cm) in diameter. Often gray green. Appressed hairy to hairless.

**Leaves.** Alternate, three-leaflet leaves. Each leaflet elliptic to ovate with a hairlike tip, 0.8 to 2 inches (2 to 5 cm) long and 0.4 to 1.2 inches (1 to 3 cm) wide. Lower surface lighter green than upper surface. Petioles 0.8 to 1.6 inches (2 to 4 cm) long. Stipules narrowly linear, 0.04 to 0.3 inch (1 to 8 mm) long.

**Flowers.** June to September. Clusters (racemes) 4 to 6 inches (10 to 15 cm) long each subtended by a tiny ovate bract—of 5 to 15 well-spaced, pealike flowers. Each flower 0.3 to 0.4 inch (8 to 11 mm) long, growing from upper leaf axils and beyond the upper leaves. Petals usually rosy purple in center and often grading to lighter shades, but can vary to white. Calyx (sepals) sparsely to very hairy with lobes 0.1 to 0.2 inch (2.5 to 4.5 mm) long.

**Fruit and seeds.** August to March. Flat legume pod 0.2 to 0.3 inch (6 to 8 mm) long, broadly elliptic with pointed hairlike tip. Green becoming gray and densely appressed hairy. Single black seed 0.12 to 0.16 inch (3 to 4 mm) long.

**Ecology.** Planted widely in forest openings for wildlife food plots and soil stabilization to later encroach into adjoining stands. Reproduces and spreads even under a medium-to-dense overstory. Spread encouraged by burning. Leguminous nitrogen fixer.

**History and use.** Introduced from Japan as an ornamental in the late 1800s. Later programs promoted use for wildlife food and soil stabilization and improvement. Still planted for quail food plots.

States with suspected infestations are shown in gray.



# Shrubby Lespedeza



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# Chinese Lespedeza











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#### Lespedeza cuneata (Dum.-Cours.) G. Don LECU Synonym: sericea lespedeza

**Plant.** Perennial ascending-to-upright leguminous forb, 3 to 6 feet (1 to 2 m) in height, with one-to-many leafy slender stems often branching at midplant, three-leaflet leaves, and tiny whitish flowers. Plant arising from a woody rootcrown. Dormant brown plants remaining upright during most of the winter.

**Stems.** Often gray green with lines of hairs along the stem.

**Leaves.** Alternate, crowded and numerous, three-leaflet leaves. Each leaflet oblong to linear with a hairlike tip, 0.4 to 0.8 inch (1 to 2 cm) long and 0.1 to 0.3 inch (3 to 8 mm) wide. Green above and dense whitish hairy to light gray green beneath. Hairy petioles 0.2 to 0.6 inch (5 to 15 mm) long, absent for upper leaves. Stipules narrowly linear.

**Flowers.** July to September. Clusters of 1 to 3 pealike flowers crowded in upper leaf axils. Flowers white with purple marks, 0.1 to 0.3 inch (4 to 7 mm) long and shorter than leaves. Hairy five-lobed calyx shorter than petals.

**Fruit and seeds.** October to March. Flat ovate to round single-seeded legume pod 0.12 to 0.15 inch (3 to 4 mm) wide. Pods clustered in terminal axils, scattered along the stem, and clasped by persistent sepals. Green becoming tan.

**Ecology.** Occurs in new and older forest openings, dry upland woodlands to moist savannas, old fields, right-of-ways, and cities. Flood tolerant. Forms dense stands by sprouting stems from rootcrowns that prevent forest regeneration and land access. Cross- and self-pollinates. Spreads slowly from plantings by seeds that have low germination, but remain viable for decades. Nitrogen fixer.

**Resembles** native lespedeza, *L. virginica* (L.) Britt., which grows in tufted clumps instead of infestations, has crowded clusters of pink-purple to violet flowers and somewhat larger leaflets 0.6 to 1.2 inches (1.5 to 3 cm) long, and brown stems.

**History and use.** Introduced from Japan in 1899—first near Arlington, VA, and soon afterwards in north-central Tennessee—and escaped. Benefited from government programs that promoted plantings for erosion control. Still planted for quail food plots, soil stabilization, and grazing. Plant improvement breeding programs still underway.

States with suspected infestations are shown in gray.



# **Chinese Lespedeza**



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# Tropical Soda Apple



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C. Bryson

C. Brysor

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#### Solanum viarum Dunal SOVI2

**Plant.** Upright, thorny perennial subshrub or shrub, 3 to 6 feet (1 to 2 m) in height, with leaves shaped like oak leaves, clusters of tiny white flowers, and green-to-yellow golf-ball size fruit. Fruit sweet smelling and attractive to livestock and wildlife. Remains green over winter in most southern locations.

**Stem.** Upright-to-leaning, much branched, hairy, covered with broad based white-to-yellow thorns.

**Leaves.** Alternate, 4 to 8 inches (10 to 20 cm) long and 2 to 6 inches (5 to 15 cm) wide. Margins deeply lobed (shaped like oak leaves). Velvety hairy with thorns projecting from veins and petioles. Dark green with whitish midveins above and lighter green with netted veins beneath.

**Flowers.** May to August (year-round in Florida). Terminal small clusters of fivepetaled white flowers. Petals first extended, then becoming recurved. Yellow-towhite stamen projecting from the center.

**Fruit and seeds.** June to November (year-round in Florida). Spherical, hairless, pulpy berry 1 to 1.5 inches (2.5 to 4 cm). Mottled green ripening to yellow. Each berry producing 200 to 400 reddish-brown seeds.

**Ecology.** Occurs on open to semishady sites. Viable seed in green or yellow fruit but not in white fruit. Reaches maturity from seed within 105 days. Persists by green stems or rootcrowns in warmer areas. Rapidly spreading by cattle and other live-stock transportation and by wildlife-dispersed seeds as well as seed-contaminated hay, sod, and machinery.

**Resembles** horsenettle, *S. carolinense* L., an 8- to 30-inch (20- to 80-cm) forb, which has similar but smaller fruit, long elliptic-to-ovate lobed leaves 3 to 5 inches (8 to 12 cm) long and 1 to 3 inches (2.5 to 8 cm) wide, and prickly yellow spines on stems and lower leaf veins.

**History and use.** Native to Argentina and Brazil and introduced into Florida in the 1980s. No known use. A Federal listed noxious weed with an eradication program underway.

States with suspected infestations are shown in gray.



# **Tropical Soda Apple**



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Species	State												
	AL	AR	FL	GA	KY	LA	MS	NC	OK	SC	ΤN	ТΧ	VA
Trees													
Norway maple, Acer platanoides L.					Х			Х			Х		Х
Paper mulberry, Broussonetia papyrifera (L.) L'Hér. ex Vent.	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Camphortree, Cinnamomum camphora (L.) J. Presi	Х		Х	Х		Х	Х	Х		Х		Х	
Glossy buckthorn, Frangula alnus P. Mill.					Х						Х		
White mulberry, Morus alba L.	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
White poplar, <i>Populus alba</i> L.	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Siberian elm, <i>Ulmus pumila</i> L	Х	Х	Х	Х	Х	Х			Х		Х	Х	Х
Tungoil tree, Vernicia fordii (Hemsl.) Airy-Shaw	Х		Х	Х		Х	Х						
Shrubs													
Coral ardisia. Ardisia crenata Sims	Х		Х			Х							
Japanese barberry, Berberis thunbergii DC.				Х	Х			Х		Х	Х		Х
Japanese knotweed, Polygonum cuspidatum Sieb. & Zucc.		Х		Х	Х	Х	Х	Х	Х	Х	Х		Х
Callery pear, Pyrus calleryana Dcne.	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Wineberry, wine raspberry, Rubus phoenicolasius Maxim.		Х		Х	Х			Х		Х	Х		Х
Japanese spiraea, meadowsweet, Spiraea japonica L. f.				Х	Х			Х		Х		Х	Х
Saltcedar, Tamarix ramosissima Ledeb.		Х		Х		Х	Х	Х	Х	Х		Х	Х
Vines													
Fiveleaf akebia, chocolate vine, Akebia guinata (Houtt.) Dcne.			х	Х	Х			Х		х			х
Purple crownyetch. <i>Coronilla varia</i> L.	Х	Х	Х	Х	Х		Х	Х	Х	Х	Х	Х	
Porcelain berry, Amur peppervine, Ampelopsis brevipedunculata													
(Maxim.) Trautv.				Х	Х			Х					Х
Grasses													
Torpedo grass Panicum repens	х		х			х	х	х		х		х	
Vasev's grass. Paspalum urvillei Steud.	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Johnsongrass, Sorghum halepense (L.) Pers.	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Forbs and subshrubs													
Spotted knapweed. Centaurea biebersteinii DC	х	х	х		х	х		х		х	х		Х
Dames rocket. Hesperis matronalis L	~	X	~	Х	X	~		X		~	X		X
Purple loosestrife. Lythrum salicaria L.	Х	X	Х		X		Х	X	Х		X	Х	X
Mile-a-minute, Asiatic tearthumb, Polygonum perfoliatum L.												-	Х

# Other Nonnative Plants Invading Southern Forests and Their Margins

# **General Principles for Controlling Nonnative Invasive Plants**

The best defense against nonnative plant takeovers is constant surveillance of right-of-ways, streambanks, and internal roads and trails followed by effective control measures at the first appearance of new arrivals. Early detection and treatment will minimize efforts and costs that come with treating well-established plants or full-blown infestations. More effort is required for successful eradication of established infestations, but it still can be accomplished with proper treatments, although costs may be prohibitive. In severe cases, large-scale conversion of existing infestations is the only solution, involving eradication procedures that incorporate integrated management treatments and reestablishment of native plants. Fortunately, in southern forests native plants in the soil seed bank or plants from surrounding areas will naturally reestablish once the invaders are eliminated.

### **Effective Treatments**

If an infestation is spotted or already occurs, then proper and aggressive eradication measures should be undertaken to avoid the inevitable spread. Continued treatment and retreatments will be necessary. Most nonnative invasive plants are perennials, having extensive tough roots and runners. This means that effective herbicide applications offer the best means of containment or eradication, because herbicides can kill roots and do so



Broadcast treatment of herbicide spray to kudzu.

without baring soil for reinvasion or erosion. To be successful with herbicide treatments:

- 1. Use the most effective herbicide for the species.
- 2. Follow the application methods prescribed on the label.
- 3. Choose an optimum time period to apply treatments; for foliar-applied herbicides this is usually mid-summer to early fall and not later than a month before expected frost. Evergreens and semi-evergreens with leaves can be treated effectively in the winter.
- 4. Adhere to all label prohibitions, precautions, and Best Management Practices during herbicide transport, storage, mixing, and application.
- 5. Remember that some herbicides require up to a month or more before herbicidal activity is detectable as yellowing of foliage or leaves with dead spots or margins. Thus, after application, be patient; allow herbicides to work for several months before resorting to other treatment options.

