

Effective Herbicide Use in Christmas Tree Plantations



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Introduction

Christmas tree production has developed into an intensive agricultural operation designed to produce a speciality product. Consumer demands and production costs necessitate that growers maximize the production of high quality trees per acre in as few years as possible. This requires an intensive management program that focuses on the factors that affect tree growth, foliage quality and general appearance. Management includes the effective use of herbicides.

Why Use Herbicides?

When properly used, herbicides provide benefits not only during initial establishment and growth of the tree, but also later, during crop rotation (Figure 1). Some objectives of herbicide use include:

Helps prepare sites where Christmas trees will be established. Herbicides can be used effectively to control woody and herbaceous vegetation. Pre-establishment treatments facilitate planting as well as reduce competing vegetation.

Increases survival and early growth of newly planted trees. Whether applied as a preplant or postplant treatment, herbicides can control competing vegetation, which also increases the moisture available to planted seedlings, and results in increased survival and growth. Maximum growth in the first two to three years after planting is necessary to obtain large salable trees in as few years as possible.

Increases the supply of nutrients available to the tree. By preventing herbaceous plants from growing, the nutrients these plants would have used become available to the tree. In plantations where herbicides are used effectively, the grower can expect improved foliage color and more rapid growth. Growth is affected most in the first few years after planting.

Reduces the need for furrow planting. Furrow planting is used by some Christmas tree growers to reduce plant competition. While furrowing provides some relief from competition, there are disadvantages. Furrowing physically removes much of the nutrient-rich top soil from around the newly planted trees. This reduces growth and increases the possibility of soil erosion and the likelihood of rodent injury. Furrowing also makes it more difficult to shear, mow, spray, harvest, and clean up the plantation after harvest. Effective weed and grass control offers the advantage of furrow planting without the associated disadvantages.

Reduces damage and loss due to rodents. Abundant grass and weed growth is a favorable environment for rodents, especially mice and voles. Mice will often feed on the tree bark, causing severe injury or death. Controlling grass and weed growth in the plantation reduces the mouse and vole population by eliminating habitat and lessens the probability of injury.

Helps develop better quality foliage on the lower part of the tree (Figure 2). Heavy weed growth shades needles on the trees' lower branches and prevents full foliage development. Shading also causes earlier-than-normal needle loss and may cause some branches to die. This reduces tree quality and prolongs the development of a full size tree.

Permits easier and higher quality shearing. Heavy grass and weed growth makes shearing and shaping the trees difficult, if not impossible. Lower tree branches are difficult to see, slowing the shearing process. Working in heavy grass and weeds is uncomfortable and discourages work crews from doing the best job.

Reduces the probability of foliage diseases. The environment maintained by heavy weed growth—shade, high relative humidity, excessive moisture due to slow drying of dew and rain and cooler temperatures in the lower part

of the tree—favors the development of foliar diseases. Effective weed control helps reduce the occurrence of diseases such as *Lophodermium* needlecast, brown spot needle disease, Swiss needlecast and *Rhizosphaeria* needlecast.

Reduces the likelihood of wildfire in the plantation. Dry weeds and grass are a fire hazard that threatens Christmas trees growing in the same area. Effective weed and grass control will lessen the likelihood or severity of a fire in the plantation.

Promotes better wholesale buyer and consumer relations. This benefit may be intangible, but it is still real. With increasing emphasis on the production of quality trees, the impression a clean, well-managed plantation makes on potential buyers cannot be overlooked. For choose-and-cut operations, a well-manicured plantation makes customers' selections easier and conveys an image of concern about quality. The individual consumer will be more inclined to pay a fair price if he or she is convinced the product is top-of-the-line.

Herbicide Characteristics

By definition, herbicides are chemical compounds that affect the germination, growth and behavior of plants. There is a wide variety of herbicidal materials—some are better adapted to certain uses than others. To choose the appropriate herbicide for a particular situation, the grower must understand some basic herbicide characteristics. These include:

Selectivity or Specificity. Herbicides are not equally effective on all types of vegetation. This is fortunate because one or more targeted weed plants can be controlled without causing significant injury to the Christmas trees (Figure 3). Herbicides are available that control grasses only, broadleaf plants only, or certain grasses and broadleaf plants. Some herbicides are selective in Christmas tree plantations when applied during certain periods of the year, such



Figure 1: In addition to encouraging tree growth and facilitating management operations, a well manicured plantation emphasizes a commitment to the production of quality Christmas trees.



Figure 2: Competition from grasses and weeds may cause needle loss and dieback of lower branches. This reduces tree quality and increases the time necessary to produce salable trees.



