

## S U M M A R Y

Invasive exotic plants are aggressively competing with native plant species in Florida. In some situations, infested habitats will no longer support native wildlife, and endangered plants and animals are being pushed closer to extinction. Managers of these natural areas are finding herbicide treatments to be the most effective and economical way to control exotic plants with minimal risk to native species. This article describes the methods and equipment used to treat invading plants and presents general guidelines on herbicide selection.

# MANAGEMENT OF INVASIVE EXOTIC PLANTS WITH HERBICIDES IN FLORIDA

By W.N. Kline<sup>1</sup> and J.G. Duquesnel<sup>2</sup>

## INTRODUCTION

Invasive exotic plants are displacing native species and disrupting Florida's ecosystems. Over 100 aggressive exotic plant species, most of them imported for ornamental or agricultural purposes, have escaped from cultivated areas and are competing with native species for nutrients, water, sunlight, and space (1). Of these, approximately 60 species have invaded undisturbed wilderness areas. At some sites, altered plant communities no longer support codependent native wildlife. Endangered plants, animals, and ecosystems are being pushed closer to extinction by invasive pest plants.

This article describes selective control measures for many of the invasive exotic plants found in Florida. The methods, equipment, and herbicides discussed have

been demonstrated to be effective tools in Florida and may also be effective on similar species in other areas.

## BACKGROUND

The profile of an invasive exotic plant is typically represented by a fast rate of growth and maturation, prolific seed production, and long-range dispersal mechanisms (seeds dispersed by wind, water, or birds). Early successional stage (pioneer) plants from areas with climates similar to Florida are most likely to cause problems. When moved beyond the influence of insects and diseases from their land of origin, these plants can displace entire native plant communities (2).

Managers of remaining natural areas in Florida are often challenged to preserve or restore native ecosystems and species.



*Treatments to selectively remove exotic plants are often hand-applied and require only a small investment in equipment. The equipment shown here is all that is needed for a basal-bark treatment program.*



This article originally appeared in Volume 51, Number 2, of *Down To Earth*® magazine.

© 1996 by DowElanco

<sup>1</sup>Senior Scientist, DowElanco, Duluth, Georgia.

<sup>2</sup>Biologist, Florida Department of Environmental Protection, Key Largo, Florida.

The control of invasive pest plants is an increasingly important part of that task. Selectively removing exotic species usually serves as a “release treatment” for native species by reducing competition for light, water, and nutrients. Response by native plants can be rapid and may eliminate the need for replanting. As native species recover and a site stabilizes, the site becomes less susceptible to future invasions.

In the early stages of exotic plant invasions, low-impact removal methods are usually the best way to reestablish dominance by native communities. Herbicide treatments that are properly applied can selectively remove individual plants while causing minimal soil disturbance. Even disturbance of the litter layer can create conditions favorable to reinvasion. Therefore, the benefits of using heavy equipment such as tractors are often outweighed by the potential for soil disturbance and erosion. Physical removal by hand or hand tools causes less disturbance than mechanical methods but is very labor intensive.

When choosing herbicides, resource managers must understand and carefully consider herbicide labeling, precautions, application method, and site. Not all herbicides are appropriate for all areas. Herbicides preferred for selective use in natural areas are generally products with negligible soil activity that are not taken up by the root systems of untreated plants. Herbicides that normally break down with little soil movement may degrade more slowly in saturated (anaerobic) soils or move downward in inorganic sands. A monitoring program, carefully designed and implemented, is necessary to assess the effectiveness of management efforts, especially where complete removal of invasive species is the goal.

In the hands of well-trained resource managers, herbicides are an effective tool for the management of invasive pest plants. Although herbicide training is available through state pesticide certification programs, professional associations such as the Florida Exotic Pest Plant Council and local working groups offer practical information and specific training. Such networks provide access to the experiences of



*Removal of scaevola by cut-stump treatment allows control in a dense stand of native seagrape.*

other resource stewards, regulatory guidelines, and academic research. The table at the end of this article lists herbicide treatments that have been successfully used in Florida by a variety of associations and local groups.