### **Selective Herbicide Application Methods**

Although treating extensive inaccessible infestations may require broadcast treatments of herbicide sprays or pellets by helicopter or tractormounted application systems, the best approach is usually selective

applications of herbicides to target nonnative plants while avoiding or minimizing application to desirable plants. The selective methods described are directed foliar sprays, stem injection, cut-treat, basal sprays, and soil spots.

### **Directed Foliar Sprays**

Directed foliar sprays are herbicide-water sprays aimed at target plant foliage to cover all leaves to the point of run off, usually applied with a backpack sprayer (use low pressure, drift retardants, and spray shields to avoid drift). Herbicide application by directed foliar spray is the most costeffective method for treating most types of invasive plant species. With this method, herbicides are thoroughly mixed in water,



Directed foliar sprays with a backpack sprayer. Page 387 of 416



A spray shield fashioned from a used gallon milk jug (bottom removed and cap bored.)



Spray gun with swivel that holds two tips—narrow and wide angle.

often with a non-ionic surfactant, and applied to the foliage and growing tips of woody plants or to completely cover herbaceous plants. Foliar sprays are usually most effective when applied from midsummer to late fall, although spring and winter applications have use on specific plants and situations. Selective treatment is possible because the applicator directs the spray towards target plants and away from desirable plants. The addition of a water-soluble dye can assist in tracking treatment and detecting spray drift on desirable plants. Although dyes are messy and short-lived as a visible marker, they are helpful in training and tracking critical applications. Another safeguard is to only use foliar active herbicides, because directed sprays of soil-active herbicides can damage or kill surrounding plants when their roots are within the treatment zone. Never use herbicides with soil activity to treat invasive plants under desirable trees or shrubs.

Directed sprays are usually applied with a backpack sprayer and a spray wand equipped with a full cone, flat fan, or adjustable cone spray tip. These tips and spraying pressures of 20 to 30 pounds per square inch can ensure



Higher spray heights achieved with narrow-angle nozzle, wand extension, and higher pressure.

productivity with only a few fine droplets that may drift to surrounding plants. To safeguard surrounding plants from damage by spray drift, suspend applications during windy conditions. A spray shield that attaches to the end of the wand can further minimize drift. Adding a drift retardant to the spray mixture can eliminate drift although effectiveness may be diminished.

Plants up to 6 feet tall can be treated with this equipment, while the addition of a commercially available wand extension can slightly increase height capabilities. To treat plants up to about 18 feet tall, use higher spray pressures with a straight-stream or narrow flat fan tip.

Directed foliar sprays are also applied using wands on hoses attached to spraying systems mounted on all-terrain vehicles, trucks, or tractors. Also, a spray gun with a narrow flat fan tip can replace a wand for some applications. Another useful alternative for treating different sized woody plants is a spray gun with a swivel that holds two tips—narrow and wide-angled—that can be quickly changed during application.

### **Stem Injection**

Stem injection (including hack-and-squirt) involves herbicide concentrate or herbicide-water mixtures applied into downward incision cuts spaced around woody stems made by an ax, hatchet, machete, brush ax, or tree injector. Tree injection, including the hack-





Stem injection using a hatchet and spray bottle for hack-and-squirt (A) and a tree injector (B).

and-squirt technique, is a selective method of controlling larger trees and shrubs (more than 2 inches in diameter) with minimum damage to surrounding plants. It requires cuplike downward incisions spaced around the stem with a measured amount of herbicide applied into each of the incisions. Special tree injectors are available to perform this operation, or a narrow-bit ax, hatchet, or machete along with a spray bottle can be used in sequence to perform the hack-and-squirt method. Completely frilling the stem with edge-to-edge cuts or injections is required for very large stems or difficult-tocontrol species. The herbicide should remain in the injection cut to avoid wasting herbicide on the bark and to prevent damage of surrounding plants. All injected herbicides can be transferred to untreated plants by root grafts and uptake of root exudates. Herbicides with soil activity can damage nearby plants when washed from incisions into the soil by unexpected rainfall soon after application. Avoid injection treatments if rainfall is predicted within 48 hours.

Tree injection treatments are most effective when applied in late winter and throughout the summer. Heavy spring sap flow in spring can wash herbicide from incision cuts, making this an ineffective period.

### **Cut-Treat**

Cut-treat involves herbicide concentrates or herbicide-water mixtures applied to the outer circumference of freshly cut stumps or the entire top surface of cut stems, applied with a backpack sprayer, spray bottle, wick, or paint brush. Freshly cut stems and stumps of woody stems, including canes and bamboo, can be treated with herbicide mixtures to prevent resprouting and to kill roots. Cutting is usually by chainsaw or brush saw, but can be accomplished by handsaws or cutting blades. To minimize deactivation of the herbicide, remove sawdust from stumps before treatment. Treat stems and stumps as quickly as possible after cutting with a



Cut-treat the circumference of large stems (A) and the entire top of small stems (B).

backpack sprayer or utility spray bottle for spray applications or a wick applicator, lab wash bottle, or paintbrush for small stems. Add a non-ionic surfactant to the mix to aid in penetration, if permitted by the label.

For stumps over 3 inches in diameter, completely wet the outer edge with the herbicide or herbicide mixture. Completely wet the tops of smaller stumps and all cut stems in a clump. Apply a basal spray mixture of herbicide, oil, and penetrant to stumps that have remained untreated for over 2 hours or use Pathfinder II and wet stump sides too.

The most effective time for the stump spray method is late winter and summer. Although winter treatments are slightly less effective than growing season applications, the absence of foliage on cut stems and branches produces some offsetting gains in application efficiency.

### **Basal Sprays**

Basal sprays are herbicide-oil-penetrant mixtures sprayed or daubed onto the lower portion of woody stems, usually applied with a backpack sprayer or wick applicator. Full basal treatments require that the lower 12 to 20 inches of target woody stems be completely wetted on all sides with an oilbased spray mixture. Application is to smooth juvenile bark. Full basal sprays are usually effective in controlling woody stems less than about 6

inches in diameter or larger diameters of susceptible species, before bark becomes thick, corky, and furrowed. The appropriate equipment for this treatment is a backpack sprayer with a wand or spray gun fitted with a narrow-angle flat fan, cone, or adjustable tip. A wick applicator can also be used. Herbicides that are soluble in oil (mainly Garlon 4) are mixed with a commercially available basal oil, vegetable oil, crop oil, diesel fuel, or kerosene often adding a special penetrant. Some herbicides, such as Pathfinder II and Vine-X, are sold readyto-use with these ingredients.

A modified method, streamline basal sprays, is effective for many woody species up to 2 inches in diameter, as well as trees and shrubs up to 6 inches in diameter if the species is susceptible. Equipment for this



Basal sprays applied by spray gun and straight-stream nozzle to low stem.

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Basal spray mixture applied by a wick applicator to safeguard nearby plants.

treatment is a backpack sprayer with a spray gun and a low-flow straight-stream or narrow-angle spray tip. To prevent waste, maintain pressure below 30 pounds per square inch with a pressure regulator. At this pressure, an effective reach of 9 feet is possible while bark splash is minimized. For treating stems less than 2 inches in diameter, apply the stream of spray up-anddown single stems for about 6 to 8 inches, or apply across multiple stems creating 2to 3-inch-wide bands. This same multipleband treatment can be effective on larger stems. Direct the spray stream to smooth

juvenile bark at a point about 4 to 18 inches from the ground. Stems that are thick barked or near 3 inches in diameter require treatment on all sides.

Applications are usually in late winter and early spring, when leaves do not hinder spraying the stem. Summer applications are effective but more difficult. Avoid ester herbicide formulations on hot days to prevent vapor drift injury to nontarget plants.

### Soil Spots

Soil spots are Velpar L herbicide applied as metered amounts to the soil surface around target woody stems or in a grid pattern for treating many stems in an area; they are usually applied with a spot gun or with a back-pack sprayer equipped with a straight-stream nozzle. Spots of soil-active herbicide (mainly Velpar L) are applied to the soil surface in grid patterns or around target woody stems. This method requires exact amounts and



Soil spots applied as metered herbicide amounts to the soil surface.

prescribed spacings that are specified on the herbicide label or label supplements. It is only effective on specific nonnative plant species and usually only when applied in spring and early summer. Equipment is a special spot gun, utility spray bottle, or a backpack sprayer with a spray gun equipped with a straight-stream spray tip.

### Selecting an Effective Herbicide

Only herbicides registered by the U.S. Environmental Protection Agency for forestry use and noncroplands in the Southern States will be discussed here, although herbicides for other "land use areas," such as right-of-ways, pastures, and rangelands, may be just as effective or may contain the same active ingredient. The herbicides that will be identified by trade name (and common active-ingredient name) are:

### Foliar active (mostly) herbicides

Glyphosate herbicides (glyphosate) such as: Accord Concentrate, Gly-Flo Herbicide, and etc. Garlon 3A (triclopyr) Garlon 4 (triclopyr) Krenite S (fosamine) Pathfinder II (triclopyr) Milestone VM (aminopyralid)

### Foliar and soil-active herbicides

Arsenal AC (imazapyr) Escort XP (metsulfuron) Pathway (2,4-D + picloram) Plateau (imazapic) Tordon 101 (2,4-D + picloram) Tordon K (picloram) Transline (clopyralid) Vanquish (dicamba) Velpar L (hexazinone)

Because nonnative invasive plants are usually difficult to control, selecting the most effective herbicide(s) is important. Often herbicides that have both soil and foliar activity are most effective with the least number of applications. However, applying herbicides with soil activity can damage desirable plants when their roots are present within the treatment zone or when herbicides move downhill to untreated areas following heavy rainfall. Garlon herbicides are mainly foliar active, but they have some soil activity at high rates or when mixed with oils. Garlon 4 and Vanquish can volatilize at high temperatures and their residues can move by air currents to affect surrounding plants; therefore, avoid application on days when temperatures exceed 80° F. If possible, also avoid applications when rainfall is anticipated within 8 hours, unless soil activation is needed, and during periods of severe drought as effectiveness can be reduced during these times.

When possible, use selective herbicides that target specific nonnative species, such as Transline that controls mainly legumes and composites, and minimize damage to surrounding desirable plants even though they receive herbicide contact. Minimizing damage to desirable cohorts can also be achieved by making applications when the cohorts are dormant. For example, apply basal sprays to the bark of invasives in late winter before most other plants emerge, or foliar spray evergreen or semievergreen invasives after surrounding plants have entered dormancy. Remember that desirable woody plants can be damaged through transfer of herbicides by Page 390 of 416

root exudates following stem injection and cut-treat treatments or when soilactive herbicides wash off treated stems. Damage to surrounding native plants can be minimized with care and forethought during planning and application.