Figure 3: Selective herbicides allow the plantation manager to control certain undesirable plants without damaging growing Christmas trees.

Figure 4: Herbicides are available in several different formulations. The most common are liquid (L), wettable powder (WP) and granular (G).



as before the trees begin growing in the spring, after they have hardened-off in the late summer, or when they are dormant.

Mode of Activity. Herbicides affect plants in several different ways. Some are absorbed through the foliage, while others are applied to the soil and are absorbed through the root system of actively growing plants. A few herbicides kill only the portion of the plant to which they are applied. Other herbicides, when applied to or incorporated in the soil, prevent the germination of weed and grass seeds.

Residual Nature. Herbicide effects vary, in part, because of their residual characteristics. A herbicide is considered to have residual effect if it prevents the regrowth of vegetation for a period of time after application. This time period varies from a few months to more than a year. Several residual herbicides exert pre-emergent control by continually killing weeds as their seeds germinate.

Application rate, soil texture (particularly clay content), organic matter content, soil moisture level, and herbicide solubility affect a herbicide's residual properties. Many herbicides that are absorbed through foliage have little or no residual effect, whereas those applied to the soil before plant growth usually do.

Formulation. Herbicides are available in several different formulations (Figure 4): *solutions*, which are completely soluble in water or other solvents, such as fuel oil; *emulsions*, which are two unlike liquids mixed together; *wettable powders*, which consist of finely divided solid particles that can be dispersed in a liquid; and *granules*, which contain crystals of the effective chemical bound together with an inert carrier. Each formulation has advantages related to its manner of application and the targeted plants' susceptibility to the formulation used.

A herbicide mixture's effectiveness depends on the user's knowledge of the

formulation characteristics. For example, soluble herbicides must be mixed with clean water because dirt will inactivate them. Combinations of emulsifiable compounds or wettable powders and water require spray tank agitation to maintain a uniform suspension. Failure to agitate may result in erratic application rates.

Factors Influencing Herbicide Effectiveness

Effective vegetation control through herbicide use varies among Christmas tree growers. Many individuals obtain only partial control at best, while others are more successful. To successfully control vegetation, the grower must understand the factors that influence herbicide effectiveness. Effective control is related to:

Application Rate. The amount of herbicide required per acre to obtain effective control depends on several variables including herbicide formulation, soil type and targeted vegetation. Specific application rates for various conditions are stated on the herbicide label. Follow these recommendations to obtain safe, economical, and effective results. When preparing the spray mixture, carefully weigh or measure the amount of herbicide.

Equipment Calibration. Proper calibration of application equipment is required to obtain good results when using herbicides. Calibration is simply the determination of how much material is being applied to a given area of land. MSU Extension Bulletin E-916, "In Forest Plantings: Sprayer Calibration for Herbicide Application," gives recommendations for calibrating spray equipment. Calibrate equipment yearly, especially if it is used frequently. Once equipment is calibrated, it is essential that the same ground speed, pump pressure and nozzle size are maintained during actual application.

Application Method. Application method is closely related to application

rate and proper equipment calibration. Herbicides used in Christmas tree operations are usually applied by broadcast treatments, using ground or aerial equipment, or in 24- to 36-inch bands over each row (Figure 5). For successful results, it is essential that coverage is uniform, regardless of method used. Routinely check and clean screens, filters and nozzles. When using foliar-active compounds, check the label to determine if a wetting agent is recommended. For herbicides that do not form true solutions, be sure to use spray tank agitation to maintain herbicide suspension. Wettable powders especially require agitation. Failure to agitate can cause erratic application rates—areas treated when the tank is full will receive too little herbicide, while those areas treated when the tank is low will receive too much herbicide.

Targeted Vegetation. Because of differences in anatomy and physiology, some plants are more affected by herbicides than others. Annual weeds and grasses are easily controlled with pre-emergent products, while perennial grasses and weeds, particularly those with deep root systems, are more difficult to control chemically (Figure 6). Some plants, such as horsetails and sedges, are especially difficult to control. Because of such differences, growers often combine two or more herbicides in the spray tank. Foliar-active compounds and pre-emergent herbicides with residual properties are often combined to control existing vegetation and to maintain an area clean of vegetative regrowth. Determine the compatibility of different herbicide compounds before preparing tank mixes to avoid interactions that may make each compound less effective. Herbicide dealers provide charts that outline the compatibility of many different herbicides.