## TREATMENT METHODS

Selective control of invasive plants within mixed stands of desirable plants usually requires single-stem treatments such as basal-bark treatments, cut-surface treatments (injection, cut stump, or girdle), or directed foliar applications. Broadcast herbicide treatments may be appropriate where vines or other rapidly growing plants form dense monocultures and eliminate all desirable plants.

### Basal-Bark Treatments

Basal-bark applications are effective for selective control of many perennial plants in Florida, including Brazilian pepper, Australian pine, Chinese tallow, and other tall-growing, invasive arborescent species. Basal applications offer the advantage of low-profile management, particularly in the dormant season. In contrast, broadcast spray treatments are often followed by large-scale brownout. Basal applications also provide selective removal of target plants and can be applied with hand-held

or backpack equipment. Applications can be made year-round but are more efficient when access to the base of undesirable stems is easiest (during periods when foliage is absent or less dense). Basal treatments can be applied on a range of stem sizes, from saplings to large trees. As bark thickness increases, more herbicide is needed and efficacy is sometimes reduced.

An effective basal herbicide mixture contains Garlon® 4 herbicide in an oil diluent. Oils such as JLB Oil Plus, JLB Oil Plus Improved, Arborchem basal oil, CWC basal diluent, Hygrade oil, Penevator oil, or generic mineral or vegetable oils are effective diluents. Naturally derived oils, such as vegetable oil products, are generally less offensive to the applicator and the environment than diesel oil or kerosene.

Pathfinder® II herbicide and Chopper<sup>1</sup> herbicide are ready-to-apply basal-bark products. Pathfinder II contains the same active ingredient (triclopyr) as Garlon 4, but comes premixed with a naturally derived oil diluent. It is equivalent to a mixture of 19% Garlon 4 in oil. Chopper is also

<sup>\*</sup>Trademark of DowElanco  
The active ingredient in Garlon 4 herbicide and Pathfinder II herbicide is triclopyr.

<sup>1</sup>Trademark of American Cyanamid Company  
The active ingredient in Chopper herbicide is imazapyr.

a premix with oil and may be used alone or mixed with other basal products. Chopper contains the same active ingredient, imazapyr, as Arsenal<sup>1</sup> herbicide. Imazapyr is soil-active and can potentially damage desirable plants bordering treated stems. Specific directions and precautions on the product label should always be followed.

For most species, mixtures of 10% to 20% Garlon 4 in an oil diluent (as described above) are used for low-volume basal applications. Direct application to the lowest 12 to 24 inches of target stems should form a band at least 6 inches wide that completely encircles the stem or trunk, but not to the point of run-off. Complete control of foliage, stems, and roots is possible with this treatment.

Concentrations of 4 to 10% Garlon 4 are often effective on sensitive Florida exotic species, including Brazilian peppers up to about 20 inches in diameter and Australian pines up to 8 inches in diameter. Larger Brazilian peppers (up to several feet in basal diameter) and Australian pines (more than 2 feet in basal diameter) can also be controlled with basal treatments. However, larger sizes require higher mix ratios (15% to 20% Garlon 4 in oil) and wider application bands.

Follow-up re-treatments should be planned for missed stems, new seedlings, and root suckers. Usually one or two follow-up spot treatments at 6-month intervals will provide complete removal. Re-treatment should include any living parts of treated stem(s) or resprouted stems.

A spray pattern indicator dye or other colorant is often added to basal mixtures to aid treatment monitoring, especially when the applications are done on a contractual basis. Bas-Oil Red and Bullseye Basal 55 are examples of oil-soluble dyes that are suitable for use with basal mixtures. When dyes are used, application equipment usually requires more maintenance, especially regular cleaning.

## Cut-Surface Treatments

Tree injection, girdle (frill), and cut-stump treatments are common cut-surface applications for exotic, woody plant management. These methods are generally used



*By controlling Brazilian pepper with basal-bark treatments of Garlon 4 herbicide, managers can effectively release desirable native vegetation.*

to eliminate larger undesirable stems. Cut-surface treatments require very little equipment (a hatchet or machete and a squirt bottle) and are very economical. Cut-surface treatments in combination with basal or directed foliar applications are very effective management strategies where both large and small undesirable stems are selected for removal.

