

SECTION M.

FORESTRY AND HYBRID COTTONWOODS

Forestry

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Undesirable woody and herbaceous plants can manifest as problems in managed forests, fence lines and forest right-of-ways. Reforestation, in particular, may depend heavily on weed control. Besides federal regulations surrounding pesticide products and their use, individual state forest practices laws in Oregon, Washington and Idaho also prescribe certain rules regarding herbicide use to protect plantations, forest resources, and water. Operators should be familiar with their state forestry rules and state product labels whenever herbicides are used. Any product used in forestry applications must be EPA-registered for that use. Products not carrying a forest, reforestation, forest management, conifer plantation, or similar use on their labels should not be used in forest management, even if they have active ingredients that are registered on other products. Always follow directions on the herbicide label. The information in this handbook is not intended to be a complete guide to herbicide use. Before using any herbicide, read the label recommendations on the container.

Vegetation Control in Concert with Non-chemical Methods

In some instances, weeds and brush can be suppressed or controlled with non-herbicide treatments or used in addition to chemicals. Site preparation treatments such as machine scarification, slash piling, or prescribed burning can eliminate or temporarily suppress brush and weeds and set up conditions that allow for more conservative use of herbicides later in the life of a plantation.

Hand cutting of most trees and shrubs usually results in resprouting from the stump, but cutting at the ground line from mid-June to mid-August may reduce vigor of resprouts. Larger alder stems (greater than about 2 inches) and larger Scotch broom cut near the ground line in summer can nearly eliminate resprouting. Treating freshly cut stumps with a cambial application of a herbicide may allow the use of less chemical than broadcast foliar applications and provide better control on some species.

Controlling grasses and other herbaceous weeds is more difficult without herbicides. Scalping of sod or weeds around seedlings needs to be done in a large area and is often temporary but can give some initial reduction in competition. When used in combination with a herbicide spots can remain weed free for at least one season.

Laminated or fiber reinforced paper or similar mulch material can be effective at reducing competition if done correctly. This method has had some success comparable to that of grass herbicides. Mulch material should be at least 9 sq ft (3 ft x 3 ft). Mulch must be well weighted on all four corners, or pinned to the ground. Slash may need to be removed before installation to ensure good contact with the ground.

Vegetation Control with Herbicides

The herbicides selected for weed and brush control depend on the species composition, proximity of crops, degree of control required, and whether it is for site preparation or conifer release. The commonly used control methods and typical herbicides used are described below.

Major Herbicides and Common Brand Names of
Forest Management Products

Herbicide Name	Common Brand Names
2,4-D ester	Weedone LV-4, Weedone LV-6 and others
aminopyralid + metsulfuron	Opensight
aminopyralid + triclopyr	Capstone
clopyralid	Transline and others
flazasulfuron	Mission
flumioxazin	Lock Down SC, SureGuard SC, and others
fluroxypyr	Vista XRT
glyphosate	Roundup Custom, Aquamaster, Aquaneat, and others
hexazinone	Velpar DF VU
imazapyr (2 lb ae/gal)	Chopper Gen2, Polaris SP, Rotary 2 SL, and others
imazapyr (4 lb ae/gal)	Arsenal Applicators Concentrate, Polaris AC, Imazapyr 4 SL and others
indaziflam	Esplanade 200 SC
metsulfuron	Escort, MSM and others
penoxsulam + oxyfluorfen	Cleantraxx
picloram	Tordon 101, Tordon K and others
sethoxydim	Segment II
sulfometuron	Oust XP, Spyder, SFM and others
triclopyr ester	Garlon 4 Ultra and others
triclopyr salts	Garlon 3A, Vastlan and others

Foliage Application

Foliage spraying is extensively used for conifer release, site preparation, and directed spot treatments with a relatively small group of herbicides. Products containing aminopyralid, 2,4-D, clopyralid, fluroxypyr, triclopyr, imazapyr, glyphosate, metsulfuron, and picloram are used for most foliage applications on both deciduous and evergreen trees, shrubs and weeds.

Several products can be used selectively for over-the-top broadcast conifer release. Clopyralid, fluroxypyr, 2,4-D, triclopyr, and glyphosate have good to moderate conifer selectivity when used over the right conifer species at the correct rate and season. Most applications occur when conifers are dormant, usually before budbreak in the spring or after bud set in the late summer. Selectivity for conifers depends on managing a host of variables such as season, timing, dosage, target species and conifer species to be released.

Conifer release works well in the late summer and fall because conifers are becoming dormant and several vegetation groups are sensitive to treatment. Deciduous shrubs and trees are effectively controlled by glyphosate and imazapyr. Blackberries are sensitive to triclopyr and fluroxypyr at this time. Both Scotch broom and some evergreen brush species can be treated with triclopyr. Alder, madrone and manzanita species are sensitive to 2,4-D. Elderberry is well controlled by clopyralid over the whole growing season including late summer. Because many of these species are deciduous, the window for application starts when conifers set a dormant bud and effectively ends with leaf fall. Applications should be timed so that target species are still active enough to absorb the herbicides applied.

Foliar release treatments in the spring before conifer break bud are more limited but can still be effective on some vegetation groups. Scotch broom and evergreen species like snowbrush, ceanothus, madrone and manzanita are controlled by triclopyr or 2,4-D. Alder can be controlled with an early foliar application of 2,4-D as Douglas-fir buds are breaking. After budbreak new conifer growth will be very sensitive to most release herbicides and severely injured.

Site preparation applications made before conifers are planted utilize the same products on target species as conifer release above but at higher rates and during the growing season. In addition, some products are registered only for site preparation. Products containing aminopyralid such as Capstone (aminopyralid + triclopyr salt) and Opensight (aminopyralid + metsulfuron) are registered for brush control during site preparation as well as directed spraying. Metsulfuron is a common site preparation component often mixed with other herbicides and has strengths controlling *Rubus* species, snowberry and ferns. While not widely used, picloram products are federally restricted and labeled for broad spectrum brush control during site preparation. Tank mixes of these products are common and offer broad spectrum control on diverse plant communities found on forest sites.