Soil-site Characteristics. Soils with high clay or organic matter contents require a heavier application of residual herbicides than coarse-textured sands or gravelly soils. If the amount of herbicide necessary for effective control on

heavy soil is applied to a lighter-textured soil, the herbicide may injure any trees present. Further, residual herbicides persist longer on heavier soils because clay and organic particles absorb more of the material.

Soil moisture content and the soil's ability to retain moisture also influence herbicide effectiveness. Growers can expect more complete control on moister soils than on sites with dry soils.

Weather Conditions. Weather factors at the time of, and following, application can influence herbicide effectiveness. Cool and cloudy weather following application of foliar herbicides will reduce their effectiveness. Heavy rain immediately following application will wash away foliar herbicides and therefore reduce their effectiveness. On the other hand, rainfall within a few days of application is necessary to move soil-applied herbicides into the soil solution. If there is a lack of precipitation following application, weeds can germinate and grow before the herbicide can work. However, heavy rains, especially in a short time, may leach the herbicide from the upper soil or wash it to low-lying areas. In both cases, herbicide effectiveness is reduced, and damage to trees may occur.

Wetting Agents. Wetting agents influence the effectiveness of foliar-applied herbicides. Because many plant leaves are waxy or hairy, they tend to repel herbicide spray droplets. The wetting agent (also called spreader or sticker) decreases the surface tension of herbicide solutions by reducing the spray droplet size so they stick to the plant leaves better. This increases absorption and therefore provides better control (Figure 7). Not all herbicide formulations require a wetting agent because some already contain these compounds. Check the herbicide label and follow any recommendations given regarding their use.

Commonly Used Herbicides

Fortunately for Christmas tree producers, there are many compounds that control herbaceous and woody plants. The following list names the most commonly used herbicides and describes their formulations, characteristics and specific uses.

Amitrole (tradename: *Amitrol-T*). Amitrole is a systemic herbicide (i.e., translocated), with a short-term residual effect in the soil. The commercial formulation, *Amitrol-T*, contains ammonium thiocyanate to improve translocation. This chemical controls a wide variety of broadleaf weeds and grasses. It will also control some woody vegetation, including brambles, poison ivy and sumac, if applied at the highest rates.

Amitrole is usually mixed with other more persistent herbicides to provide longer-lasting control. In Christmas tree plantations, apply as a water solution at rates of 1/2 to 2 gal product/acre. To prevent damage to the Christmas trees, apply using a directed spray. Do not plant trees immediately after amitrole application because it persists in the soil for several weeks.

Amizine (tradename). *Amizine* is a commercially prepared product of 15 percent *Amitrol-T* and 45 percent simazine. To control existing vegetation and provide some residual control of grasses and broadleaf weeds, apply at rates of 5 to 7 lb ai (active ingredient)/acre. For best results, apply in the early spring when herbaceous growth is small but active. Avoid spraying *Amizine* on Christmas tree foliage.

Asulam (tradename: *Asulox*). In Christmas tree plantations, spray asulam over the top of actively growing bracken fern and trees at a rate of 1 gal product/acre. Control is not evident in the year of application, but new growth fails to appear the following year. Control will usually last for two or more years. For best results, do not cut or disturb

existing bracken fern after asulam application.

Atrazine (tradename). Although widely used in agricultural crop production, *Atrazine* has application to Christmas tree production also. It controls existing vegetation and is usually mixed with simazine to provide pre-emergent control as well. *Atrazine* is available in wettable powder, liquid and dispersable liquid formulations under various trade names. Apply over the top of trees at rates of 1 to 2 lb ai/acre in the spring when grasses and broadleaf weeds are less than 2 inches tall and trees are still dormant. Plants absorb the herbicide through roots, and like simazine, *Atrazine* inhibits plant photosynthesis causing weeds to die from the top down. *Atrazine* persists in the soil for up to several years, depending on soil texture and organic matter content. Occasionally, tree seedling injury is observed on sites where *Atrazine* has been used

2,4-D (tradename). *2,4-D* is a systemic that controls many broadleaf herbaceous weeds and woody species. It is available under many different tradenames and commercial formulations (over 1,500 products are registered with the EPA). *2,4-D* is used in Christmas tree management to eliminate broadleaf weeds, brush and unwanted hardwoods for site preparation, and to control invading brush on established sites. Although *2,4-D* effectively controls many hardwood species such as aspen, alder, birch, willow and sumac, others are not affected. Mixtures of *2,4-D* with picloram, dicamba or *2,4-DP* (dichlorprop) provide broader control.