Read and thoroughly understand the herbicide label and its prohibitions before and during use. Many herbicides require the addition of a non-ionic surfactant to the spray tank. Always use clean water in a herbicide mixture and mix spray solutions thoroughly before applying. Do not mix in the sprayer but in a bucket with a stirring stick—stirring for several minutes or more—before transferring to the sprayer. Water that is highly basic (pH greater than 6) and contains high amounts of calcium and magnesium interferes with glyphosate herbicide effectiveness, requiring the addition of ammonium sulfate or appropriate additives. When changing from a waterbased mix to an oil-based mix in a backpack sprayer, thoroughly evacuate the water from the pump and run a small amount of oil through the pumping system before filling with the oil-based mix, otherwise, a white sludge will clog the sprayer. And, always wear personal protective equipment prescribed on the label and in supplementary materials.

### Other Treatments for an Integrated Approach

Overgrazing is a way to reduce the vigor of palatable invasive plants like kudzu, but this rarely yields eradication and may spread seeds (as with tropical soda apple). Mechanical treatments and prescribed burning can assist eradication measures, but are limited in effectiveness. Prescribed burning cannot control rootcrowns or rhizomes of perennial plants and usually only deadens small aboveground shoots, providing only temporary aboveground control. In a similar way, cutting woody plants (by chainsaw and brush saw felling or brush mowing) and mowing vines and herbs

without killing roots remove only aboveground plant parts. Mechanical root raking and disking can actually intensify and spread infestations of invasive plants with runners by chopping them into resprouting segments and transporting them on the equipment. Fireplows can also spread invasive plant rhizomes and roots.



Overgrazing for kudzu control.

However, root raking, piling, brush mowing, or burning may be the only way to start controlling dense infestations of multiple woody invasive plants. Small infestations may respond to hand pulling, grubbing with a stout hoe, or shrub pulling with newly introduced devices. Hand pulling or grubbing may be the quickest and easiest way to halt invaders when first spotted and stop them from gaining a foothold. String trimmers can reduce infestation densities and injure thick waxy leaves to improve herbicide uptake and effectiveness.



Hand pulling privet.

Although ineffective by themselves to achieve eradication, both mechanical and burning treatments can give added kill of herbicide-weakened plants and have a place in an integrated pest management program. The

stumps and stems of nonnative trees, shrubs, and bamboos can be treated with herbicides immediately after cutting to kill roots. Resprouts of trees, shrubs, and vines that are topkilled by burning or brush mowing can be more easily treated with foliar sprays, often the most cost-effective way to use herbicides. Herbicide applications should be delayed after burning, disking, or mowing to permit adequate resprouting of target plants and, thereby maximizing herbicide uptake and effectiveness. Prescribed burning can also destroy invasive plant seeds (and bulbils of air yams) and often stimulate germination for efficient herbicide



Prescribed burn.



Wildland disk.

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control treatments. Burning can prepare the site for effective herbicide applications by clearing debris and revealing application hazards, such as old wells and pits. Disking and root raking, if applied correctly, can dislodge herbicide-damaged woody roots and large runners, leaving them to dry and rot. With mechanical and burning treatments, take precautions, such as burning in late winter or spring leaf-out, to minimize the period of bare soil. The most effective time for controlling woody invasive plants and their germinants with fire is after plants have initiated growth in spring.

An eradication program for infestations of invasive plants usually requires several years of treatment and many more years of surveillance to check for rhizome sprouts, root sprouts, seed germination, or new invasions. Following these steps in a planned manner and with persistence is the only successful strategy to safeguard land access, productivity, native plants, and suitable habitats for wildlife.



Sowing native plant seed.

### **The Rehabilitation Phase**

Rehabilitation is the most important final phase of an integrated invasive plant eradication and reclamation program. The rehabilitation phase requires establishment and/or release of fast-growing native plants that can outcompete and outlast any surviving nonnative plants while stabilizing and protecting the soil. If the soil seed bank remains intact, native plant communities may naturally reinitiate succession after eradication of nonnative plants. Lightseeded native species are usually present in the seed bank while heavier seeded plants will gradually be deposited on a site by birds and other animals. In recent years, native plant seed and seedlings have become increasingly available for rehabilitation sowing and planting, but a limited number of species and absence of well-developed establishment procedures often hinder use. Tree nurseries operated by State forestry agencies are a good source of many species of native trees and shrubs. Often it is necessary to establish fast-growing tree species during the later control phase to hinder reestablishment of shade intolerant nonnative invasive plants. Reestablishing native grasses and forbs is equally important. These species are available from commercial nurseries specializing in native plants, utilizing local sources when possible. Native plant seeds will require proper treatments to assure timely germination. Seedling native plants can be also collected and transplanted from suitable field sites. Their establishment will be more challenging than the commonly available nonnative plants so often used for soil stabilization and wildlife food plots. Constant surveillance, maintaining forest vigor with minimal disturbance, treatment of new unwanted arrivals, and finally rehabilitation following eradication are critical to preventing and controlling invasions on a specific site.



Containerized native plants for rehabilitation plantings.

# **Prescriptions for Specific Nonnative Invasive Plants**

The following are herbicide prescription summaries for prevalent invasive plants, detailing mainly selective application treatments. These prescriptions have been assembled from published research results, unpublished trials, State reports, weed council manuals, magazines, and Web sites. In general, very few species-specific experiments have been reported that compare a full array of treatments for nonnative invasive plant species. But until further specific understanding is gained, we must proceed with current knowledge and technology to combat this invasion. Herbicides are mentioned in order by effectiveness when comparative information is available or alphabetically when such information is lacking. Remember to follow the label-specified maximum herbicide amounts that are permissible for an acre of land when using selective application treatments.

### **Nonnative Trees**

Nonnative tree species hinder reforestation and management of right-ofways and natural areas as well as dramatically altering habitats. Some occur as scattered trees while others form dense stands. Most spread by prolific seed production and abundant root sprouts. They can be eliminated with herbicides by stem injection, cut-treat, and soil spots, with basal and foliar sprays for seedlings and saplings. Following stem control, total elimination requires surveillance and treatment of root sprouts and plant germinants that originate from the soil seed bank.



### Tree-of-Heaven, Ailanthus

Tree-of-heaven or ailanthus (*Ailanthus altissima*) is a deciduous tree to 80 feet (25 m) tall with long pinnately compound leaves, gray slightly fissured bark, and large terminal clusters of greenish flowers in early summer. Flowers and other parts of the plant have a strong odor.

Viable seed are produced by 2- to 3-year-old plants. Immature appearing seeds are capable of germination. Root sprouts may appear after the main stem is deadened, and root segments left in soil after pulling treatments will sprout. Tree-of-heaven sprouts have been found to have 10 to 14 feet (3 to 4 m) of first year height growth, while seedlings can grow 3 to 6 feet (1 to 2 m) in the first year. This vigorous growth can continue for 4 or more years.

### Recommended control procedures:

**Large trees.** Make stem injections and then apply Garlon 3A, Pathway<sup>\*</sup>, Pathfinder II, or Arsenal AC<sup>\*</sup> in dilutions and cut spacings specified on the herbicide label (midsummer best, late winter somewhat less effective). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.

**Saplings.** Apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

**Seedlings and saplings.** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix), Krenite S as a 15-percent solution (3 pints per 3-gallon mix), Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix), or Escort XP<sup>\*</sup> at 1 ounce per acre.



### Silktree, Mimosa

Silktree or mimosa *(Albizia julibrissin)* is a small legume tree to 10 to 50 feet (3 to 15 m) tall that reproduces by abundant seeds and root sprouts. It has feathery deciduous leaves, smooth light-brown bark, and showy pink blossoms that yield dangling flat pods. Seedpods float and seed remain viable for many years.

### Recommended control procedures:

**Large trees.** Make stem injections using Arsenal AC<sup>\*</sup> or Garlon 3A in dilutions as specified on the herbicide label (anytime except March and April). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.

**Saplings.** Apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

**Resprouts and seedlings.** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant:

■ July to October—Garlon 3A, Garlon 4, or glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix)

■ July to September—Transline<sup>†</sup> as a 0.2- to 0.4-percent solution (1 to 2 ounces per 3-gallon mix)

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

<sup>&</sup>lt;sup>†</sup> Transline controls a narrow spectrum of plant species.


#### Princesstree, Paulownia

Princesstree or paulownia (*Paulownia tomentosa*) is a deciduous tree to 60 feet (18 m) tall with large heartshaped leaves that are fuzzy hairy on both sides and pecan-like nuts in clusters (containing many tiny winged seeds) following showy pale-violet flowers in early spring. Stump sprouts and root sprouts may eventually emerge after main stems are deadened.

#### Recommended control procedures:

**Large trees.** Make stem injections using Arsenal AC<sup>\*</sup> or a glyphosate herbicide in dilutions and cut spacings specified on the herbicide label (anytime except March and April). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.

**Saplings.** Apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

**Resprouts and seedlings.** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-galllon mix); a glyphosate herbicide, Garlon 3A, or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).



#### Chinaberrytree

Chinaberrytree (*Melia azedarach*) is a deciduous tree growing to about 50 feet (15 m) tall. It has lacy, manydivided leaves that are dark green and blue flowers in spring that yield round yellow fruit that persist during winter. Stump sprouts and root sprouts may eventually emerge after main stems are deadened.

#### **Recommended control procedures:**

**Trees.** Make stem injections using Arsenal AC<sup>\*</sup>, Pathway<sup>\*</sup>, Pathfinder II, or Garlon 3A in dilutions and cut spacings specified on the herbicide label (anytime except March and April). For felled trees, apply these herbicides to stem and stump tops immediately after cutting.

**Saplings.** Apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

**Sprouts and seedlings.** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 3A or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix); Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix).



#### Tallowtree, Popcorntree

Tallowtree or popcorntree (*Triadica sebifera*, formerly *Sapium sebiferum*) is a deciduous tree growing to 60 feet (18 m) tall that has heart-shaped leaves turning scarlet in fall, long drooping flowers in spring, and bundles of white waxy "popcorn-like" seeds in fall and winter. Three-year-old plants can produce viable seed and small seedlings can be easily hand pulled. Burning results in abundant seedlings.

#### Recommended control procedures:

**Large trees.** Make stem injections using Arsenal AC<sup>\*</sup>, Garlon 3A, or Pathfinder II in dilutions and cut spacings specified on the herbicide label (anytime except March and April). For felled trees, apply the herbicides to stem and stump tops immediately after cutting (at least a 10-percent solution for Garlon 3A). Ortho Brush-B-Gone (triclopyr) and Enforcer Brush Killer (triclopyr) are effective for treating cut stumps and readily available to homeowners in retail garden stores. For treatment of extensive infestations in forest situations, apply Velpar L<sup>\*</sup> to the soil surface within 3 feet of the stem (one squirt of spot gun per 1-inch stem diameter) or in a grid pattern at spacings specified on the herbicide label.