Directed spraying on individual plants can be accomplished with nearly all of the above herbicides. Applications made in conifer plantations should avoid overspray onto seedlings to avoid potential conifer injury. Ester forms of triclopyr and 2,4-D are also volatile and vapors can move off in warm weather and potentially damage conifers or other plants. Products containing aminopyralid and imazapyr require extra caution since they have soil activity and heavy dosing near conifers can result in damage even without foliar contact.

Surfactants and other adjuvants may be added to spray mixtures to enhance foliage activity. However, each commercial herbicide product may or may not have its own emulsifiers and wetting agents. Follow label recommendations on their use. Adjuvants do not always increase efficacy and some surfactants can decrease selectivity of herbicides when sprayed over conifers. In general, adjuvants should be used carefully if conifer selectivity is desired, unless experience shows conifer tolerance with the herbicides in use.

Foliage applications mainly rely on helicopters or backpack sprayers on forest sites. The waving-wand backpack method of application is uniquely suited for treating small clearings and low brush. It allows for a calibrated broadcast application for site preparation and conifer release.

provided terrain is moderate. A recent publication describing the waving wand method appears in <https://ir.library.oregonstate.edu/downloads/rf55z810k?locale=en>. Other resources for sprayer calibration can be found under the Grass and Herb Control for Plantation Establishment section near the end of this chapter.

Dormant Stem Application

Dormant applications are made to bare stems and branches of trees and shrubs in late winter and early spring when conifer buds have begun to swell but have not opened. Water-soluble products generally are not used at this time. Dormant applications are used where Douglas-fir or true firs are established and require release from brush that is susceptible during this season. Unless the brush species retain green foliage during winter, oil is used for the herbicide carrier on bare deciduous brush stems. Emulsions containing oil may be as effective on the persistent-leaved evergreen brush. Pines, especially ponderosa, are sensitive to dormant sprays, particularly those containing oil, after the end of January. Sprays containing oil appreciably increase the cost of treatment, leading to decreased reliance on dormant sprays. Spraying well before conifer bud swell may be best for Scotch broom control.

Triclopyr esters and 2,4-D ester are the most frequently used products in dormant applications. They are generally applied in low volumes of oil or water-oil mixtures. There are no known substitutes for oil on stems of certain deciduous brush species and Scotch broom when there are no leaves. Water is appropriate on evergreen brush; adding a surfactant or 5% oil may improve results. Consult labels for proper mixing order and rates to avoid mixing problems.

Basal Bark Application

The basal bark application method is generally used to selectively treat individual woody plants. This method also lengthens the period of time that brush can be sprayed; basal applications are effective from January to November. For basal treatments, mix a triclopyr ester herbicide with an oil and apply completely around the lower 15 inches of a tree trunk or brush stem, soaking the trunk liberally to the ground line. Basal treatments usually control even larger hardwood trees with thick bark. Application is easiest if the base of the tree is scraped bare of moss and debris before treating. While allowing for selective brush control, this method can use a large amount of herbicide and oil. In some cases, frill or stem injection can be faster and use less material.

Basal sprays are applied with oil as a carrier, using either one of the basal carrier oils, kerosene, or plant seed oils. Diesel oil can also be used since it is readily available, but is not as good of a carrier on some species because it can damage plant tissue and interfere with herbicide uptake. Mixtures with water have not been effective. Rates are 1% to 5% by volume of triclopyr ester herbicide (e.g., 1 to 5 gal Garlon 4 Ultra/100 gal) in oil. The concentration used for basal sprays is much greater than for foliage sprays. For success, the stem must be soaked and thoroughly covered completely around its circumference. Note that when trash is kicked away from the base, thinner bark is often exposed. If all of this is treated, thicker bark above may not need coverage. Results from basal treatments are not apparent immediately. Often the tree will leaf out and die back one or two years before finally dying. Incompletely covering the stem circumference leads to sprouting, and the entire tree is likely to survive.

For susceptible woody plants with stems less than 6 inches in diameter at the base, a low volume basal application can be used. Mix 4% to 30% by volume of a 4 lb ae triclopyr ester product in oil. Concentrations of 10 to 15 percent have provided good control on many Pacific Northwest species. Apply with backpack sprayer, using low pressure and a solid cone or flat fan nozzle. Lightly spray basal parts of brush and tree trunks to thoroughly cover lower stems, including root

collar area, but not to the point of runoff. Vary herbicide concentrations with size and susceptibility of species treated. Apply at any time from January to November except when snow or water prevents spraying to the ground line. Avoid treating when bark is soaking wet with water.

To control susceptible woody plants with stem diameters less than 6 inches a “thinline” application can also be employed. Apply an undiluted triclopyr ester product in a thin stream to all sides of lower stems as allowed on the label. Direct the stream horizontally to apply a narrow band of herbicide around each stem or clump. Up to 0.5 oz of chemical will be needed to treat single stems, and from 1 to 3 oz to treat clumps of stems. Use an applicator metered or calibrated to deliver the small amounts required. A D2 nozzle can give the desired stream. This is effective on sprouts with smooth exposed bark. Thinline applications can be effective but can use more product and as a result cost more than a low volume basal treatment.

Cut Surface Applications: Hack-and-Squirt, Stem Injection and Cut Stump

Individual trees or resprouting cut stumps can be treated using stem injection or a hack and squirt. In the commonly used hack-and-squirt method, the tree trunk is frilled or cut at intervals around the trunk using an axe or machete and herbicide is applied with a spray/squeeze bottle or similar applicator. Cut spacing can vary depending on the herbicide and dilution with water. A complete frill or girdle can be effective, but is labor intensive and often not needed.

Each herbicide used and species controlled will have different cut spacing ranging from 1 cut /1 inch of stem diameter (roughly spaced 3 inches on center) to 1 cut/3 inches of stem diameter (see table: Herbicide Recommendations for Control of Listed Species). Cuts must be through the bark and into the sapwood; chips remain connected to the tree to form a small cup or frill. The cut should be treated with concentrated salt-formulated herbicide solution immediately after the frill is made. Few species require complete frilling. Spaced axe cuts treated with one milliliter (ml) (0.25 tsp or cubic centimeter) of water-soluble herbicide solution per cut are usually adequate. For stem injection, special injector hatchets and stem injectors are available to make the cut and inject the herbicide at the same time using similar rates.