Apply *2,4-D* to actively growing target plants at the rates specified on the label. Apply to established sites after trees have gone into dormancy in late summer. *2,4-D* may be applied as a water solution, an emulsion or a fuel oil spray, depending upon formulation. Do not use volatile ester formulations if susceptible crops or ornamental plants are

growing nearby because 2,4-D vapors can cause injury.

Dicamba (tradename: *Banvel*). Dicamba is used primarily for site preparation to control woody plants. It is available in liquid and granule pellet formulations and is also marketed as a mixture with 2,4-D. Apply dicamba at rates of 2 to 8 lb ai/acre as a foliar or basal bark spray during summer. It may also be spread on the soil around target trees or injected directly into tree trunks. Dicamba does not affect grass, but will damage or kill unprotected Christmas trees.

Dichlorobenil (tradename: *Casoron*). This compound inhibits seed germination of both grasses and broadleaf vegetation. Do not apply to newly planted Christmas trees because it may cause injury. Dichlorobenil is more commonly used in nurseries that produce container stock. Apply dichlorobenil at rates of 2 to 8 lb ai/acre. For best results, apply in late fall or early spring. A good rain is needed following application to move the material into the soil.

Dalapon (tradename: *Dowpon*). Dalapon is an effective grass killer and is used for site preparation or for spot treatment of troublesome weeds, such as quackgrass, in Christmas tree plantations. It is applied at rates of 10 to 15 lb product/acre when weed growth is 6 to 8 inches high. However, two to three applications at 5 to 8 lb product/acre made from 1 to 3 weeks apart will provide better control. Do not apply dalapon over or around actively growing trees. Dalapon tends to lose its effectiveness if it is not absorbed within 24 hours. This problem is more serious at temperatures above 80°F. For best results, add a wetting agent to the spray solution.

Fosamine (tradename: *Krenite*). Fosamine is a brush control agent that is used only for site preparation. It has little affect on herbaceous plants. Fosamine is a water soluble, foliar-applied herbicide that kills only the portion of a plant to which it is applied. Apply fosamine to brush in late summer

or early fall before leaf coloration at rates of 1.5 to 3 gal product/acre. Control is evident the following spring when susceptible plants fail to re-leaf and, therefore, die.

Fluazifop-butyl (tradename: *Fusilade*). This new herbicide has good potential for Christmas tree growers because it is highly selective. When applied post-emergence, it controls annual and perennial grasses, but not broadleaf weeds or sedges. This herbicide is effective when grasses are actively growing but before they reach the growth stages indicated on the label (e.g., quackgrass should be less than 10 inches high). Growth stops soon after application, and the plants turn yellow or red before dying. Apply fluazifop-butyl at rates of 1/4 to 1/2 pt/product acre and add a crop oil concentrate or non-ionic surfactant. Two applications of the same total amount are generally more effective for full season control than a single application.

Glyphosate (tradename: *Roundup*). As a broad spectrum, water-soluble herbicide, glyphosate is effective on annual and biennial grasses, sedges and broadleaf weeds. It is foliar-applied and is rapidly translocated throughout plants. It is not absorbed through plant root systems, so there is no residual effect.

In Christmas tree operations, use glyphosate for site preparation or to control grasses and weeds in established plantations. For best results, apply to actively growing vegetation using a directed spray or a wick at rates of 1 to 2 qt product/acre. To obtain residual effects, prepare a tank mix with simazine. Do not add a wetting agent if using the *Roundup* formulation because it already contains one. To control woody perennials and some broadleaf tree species apply at heavier rates in late summer or early fall. Use non-directed applications over the top of established conifers at a rate not to exceed 1 qt product/acre to control quackgrass and late season annual grasses and weeds. Glyphosate may also be used effectively with a tree injector.

Hexazinone (tradename: *Velpar*). Hexazinone is an effective herbicide that provides both contact and residual control of annual and perennial weeds, grasses and many woody plant species. It is available in wettable powder, liquid and solid granule (gridball) formulations. Though no longer manufactured under the Velpar tradename, the gridball formulation is particularly effective in controlling undesirable hardwoods in Christmas tree plantations. For best results, apply at rates of 1 to 2 lb ai/acre when herbaceous growth is small, soil moisture is ample and temperature and relative humidity are high.

Hexazinone affects each Christmas tree species differently. Scotch pine is highly tolerant of this compound, while white pine is extremely sensitive. Douglas fir and Colorado blue spruce are somewhat tolerant. Test the herbicide on a small area before applying to large plantations. When correctly applied, hexazinone is particularly effective in controlling weeds and brush in Scotch pine plantations.