**Saplings.** Apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

**Seedlings and saplings.** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix), Krenite S as a 20-percent solution (2 quarts per 3-gallon mix), or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).



#### **Russian Olive**

Russian olive (*Elaeagnus angustifolia*) is a small thorny tree to 35 feet (10 m) tall that has microscopic silvery scales covering leaves, twigs, and fruits. Leaves are long and narrow with entire margins. Bark is fissured and reddish brown. Olive-like fruit are yellow and appear in late summer to fall.

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

#### **Recommended control procedures:**

**Trees.** Make stem injections using Arsenal AC<sup>\*</sup> or Garlon 3A in dilutions and cut spacings specified on the herbicide label (anytime except March and April). For felled trees, apply the herbicides to stem and stump tops immediately after cutting.

**Saplings.** Apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

**Seedlings and saplings.** Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Arsenal AC<sup>\*</sup> as a 1-percent solution in water (4 ounces per 3-gallon mix); a glyphosate herbicide, Garlon 3A, or Garlon 4 as a 2-percent solution in water (8 ounces per 3-gallon mix) for directed spray treatments that have limited or no soil activity.

### **Nonnative Shrubs**

Nonnative shrubs often occur with nonnative tree species and present similar problems. Herbicide control options are similar to trees, with the exception that foliar sprays can be used more often and are more effective. All are shade tolerant with bird-dispersed seeds resulting in scattered plants under existing forest canopies (except nonnative roses), which requires additional surveillance within the interior of forest stands.



### Silverthorn, Thorny Olive

Silverthorn or thorny olive (*Elaeagnus pungens*) is an evergreen, densely bushy shrub 3 to 25 feet (1 to 8 m) in height. It has long limber projecting shoots, scattered thorny, dense alternate leaves silver scaly in spring on both top and bottom becoming dark green above and silvery beneath by midsummer. Oblong fruit red and brown scaly appear in spring.

#### Recommended control procedures:

■ Thoroughly wet all leaves with Arsenal AC<sup>\*</sup> or Vanquish<sup>\*</sup> as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant; Garlon 3A and Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix).

■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts

per 3-gallon mix) with a penetrant (check with herbicide distributor) to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC\* as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).



#### 🎽 Autumn Olive

Autumn olive (*Elaeagnus umbellata*) is a tardily deciduous bushy leafy shrub, 3 to 20 feet (1 to 6 m) in height, with scattered thorny branches. It has alternate leaves green above and silvery scaly beneath, with many red berries in fall having silvery scales.

#### Recommended control procedures:

■ Thoroughly wet all leaves with Arsenal AC<sup>\*</sup> or Vanquish<sup>\*</sup> as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (April to October).

■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC<sup>\*</sup> as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).



#### Winged Burning Bush

Winged burning bush (*Euonymus alata*) is a deciduous, wing-stemmed, bushy shrub to 12 feet (4 m) in height, multiple stemmed and much branched, canopy broad and leafy. It has small and obovate opposite leaves, green turning bright scarlet to purplish red in fall, along stems with

four corky wings. Many orange fruit appear as stemmed pairs in leaf axils and turning purple in fall.

#### Recommended control procedures:

■ Thoroughly wet all leaves with Arsenal AC<sup>\*</sup> or Vanquish<sup>\*</sup> as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (April to October).

■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene Page 395 of 416

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

(2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC\* as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).



#### **Chinese Privet, European Privet**

Chinese privet (*Ligustrum sinense*) and European privet (*L. vulgare*) are difficult to distinguish except at flowering, both are evergreen to semievergreen. Both are thicket-forming shrubs to 30 feet (9 m) in height that are soft woody, multiple stemmed with long leafy branches and

opposite leaves less than 2 inches long. Showy clusters of small white flowers in spring yield clusters of small ovoid, dark-purple berries during fall and winter.

#### Recommended control procedures:

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (August to March): a glyphosate herbicide as a 3-percent solution (12 ounces per 3-gallon mix) or Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix).

■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray. Or, cut large stems and immediately treat the stumps with Arsenal AC<sup>\*</sup> or Velpar L<sup>\*</sup> as a 10-percent solution in water (1 quart per 3-gallon mix) with a surfactant. When safety to surrounding vegetation is desired, immediately treat stumps and cut stems with Garlon 3A or a glyphosate herbicide as a 20-percent solution in water (2.5 quarts per 3-gallon mix) with a surfactant.



#### Japanese Privet, Glossy Privet

Japanese privet (*Ligustrum japonicum*) and glossy privet (*L. lucidum*) are evergreen to 35 feet (10 m) in height, with an upward spreading canopies. They have thick leathery opposite leaves 2 to 4 inches (5 to 10 cm) long, and hairless leaves and stems. Clusters of small showy white flowers in spring yield small rounded green to purple fruit.

#### **Recommended control procedures:**

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (August through March): Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix); Garlon 4 as a 3-percent solution (12 ounces per 3-gallon mix); or a glyphosate herbicide as a 3-percent solution (12 ounces per 3-gallon mix).

■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with Arsenal AC<sup>\*</sup> or Velpar L<sup>\*</sup> as a 10-percent solution in water (1 quart per 3-gallon mix) with a surfactant. When safety to surrounding vegetation is desired, immediately treat stumps and cut stems with a glyphosate herbicide or Garlon 3A as a 20-percent solution in water (2.5 quarts per 3-gallon mix) with a surfactant.



#### Bush Honeysuckles

Amur honeysuckle (*Lonicera maackii*), Morrow's honeysuckle (*L. morrowii*), Tatarian honeysuckle (*L. tatarica*), and sweet-breath-of-spring (*L. fragrantissima*) are all tardily deciduous, upright, arching-branched shrubs. Amur is to 30 feet (9 m) in height and spindly in forests, Morrow's is to 6.5 feet (2 m) in height, and Tatarian and sweet-breath-ofspring are to 10 feet (3 m) in height. All are much branched

and arching in openings, multiple stemmed, with dark-green oval-to-oblong distinctly opposite leaves 0.8 to 2.4 inches (2 to 6 cm) long. Fragrant showy tubular white-to-pink or yellow paired flowers appear from May to June. Abundant paired berries are red to orange during winter. Seeds are long-lived in the soil.

#### Recommended control procedures:

■ Thoroughly wet all leaves with glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant (August to October). Or, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

■ For stems too tall for foliar sprays, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC<sup>\*</sup> as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.



#### Sacred Bamboo, Nandina

Sacred bamboo or nandina (*Nandina domestica*) is an evergreen erect shrub to 8 feet (2.5 m) in height, with multiple bushy stems resembling bamboo, glossy pinnately to bipinnately compound green or reddish leaves. Early summer terminal clusters of tiny white-to-pinkish flowers yield dangling clusters of red berries in fall and winter.

#### **Recommended control procedures:**

■ Thoroughly wet all leaves with glyphosate herbicide as a 1-percent solution in water (4 ounces per 3-gallon mix) with a surfactant (August to October). Or, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray.

■ For stems too tall for foliar sprays, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC\* as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).

■ Collect and destroy fruit.



#### Nonnative Roses

Multiflora rose (*Rosa multiflora*), Macartney rose (*R. bracteata*), Cherokee rose (*R. laevigata*), and other nonnative roses are all evergreen except multiflora and are all erect, arching, or trailing shrubs to 10 feet (3 m) in height or long, clump forming. They have pinnately compound leaves with three to nine leaflets, frequent recurved or straight

thorns. Clustered or single white-to-pink flowers in early summer yield red rose hips in fall to winter.

#### **Recommended control procedures:**

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant: April to June (at or near the time of flowering)—Escort\* at 1 ounce per acre in water (0.2 dry ounces per 3-gallon mix); August to October—Arsenal AC\* as a 1-percent solution (4 ounces per 3-gallon mix) or Escort\* XP at 1 ounce per acre in water (0.2 dry ounces per 3-gallon mix); May to October—repeated applications of a glyphosate herbicide as a 4-percent solution in water (1 pint per 3-gallon mix), a less effective treatment that has no soil activity to damage surrounding plants. ■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II to young bark as a basal spray (January to February or May to October). Or, cut large stems and immediately treat the stumps with one of the following herbicides in water with a surfactant: Arsenal AC<sup>\*</sup> as a 10-percent solution (1 quart per 3-gallon mix) or a glyphosate herbicide as a 20-percent solution (2.5 quarts per 3-gallon mix).

### **Nonnative Vines**

Nonnative vines are some of the most troublesome invaders because they often form the densest infestations, making herbicide applications difficult. Many of these vines overtop even mature forests and often form mixed-species infestations with nonnative trees and shrubs. Specific herbicides can be effective on certain vines while not controlling, but actually releasing any underlying nonnative trees and shrubs. In these situations, select the best herbicide or herbicide mixture for controlling all the nonnative species in a mixed-species infestation. Vine control is always difficult because foliar active herbicides must move through lengthy vines to kill large unseen woody roots and tubers. Thus, herbicides that have both soil and foliar activity are often the most effective. Only the lower foliage within sprayer reach needs to be treated with a herbicide having both foliar and soil activity. With all herbicides, spray foliage of climbing stems as high as possible and if not controlled, then cut vines before retreatment.



#### **Oriental Bittersweet**

Oriental bittersweet (*Celastrus orbiculatus*) is an attractive but very invasive deciduous, twining, and climbing woody vine to 60 feet (20 m) with drooping branches in tree crowns, forming thicket and arbor infestations. It has alternate elliptic-to-rounded leaves 1.2 to 5 inches (3 to 12 cm) long. Its axillary dangling clusters of inconspicuous yellowish flowers yield green spherical fruit that split to reveal

three-parted showy scarlet fleshy covered seeds, which remain through winter at most leaf axils.

#### **Recommended control procedures:**

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 4, Garlon 3A, or a glyphosate herbicide as a 3-percent solution (12 ounces per 3-gallon mix).

■ For stems too tall for foliar sprays, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

(2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II as a basal spray to the lower 16 inches of stems. Or, cut large stems and immediately treat the cut surfaces with one of the following herbicides in water with a surfactant: Garlon 4 or a glyphosate herbicide as a 25-percent solution (32 ounces per 1-gallon mix).



### **Climbing Yams**

Air yam (*Dioscorea bulbifera*), Chinese yam or cinnamon vine (*D. oppositifolia*, formerly *D. batatas*), and water yam (*D. alata*) are herbaceous, high climbing vines to 65 feet (20 m) that cover shrubs and trees in infestations. They have twining and sprawling stems with long-petioled smooth heart-shaped leaves and dangling potato-like tubers (bulbils) that appear at leaf axils and drop to form

new plants. Aerial tubers spread down slope by gravity and by water. All species also have large underground tubers that make control difficult.