Season can be important in cut-surface applications. Certain herbicides, including 2,4-D or triclopyr salts, are most effective during the early summer. Picloram, glyphosate, and imazapyr, are most effective when applied from midsummer to leaf fall. Rising sap in late winter/spring dilutes the herbicide and may prevent movement to the roots resulting in variable performance.

Cut stumps may be treated by applying concentrated or diluted water-soluble herbicides (imazapyr, glyphosate, or the salt form of triclopyr) to only the cambium perimeter (the thin layer of wood just inside the bark) of the freshly cut stump surface and any exposed cambium where bark may have been ripped or damaged down the side. Treated stumps may sprout weakly the second year if treated during the growing season or fall. Spring stump treatment is not as successful. Try to treat stumps within 1 hour of cutting as the cut surface will tend to dry out and not effectively absorb herbicide. Triclopyr ester herbicide applied undiluted as above can be used as an alternate treatment on stumps that have dried out or where a significant delay has occurred.

Imazapyr, glyphosate, triclopyr salts, or picloram are used with the hack and squirt method or stem injection. Most herbicides can be used diluted with water, and some products allow using the undiluted material. A dilution of 50% by volume in water works well for most herbicides. Be sure to check the label on maximum concentrations and rates. For products allowing undiluted applications, users can save on carrying material but this also requires more precise application to meter out very small volumes per cut. Animal health syringes attached by tubing to small tanks/reservoirs that can be adjusted to 1 ml increments have shown usefulness.

Injecting/frilling conifers can be an inexpensive way to thin stands of fewer than 1,000 conifer trees per acre. Total kill is not required, and minimal dosages permit good development of untreated trees. Heavy dosages, particularly of picloram and imazapyr, offer danger of flashback damage to untreated leave trees whereas glyphosate involves less risk.

Special Considerations

Besides federally restricted-use products like picloram, some forestry labeled products can have restricted uses in an individual state. A list of ingredients that have restricted uses in the Pacific Northwest are located in the beginning of this handbook. Users should consult the label and the respective state department of agriculture for additional restrictions.

Definitions of treatment boundaries and stream buffers must be very clear to avoid trespass and resource contamination. Forest treatment areas are often irregular and border other forest ownerships, crops, or water sources. It is always wise to consult neighboring landowners before spraying and take the needed precautions to avoid chemical trespass.

Some commonly used herbicides are injurious to conifers at high doses or during the growing season. Control difficult weed problems before planting, as part of site preparation. Use maximum rates only with experience or in exceptional circumstances.

Invasive Weeds in Forests

Exotic invasive weeds have many opportunities to establish and spread in forests. Once introduced, they are very costly to eradicate and can inflict serious harm on forest ecosystems. Many forest invasive species are plants that have been propagated and distributed commercially. English holly, English ivy, gorse, Scotch broom, pampas grass, butterfly bush and false brome have been planted as ornamentals and have escaped to cover large areas. Himalayan and evergreen blackberries are popular for recreational picking. Others, like knapweeds, starthistle, mare's tail, and exotic thistles, are widely distributed nationally and even globally. For specific weed information and geographic locations contact the state department of agriculture. For control of these and other species, see "Control of Problem Weeds" in this handbook.

Invasive plants are often spread by machines, including logging equipment and various motor vehicles. One of the most important conduits for invasive plants is roads. Controlling invasives on road shoulders is one way to prevent spread. Requiring washing of all equipment brought in to do logging and road work before entering and leaving the property is another preventive procedure. Landowners may also have additional herbicide control options on roadsides since they are considered a separate use site from forest management sites. Herbicides useful for controlling plants on roadsides and non-crop sites can be found under "Non-Cropland and Right-of-Way" in this handbook.

Effectiveness of Major Forestry-registered Herbicides during Seasons of Optimum Usage, Oregon Basis

Species	clopyralid (all)	glyphosate (summer to fall)	picloram (all)	2,4-D (spring, fall)	hexazinone (spring)	sulfometuron (spring or fall)	met sulfuron (summer to fall)	indaziflam (spring or fall)	triclopyr ester (spring to fall)	imazapyr (summer or fall)	penoxsulam + oxyfluorfen (spring or fall)
CONIFERS (WHEN DORMANT IN SPRING OR FALL)											
Douglas-fir	R	R	S	R	R	R	S	R	R	I-R	R
True firs (Abies sp)	R	R	S	I-R	R	R	S		I-R	S-I	R
Western hemlock	R	I-R	S	I-R	R	R	S		I-R	S-I	R
Ponderosa Pine	R	R	I-S	S-I	R	R	S	R	S	S	R
Western red / incense cedar	R	I-R	S	I-R	S	I-R	S	R	R	S-I	R
Western larch	R	S-I	S	I	S	R	S	R	S	S	R
Coast redwood	R	S	S	I	S	I-R	S	R	I	S	R
WOODY SPECIES											
Alder		I	S	I-S	I-R		R		S	S	
Blackberry		I	S	R	I	I-S	S		S	R	
Cascara		S	I	I	R		I		S	I	
<i>Ceanothus</i> spp.- evergreen		I-R*		S	I		I		S	S-I	I
Cherry		S	S	S	R		S		I	S	
Chinquapin		I-R*		I	R		I		S	S	
Elderberry	S	S	S	R	R		S		S	S	
Hazel		S	I	I	R		R		I	S	
Madrone		I-R*	S	S	R		I		I	S	
<i>Manzanita</i> spp		R	S	S	R		I		I	R	I
Maple, bigleaf		I	I	R	R		R		I	S	
Maple, vine		S	I-S	R	R		I		I-S	S	
Poison-oak		S	S	R	R				I-S	S	
Salmonberry		S	I	R	I	I	S		I	I	
Scotch broom		I		I					S	R	
Snowberry		S		I-S			S		I	I	
Tanoak		R	S	I	R		I		I-S	I	