Although most cut-surface treatments can be applied during any season, most herbicides work best during the growing season. Free-bleeding species (e.g., red maple (*Acer rubrum*) and *Ficus* spp.) should not be treated during the spring sap rise; the sap may push the herbicide out of the injection points. Accord<sup>2</sup> and Roundup<sup>2</sup> herbicides work best in late summer and fall.

Herbicides commonly used for cut-surface treatments are Garlon 3A herbicide, Arsenal, Velpar<sup>3</sup> L herbicide, Accord, and Roundup. Garlon 3A diluted to 50% with water is effective for controlling Brazilian pepper and Australian pine. Velpar L diluted in a 1:1 ratio with water is effective for controlling Brazilian pepper and melaleuca trees. Arsenal AC diluted in a 1:1 ratio with water is particularly effective for controlling melaleuca trees. Arsenal and Velpar L are soil-active herbicides,

and caution should be exercised when these materials are applied near desirable plants or trees.

A colorant is often added to the herbicide or herbicide mix to aid in treatment monitoring, especially when the applications are done on a contractual basis. Blazon Blue Spray Pattern Indicator and Bullseye Spray Pattern Indicator are examples of water-soluble dyes suitable for use with cut-surface herbicide mixtures. When dyes are used, application equipment usually requires more maintenance and regular cleaning.

For tree injections, tools designed specifically for making the cut in the tree and simultaneously applying the herbicide to the opening are available. A simpler and effective method is to use a hatchet to make the cut and a squirt bottle to apply the herbicide. The wounds should angle downward through the bark into the sapwood. A waist-high cut is acceptable for hatchet treatments; however, injections are usually at the base of the tree. Single cuts should be evenly spaced around the stem diameter and separated by the distance recommended on the product label. When a hatchet and squirt bottle are used, the herbicide application should be made to the cut when the hatchet is removed. The squirt bottle should have chemical-resistant seals and be calibrated to produce about 1 mL for each pull of the application handle.

The girdle or frill method involves cutting completely around the tree into the sapwood with an ax or hatchet and wetting the cuts with the herbicide using a squirt bottle or a small pressurized spray unit. When making tree injection or girdle applications, additional cuts and/or increased herbicide rates are usually required for trees 10 inches and larger in diameter or for damaged trees.

For cut-stump treatments, large stems

<sup>1</sup>Trademark of American Cyanamid Company  
The active ingredient in Arsenal herbicide is imazapyr.

<sup>2</sup>Trademark of Monsanto Corporation  
The active ingredient in Accord and Roundup herbicides is glyphosate.

<sup>3</sup>Trademark of Du Pont de Nemours Company, Inc.  
The active ingredient in Velpar L herbicide is hexazinone.



are usually cut with a chain saw or pruning saw; smaller stems can be cut with pruning shears or any method that produces a clean cut. Freshly cut stumps should be treated as soon after cutting as possible. A delay of more than 2 hours between cutting and herbicide treatment can significantly reduce the effectiveness of the herbicide treatment. A pressurized backpack sprayer or spray bottle is very effective for this type of application. The cambial area and sapwood (outer 1 inch of the stump) must be thoroughly sprayed with the herbicide. Smooth, level stumps, which are free of bark tears, sawdust, or other debris, can be most easily and effectively treated.

Stumps cut previously, from a few days up to about 8 months, can be treated effectively with the previously described basal-bark (herbicide + oil) spray mixture. The outer edges and sides of the stump should be sprayed. If the stump height is 1 ft or more, the application may be made as a basal-bark treatment.

### Combination Treatments

Basal treatments can be used in combination with cut-surface treatments when large, undesirable trees are mixed with smaller stems. Although freshly cut stumps should be treated with herbicide formulations labeled for cut-surface use, previously cut stumps can be treated with basal herbicide mixtures. The outer edges of the stump should be sprayed until the spray runs down the sides of the stump. If the stump height is 1 ft or more, the application can be made as a basal-bark treatment.

