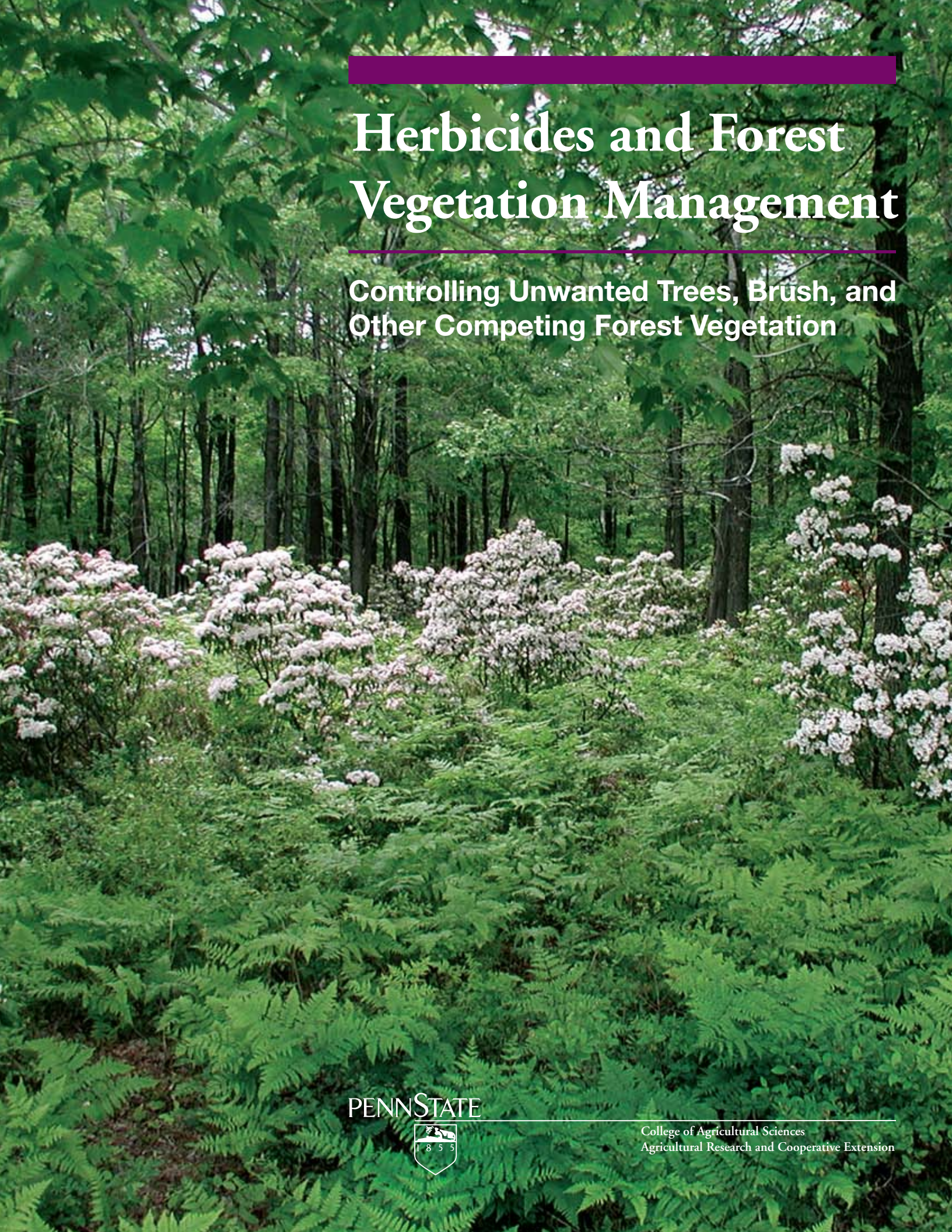

Herbicides and Forest Vegetation Management

Controlling Unwanted Trees, Brush, and Other Competing Forest Vegetation

PENNSTATE
1855
College of Agricultural Sciences
Agricultural Research and Cooperative Extension

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Introduction

There are a number of ways to manage vegetation: manual, mechanical, biological, cultural, and chemical. Integrated vegetation management (IVM) 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.

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 cost-effective 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.

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.

Herbicide Summaries can be found on Penn State's Forest Vegetation Management Web site at http://fvm.cas.psu.edu. The summaries will help you quickly compare herbicides commonly used in forestry and registered for use in Pennsylvania. They convey key points found on the product label and allow 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

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

page of the product label lists currently labeled sites. Applying a pesticide to a site not listed on the label is illegal. The Forest Vegetation Management Web site (http://fvm.cas.psu.edu/) includes common herbicides currently labeled for forest sites in Pennsylvania.

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, broad-spectrum 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.

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 (Phytotoxic) Susceptible, Non-Target Plants. For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification. Commercial certified applicators must also ensure that all persons involved in these activities are informed of the precautionary statements.

Dow AgroSciences™

Tordon* 101 Mixture

Specialty Herbicide

*Trademark of Dow AgroSciences LLC

Herbicide activity is an important consideration when selecting a product. Activity refers to how the product 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, rate information, and time of year. 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.

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.

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

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

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_{50} (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_{50} values are expressed in milligrams of pesticide per kilogram of body weight (mg/kg). The larger the LD_{50} value, the less toxic the chemical.

The LD_{50}, 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, page 12, provides the signal words and acute oral toxicity values for many commonly used forestry herbicide chemicals. To provide a basis for comparison 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_{50} 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_{50})
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
	Nicotine		50

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.

Always check the label for the required PPE for the product you plan to use.

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[1] 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 reviewed for 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 generally 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.

[1.] Revised from K. McNabb, *Environmental Safety of Forestry Herbicides*, Alabama Cooperative Extension System, 1997.

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.

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

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

continued on next page

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.

Caution: Root grafts may occur between species.

Herbicide Application Methods
Frill Girdle (Hack and Squirt)
Stem Injection
Basal Bark

27. Hack and squirt application to thin poletimber hardwood stand.

28. Overstocked white pine stand thinned using herbicides.

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

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 vegetation.

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.

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

34. Tree shelters can protect seedlings from herbicide.

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

A summary of forestry-labeled herbicides registered for use in Pennsylvania is available on the Penn State Natural Resources Extension Forest Vegetation Management Web site (http://fvm.cas.psu.edu/). The site contains informational summaries of herbicides effective at controlling competing vegetation in Northeastern hardwood and coniferous forests.

The following are also available on the Forest Vegetation Management Web site:

- An overview of integrated vegetation management (IVM)
- An IVM Web resource center
- A listing of herbicide manufacturers, distributors, and applicators
- A table listing herbicides, application methods, and current costs
- A table listing trees, shrubs, vines, and ferns controlled by herbicides labeled for use in Pennsylvania

http://fvm.cas.psu.edu/