Species	clopyralid (all)	glyphosate (summer to fall)	picloram (all)	2,4-D (spring, fall)	hexazinone (spring)	sulfometuron (spring or fall)	met sulfuron (summer to fall)	indaziflam (spring or fall)	triclopyr ester (spring to fall)	imazapyr (summer or fall)	penoxsulam + oxyfluorfen (spring or fall)
Thimbleberry		S	I	I	I	I	S		I	I	
Willow (<i>Salix</i> spp.)		S	I-S	R-S	R				I-S	S	
GRASSES AND HERBS											
Fern, bracken		I-S	I	R	I	S	S		R		
Fern, sword		I	R	R	R	I-S	S		R		
Grasses, annual		S	R	R	S	S	R	S-I	R	S	S
Grasses, perennial		S	R	R	S	S	R		R	S	S
Herbs, broadleaf	S**	S	S-I	S	S	S-R	S-R	S- I	I-S	S	S
R = resistant to highest rates; I = intermediate or variable, highest rates effective; S = sensitive, killed by medium or lower rates * Glyphosate has intermediate activity if applied after full leaf expansion but before wax develops on leaves of evergreen species; it has marginal conifer selectivity in spring. ** Clopyralid has activity on selected broadleaf weeds such as Canada thistle and other thistles.											

Recommendations for Directed Spot Spray, Tree Injection, and Basal Bark Treatment

Hand applications of herbicides can be very effective in controlling individual plants or small areas of weeds. The information below lists applications for directed foliage spraying using common herbicide products. Following this is a species specific table with information on foliage sprays, basal applications and cut surface stem treatments. Spot foliage treatments can use larger volumes of spray solution than broadcast sprays. The table assumes volumes applied at 50-100 gal per acre. Users should always read the label of the products they are using to make sure they don't exceed any per acre maximum listed and adjust the herbicide concentration accordingly. When spraying around conifers or other desirable plants, avoid foliage contact especially during active growth.

Commonly Used Herbicides for Directed Spot Foliage Applications

2,4-D ester (Weedone LV 6 and others)

Rate 5.5 pints/100 gal product v/v in water)

Time Apply when broadleaved weeds are small in the spring for best results. For woody plants treat when they are active from spring through summer. Avoid contact with conifers especially when they are actively growing.

Remarks 2,4-D controls a large spectrum of broadleaved weeds and woody plants including thistles, false dandelion, woodland groundsel, sow thistle, alder, madrone, manzanita species and many others. Salt formulations can also be used, but ester products

perform better in early spring and on woody species. For best herbaceous control apply in spring while plants are small. Addition of an oil or seed oil surfactant may improve control on evergreen brush species and some broadleaved weeds.

Caution Consult label to avoid exceeding maximum yearly and single application rate. Esters are volatile and vapors can move off target in hot weather potentially damaging conifers and desirable plants.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

clopyralid (Transline and others)

Rate 0.25 to 0.49 oz product per gal of water to treat 1,000 sq ft (equivalent to 0.67 to 1.33 pints per acre)

Time Apply when plants are actively growing, but especially in the spring when susceptible weeds are present and developing.

Remarks Clopyralid controls a select group of herbaceous plants and elderberry on forest sites. For control of bull thistle and small woodland groundsel, use the lower rate early in the growing season. In late spring higher product rates may be needed to control larger plants. Canada thistle is best controlled at bud stage in late spring. Fall applications can be effective on certain species. Additional sensitive weeds include other thistles, clovers, hawkweeds, yellow starthistle, sow thistles, prickly lettuce, some knapweeds and vetches. Red elderberry is effectively controlled during the summer foliage season. Clopyralid can be an effective tank mix herbicide with 2,4-D for broad spectrum control on mixed broadleaved weeds in reforestation sites. Conifers, grasses and many other broadleaved weeds are tolerant.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

glyphosate (Roundup Custom, Aquamaster and others)

Rate 1 to 5 % product v/v in water

Time Apply as a directed spray on foliage of grasses and annual weeds any time they are green and growing. Perennial weeds like bracken fern and deciduous shrubs should be treated from mid-summer through fall before significant leaf fall. Avoid contact with desirable conifers and non-target plants.

Remarks Glyphosate can control a wide variety of deciduous shrubs such as salmonberry, thimbleberry, hazel, ocean spray, ninebark, vine maple, cherry, elderberry, poison oak, blackberries and perennial forbs like bracken fern as a foliage spray.

There are many glyphosate products labeled for forestry use. Users should carefully read the product label they are using and make sure they do not exceed maximum labeled concentrations. Use the lower rates for grasses and weeds and higher concentrations for woody plants. Products that have no surfactant in the formulation may be safer spraying near conifers in case of accidental overspray, although additional surfactant may improve control.

Caution Douglas-fir and other conifers can be injured by glyphosate because of any overspray during directed spraying. They are most sensitive as buds swell and budbreak occurs in the spring through early summer. Apply around dormant seedlings or use shields to mitigate risk of injury.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazapyr 4 lb ae/gal (Arsenal Applicators Concentrate, Polaris AC Complete and others)

Rate 0.25 to 2.5 % product v/v in water.

Time Apply when brush plants and hardwoods are fully leafed out from mid-summer through leaf color in the fall avoiding conifer contact and over application near their roots.

Remarks A wide variety of deciduous shrubs and some evergreen plants are sensitive to imazapyr. Maples, hazel, ocean spray, cherries, oaks, cottonwood, willow, poison oak, madrone and chinkapin are sensitive. Recovering bigleaf maple sprout clumps (one to two years from cutting) are effectively controlled with a 2.5% solution from summer into fall. Applications should be made just to cover foliage but not to runoff. Although imazapyr has activity on many grasses and forbs, it is rarely used for those species in forestry in the Northwest.