#### Recommended control procedures:

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon 3A or Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix). Sometimes the air yams take up the herbicide; otherwise, they must be collected and destroyed (not composted).

■ Cut climbing plants just above the soil surface and immediately treat the freshly cut stem with undiluted Garlon 3A (safe to surrounding plants).



### Winter Creeper, Climbing Euonymus

Winter creeper or climbing euonymus (*Euonymus fortunei*) is an evergreen shrub to 3 feet (1 m) in height and woody trailing vine to 40 to 70 feet (12 to 22 m) that forms a dense ground cover and climbs by clinging aerial roots along the stem. It has leaves that are opposite, thick, and dark green

or green-white variegated on green stems. Pinkish-to-red capsules split open in fall to expose orange fleshy covered seeds.

#### Recommended control procedures:

■ Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant (July to October for successive years): Tordon 101<sup>\*†</sup> as a 3-percent solution (12 ounces per 3-gallon mix) or Tordon K<sup>\*†</sup> as a 2-percent solution (8 ounces per 3-gallon mix). ■ Or, repeatedly apply Garlon 4 or a glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix) in water with a surfactant, a less effective treatment that has no soil activity to damage surrounding plants.

Cut all vertical climbing stems to prevent fruiting and spread by birds.

### English Ivy



English ivy (*Hedera helix*) is an evergreen vine climbing to 90 feet (28 m) that forms dense ground cover and climbs by aerial roots. It has thick dark-green leaves with whitish veins when juvenile that are heart-shaped with three to five pointed lobes, later becoming broadly lanceolate, and terminal flower clusters in summer that yield dark-purple berries in winter and spring.

#### Recommended control procedures:

■ Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant (July to October for successive years): Garlon 3A or Garlon 4 as a 3- to 5-percent solution (12 to 20 ounces per 3-gallon mix) or a glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix). Use a string trimmer to reduce growth layers and injure leaves for improved herbicide uptake. Cut large vines and apply these herbicides to cut surfaces.

■ Or, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II as a basal spray to large vines being careful to avoid the bark of the host tree.

#### Japanese Honeysuckle

Japanese honeysuckle (*Lonicera japonica*) is a semievergreen to evergreen woody vine, high climbing and trailing to 80 feet (24 m), branching and often forming arbors in forest canopies and/or ground cover under canopies. It has opposite leaves and long woody rhizomes that sprout frequently and make control difficult.

#### Recommended control procedures:

■ Apply Escort<sup>\*</sup> XP with a surfactant to foliage June to August—either by broadcast spraying 2 ounces per acre in water (0.6 dry ounces per 3-gallon mix) or by spot spraying 2 to 4 ounces per acre in water (0.6 to 1.2 dry ounces per 3-gallon mix).

• Or, treat foliage with one of the following herbicides in water with a surfactant (July to October or during warm days in early winter) keeping

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

<sup>&</sup>lt;sup>+</sup> When using Tordon herbicides, rainfall must occur within 6 days after application for needed soil activation. Tordon herbicides are Restricted Use Pesticides.

spray away from desirable plants: a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix) or Garlon 3A or Garlon 4 as a 3- to 5-percent solution (12 to 20 ounces per 3-gallon mix).

■ Or, cut large vines just above the soil surface and immediately treat the freshly cut stem with a glyphosate herbicide or Garlon 3A as a 20-percent solution (2.5 quarts per 3-gallon sprayer) in water with a surfactant July to October (safe to surrounding plants).

■ Prescribed burning in spring will reduce dense ground mats and sever climbing vines for more effective herbicide treatments to resprouting vines.



#### Kudzu

Kudzu (*Pueraria montana*) is a deciduous twining, trailing, mat-forming, woody leguminous vine 35 to 100 feet (10 to 30 m) with lobed three-leaflet leaves. Large root crowns that increase in size with age are difficult to control. Prescribed burning in spring can clear debris, sever climbing vines, and reveal hazards before summer applications.

#### **Recommended control procedures:**

■ Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant: July to October for successive years when regrowth appears—Tordon 101<sup>\*‡</sup> as a 3-percent solution (12 ounces per 3-gallon mix) or Tordon K<sup>\*‡</sup> as a 2-percent solution (8 ounces per 3-gallon mix), either by broadcast or spot spray—spraying climbing vines as high as possible. July to September for successive years—Escort<sup>\*</sup> XP at 3 to 4 ounces per acre in water (0.8 to 1.2 dry ounces per 3-gallon mix)—or when safety to surrounding vegetation is desired, Transline<sup>†</sup> as a 0.5-percent solution in water (2 ounces per 3-gallon mix); spray climbing vines as high as possible or cut vines that are not controlled after herbicide treatment.

■ For partial control, repeatedly apply Garlon 4 or a glyphosate herbicide as a 4-percent solution in water (1 pint per 3-gallon mix) with a surfactant during the growing season. Cut large vines and immediately apply these herbicides to the cut surfaces. Or, apply Garlon 4 as a 20-percent solution in basal oil, vegetable oil, crop oil concentrate, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) or apply undiluted Pathfinder II as a basal spray to large vines as a basal spray (January to April), which controls vines less than 2 inches in diameter.



### Vincas, Periwinkles

Common periwinkle (*Vinca minor*) and bigleaf periwinkle (*V. major*) are evergreen to semievergreen (leaves always present) somewhat-woody, trailing or scrambling vines to 3 feet (1 m) long and upright to 1 foot (30 cm) that form dense ground cover. They have opposite lanceolate-to-

heart-shaped leaves and five-petaled pinwheel-shaped violet single flowers. Viable seed appear to be produced only rarely.

#### Recommended control procedures:

■ Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant (July to October for successive years): Tordon 101<sup>\*‡</sup> as a 3-percent solution (12 ounces per 3-gallon mix), Tordon K<sup>\*‡</sup> as a 2-percent solution (8 ounces per 3-gallon mix), or Garlon 4 as a 4-percent solution (15 ounces per 3-gallon mix).

• Or, during the growing season, repeatedly apply Garlon 4 or a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant. In winter, herbicide treatments should be limited to warm days.



### Chinese Wisteria, Japanese Wisteria

Chinese wisteria (*Wisteria sinensis*) and Japanese wisteria (*W. floribunda*) are deciduous high climbing, twining, or trailing leguminous woody vines to 70 feet (20 m) with long pinnately compound leaves and showy spring flowers. Chinese and Japanese wisterias are difficult to distinguish due to possible hybridization.

#### Recommended control procedures:

Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant:

■ July to October for successive years when regrowth appears—Tordon 101<sup>\*‡</sup> as a 3-percent solution (12 ounces per 3-gallon mix), Tordon K<sup>\*‡</sup> as a 2-percent solution (8 ounces per 3-gallon mix), or Garlon 4 as a 4-percent solution (15 ounces per 3-gallon mix)

■ July to September for successive years when regrowth appears— Transline<sup>\*</sup><sup>†</sup> as a 0.5-percent solution in water (2 ounces per 3-gallon mix) when safety to surrounding vegetation is desired

September to October with repeated applications—a glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix)

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

<sup>&</sup>lt;sup>†</sup>Transline controls a narrow spectrum of plant species.

<sup>&</sup>lt;sup>‡</sup>When using Tordon herbicides, rainfall must occur within 6 days after application for needed soil activation. Tordon herbicides are Restricted Use Pesticides.

### **Nonnative Grasses**

Nonnative grasses continue to spread and increasingly reside along highway right-of-ways and thus gain access to adjoining lands. Most nonnative invasive grasses are highly flammable, increasing fire intensities, subjecting firefighters to increased risk, and spreading even faster after wildfire or a prescribed burn. Nonnative grasses have become one of the most insidious problems in the field of wildlife management on pasture and prairie lands, because they have little wildlife value and leave no room for native plants. Repeated applications of herbicides are required for control.



### **Giant Reed**

Giant reed (*Arundo donax*) is a giant leafy reed grass to 20 feet (6 m) in height that forms thickets in distinct clumps. It has cornlike gray-green and hairless leaves jutting from stems and drooping at the ends. Erect plumelike terminal panicles of flowers and seed heads appear in late summer and persist through winter. Seed are not viable.

#### Recommended control procedures:

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (September or October with multiple applications to regrowth):

- A glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix)
- Arsenal AC\* as a 1-percent solution (4 ounces per 3-gallon mix)
- A combination of the two herbicides



### Tall Fescue

Tall fescue (*Lolium arundinaceum*, formerly *Festuca arundinacea* and *F. elatior*) is an erect, tufted cool-season perennial grass, 2 to 4 feet (60 to 120 cm) in height. It has whitish-eared areas where leaf blades connect to the stem, and the stem has swollen nodes. Dark-green seedstalks and leaves appear in late winter, usually flowering in spring (infrequently in late summer). This grass is dormant in midsummer. Most tall fescue is infected with a fungus that

can reduce weight gains and lower reproductive rates in livestock, while adversely affecting the nutrition of songbirds and Canada geese. Tall fescue monocultures are generally poor habitat for wildlife.

#### Recommended control procedures:

■ On forest lands, apply a glyphosate herbicide as a 0.5-percent solution in water (2 quarts per 10 gallons mix per acre), or Arsenal AC\* as a 1-percent solution (25 ounces per 20 gallons mix per acre) in spring.

■ On noncroplands, apply 10 to 12 ounces of Plateau or 20 to 24 ounces of Journey per 20 gallons mix per acre (consult the label for additives) in spring. Mixing Plateau or Journey with a glyphosate herbicide will improve control but may damage associated native plants. Vantage (sethoxydim), Poast (sethoxydim), Assure (quizalofop), and Select (clethodim) may be useful on pastures, but they are usually more costly than a glyphosate mix with Plateau or Journey.

Early spring burning—if repeated—inhibits fescue and encourages native warm-season grasses.

## Cogongrass



Cogongrass (*Imperata cylindrica*) is an aggressive, colonyforming dense erect perennial grass 1 to 5 feet (30 to 150 cm) in height. It has tufts of long leaves, yellow-green blades (each with an off-center midvein and finely sawtoothed margins), and silver-plumed flowers and seeds in

spring, arising from sharp-tipped branching rhizomes. Older infestations will be more difficult to control.

#### Recommended control procedures:

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (September or October with multiple applications to regrowth): Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix), a glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix), or combination of the two herbicides.

Repeat before flowering in spring to suppress seed production and again in successive years for eradication.