### Foliar Spray Treatments

Foliar applications can be made to individual plants or as a broadcast treatment over a large area. Broadcast applications, using ground or aerial (helicopter) equipment, allow treatment of large, dense infestations at relatively low cost. Individual plant treatments are usually best suited for light to moderate infestations and will minimize the effects to nontarget vegetation. In situations where nearly pure stands of exotic plants are present, initial broadcast treatments may be the most effective and economical method to reduce exotic



*Follow-up treatments are often required for eradication. This Australian pine was inadvertently skipped by the crew during the initial phase of the eradication program. Missed stems are easily recognized during follow-up treatments.*

plant populations to a level that can then be controlled with single-stem treatments. In certain situations, herbicides can be broadcast to reduce the exotic plant populations with minimal damage to desirable, native plants. For example, a 0.25% foliar spray solution of Garlon 4 herbicide in water can control Brazilian pepper without significant damage to most native plants. This type of selective program is usually followed by single-stem treatments.

Selective broadcast foliar treatments are generally most effective when applied at spray volumes of 30 gal/A or more. Volumes of 100 gal/A or more usually provide the best coverage and control for dense, tall-growing exotic plants. Herbicide rates for broadcast foliar treatments should follow specifications on the label and will depend on whether selective or complete elimination is desired.

Backpack spray applications are used primarily to control widely spaced plants less than 6 feet tall. Target plants are usually sprayed until the crown is wet, but not to run-off. Application is made by directing the spray onto the target foliage, especially the growing tips and terminal leader. It is important to prevent the spray from contacting foliage of desirable plants.

Commonly used herbicides for foliar applications are Garlon 3A, Garlon 4, Arsenal AC, Roundup, and Accord.

## EQUIPMENT

### Basal-Bark Treatments

The Solo Model 475 backpack sprayer with a diaphragm pump and the Swissmex SPI are commonly used backpack sprayers for basal-bark applications. The spray tip should be a narrow angle (15 to 25 degrees) flat fan nozzle, a solid cone nozzle, or an adjustable Conejet or equivalent. Any of these tips can be installed on the spray wand of the spray unit. A better alternative is a brass-tip shut-off wand that can be attached to most backpack spray units that produce pressures between 20 and 50 psi. All backpack sprayers and spray guns should have chemical-resistant seals appropriate for the herbicides and carriers being used.

A hand-held spray bottle can also be used for basal-bark treatments as a “ready-to-use” applicator or for limited treatment programs.

### Cut-Surface Treatments

Backpack sprayers or 1- to 2-gallon pump-up sprayers containing chemical-resistant seals are suitable for cut-surface herbicide

mixtures. Delta Industries produces a chemical-resistant 1-quart squirt bottle that is effective for cut-surface herbicide mixtures.

### **Foliar Spray Treatments (Selective)**

A backpack sprayer with diaphragm pump can be used for selective foliar spray treatments. A spray tip that produces large spray droplets will help reduce spray drift. Spray tips can be installed in the spray wand or attached. All backpack sprayers and spray guns should have chemical-resistant seals.

### **Foliar Spray Treatments (Broadcast)**

Power-driven ground equipment is commonly used to spray large plants and areas. Properly adjusted equipment should

deliver a uniform spray with nozzle pressures at 30 to 80 psi and should generate large spray droplets to reduce the potential of spray drift. Higher spray pressures produce smaller spray droplets, which may drift onto sensitive, desirable plants adjacent to the treated area.

Commonly used power equipment consists of portable, power-driven spray units mounted on a truck or all-terrain vehicle. A wide variety of pumps, tanks, and accessories is used. The most common pump is a diaphragm pump driven by a gasoline engine or a self-contained 12-volt pump unit. Routinely used spray guns are adjustable spray guns that produce patterns ranging from a solid stream to a wide cone spray. These spray guns may produce small spray droplets at the cone-spray setting, resulting in spray drift.