Some product labels restrict applications for site preparation to sites that will be planted to certain conifer species (Douglas-fir, western hemlock, ponderosa pine, lodgepole pine, sugar pine and white pine) or around certain established conifers (Douglas-fir, lodgepole pine, white pine) for release. Users should carefully read product labels for labeled sites, conifer species and any maximum per acre rates. Some products containing 2 lb ae/gal are available for forest management and are generally used at twice the rate as 4 lb ae products.

Caution Imazapyr has significant soil activity and high rates or over application can result in mortality or injury to conifers and non-target plants that have root systems extending into treated areas. Do not apply more than 1.5 lb ae/A per year. Avoid contact with conifer foliage.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

metsulfuron (Escort XP and others)

Rate 2 to 4 oz product mixed in water to make 100 gallons.

Time Apply when brush plants and hardwoods are fully leafed out from summer through the fall but before leaf coloration. Avoid conifer foliage contact.

Remarks Metsulfuron controls a wide variety of deciduous shrubs and herbaceous plants prior to planting or in established plantations as a directed spray. Rubus species such as blackberries, salmonberry, thimbleberry, and blackcap are especially sensitive to metsulfuron and lower rates effectively control these. Other species controlled include snowberry, cottonwood, cherry, willow, oak, and ocean spray. A number of herbaceous weeds are controlled, but bracken fern and sword fern are the major forestry targets. Consult labels for additional weeds controlled.

Caution Metsulfuron can be damaging to conifers and users should avoid contact with conifer foliage.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

triclopyr ester (Garlon 4 Ultra, Garlon 4, Triclopyr 4)

Rate 1 to 5% product v/v in water.

Time Apply when deciduous brush plants and hardwoods are fully leafed out from summer through the fall but before leaf coloration. Treat evergreen plants from spring into summer. Avoid contact with conifer foliage especially during active growth.

Remarks Triclopyr ester controls a wide variety of deciduous and evergreen shrubs as well as herbaceous plants prior to planting or in established plantations as a directed spray. Species such as blackberries, poison oak, Scotch broom, gorse, snowbrush ceanothus, madrone, tanoak, and myrtle are especially sensitive to triclopyr. For blackberries treat in late summer into late fall for best control at lowest rates (1%). Scotch broom, gorse and many evergreen brush species can be effectively controlled from spring and early summer applications at a 2% concentration along with oil type surfactants. Other species controlled include cottonwood, alder, cherry, willow, and oak. A number of broadleaved herbaceous weeds are controlled but these uses are not generally used in the Northwest on forest sites. Consult labels for additional weeds controlled. To control blackberries in ponderosa pine, fluroxypyr may offer some advantages.

Caution Avoid contact with conifer foliage, especially ponderosa pine. Triclopyr ester is volatile and vapors can move off site during warm temperatures and damage conifers or other desirable plants. Products containing triclopyr salts are less volatile and have less risk of off-site movement but control of some species may be reduced.

Site of action Group 4 synthetic auxin

Chemical family Pyridine

aminopyralid + triclopyr salt (Capstone)

Rate 9 pints product mixed in water to make 100 gallons.

Time Apply when brush and herbaceous plants are fully leafed out from spring through the fall. Avoid conifer foliage and root contact.

Remarks Capstone controls a wide variety of shrubs and herbaceous plants prior to planting or in established plantations as a directed spray. Soil activity may offer preemergent control on sensitive species. Blackberries, Scotch Broom, poison oak, cottonwood, *Ceanothus* species, knapweeds, hawkweeds, starthistles, Canada thistle and other thistles are especially sensitive. Consult labels for additional weeds controlled.

Caution Capstone has significant soil and foliage activity and can be damaging to conifers and other non-target plants. Users should avoid contact with conifer foliage or overdosing on target plants where conifer roots are growing as injury may occur through root uptake. Do not exceed 9 pints of Capstone per acre per year.

Site of action Group 4 synthetic auxin

Chemical family Pyridine

Treatments for Tree Stem Injection/Hack and Squirt and Cut Stump

glyphosate (Roundup Custom, Aquamaster and others)

Rate 50% product concentration v/v in water for stem and stump treatments. For stem treatments make at least one cut per inch of tree diameter with an ax or similar tool and apply one ml of solution per cut. For stump treatment apply a narrow band of solution completely around the cambium just inside the bark.

Time Best results for stem treatments occur from mid-summer through early winter. Late winter and spring give more variable results. Stump treatments should be done right after the tree or stem is cut off regardless of season.

Remarks Glyphosate can control a wide variety of shrub or trees species. Sensitive hardwoods for stem treatment include alder, oaks, and madrone. Conifers can also be treated with at least top kill expected. While labor intensive, many shrubs can be also be controlled by

treating each stem. Many deciduous hardwoods and shrubs can also be controlled with a cut stump application. Bigleaf maple will only be suppressed with glyphosate and generally recover.

There are many glyphosate products labeled for forestry use. Users should carefully read the product label they are using and make sure they do not exceed maximum labeled concentrations. Many product labels allow for use of undiluted product for hack and squirt and stump treatment. While effective, dilute solutions appear to work just as well.

Caution Non-target plants of the same species growing near treated plants can possibly be injured through herbicide movement through root grafts.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazapyr 4 lb ae/gal (Arsenal Applicators Concentrate, Polaris AC Complete, Imazapyr 4 SL and others)

Rate 50% product concentration v/v in water for hack and squirt or stem injection. For stem treatments make at least one cut per three inches of tree diameter with an ax or similar tool and apply one ml of solution per cut or until wet. Some product labels allow for undiluted product use; read labels carefully to use this concentration. For stump treatment mix 4 to 6 ounces of herbicide with one gallon of water and apply a narrow band of solution completely around the cambium just inside the bark. Treat immediately after cutting.

Time Best results for stem treatments occur from mid-summer through early winter. Late winter and spring give more variable results. Stump treatments should be done right after the tree or stem is cut off regardless of season.

Remarks Imazapyr controls the widest variety of trees and shrubs with cut stem treatments in the Pacific Northwest. Bigleaf maple and other maples, alder, cherries, oaks, cottonwood, madrone, chinquapin, ash and tanoak are sensitive. Recovering bigleaf maple sprout clumps are effectively controlled by treating the largest 25-50 percent of the sprouts evenly distributed throughout the clump.