### **Nepalese Browntop**

Nepalese browntop (*Microstegium vimineum*) is a sprawling, dense, mat-forming annual grass, 0.5 to 3 feet (15 to 90 cm) long with stems growing to 1 to 3 feet (30 to 89 cm) in height, often bending over and rooting at nodes to form

extensive infestations. It has alternate, lanceolate leaf blades to 4 inches (10 cm) long with off-center veins and thin seed heads in summer and fall. Apply treatment to stop seed production.

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

#### Recommended control procedures:

■ Apply a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant in summer. Or, apply Vantage (see label) for situations that require more selective control and less impact on associated plants.

■ Repeat treatments for several years to control abundant germinating seeds. Mowing or pulling just before seed set will also prevent seed buildup in the soil seed bank.



#### **Chinese Silvergrass**

Chinese silvergrass (*Miscanthus sinensis*) is a tall, densely tufted, perennial grass, upright to arching, 5 to 10 feet (1.5 to 3 m) in height. It has long, slender, and upright-to-arching leaves with whitish upper midveins and many loosely plumed panicles turning silvery to pinkish in fall.

#### Recommended control procedures:

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (September or October with multiple applications to regrowth):

- Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix)
- A glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix)
- A combination of the two herbicides



### Bamboos

Golden bamboo (*Phyllostachys aurea*) and other nonnative bamboos (*Phyllostachys* spp. and *Bambusa* spp.) are perennial infestation-forming grasslike plants 16 to 40 feet (5 to 12 m) in height. They have jointed cane stems and bushy tops of lanceolate leaves in fan clusters on grasslike stems, often golden green.

#### Recommended control procedures:

■ Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (September or October with multiple applications to regrowth): Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix), a glyphosate herbicide as a 4-percent solution (1 pint per 3-gallon mix), or combination of the two herbicides.

■ Cut just above ground level and treat stems immediately with a doublestrength batch of the same herbicides or herbicide mixture.

### **Nonnative Ferns**

Japanese climbing fern is presently the only nonnative invasive fern in the temperate parts of the South.



#### Japanese Climbing Fern

Japanese climbing fern (*Lygodium japonicum*) is a climbing and twining, perennial viney fern to 90 feet (30 m), often forming mats of shrub- and tree-covering infestations. It has lacy finely divided leaves along green-to-orange-toblack wiry vines.

#### Recommended control procedures:

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October):

Escort\* XP at 1 to 2 ounces per acre in water (0.3 to 0.6 dry ounces per 3-gallon mix) and as a mixture with a glyphosate herbicide

- Arsenal AC<sup>\*</sup> as a 1-percent solution (4 ounces per 3-gallon mix)
- Glyphosate herbicide, Garlon 3A, or Garlon 4 as a 4-percent solution (1 pint per 3-gallon mix), or a combination of these herbicides

### Nonnative Forbs and Subshrubs

Forbs are broadleaf herbaceous plants and subshrubs are short semiwoody plants. Control treatments are usually by foliar sprays of herbicides.



#### Garlic Mustard

Garlic mustard (*Alliaria petiolata*) is an upright biennial forb in small-to-extensive colonies under forest canopies, characterized by a faint-to-strong garlic odor from all parts of the plant when crushed (odor fading as fall approaches). It has basal rosettes of broadly arrow-point shaped leaves with wavy margins in the first year (remaining green during winter), a 2- to 4-foot (60- to 120-cm) flower stalk and

terminal clusters of flowers with four white petals in the second year, and eventually dead plants with long slender seed pods after June of the second year. Stand density varies yearly depending on germination requirements of

<sup>83</sup> 

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

seeds in the soil seed bank, with a single crop germinating over a 2- to 4vear period.

#### Recommended control procedures:

To control two generations, thoroughly wet all leaves with a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) during flowering (April through June). Include a surfactant unless plants are near surface waters.

In locations where herbicides cannot be used, pull plants before seed formation. Repeated annual prescribed burns in fall or early spring will control this plant, while "flaming" individual plants with propane torches has also shown preliminary success.



Shrubby lespedeza (Lespedeza bicolor) and Chinese lespedeza (L. cuneata) are perennials, with three-leaflet leaves, that remain standing dormant most of the winter and form dense stands that prevent forest regeneration and land access. Shrubby lespedeza is a much-branched legume up to 10 feet (3 m) in height with small purple-pink pealike flowers, and single-seeded pods. Chinese lespedeza is not really a shrub, but a semiwoody ascending-toupright leguminous forb to 6 feet (2 m) in height with many leaves feathered along erect slender whitish stems that often branch in the upper half and tiny cream-colored

flowers in leaf axils during summer. Seed of both are long lived in the soil seed bank and require long-term monitoring after control treatments. Prescribed burning can promote spread of the infestation margins.

#### **Recommended control procedures:**

Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to September): Garlon 4 as a 2-percent solution (8 ounces per 3-gallon mix), Escort\* XP at three-fourths of an ounce per acre (0.2 dry ounces per 3-gallon mix), Transline<sup>†</sup> as a 0.2-percent solution (1 ounce per 3-gallon mix), a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix), or Velpar L\* as a 2-percent solution (8 ounces per 3-gallon mix).

Mowing 1 to 3 months before herbicide applications can assist control.

### Tropical Soda Apple

Tropical soda apple (*Solanum viarum*) is an upright, thorny perennial sub-shrub or shrub, 3 to 6 feet (1 to 2 m) in height, characterized by remaining green year-round in most southern locations. It has oak-shaped leaves, clusters of tiny white flowers, and golf-ball size fruit that are

mottled green white turning to yellow in late summer to fall, which have a sweet smell attractive to livestock and wildlife. Even green fruit contain viable seeds. Report infestations to county agents for treatment under a federally sponsored eradication program.

#### Recommended control procedures for isolated sightings:

Thoroughly wet leaves and stems with one of the following herbicides in water with a surfactant at times of flowering before fruit appear: Garlon 4 (or Remedy in pastures) or Arsenal AC\* as a 2-percent solution (8 ounces per 3-gallon mix); Mileston VM as a 0.5-percent solution (2 ounces per 3-gallon mix) applied as 10 gallons per acre; a glyphosate herbicide as a 3-percent solution in water (12 ounces per 3-gallon mix).

Collect and destroy fruit to prevent reestablishment.

If mowing is used to stop fruit production, delay herbicide applications until 50 to 60 days to ensure adequate regrowth.

<sup>\*</sup>Nontarget plants may be killed or injured by root uptake.

<sup>&</sup>lt;sup>†</sup> Transline controls a narrow spectrum of plant species.

### **Sources of Control Information**

#### Books

- Langeland, K.A.; Burks, K.C., ed. 1998. Identification & biology of non-native plants in Florida's natural areas. Gainesville, FL: University of Florida. 165 p.
- Randall, J.M.; Marinelli, J., ed. 1996. Invasive plants: weeds of the global garden. Handb. 149. Brooklyn, NY: Brooklyn Botanic Garden. 111 p.

#### Manuals

- Langeland, K.A.; Stocker, R.K. 2001. Control of nonnative plants in natural areas of Florida. SP-242. Gainesville, FL: University of Florida, Institute of Food and Agricultural Sciences. 34 p. <u>http://edis.ifas.ufl.edu</u>. [Date accessed: February 1, 2001].
- Smith, Tim E., ed. 1993. Missouri vegetation management manual. Jefferson City, MO: Missouri Department of Conservation, Natural History Division. 148 p.
- Tennessee Exotic Pest Plant Council. 1996. Tennessee exotic plant management manual. Nashville, TN: Tennessee Exotic Pest Plant Council, Warner Parks Nature Center. 118 p.

#### **Articles and Reports**

- Bruce, K.A.; Cameron, G.N.; Harcombe, P.A.; Jubinsky, G. 1997. Introduction, impact on native habitats, and management of a woody invader, the Chinese tallow-tree, *Sapium sebiferum* (L.) Roxb. Natural Areas Journal. 17: 255–260.
- Call, N.M.; Coble, H.D.; Perez-Fernandez, T. 2000. Tropical soda apple (Solanum viarum) herbicide susceptibility and competitiveness in tall fescue (Festuca arundinacea). Weed Tech. 14: 252-260.
- Derr, J.F. 1989. Multiflora rose (*Rosa multiflora*) control with metsulfuron. Weed Technology. 3: 381–384.
- Dreyer, G.D. 1988. Efficacy of triclopyr in rootkilling oriental bittersweet (*Celastrus orbiculata* Thunb.) and certain other woody weeds. Northeast Weed Science Society Annual Meeting Proceedings. 42: 120–121.
- Edgin, B.; Ebinger, J.E. 2001. Control of autumn olive (*Elaeagnus umbellata* Thunb.) at Beall Woods Nature Preserve, Illinois, USA. Natural Areas Journal. 21: 386–388.

- Edwards, M.B.; Gonzalez, F.E. 1986. Forestry herbicide control of kudzu and Japanese honeysuckle in loblolly pine sites in central Georgia. Southern Weed Science Society Annual Meeting Proceedings. 39: 272–275.
- Everest, J.W.; Miller, J.H.; Ball, D.M.; Patterson, M. 1999. Kudzu in Alabama: history, uses, and control. ANR–65. Auburn, AL: Alabama Cooperative Extension. 6 p.
- Judge, C.A.; Neal, J.C.; Derr, J.F. 2005. Response of Japanese siltgrass (*Microstegium vimineum*) to application timing, rate, and frequency of postemergence herbicides. Weed Technology. 19: 912-917.
- Kline, W.N.; Duquesnel, J.G. 1996. Control of problem vegetation: a key to ecosystem management. Down to Earth. 51: 20–28.
- Koger, T.H.; Stritzke, J.F. 1997. Influence of herbicide timing and mowing on control of sericea lespedeza (*Lespedeza cuneata*). Southern Weed Science Society Annual Meeting Proceedings. 50: 76.
- Miller, J.H. 1986. Kudzu eradication trials testing fifteen herbicides. Southern Weed Science Society Annual Meeting Proceedings. 39: 276–281.
- Miller, J.H. 1988. Kudzu eradication trials with new herbicides. Southern Weed Science Society Annual Meeting Proceedings. 41: 220–225.
- Miller, James H. 1998. Exotic invasive plants in southeastern forests. In: Britton, K.O., ed. Proceedings of the exotic pests of eastern forests. Nashville, TN: Exotic Pest Plant Council: 97–105.
- Miller, James H. 1998. Primary screening of forestry herbicides for control of Chinese privet (*Ligustrum sinense*), Chinese wisteria (*Wisteria sinensis*), and trumpetcreeper (*Campsis radicans*). Southern Weed Science Society Annual Meeting Proceedings. 51: 161–162.
- Miller, James H. 1999. Controlling exotic plants in your forest. Forest Landowner. 58: 60–64.
- Miller, James H. 2000. Refining rates and treatment sequences for cogongrass (*Imperata cylindrica*) control with imazapyr and glyphosate. Southern Weed Science Society Annual Meeting Proceedings. 53: 181.
- Mueller, T.C.; Robinson, D.K.; Beeler [and others]. 2003. *Dioscorea oppositifolia* L. phenotypic evalutations and comparison of control strategies. Weed Tech. 17: 705-710.