## **SUMMARY AND CONCLUSIONS**

Treatment with herbicides is an effective and economical way to selectively remove undesirable exotic plants from natural areas in Florida. Suggested treatment methods include basal-bark, cut-surface, and foliar-spray applications of Garlon herbicides. Where invasive and desired native plants are growing together, these individual plant treatments can be used to maintain and restore native plant communities.

## **REFERENCES**

1. Austin, D.F. 1995. Florida Exotic Pest Plant Council's most invasive species list.
2. Moyroud, R. 1995. Exotic pest plants—giving “green” a bad name. *Florida Exotic Pest Plant Council Newsletter*. 5(5):1–2.

## Use Guide by Plant Species, Application Method, Herbicides, and Recommended Concentrations

This use guide was developed from use experience provided by resource managers and persons involved in exotic plant control in the state of Florida. In particular, the authors would like to thank Sandra

Vardaman Wells and Joy Klein, Metropolitan Dade County Park and Recreation Department, for providing extensive information in the development of this table. This table should be viewed as a guide for

potential herbicides and application methods. The authors have compiled this list based upon the best information that they could obtain but they cannot guarantee that these suggested treatments are effective.

Plant	Method	Herbicide	Concentration	Effectiveness
Air potato ( <i>Dioscorea bulbifera</i> )	Basal	Garlon 4	10%	Good
	Cut surface	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
Ardisia ( <i>Ardisia</i> spp.)	Basal	Garlon 4	10%	Good
Australian pine ( <i>Casuarina</i> spp.)	Basal	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
Bishopwood ( <i>Bischofla javanica</i> )	Basal	Garlon 4	10%	Good (up to 4 in. dia)
	Basal	Garlon 4	20%	Good (greater than 4 in. dia)
	Cut surface	Garlon 3A	50%	Good
	Cut surface	Garlon 4	20%	Good
Black sapote ( <i>Siospyroe digyna</i> )	Cut surface	Garlon 3A	50%	Moderate
Bowstring hemp ( <i>Sansevieria hyacinthoides</i> )	Cut stump	Roundup	5%	Moderate
Brazilian pepper ( <i>Schinus terebinthifolius</i> )	Basal	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
	Foliar	Arsenal	1%	Excellent
	Foliar	Garlon 3A + Arsenal	0.5% + 0.5%	Good (hi vol reqd)
Burma reed ( <i>Neyraudia reynaudiana</i> )	Foliar	Roundup	2–5%	Good
	Foliar	Arsenal	1%	Good
Carrotwood ( <i>Cupaniopsis anacardioides</i> )	Basal	Garlon 4	10%	Good
	Cut surface	Garlon 3A	50%	Good
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
	Foliar	Arsenal	1%	Good
Castor bean ( <i>Ricinus communis</i> )	Basal	Garlon 4	10%	Good
Catclaw mimosa ( <i>Mimosa pigra</i> )	Basal	Garlon 4	15%	Excellent
Chinaberry ( <i>Melia azedarach</i> )	Basal	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
Chinese tallow ( <i>Sapium sebiferum</i> )	Basal bark	Garlon 4	15%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
	Cut surface	Arsenal	10%	Excellent
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
	Foliar	Arsenal	1%	Good (hi vol reqd)
Citrus ( <i>Citrus</i> spp.)	Basal	Garlon 4	10%	Good
Cow itch ( <i>Mucuna pruriens</i> )	Basal	Garlon 4	10%	Good
Fig ( <i>Ficus</i> spp.)	Basal	Garlon 4	5–10%	Good
Fishtail palm ( <i>Cayota</i> spp.)	Cut surface	Garlon 3A	50%	Good
	Cut surface	Garlon 4	10%	Good
Gold coast jasmine ( <i>Jasminum dichotomum</i> )	Basal	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
	Cut surface	Garlon 4	10%	Excellent
Jambolan plum ( <i>Syzyglum cumini</i> )	Basal	Garlon 4	10%	Good
	Cut surface	Garlon 3A	50%	Good
	Cut surface	Garlon 4	10%	Good
Japanese climbing fern ( <i>Lygodium</i> spp.)	Foliar	Rodeo	2–3%	Moderate (hi vol reqd; re-treatment usually required)

Table continued on following page.