Caution Imazapyr has significant soil activity and readily spreads through root systems. Injury to non-target plants that have root systems connected by root grafts to the same treated species can occur. Conifers growing near treated plants can pick up herbicide residues through root uptake in the soil and exhibit injury symptoms but typically recover. Users should avoid over-application into cuts and stump surfaces that results in stem flow.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

triclopyr salts (Garlon 3A, Vastlan, Triclopyr 3 and others)

Rate 50% product concentration v/v in water for stem treatments or use undiluted. For hack and squirt make approximately one cut per inch of tree diameter so that cut edges slightly overlap around the circumference and apply one ml of diluted solution per cut. For undiluted product use ½ ml per cut. For stem injection make one cut every 3 to 4 inches on center around the tree. For stump treatment apply a narrow band of undiluted product completely around the exposed cambium just inside the bark after cutting.

Time Best results occur during the growing season. Treatments during late winter and spring sap flow will give more variable results.

Remarks Triclopyr controls a variety of deciduous and evergreen trees including oaks, alder, cottonwood, and madrone. Maples can be partially controlled. For stumps that have been cut but left untreated for an extended time period, labeled triclopyr ester products can be used undiluted. Treat normally around the cambium as with the salt forms.

Site of action Group 4 synthetic auxin

Chemical family Pyridine

Treatments for Basal Bark Application

triclopyr ester (Garlon 4 Ultra, Garlon 4, Element 4, Triclopyr 4, and others)

Rate 10-20% product v/v in oil carrier for low volume basal applications in an approximately 15-inch band on basal bark portions of tree or shrub stems. See remarks below for other rates and treatments.

Time Apply between January and early November for best performance. Treatments in midwinter have seen variable control. Applications during the dormant season when branches are bare allows for less labor and ease of application.

Remarks Low volume basal treatments of 10-20% product in oil provide the best combination of ease of application, reduced spray solution and cost. This method uses low volumes of solution to just cover bark on stems of individual target plants. Conventional basal applications of 1-5% require larger volumes of spray solution to thoroughly flood stems and root collars. Thinline treatments use undiluted product applied directly on and across tree and shrub stems that can result in more material applied than needed with added cost if users are not careful

Use only oil as a carrier. Commercial basal oils, kerosene, or plant-based oils work well as carriers. Diesel oil is not as good of an option since it can damage bark before the herbicide can move through the plant. Apply when bark is free from water or ice. Complete coverage around the total circumference of the stem is critical to good control. In some cases, removing dead leaves or moss at the base of the tree or clump can improve coverage and control.

Low volume basal is effective on bigleaf maple trees and sprout clumps, other maples, alder, oaks, Scotch broom, Ceanothus spp., myrtle, tanoak and many other shrubs and trees.

Caution Avoid contact with conifer foliage, especially ponderosa pine. Triclopyr ester is volatile and vapors can move off site during warm temperatures and damage conifers or other desirable plants. New growth on conifers actively growing in spring and early summer is extremely sensitive to spray drift and vapor movement.

Site of action Group 4 synthetic auxin

Chemical family Pyridine

Herbicide Recommendations for Control of Listed Species

Species	Herbicide ¹	Active ingredient per 50-100 gal of solution	Carrier	Expected control	Application and remarks
Alder, red <i>Alnus rubra</i>	2,4-D	3 lb	Water	Excellent	Foliage spray. See label for release timing.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Excellent	Foliage spray. Site prep only.
	2,4-D amine	Undiluted	None	Good	Injection, 3 inches between centers, 1-2 ml/injection.
	picloram + 2,4-D	Undiluted	None	Good	Injection, 3 inches between centers.
	triclopyr ester	3 lb	Water	Good	Midsummer directed foliage spray.
	triclopyr salt	50%	Water	Excellent	Injection, 3-4 inches between centers. Use full strength in maple and tanoak.
	triclopyr ester	2 to 15% product in oil	Oil	Excellent	Low-volume basal treatment.
	glyphosate	3 lb ae	Water	Good to excellent	Foliage spray. Summer.
	glyphosate	50%	Water	Excellent	Hack and squirt summer through fall
	imazapyr	25-50%	Water	Excellent	Trunk injections, 6 inches between centers.
		10 lb (2.5%)	Water	Excellent	Low-volume sprays June-Aug. on sprout clumps.
Ash, Oregon <i>Fraxinus latifolia</i>	triclopyr salt	3 lb	Water	Excellent	Foliage spray.
	triclopyr ester	3 lb	Water	Excellent	Directed foliage spray.
Birch <i>Betula</i> spp.	glyphosate	3 lb ae	Water	Good	Directed foliage spray; summer to fall. Adding imazapyr may improve control.
Blackberry	glyphosate	3 lb ae	Water	Good	Sept.-Oct., as long as most foliage is still green.
Himalayan <i>Rubus procerus</i>	metsulfuron	2 oz	Water	Excellent	Spring, summer, fall site prep.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Foliage spray. Aug.-Sept. Site prep only.
Evergreen <i>R. laciniatus</i>	triclopyr ester	3 lb	Water	Excellent	Directed foliage spray; midsummer to fall. Use directed spray around pines.
Trailing	triclopyr salt	2 to 3 lb	Water	Excellent	Foliage spray; midsummer to fall. Use directed