Oryzalin (tradename: *Surflan*). While this compound is not widely used on Christmas tree plantations, it is effective in areas where annual and late-season grasses are troublesome. Oryzalin will not control established vegetation, so it is commonly mixed with a contact herbicide. To provide season-long control apply before weed and grass seeds germinate at rates of 1.5 to 2.6 lb ai/acre. It may be applied over the top of established seedlings and transplants. Because it is not foliar-active, approximately 1/2-inch of rain following application is required to activate the herbicide. For excellent season-long vegetation control, Christmas tree growers use a tank mix containing glyphosate (*Roundup*), simazine and oryzalin.

Oust (tradename). This recently marketed herbicide has potential for Christmas tree plantations, although it requires more testing. *Oust* is a broad-spectrum herbicide that provides pre- and post-emergent control of many grasses and broadleaf weeds. It shows

particular promise for site preparation when used in conjunction with *Paraquat*, glyphosate or amitrole. *Oust* is compatible with many other herbicides, including atrazine and hexazinone, but it has not been recommended yet for selective weed control in established plantations. As with many of the newer generation herbicides, *Oust* is applied at low rates, generally under 10 oz product/acre.

Oxazadone (tradename: *Chipco Ronstar G*). Like oxyfluorfen, oxazadone is most commonly used in seedbeds and tree nurseries to control a wide variety of annual broadleaf weeds and grasses in container stock and potted trees. Although effective on Christmas tree plantations, its relatively high cost per acre treated precludes widespread use. Apply oxazadone as a granular formulation in early spring before weed seed germination at rates of 100 to 200 lb product/acre.

Oxyfluorfen (tradename: *Goal*). Oxyfluorfen is normally used in nurseries, although it has some application to Christmas tree plantations. It is a selective herbicide with both pre- and post-emergent activity and controls annual grasses and many species of broadleaf weeds. Apply oxyfluorfen in early spring when seedlings are dormant, at rates of 1/2 to 1 gal product/acre. Tank mixes with simazine provide effective residual control.

Paraquat (tradename). *Paraquat* is a restricted-use herbicide that can be purchased by certified pesticide applicators only. Because it is a rapidly absorbed, foliar-applied herbicide, *Paraquat* controls existing vegetation. It shows its effects almost immediately—from within a few hours to a few days. However, *Paraquat* is not translocated and has no residual activity. It therefore has limited effectiveness on sprouting or perennial plants. To kill existing vegetation, apply *Paraquat* at rates of 1/2 to 1 lb ai/acre. Avoid tree foliage injury by using a directed spray in established plantations. For longer-lasting results, use *paraquat* in conjunction with a residual herbicide.

Picloram (tradename: *Tordon*). Although it is a restricted-use herbicide, picloram is one of the most commonly used herbicides in forestry because of its relatively low cost and versatility. It is marketed in various formulations, including pellets (*Tordon 10K*), beads (*Tordon Beads*) and liquid (*Tordon 22K*), and is available in pre-mix combinations with other herbicides, such as *2,4-D* (*Tordon 101* and *Tordon Ready-to-Use*). Because picloram is highly residual, it controls most woody plants and annual and perennial broadleaf weeds. Most grasses are resistant, but conifers are not. Therefore, it is used for site-preparation one year prior to planting, or for selective control of unwanted trees and shrubs by tree injections, frill or girdle treatments, stump or basal bark spraying or by spreading solid formulations on the soil around targeted trees.

Pronamide (tradename: *Kerb*). Pronamide is a selective herbicide that controls certain broadleaf plants and grasses, particularly quackgrass. It is a soil-applied herbicide that has little foliar activity and requires rain following application so root uptake can occur. Pronamide is usually used in conjunction with other herbicides to control late annual weeds and grasses.

For best results, when using pronamide, apply in late fall when soil temperature is 60° F or lower at rates of 3/4 to 2 lb ai/acre. Pronamide is more effective on soils with low levels of organic matter content than on those with high levels.

Sethoxydim (tradename: *Poast*). Sethoxydim is a relatively new broad-scale, post-emergent herbicide that controls a wide variety of annual and perennial grasses and appears especially effective in controlling quackgrass and heavy infestations of late summer annual grasses in established plantations. It doesn't control sedges or broadleaf weeds. Sethoxydim is readily absorbed by grass foliage and moves quickly throughout the plant.

Apply sethoxydim at rates of 1 to 2-1/2 pt product/acre and add a 1/2 to 1 percent crop oil concentrate to the spray mix for maximum effectiveness. Sethoxydim may be applied over the top of actively growing trees.