- Mullahey, J.J.; Colvin, D.L. 2000. Weeds in the sunshine: tropical soda apple (*Solanum viarum*) in Florida–1999. Gainesville, FL: University of Florida, Institute of Food and Agricultural Sciences. 7 p.
- Neal, J.C.; Skroch, W.A. 1985. Effects of timing and rate of glyphosate application on toxicity to selected woody ornamentals. Journal of American Society of Horticultural Science. 110: 860–864.
- Nuzzo, V.A. 1991. Experimental control of garlic mustard (*Alliaria petiolata* (Bieb.) Cavara & Grande) in northern Illinois using fire, herbicide, and cutting. Natural Areas Journal. 11: 158–167.
- Regehr, D.; Frey, D.R. 1988. Selective control of Japanese honeysuckle (*Lonicera japonica*). Weed Technology. 2: 139–143.
- Szafoni, R.E. 1991. Vegetation management guidelines: multiflora rose (*Rosa multiflora* Thunb.). Natural Areas Journal .11: 215–216.
- Thomas, L.K., Jr. 1993. Chemical grubbing for control of exotic wisteria. Castanea. 58: 209–213.
- Underwood, J.F.; Sperow, C.B., Jr. 1985. Control methods for multiflora rose (*Rosa multiflora* Thunb.) with metsulfuron methyl. North Central Weed Science Society Annual Meeting Proceedings. 40: 59–63.
- Washburn, B.E.; Barnes, T.G. 2000. Postemergence tall fescue (*Festuca arundinacea*) control at different growth stages with glyphosate and AC 263,222. Weed Technology. 14: 223–230.
- Washburn, T.G.; Washburn, B. 2001. Controlling tall fescue, common Bermuda, and bahia grass. Wildland Weeds. 4: 5–8.
- Willard, T.R.; Gaffney, J.F.; Shilling, D.G. 1997. Influence of herbicide combinations and application technology on cogongrass (*Imperata cylindrica*) control. Weed Technology. 11: 76–80.
- Yeiser, J.L. 1999. Japanese honeysuckle control in a minor hardwood bottom of southwest Arkansas. Southern Weed Science Society Annual Meeting Proceedings. 52: 108–111.
- Zeller, M.; Leslie, D. 2004. Japanese climbing fern control trials in planted pine. Wildland Weeds 7: 6, 8-9.

#### **Newsletters and Magazines**

Florida Exotic Plant Pest Council. 1996–2002. Wildland weeds. Gainesville, FL. Quarterly.

#### Web Sites

Alien Plant Working Group: http://weedsgonewild.org

- Bugwood Network: www.bugwood.org
- California Exotic Plant Pest Council: www.caleppc.org

Florida Exotic Plant Pest Council: www.fleppc.org

Southeast Exotic Plant Pest Council: www.se-eppc.org

- Southern Weed Science Society: www.weedscience.msstate.edu/swss
- The Nature Conservancy's Invasive Species Team's Control Methods Handbook , Tu, M.; Hurd, C.; Randall, J.M. 2001 http:// tncweeds.ucdavis.edu/handbook.html
- USDA Animal and Plant Health Inspection Service's Federal Noxious Weed Program: www.aphis.usda.gov/ppq/weeds
- USDA, Forest Service, Southern Research Station: www.srs.fs.fed.us or www.srs.fs.usda.gov
- USDA Natural Resources Conservation Service's National Noxious Weed Program: http://dogwood.itc.nrcs.usda.gov:90/Weeds

#### **Sources of Native Plants**

USDA Natural Resources Conservation Service's Plant Materials Program: http://plant-materials.nrcs.usda.gov/

### **Glossary of Important Terms**

acute tip: terminating in a sharp or well-defined point, with more or less straight sides.

**allelopathic:** referring to a plant known to emit chemicals that retard the growth or seed germination of associated plants.

alternate leaves: one leaf at each node and alternating on sides of the stem.

**alternately whorled leaves:** one leaf at each node and their points of attachment forming a spiral up the stem.

**annual:** a plant that germinates, flowers, produces seed, and dies within one growing season.

**anthers:** the pollen-producing portion of the stamen or male reproductive part of a flower.

appressed: lying close to or flattened against.

arbor: vine entanglement within the crowns of shrubs or trees.

ascending: tending to grow upward, slightly leaning to somewhat erect.

asymmetric: not identical on both sides of a central line.

**axil:** the angle formed between two structures, such as between a leaf and the stem.

axillary: located in an axil or angle.

**berry:** a fleshy or pulpy fruit from a single ovary with one to many embedded seeds, such as tomato and grape.

**biennial:** a plant that lives for about 2 years, typically forming a basal rosette in the first year, flowering and fruiting in the second year, and then dying.

**bipinnately compound:** twice pinnately compound; a pinnately compound leaf being again divided.

blade: the expanded part of a leaf.

**bract:** a small leaf or leaflike structure at the base of a flower, inflorescence, or fruit.

**branch scar:** a characteristic marking on a stem where there was once a branch.

**bud:** an undeveloped flower, flower cluster, stem, or branch, often enclosed by reduced or specialized leaves termed bud-scales.

bulbil: an aerial tuber.

**bunch grass:** a grass species with a cluster-forming growth habit; a grass growing in an upright large tuft.

**bundle scar:** tiny raised area(s) within a leaf scar, from the broken ends of the vascular bundles, found along a twig.

**calyx:** the collective term for all of the sepals of a flower, commonly green, but occasionally colored and petal-like or reduced to absent.

calyx tube: a tubelike structure formed by wholly or partially fused sepals.

**cane:** very tall grasses, for example, switchcane and bamboo; tall, stiff stem.

**capsule:** a dry fruit that splits into two or more parts at maturity, for example, the fruit of tallowtree.

**clasping:** base that partly or wholly surrounds another structure, such as a leaf base surrounding a stem.

collar: the area of a grass leaf blade where it attaches to the sheath.

**colony:** a stand or group of one species of plant, from seed origin or those connected by underground structures such as rhizomes.

cordate: heart-shaped.

**cordate base:** a leaf base resembling the double-curved top of a heart shape.

corolla: the collective name of all of the petals of a flower.

cotyledon: the initial leaves on a plant germinant.

crenate: margin with shallow, rounded teeth; scalloped.

cultivar: a form or variety of plant originating under cultivation.

**deciduous:** falling off or shedding; not persistent; refers to leaves, bracts, stipules, and stipels.

**dioecous:** plants with unisexual flowers and having male and female flowers on separate plants.

**drupe:** a fleshy fruit, surrounding a stone (endocarp) that contains a single seed.

**ellipsoid:** a three-dimensional ellipse; narrow or narrowly rounded at ends and widest in the middle.

**elliptic:** oval-shaped; broadest at the middle and rounded and narrower at the two equal ends.

entire: margins without teeth, notches, or lobes.

**even pinnately compound:** a leaf with two or more leaflets arranged opposite along a leafstalk or rachis.

evergreen: green leaves remaining present through winter.

exotic: foreign; originating on a continent other than North America.

**fern:** a broadleaf pteridophyte of the order Filicales, typically with muchdivided leaves and spore reproduction.

filament: the long, slender stalk of a stamen that supports the anther.

forb: a broad-leaved herbaceous (nonwoody) plant.

frond: a large, once- or twice-divided leaf, here referring to fern leaves.

**gland:** a structure which contains or secretes a sticky, shiny, or oily substance.

grain: a grass seed.

grass: plants of the family Poaceae, typically with narrow leaves and jointed stems.

**hairy:** surface features of plants, many protruding filaments or glands that give texture; pubescent.

**herb or herbaceous:** a plant with no persistent aboveground woody stem, dying back to ground level at the end of the growing season.

**hip fruit:** the fruit of the genus *Rosa* that is ovoid, fleshy, and usually red when ripe.

husk: the outer scalelike coverings of a grass seed.

**inflorescence:** the flowering portion of a plant; the flower cluster; the arrangement of flowers on the stem.

**internode:** the space on an herb or grass stem between points of leaf attachment.

**lanceolate:** lance-shaped; widest at or near the base and tapering to the apex.

lateral: on or at the sides, as opposed to terminal or basal.

leaflet: an individual or single division of a compound leaf.

leaf scar: the scar or marking left on a twig after leaf fall.

leafstalk: the main stem of a compound leaf, rachis.

**legume:** a plant in the family Fabaceae; a dry, splitting fruit, one-to-many seeded, derived from a single carpel and usually opening along two sutures, confined to the Fabaceae.

legume pod: the fruit of a legume.

**lenticel:** a raised dot or short line, usually corky to white in color, on twigs and stems.

**ligule:** a tiny membranous projection, often fringed with hairs, from the summit of the sheath (top of the throat), where the leaf attaches, in many grasses and some sedges.

linear: long and narrow shaped with roughly parallel sides.

**lobed leaf:** margins having deep indentations resulting in rounded-topointed portions.

margin: the edge of a leaf blade or flower petal; the edge of a forest.

**marsh:** a poorly drained portion of the landscape with shallow standing water most of the year, most extensive around intertidal zones.

membranous: thin, filmy, and semitransparent.

midvein: the central vein of a leaf or leaflet.

milky sap: sap being opaque white and often of a thick consistency.

**monocot:** the class of plants having one cotyledon (or monocotyledonous) and parallel leaf veins, including grasses, sedges, lilies, and orchids.

mottled: spotted or blotched in color.

**node:** the point of leaf or stem attachment, sometimes swollen on grass stems where the sheath is attached.

**nutlet:** a small, dry, nonsplitting fruit with a woody cover, usually containing a single seed.

**oblanceolate:** lance-shaped with the widest portion terminal; inversely lanceolate.

**oblong:** a shape two-to-four times longer than wide with nearly parallel sides.

**obovate:** two-dimensional egg-shaped, with the attachment at the narrow end; inverted ovate.

**odd pinnately compound:** pinnately compound leaves with a terminal leaflet rather than a terminal pair of leaflets or a terminal tendril.

opposite: leaves born in pairs at each node on opposite sides of the stem.

ornamental: a plant cultivated for aesthetic purposes.

oval: broadly elliptic in shape, with the width greater than half of the length.

ovate: two-dimensional egg-shaped, with the attachment at the wider end.

**ovoid:** three-dimensional egg-shaped, with the attachment at the wider end.

**panicle:** an irregularly branched inflorescence with the flowers maturing from the bottom upward.

**pealike flower:** irregular flower characteristic of sweet peas and beans in the family Fabaceae.

**perennial:** any plant that persists for three or more growing seasons, even though it may die back to rhizomes or rootstock during the dormant period.