Species	Herbicide ¹	Active ingredient per 50-100 gal of solution	Carrier	Expected control	Application and remarks
<i>R. vitifolius</i>					spray around pines.
	aminopyralid + triclopyr amine (Capstone)	0.075 to 0.11 + 0.75 to 1.12 lb (6 to 9 pints product/A)	Water	Good to excellent	Midsummer to fall foliage spray
All <i>Rubus</i> spp.	metsulfuron	2 oz	Water	Excellent	June–Sept. Damages conifers.
Broom, Scotch <i>Cytisus scoparius</i>	2,4-D	2 lb	Water-oil emulsion	Excellent	March. See label for release timing.
	triclopyr ester	2 to 15% product in oil	Oil	Excellent	Basal spray Feb. to Oct.
	triclopyr ester	2 to 4 lb	Water	Excellent	Foliage spray Feb. to Oct. Oil or oil surfactants may improve control.
	aminopyralid + triclopyr amine (Capstone)	0.075 to 0.11 + 0.75 to 1.12 lb (6 to 9 pints product/A)	Water	Good to excellent	Foliage spray. Optimum at bud to bloom.
Cascara, buckthorn <i>Rhamnus purshiana</i>	glyphosate	3 to 4 lb ae	Water	Good	Midsummer to late summer.
<i>Ceanothus</i> spp.*	triclopyr ester	3 lb	Water	Good to excellent	Midsummer directed foliage spray.
Mountain whitehorn <i>C. cordulatus</i>	imazapyr	1 lb	Water	Good to excellent	Midsummer directed foliage spray.
Blue blossom <i>C. thyrsiflorus</i>	2,4-D	2 lb	Water	Excellent	Foliage spray. See label for release timing.
Snowbrush <i>C. velutinus</i>	glyphosate	3 lb ae	Water	Excellent	Sept., foliage spray. Deerbrush or Redstem only.
Deerbrush <i>C. integerrimus</i>	aminopyralid + triclopyr amine (Capstone)	0.075 to 0.11 + 0.75 to 1.12 lb (6 to 9 pints product/A)	Water	Good	Foliage spray.
Redstem <i>C. sanguineus</i>					
Cherry, bitter <i>Prunus emarginata</i> Chokecherry <i>P. virginiana</i>	picloram + 2,4-D	1 gal (0.54 to 2 lb ae)	Water	Good to excellent	Foliage spray. Site prep only.
	glyphosate	3 lb ae	Water	Excellent	Summer foliage spray. Imazapyr additions may improve control
	triclopyr ester	2 to 15% product in oil	Oil	Excellent	Basal spray.
	triclopyr ester	undiluted	None	Excellent	Thin-line basal bark treatment.
	metsulfuron	2 oz	Water	Excellent	June foliage spray.
	2,4-D amine	undiluted	None	Excellent	Injection, stump treatment, or frill June–Aug.

Species	Herbicide ¹	Active ingredient per 50-100 gal of solution	Carrier	Expected control	Application and remarks
	imazapyr	25-50%	Water	Excellent	Injection or frill June- December
Chinquapin <i>Castanopsis</i> spp.	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Foliage spray. Site prep only.
	2,4-D amine	undiluted	None	Good	Frill treatment.
	triclopyr ester	4 lb	Water	Excellent	Foliage spray. Directed spray.
		2 to 15% product in oil	Oil	Excellent	Basal spray.
	imazapyr	25-50%	Water	Excellent	Injection or frill June-December
Coffeeberry <i>Rhamnus californica</i>	2,4-D	4 lb	Water**	Poor	Directed foliage spray or site prep
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Foliage spray. Site prep only.
Cottonwood <i>Populus trichocarpa</i>	2,4-D amine	undiluted	None	Good	Frill treatment or injection.
	triclopyr ester	2 to 15% product in oil	Oil	Excellent	Basal spray.
	glyphosate	3 lb ae	Water	Excellent	Foliage spray, July–Aug. Not recommended in Idaho.
	metsulfuron	2 oz	Water	Excellent	Full foliar.
Currant and Gooseberry <i>Ribes</i> spp.	2,4-D + picloram	1 gal	Water	Good	Summer.
	glyphosate	3 lb ae	Water	Poor	Summer–fall.
Douglas-fir <i>Pseudotsuga menziesii</i>	picloram + 2,4-D	2 gal (1.08 + 4 lb ae)	Water	Good	Roadside spray.
	glyphosate	50%	Water	Excellent	injection or frill, summer to winter.
	picloram + 2,4-D	undiluted	None	Excellent	Injection (thinning) fall-winter.
	metsulfuron	2.4 oz	Water	Poor to excellent	Full foliage spray, spring to summer.
Elderberry, red <i>Sambucus callicarpa</i>	clopyralid	6 oz	Water	Excellent	Foliage spray, summer-fall
	glyphosate	3 lb ae	Water	Excellent	July–Sept.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Excellent	Foliage spray, summer.
	triclopyr ester	3 lb	Water	Excellent	June–July.
Gorse <i>Ulex europaeus</i>	picloram + 2,4-D	1 gal (0.54 + 2 lb)	Water	Excellent	Foliage spray. Best on younger plants. Site prep only.
	triclopyr ester	4 to 8 lb ae	Water	Excellent	Spring.
	metsulfuron	2 oz + surfactant	Water	Excellent	Spring.
Hazel <i>Corylus cornuta</i> var.	glyphosate	3 lb ae	Water	Excellent	Late summer foliage spray. Adding imazapyr may improve control.

Species	Herbicide ¹	Active ingredient per 50-100 gal of solution	Carrier	Expected control	Application and remarks
<i>californica</i>	triclopyr ester	2 to 15% product in oil	Oil	Excellent	Basal spray.
Madrone <i>Arbutus menziesii</i>	2,4-D ester	4 lb	Water	Good	Directed foliage spray/site prep, spring/summer.
	2,4-D amine	undiluted	None	Excellent	Injection, 1–2 ml/inch of diameter
	triclopyr ester	2 to 3 lb	Water	Fair	Midsummer directed foliage spray.
		2 to 15% product in oil	Oil	Excellent	Basal spray.
	imazapyr	25% strength	Water	Excellent	Injection, 6–9 inches between centers.
	glyphosate	50% to full strength	Water	Excellent	Cut stump/injection.
Manzanita* Hairy <i>Arctostaphylos columbiana</i> Hoary <i>A. canescens</i> Pine <i>A. parryana</i> Whiteleaf <i>A. viscida</i> Greenleaf <i>A. patula</i> Howell's <i>A. hispidula</i>	triclopyr ester	2 to 3 lb	Water	Poor to fair	Midsummer directed foliage spray. Not recommended in Idaho.
		2 to 15% product in oil	Oil	Excellent	Basal spray
	2,4-D	2 lb	Water	Good	Foliage spray. See label for release timing.
Maple* Bigleaf <i>Acer macrophyllum</i> Vine <i>A. circinatum</i> Rocky Mountain <i>A. glabrum</i>	imazapyr (4 lb/gal)	25% to 50%	Water	Excellent	Injection summer-fall.
		10 lb (2.5%)	Water	Excellent	Foliage spray on sprout clumps. Very low volume.
	triclopyr salt	undiluted to 50%	Water	Excellent	Injection, half-strength for trees less than 12 inches or for stump treatment.
	triclopyr ester	4 lb	Water	Fair	Foliage spray of sprout clumps. Not for conifer release.
	triclopyr ester	2 to 15% product in oil	Oil	Good to excellent	Basal treatment.
		undiluted to 50%	None/Oil	Good to excellent	Thin-line basal bark treatment.
		30% strength	Oil	Good to	Low-volume basal bark treatment.