Simazine (tradename: *Princep*). Undoubtedly, simazine is the most widely used herbicide in Christmas tree production. It exerts pre-emergent control over most broadleaf plants and grasses. It is often combined in a tank mix with one or more herbicides, such as *Atrazine* or oxyfluorfen, to obtain immediate as well as residual results and to control late-season grasses and weeds resistant to simazine.

Simazine is available in liquid, wettable powder and granular forms. When using the wettable powder formulation, tank agitation is required to maintain a uniform mixture. For best results, apply simazine at rates of 2 to 4 lb ai/acre in late fall after Christmas trees are dormant, or in early spring before growth begins. The herbicide may be safely applied over the top of established sites during these periods. Simazine alone will not control established vegetation, so time of application is crucial.

Using Herbicides to Control Vegetation in Christmas Tree Plantations

Preparing Areas for Planting

Woody Brush

Amitrole (*Amitrol-T*) Rate: 1/2 to 2 gal/acre.

Use in areas where a combination of annual and perennial grasses, broadleaf weeds and woody perennials, such as brambles, poison ivy and sumac, are present. Also controls some ferns and sedges. Apply after foliage is fully developed, but before plants begin dor-

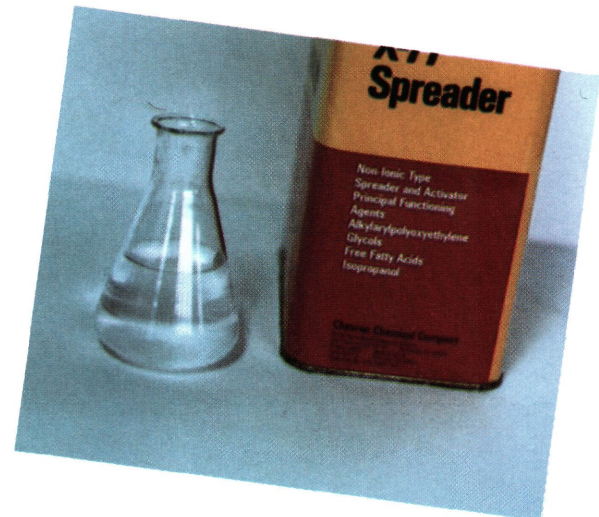


Figure 5: Applying herbicides in bands over the row concentrates the effect close to the young tree, reduces the amount of bare soil exposed and requires less total chemical per acre of plantation.



Figure 6: Some deep rooted plants are more difficult to control than grasses and annual weeds. Contact herbicides are more effective in the control of deep-rooted plants.

Figure 7: Wetting agents reduce the surface tension of the spray droplets, thereby improving plant coverage, increasing the amount of chemical absorbed and resulting in better weed control.



mancy. Saturate leaves and basal portions of stems. Do not plant conifers within six months of application.

2,4-D Amine Rate: 1 ml of a 4 lb acid equivalent ae/gal formulation.

Use to inject and treat frills on larger individual trees scattered over a proposed planting area. Space injections or frills 2 inches apart, edge to edge. Treat trees at any time of the year.

2,4-D Amine Rate: 4 gal of a 4 lb ae/gal formulation to 96 gal of water.

Apply a 4 percent solution to cut stumps to control sprouting or use as a basal spray on small, scattered, multi-stemmed hardwood brush. Saturate stumps and root collars. Both treatments are effective year-round.

2,4-D Oil Soluble Amine Rate: Use rate given for water soluble amine, but use oil as the mixer.

Use for similar situations as for water-soluble amine.

2,4-D plus picloram (Tordon 101) Rate: 1 to 4 gal/acre.

Use where cover of small brush, including oaks and maples is uniform. Apply uniformly over foliage during June and July. Grass cover is not affected, although some broadleaf weeds are controlled. Do not plant conifers within 6 months of application.

Also effective as a basal spray (50:50 solution of water and 2.5 lb ai/gal formulation) on brush, or injection (1 ml of a 2-1/2 lb ai/gal formulation) of larger individual stems during the dormant season.

2,4-D (ester) plus dicamba Rate: 2-1/2 lb ae/acre plus 1-1/4 lb ai/acre respectively/100 gal water.

Use over a uniform distribution of small brush, including oaks and maples. Provides pre- and post-emergent control of annual and perennial broadleaf weeds. Grasses are not affected. Apply uniformly over foliage during late spring and summer until foliage is fully developed, but three weeks before the first frost. Do not plant conifers within 6 months of application.

Dicamba (Banvel) Rate: 2 to 8 lb ai/acre.