## Use Guide, *continued*

Plant	Method	Herbicide	Concentration	Effectiveness
Lantana ( <i>Lantana camara</i> )	Basal bark	Garlon 4	10%	Moderate
	Cut surface	Garlon 3A	50%	Moderate
	Cut surface	Arsenal	10%	Good
	Foliar	Arsenal	1%	Good
Lather leaf ( <i>Colubrina asiatica</i> )	Basal bark	Garlon 4	10%	Good
	Cut surface	Garlon 3A	50%	Good
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
Leadtrees ( <i>Leucaena leucocephala</i> )	Basal	Garlon 4	30%	Moderate
Life plant ( <i>Kalanchoe pinnatum</i> )	Foliar	Roundup	3%	Good
Loquat ( <i>Eriobotrya japonica</i> )	Cut surface	Garlon 3A	50%	Good
	Cut surface	Garlon 4	10%	Good
	Basal	Garlon 4	10%	Good
Mango ( <i>Mangifera indios</i> )	Basal bark	Garlon 4	10%	Good
Melaleuca ( <i>Melaleuca quinquenervia</i> )	Cut surface	Arsenal	25%	Good
	Cut surface	Velpar L	50%	Good
	Cut surface	Garlon 3A	100%	Moderate
	Foliar	Arsenal + Rodeo	1.5% + 8%	Moderate
Mysore raspberry ( <i>Rubus albeicens</i> )	Cut surface	Garlon 3A	50%	Good
Napier grass ( <i>Pennisetum purpureum</i> )	Foliar	Roundup	3%	Good
Nepthytis ( <i>Syngonlum podophyllum</i> )	Basal	Garlon 4	10%	Moderate
	Foliar	Roundup	3%	Moderate
Papaya ( <i>Carica papaya</i> )	Basal bark	Garlon 4	10%	Good
Passionflower ( <i>Passiflora edulls</i> )	Basal	Garlon 4	10%	Good
	Cut surface	Garlon 3A	50%	Good
Pothos ( <i>Epipremnum pinnatum</i> )	Foliar	Roundup	3%	Moderate
Queensland umbrella ( <i>Brassaia actinophylla</i> )	Basal bark	Garlon 4	10%	Moderate (re-treat necessary)
	Cut surface	Garlon 3A	50%	Moderate (re-treat necessary)
Rosary pea ( <i>Abrus precatorius</i> )	Basal	Garlon 4	10%	Good
	Cut surface	Garlon 4	10%	Good
	Cut surface	Garlon 3A	50%	Good
Schefflera ( <i>Schefflera actinophylla</i> )	Basal bark	Garlon 4	10%	Good
	Cut surface	Garlon 3A	50%	Good
	Foliar	Garlon 3A	1%	Good (hi vol reqd)
Sewer vine ( <i>Paedaria cruddasiana</i> )	Basal	Garlon 4	10%	Good
	Foliar	Roundup	5%	Moderate
Shoe-button Ardisia ( <i>Ardisia elliptica</i> )	Basal	Garlon 4	10%	Good
Surinam cherry ( <i>Eugenia uniflora</i> )	Basal	Garlon 4	10%	Moderate
	Cut surface	Garlon 3A	50%	Good
	Cut surface	Garlon 4	10%	Good
Torpedo grass ( <i>Panicum repens</i> )	Foliar	Roundup	3%	Good
	Foliar	Arsenal	1%	Good
Tropical soda apple ( <i>Solanum viarum</i> )	Basal bark	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Excellent
	Foliar	Garlon 3A	1%	Excellent (hi vol reqd)
	Foliar	Arsenal	0.5%	Excellent (hi vol reqd)
Woman's tongue ( <i>Albizia lebeck</i> )	Basal	Garlon 4	10%	Good
	Cut surface	Garlon 4	10%	Moderate
	Cut surface	Garlon 3A	50%	Moderate
Wood rose ( <i>Merremia tuberosa</i> )	Basal	Garlon 4	10%	Excellent
	Cut surface	Garlon 3A	50%	Good