Herbicides and Forest Vegetation Management

Controlling Unwanted Trees, Brush, and Other Competing Forest Vegetation
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.

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

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.
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, non-native 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.
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.
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 (Non-photosynthetic) Susceptible Non-Target Plants. For retail sale 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

*Trademark of Dow AgroSciences LLC*
**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.

**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.

1. Hatchet and spray bottle for hack and squirt applications.
2. Making frill cuts to receive herbicide.
3. Hypo-hatchet blade showing injector port.
4. Hypo-hatchet injects calibrated volume with each blow.
5. The E-Z Ject lance injects capsules into stems.
6. 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 hardwood stumps.

13. Cut stump treatment prevents resprouting.

14. Treat only the cambial area of cut stumps.
**Basal Bark**

Using a low-pressure backpack sprayer, thoroughly wet the lower 12 to 15 inches of the stem completely around the 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.

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**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.

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**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.
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 provides the signal words and acute oral toxicity values for many commonly used forestry herbicides. 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.

<table>
<thead>
<tr>
<th>Signal Word</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caution</td>
<td>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.</td>
</tr>
<tr>
<td>Warning</td>
<td>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.</td>
</tr>
<tr>
<td>Danger</td>
<td>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.</td>
</tr>
<tr>
<td>Danger Poison (skull and crossbones)</td>
<td>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.</td>
</tr>
</tbody>
</table>

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).


Table 2. Relative Toxicity of Commonly Used Forestry Herbicides.

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

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

**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\(^1\) 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 described in this publication, \( \text{LD}_{50} \) 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.

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**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

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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.).

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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.

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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

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


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

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**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

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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

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

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.

35. Foliar application of multiflora rose.

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

<table>
<thead>
<tr>
<th>Common Name (Active Ingredient)</th>
<th>Trade Name</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>DMA 4 IVM</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td>Clopyralid</td>
<td>Transline</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td>Dicamba</td>
<td>Vanquish</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td>Fosamine</td>
<td>Krenite S</td>
<td>DuPont</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>Accord Concentrate</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td></td>
<td>Foresters’</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td></td>
<td>Razor</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td></td>
<td>Razor Pro</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td>Glyphosate and Imazapyr</td>
<td>OneStep</td>
<td>BASF</td>
</tr>
<tr>
<td>Hexazinone</td>
<td>Velpar DF</td>
<td>DuPont</td>
</tr>
<tr>
<td></td>
<td>Velpar L</td>
<td>DuPont</td>
</tr>
<tr>
<td>Imazapyr</td>
<td>Arsenal AC</td>
<td>BASF</td>
</tr>
<tr>
<td></td>
<td>Chopper</td>
<td>BASF</td>
</tr>
<tr>
<td></td>
<td>Stalker</td>
<td>BASF</td>
</tr>
<tr>
<td>Metsulfuron Methyl</td>
<td>Escort XP</td>
<td>DuPont</td>
</tr>
<tr>
<td></td>
<td>Patriot</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td>Picloram</td>
<td>Tordon K</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td>Picloram and 2,4-D</td>
<td>Tordon 101 Mixture</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td></td>
<td>Pathway</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td>Sulfometuron Methyl</td>
<td>Oust XP</td>
<td>DuPont</td>
</tr>
<tr>
<td></td>
<td>Spyder</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td>Sulfometuron Methyl and Metsulfuron Methyl</td>
<td>Oust Extra</td>
<td>DuPont</td>
</tr>
<tr>
<td>Triclopyr</td>
<td>Garlon 3A</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td></td>
<td>Garlon 4</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td></td>
<td>Pathfinder II</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td></td>
<td>Tahoe 3A</td>
<td>Nufarm Turf and Specialty</td>
</tr>
<tr>
<td></td>
<td>Tahoe 4E</td>
<td>Nufarm Turf and Specialty</td>
</tr>
</tbody>
</table>
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 LD₅₀: >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:** 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

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**Arsenal AC**

**Common Name:** Imazapyr—53.1%

**Formulation:** Water-soluble liquid (amine salt)

**Signal Word:** Caution

**Toxicity:** Practically nontoxic; oral LD₅₀: >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

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**Chopper**

**Common Name:** Imazapyr—27.6%

**Formulation:** Water-soluble liquid (amine salt)

**Signal Word:** Caution

**Toxicity:** Practically nontoxic; oral LD₅₀: >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 LD₅₀: 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 chemical-resistant 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 groundwater

**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

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**Escort XP**

**Common Name:** Metsulfuron methyl—60%

**Formulation:** Dispersible solid granule

**Signal Word:** Caution

**Toxicity:** Practically nontoxic; oral LD₅₀: >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 pre- and 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

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**Foresters’**

**Common Name:** Glyphosate—53.8%

**Formulation:** Water-soluble liquid (amine salt)

**Signal Word:** Caution

**Toxicity:** Practically nontoxic; oral LD₅₀: >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, broad-spectrum 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 LD₅₀: 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 LD₅₀: 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 LD₅₀: >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$_{50}$: >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, broad-spectrum 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

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**Oust Extra**

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

**Formulation:** Dispersible granule

**Signal Word:** Caution

**Toxicity:** Practically nontoxic; oral LD$_{50}$: >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

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**Oust XP**

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

**Formulation:** Dispersible solid granule

**Signal Word:** Caution

**Toxicity:** Practically nontoxic; oral LD$_{50}$: >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 pre- and postemergence activity

**Selectivity:** Many coniferous and hardwood 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 re-sprouting; stumps can be treated up to one month following cutting

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**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$_{50}$: >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: 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

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**Patriot**

Common Name: Metsulfuron methyl—60%

Formulation: Water-dispersible granules

Signal Word: Caution

Toxicity: Practically nontoxic; oral LD$_{50}$: >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, broad-spectrum 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 LD₅₀: >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, broad-spectrum 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 LD₅₀: >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 LD₅₀: >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 LD₅₀: 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 LD₅₀: 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 chemical-resistant 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 LD₅₀: 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$_{50}$: >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$_{50}$: >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$_{50}$: 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, broad-spectrum 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$_{50}$: 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

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**Velpar L**

**Common Name:** Hexazinone—25%

**Formulation:** Water-dispersible liquid

**Signal Word:** Danger

**Toxicity:** Slightly toxic; oral LD$_{50}$: 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 the label, but the control of species not listed.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Accord</th>
<th>Arsenal AC</th>
<th>Chopper</th>
<th>DMA 4 IVM</th>
<th>Escort XP</th>
<th>Foresters'</th>
<th>Garlon 3A</th>
<th>Garlon 4</th>
<th>Krenite S</th>
<th>One Step</th>
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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 application on a site specifically listed on the label. You may also want to check with herbicide manufacturer representatives for the control of species not listed.

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