Use over a fairly uniform distribution of small brush, including maples and oaks. Provides pre- and post-emergent control of annual and perennial broadleaf weeds. Grass cover is not affected. Apply as a foliar spray, basal bark spray or inject into larger individual trees. Apply to foliage after fully developed but 3 weeks before the first frost. Injections and frill treatments are effective on most species year-round. Do not plant conifers with 6 month of application.

Fosamine (Krenite) Rate: 1-1/2 to 3 gal/acre.

Use to control brush. Will not control broadleaf weeds and grasses. Apply to fully developed foliage within 2 months of leaf coloration; thoroughly wet foliage to ensure complete suppression.

Glyphosate (Roundup) Rate: 1 to 2 qt/acre.

Controls broadleaf weeds, grasses, sedges, woody perennials and broadleaf tree species. Apply to foliage of actively growing plants in late summer. Use the highest recommended rates when oaks and maples are present. Use full strength for injections and frill treatments.

Hexazinone (Velpar) Rate: 1 to 2 lb ai/acre.

Controls hardwood brush and grasses, broadleaf weeds and woody perennials as well. Use only on areas where Scotch pine will be planted. For best results, apply when soil moisture is ample and both temperature and relative humidity are high.

Picloram (Tordon) Rate: Follow label recommendations.

Restricted-use herbicide; only licensed individuals may purchase and apply this product. Good for treating frills and stumps, tree injections and basal bark spraying.

Grass and Herbaceous Growth

Dalapon (Dowpon) Rate: 10 to 15 lb/acre.

Effectively controls quackgrass with little or no effect on woody perennials and ferns. Apply when growth is 6 to 8 inches high. For better results, apply at a rate of 5 to 8 lb product/acre in 2 or 3 applications 1 to 3 weeks apart. Use a wetting agent and plant 2 weeks after application.

Glyphosate (Roundup) Rate: 1 to 2 qt/acre.

Effectively controls annual and perennial grasses, sedges and broadleaf weeds. Apply to actively growing vegetation. Late summer and fall applications will control bracken fern and other late-season perennial grasses and broadleaf weeds. Do not apply within 6 hours of rainfall.

Hexazinone (Velpar) Rate: 1/2 to 3/4 lb ai/acre.

Effectively controls annual and perennial forbs and grasses. Slightly effective on bracken fern. For best results, apply in early spring before herbaceous growth is well established. Use only in areas that will be planted with Scotch pine.

Oust Rate: 10 oz/acre.

Exerts pre- and post-emergent control of many annual and perennial grasses and broadleaf weeds. Apply to actively growing herbaceous vegetation. To control a broader spectrum of woody perennials, combine in a tank mix with glyphosate or amitrole.

New Plantations

Tilled, Clean Soil

Simazine (Princep) Rate: 2 to 4 lb ai/acre.

Exerts pre-emergent control over most broadleaf weeds and grasses. Apply in late fall or in spring before weed seeds germinate. Does not control woody vegetation. Do not apply to transplants less than 3 years old. Does not control late-season annual grasses or perennials. Use higher rates on soils with high silt, clay or organic matter content.

Herbaceous Growth is Present

Atrazine and Simazine Rates: 1 to 1-1/2 lb ai/acre and 1 to 3 lb ai/acre, respectively.

Controls both grasses and broadleaf weeds and provides summer-long control. Apply in spring when vegetation is less than 2 inches high. May be applied over the top of dormant Christmas trees. Does not control late-season annual grasses and broadleaf weeds.

Glyphosate (Roundup) and Simazine (Princep) Rates: 2 qt/acre and 2 to 4 lb ai/acre, respectively.

Use for summer-long control of actively growing grasses and broadleaf weeds. Does not affect late-season annual grasses and broadleaf weeds. Apply using a directed spray.

Amitrole (Amitrol-T) and Simazine (Princep) Rates: 2 gal/acre and 2 to 4 lb ai/acre, respectively.

Apply using a directed spray to control a wide variety of broadleaf weeds and grasses as well as brambles, poison ivy, sumac and other similar woody perennials. Provides summer-long control of herbaceous vegetation, but does not affect late-season annual grasses and broadleaf weeds. *Do not* apply near the base of Christmas trees.

Hexazinone (Velpar) Rate: 1/2 to 1 lb ai/acre.

Provides contact and residual control of annual and perennial weeds and grasses. Apply in spring when growth is less than 2 inches. Use only on Scotch pine plantations that have been planted for at least 2 months and have received sufficient rainfall to ensure soil settling. Increase the rate to 1 to 2 lb ai/acre when applying to medium- and fine-textured soils.