**petiole:** a stalk that attaches the leaf blade to the stem.

**pinnately compound:** a compound leaf with leaflets arising at intervals along each side of an axis or rachis (leafstalk).

**pistil:** the female reproductive portion of a flower, usually consisting of an ovary, style, and stigma.

**pith:** the soft or spongy central tissue in some twigs and stems, sometimes absent making the stem hollow.

plume: a tuft of simple or branched bristles.

**pod:** an elongated dry fruit that usually splits open upon maturity, such as a legume.

**raceme:** an elongated, unbranched inflorescence with stalked flowers generally maturing from the bottom upward.

rachis: the main axis of an inflorescence or compound leaf.

recurved: gradually curved backward or downward.

rhizome: an underground stem, usually horizontal and rooting at nodes.

**right-of-way:** a narrow corridor of land in straight sections across the landscape, repeatedly cleared and kept in low vegetation, to accommodate roadway structures, poles and wire for electrical and telephone transmissions, and pipelines.

**riparian:** situated or dwelling on the bank or floodplain of a river, stream, or other body of water.

root collar: the surface area of a perennial where the stem and roots join.

**rootcrown:** the part of a perennial plant where the stem and roots join, often swollen.

**root sprout:** a plant originating from a root or rhizome that takes root at nodes.

**rootstock:** the part of a perennial plant near the soil surface where roots and shoots originate.

**rosette (basal rosette):** a circular cluster of leaves on or near the soil surface radiating from a rootcrown, as in dandelions.

scaly: covered with minute flattened, platelike structures.

**semievergreen:** tardily deciduous or maintaining green foliage during winter only in sheltered locations.

**semiwoody plants:** species that have mostly woody stems and deciduous leaves, usually shorter than shrubs.

**sepal:** a single unit of the calyx; the lowermost whorl of flower parts.

serrate: margin with sharp forward-pointing teeth.

sessile: attached without a stalk, such as a leaf attached without a petiole.

**shade intolerant:** a plant that cannot grow and reproduce under the canopy of other plants but needs direct sunlight.

**shade tolerant:** a plant that can grow and reproduce under the canopy of other plants.

**sheath:** a more or less tubular portion of a structure surrounding another structure, such as the tubular portion of leaf bases of grasses that surround the stem.

shrub: a wood plant, typically multistemmed and shorter than a tree.

simple: not compound; single; undivided; unbranched.

**smooth:** not rough to the touch, usually hairless (or only finely hairy) and scaleless.

spherical: round in three dimensions, like a ball; synonymous with globose.

**spike:** an elongated, unbranched inflorescence with sessile or unstalked flowers along its length, the flowers generally maturing from the bottom upward.

sporangia: the case bearing spores on ferns.

**spore:** a minute (almost not visible), one-celled reproductive body of ferns, asexual.

**stamen:** the male reproductive portion of a flower, usually consisting of an anther and filament.

**stipules:** the pair of leaflike structures at the base of a leaf petiole in some species.

stone: a hard woody structure enclosing the seed of a drupe.

subshrub: a very short woody plant.

**subtend:** a structure just below another, such as flowers subtended by bracts.

succulent: fleshy or soft tissued.

swamp: a wooded or brushy area usually having surface water.

synonym: a discarded scientific name for a plant; another common name.

**taproot:** the main root axis; a long vertical, central root.

tardily deciduous: maintaining at least some green leaves into winter or early spring.

terminal: at the end.

thorn: a stiff, curved, sharply pointed modified stem, sometimes branched.

**throat:** the area inside a flower tube formed from fused petals; the upper side of a grass collar where the blade meets the sheath.

toothed: margin with outward pointed lobes; coarsely dentate.

trailing: running along the soil or leaf litter surface.

**tuber:** a thickened portion of a root or rhizome modified for food storage and vegetative propagation, such as a sweet potato.

tubular: a cylindrical structure, such as formed from fused petals or sepals.

twig: short leaf branch.

**umbel:** a compound flower with stems arising and radiating from one point of attachment.

variegated: marked with stripes or patches of different colors.

vine: a long trailing or climbing plant.

**whorled:** three or more leaves in a circular arrangement arising from a single node or radiating at different angles to the main stem.

wiry: thin, flexible, and tough.

**yam:** a tuber or potato-like organ

#### FLOWER PARTS



#### Flower parts, flower types, and inflorescences.

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Banner

Wing

Keel



Leaf arrangements, leaf divisions, shapes, and margins.



Parts of a grass plant.

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#### **Pesticide Precautionary Statement**

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels

Store pesticides in the original containers under lock and key—out of reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dust; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed them. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

# Dispose of empty pesticide containers promptly and in accordance with all applicable Federal, State, and local laws.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your State forestry agency, county agricultural agent or State extension specialist to be sure the intended use is still registered.

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Miller, James H. 2003. Nonnative invasive plants of southern forests: a field guide for identification and control. Revised. Gen. Tech. Rep. SRS–62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 93 p.

Invasions of nonnative plants into forests of the Southern United States continue to go unchecked and unmonitored. Invasive nonnative plants infest under and beside forest canopies and dominate small forest openings, increasingly eroding forest productivity, hindering forest use and management activities, and degrading diversity and wildlife habitat. Often called nonnative, exotic, nonindigenous, alien, or noxious weeds, they occur as trees, shrubs, vines, grasses, ferns, and forbs. This book provides information on accurate identification and effective control of the 33 nonnative plants and groups that are currently invading the forests of the 13 Southern States, showing both growing and dormant season traits. It lists other nonnative plants of growing concern, control strategies, and selective herbicide application procedures. Recommendations for preventing and managing invasions on a specific site include maintaining forest vigor with minimal disturbance, constant surveillance and treatment of new unwanted arrivals, and finally rehabilitation following eradication.

**Keywords:** Alien plants, exotic plant control, exotic weeds, herbicide weed control, integrated vegetation management, invasive exotic plants, invasive nonindigenous plants, noxious plant control.

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#### Literature Cited

- Burns, Russell M., and Barbara H. Honkala, techincal coordinators. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654. USDA Forest Service, Washington, DC. vol.2.
- California Rare Fruit Growers (CRFG). 1997. Mulberry. <<u>http://www.crfg.org/pubs/ff/mulberry.html</u>> Accessed Oct 22 2007.
- Evans, C.W., D.J. Moorhead, C.T. Bargeron and G.K. Douce. 2006. Invasive Plant Responses to Silvicutural Practices in the South. The University of Georgia Bugwood Network, BW-2006-03. <<u>http://www.invasive.org/silvicsforinvasives.pdf</u>> Accessed 3 Oct 2007.
- Florida Exotic Pest Plant Council [EPPC]. *Melia Azederach*. <<u>http://www.fleppc.org/ID\_book/melia%20azederach.pdf</u>> Accessed 10 Nov 2007.
- Harrington, T.B. and J.H Miller. 2005. Effects of Application Rate, Timing, and Formulation of Glyphosate and Triclopyr on Control of Chinese Privet (*Ligustrum sinense*). Weed Technology, Vol. 19: 47-54.
- Langeland, K.A. 2006. Natural Area Weeds: Chinese Tallow (*Sapium sebiferum* L.). University of Florida/Institute of Food and Agricultural Sciences (IFAS) Extension SS-AGR-45. <<u>http://edis.ifas.ufl.edu/AG148</u>> Accessed 12 Nov 2007.
- Miller, J.H and T. Albritton. 2004. Privet is a Plague: You can Help Stop it. Alabama Treasure Forests, Spring 2004, Vol. XXIII, No. 1: 20-21 (26). <<u>http://www.treesearch.fs.fed.us/pubs/8394</u>> Sept 18 2007.
- Miller, J.H. 2005. Chinese Privet Control with Herbicide Foliar Sprays. Wildland weeds, Vol. 8, No.3: 5-8. <<u>http://www.treesearch.fs.fed.us/pubs/20696</u>> Accessed 22 Sept 2007.
- Miller, J.H. 2006. Nonnative Invasive Plants in Southern Forests: A Field Guide for Identification and Control. USDA Forest Service, Southern Research Station. <a href="http://www.srs.fs.usda.gov/pubs/gtr/gtr\_srs062/">http://www.srs.fs.usda.gov/pubs/gtr/gtr\_srs062/</a> Accessed 10 Oct 2007.
- Ohio State University. 2007. Ohio Perennial and Biennial Weed Guide: White Mulberry. Ohio Agricultural Research and Development Center (OARDC) Extension, Ohio State University. <<u>http://www.oardc.ohio-state.edu/weedguide/singlerecord.asp?id=200</u>> Accessed 22 Oct 2007.
- Ryan, M. Arundo Donax: Giant Reed Invades Southern Nevada. University of Nevada Cooperative Extension Fact Sheet 01-87 <<u>http://www.unce.unr.edu/publications/files/nr/2001/FS0187.pdf</u>> Accessed 09 Oct 2008.
- Urbatsch L. 2003. Chinese Privet. USDA Natural Resource Conservation Service Plant Guide. <a href="http://plants.usda.gov/plantguide/pdf/pg\_lisi.pdf">http://plants.usda.gov/plantguide/pdf/pg\_lisi.pdf</a> Accessed 1 Nov 2007.

- USDA Forest Service. 2005. Chinaberry Tree (*Melia azedarach*). USDA Forest Service, Northeastern Area WOW 04-25-05. <<u>http://www.na.fs.fed.us/fhp/invasive%5Fplants/weeds/chinaberry-tree.pdf</u>> Accessed 10 Nov 2007.
- USDA Forest Service. 2005. White Mulberry (*Morus alba*). USDA Forest Service, Northeastern Area WOW 07-22-05. < <u>http://www.na.fs.fed.us/fhp/invasive%5Fplants/weeds/white\_mulberry.pdf</u>> Accessed 1Nov 2007.
- USDA Forest Service. 2006. Chinese Tallow Tree (*Sapium sebiferum*). USDA Forest Service, Northeastern Area WOW 02-02-06. <<u>http://www.na.fs.fed.us/fhp</u> /invasive%5Fplants/weeds/chinese\_tallow.pdf> Accessed 10 Nov 2007.
- USDA Natural Resource Conservation. 2002. Chinese Lespedeza. USDA Natural Resource Conservation Service Plant Guide. <<u>http://plants.usda.gov/factsheet/pdf/fs\_lecu.pdf</u>> Accessed 9 Oct 2008.
- U.S. Geological Survey. 2000. Chinese Tallow: Invading the Southeastern Coastal Plain. U.S. Geological Survey, National Wetlands Research Center Fact Sheet 154-000. <<u>http://www.nwrc.usgs.gov/factshts/154-00.pdf</u>> Accessed 11 Nov 2007.