Established Plantations

Dormant Trees

Apply using a directed spray:

Amizine Rate: 5 to 7 lb ai/acre.

Provides contact and residual control of most broadleaf weeds and grasses. Controls some blackberries, vines, ferns and sedges. Apply in early spring when herbaceous growth is small and actively growing. Avoid spraying Christmas tree foliage.

Glyphosate (Roundup) and Simazine (Princep) Rates: 1 to 2 qt product/acre and 1 to 3 lb ai/acre, respectively.

Provides existing and residual control of grass and broadleaf weed competition. Does not affect late season annual grasses and broadleaf weeds. Apply in late spring and early summer. Avoid spraying Christmas tree foliage.

Apply using broadcast method:

Atrazine and Simazine (Princep) Rates: 1 to 1-1/2 lb ai/acre and 1 to 3 lb ai/acre, respectively.

Controls existing grasses and broadleaf weeds and provides summer-long control of herbaceous vegetation. Apply in early spring when vegetation is less than 2 inches high and before tree growth begins.

Pronamide (Kerb) Rate: 2 to 4 lb ai/acre.

Controls many broadleaf weeds and grasses, and especially quackgrass. Apply in late fall when soil temperatures are 60 F or lower. Treatment is not completely effective on soils with high organic matter content. Rainfall following application is necessary for chemical activation.

Atrazine, Simazine (Princep) and Oryzalin (SurFlan) Rates: 1 to 2 lb ai/acre, 1 to 4 lb ai/acre and 1-1/2 to 2-3/4 lb ai/acre, respectively.

Use for season-long control of annual and perennial grasses and broadleaf weeds. Provides effective control of late-season grasses and broadleaf weeds. Apply in early spring when herbaceous vegetation is less than 2 inches high and Christmas trees are still dormant.

Glyphosate (Roundup) Rate: 1 qt/acre. Apply in late summer after Christmas trees have gone dormant. Provides ef-

fective control of late season annual and biennial grasses, quackgrass, sedges, broadleaf weeds, some woody perennials and some tree species, such as aspen, birch and pin cherry.

Growing Trees

Apply by broadcast method:

Fluazifop-butyl (Fusilade) Rate: 1/4 to 1/2 pt/acre.

Controls annual and perennial grasses, but not broadleaf weeds or sedges. Effective in late spring and early summer when grasses are actively growing, but before they exceed recommended growth stages. Effectively controls quackgrass when applied before growth exceeds 10 inches. For maximum effectiveness, apply with a crop oil concentrate or non-ionic surfactant in 2 applications at half the recommended rate.

Hexazinone (Velpar) Rate: 1 to 1-1/2 lb ai/acre.

Use only on established (at least 1 year) Scotch pine plantations. Apply when herbaceous vegetation is less than 2 inches high. For best results, apply when soil moisture is ample and both temperature and relative humidity are high.

Sethoxydim (Poast) Rate: 1 to 2-1/2 pt/acre.

Effectively controls quackgrass and late-season annual grasses. Apply anytime herbaceous vegetation is present, regardless of Christmas tree dormancy. The spray mixture requires a non-phytotoxic oil concentrate at a rate of 2 pt/acre.

Special Situations

Bracken Fern

Asulam (Asulox) Rate: 1 gal/acre. Apply to actively growing bracken fern, but after bud break and hardening of new tree growth. *Do not* disturb treated ferns after application. Shows control in the year following application and lasts for two or more years. *Do not* use a wetting agent.

Nursery Seedling Production

Dichlorobenil (Casoron) *Rate: 2 to 8 lb ai/acre.*

Inhibits the germination of grass and broadleaf plant seeds, but does not control established vegetation. Apply in late fall or early spring. Generally used to sterilize nursery soils.

Oxazadone (Chipco Ronstar G) *Rate: 100 to 200 lb/acre.*

Controls a variety of annual broadleaf weeds and grasses in seedbeds or tree nurseries. Apply anytime before weed seed germination. May be used on newly transplanted or established container stock, as well as field grown plants. Remove all existing weed growth prior to application.

Oxyfluorfen (Goal) *Rate: 1/4 to 1 lb ai/acre.*

In conifer seedbeds, exerts pre- and post-emergent control of annual grasses and broadleaf weeds. For pre-emergent control, apply in early spring after conifer seeds have been sown, but before they germinate. For post-emergent control, apply in the spring when vegetation is less than 4 inches high, but at least five weeks after conifer seeds have germinated.



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