Species	Herbicide ¹	Active ingredient per 50-100 gal of solution	Carrier	Expected control	Application and remarks
				excellent	
	picloram + 2,4-D	undiluted	None	Excellent	Frill, injection, or stump.
	glyphosate	3 lb ae	Water	Good	Foliage spray, late summer.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Foliage spray. Site prep only.
Ninebark <i>Physocarpus</i> spp.	glyphosate	3 lb ae	Water	Excellent	Summer and fall foliage spray
Oak Oregon <i>Quercus garryana</i> California black <i>Q. kelloggii</i> Canyon live <i>Q. chrysolepis</i>	glyphosate	3 lb ae	Water	Excellent	Foliage spray.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Excellent	Foliage spray. Site prep only.
	2,4-D amine or glyphosate	undiluted	None	Excellent	Frill; good on all oaks.
	triclopyr ester	2 to 3 lb	Water	Good	Directed foliage spray. Good on all oaks.
		2 to 15%	Oil	Excellent	Basal treatment. Good on all oaks.
	imazapyr	25% strength	Water	Excellent	Cut surface or injection, 6 inches between centers.
	metsulfuron	2 oz	Water	Excellent	Full foliar.
	2,4-D	24 lb	Water**	Good	Directed foliage spray or site prep, May-July. May be necessary to re-treat.
Ocean spray <i>Holodiscus discolor</i>	glyphosate	3 lb ae	Water	Good	Summer to fall foliage spray. Adding imazapyr may improve control.
Pine Lodgepole <i>Pinus contorta</i>	triclopyr salt	3 lb	None	Good	Injection; one cut per 3-inch circumference. May-Sept.
	metsulfuron	0.6 oz + silicon surfactant	Water	Good	Spring, after budbreak.
Ponderosa <i>P. ponderosa</i>	triclopyr ester or 2,4-D ester	4 lb	Water/Oil	Excellent	Foliage spray April-June.
Poison-oak <i>Toxicodendron diversilobum</i>	triclopyr ester	2 to 3 lb	Water	Good to excellent	Directed foliage spray. Spring application best.
	glyphosate	6 lb ae	Water	Excellent	Foliage spray July-Aug. (before color).
	2,4-D	4 lb	Water	Fair to poor	Directed foliage spray or site prep. Re-treat sprouts.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Fair	Foliage spray. Site prep only.
	imazapyr	4 lb	Water	Excellent	Directed spray in summer. Over application can injure nearby trees and plants through root uptake.
	aminopyralid +	0.075 to 0.11 + 0.75	Water	Good	Foliage spray. Spring application best.

Species	Herbicide ¹	Active ingredient per 50-100 gal of solution	Carrier	Expected control	Application and remarks
	triclopyr amine (Capstone)	to 1.12 lb (6 to 9 pints product/A			
Rhododendron <i>R. macrophyllum</i>	imazapyr	10 lb (2.5%)	water	good	Directed Summer foliage spray
	triclopyr ester	4 lb	Water/Oil	Fair to good	Spring foliage spray.
Salal <i>Gaultheria shallon</i>	triclopyr ester	4 lb	Water	Fair to good	Summer foliage spray. Site prep only.
	picloram	2 lb	Water	Good	Summer foliage spray. Site prep only.
	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Fair	Foliage spray. Site prep only.
	imazapyr	10 lb (2.5%)	Water	Good	Low volume.
Salmonberry <i>Rubus spectabilis</i>	glyphosate	3 lb ae	Water	Excellent	July–Sept.; Sept. only for release.
	metsulfuron	1 oz	Water	Excellent	June–July. Injures conifers.
	sulfometuron	1.5 to 3 oz	Water	Good	April–May.
Serviceberry <i>Amelanchier</i> spp.	2,4-D	2 lb	Water**	Poor to fair	Foliage spray. Several treatments required. See label for release timing.
	glyphosate	3 lb ae	Water	Good	Summer–fall.
	triclopyr ester	2 to 3 lb	Water	Good	Directed foliage spray.
Snowberry <i>Symphoricarpos albus</i>	glyphosate	4 lb ae	Water	Good	Foliage spray July–Sept. Not recommended in Idaho.
	metsulfuron	2 oz	Water	Excellent	Full foliar.
	triclopyr ester	2 to 3 lb	Water	Fair	Foliage spray.
Sweetbriar rose <i>Rosa eglantheria</i>	picloram + 2,4-D	1 gal (0.5 + 2 lb ae)	Water	Good	Good initial kill, some re-treatment on sprouts. Site prep only.
	triclopyr ester	2 to 3 lb	Water	Good	Directed foliage spray.
	glyphosate	3 lb ae	Water	Good	Directed foliage spray.
Tanoak* <i>Lithocarpus densiflora</i>	2,4-D	4 lb		Poor	Directed foliage spray. Several treatments needed.
	imazapyr	50%	Water	excellent	Injection or frill, 6 inches between centers.
	triclopyr salt	Undiluted	—	Excellent	Injection any season, 4 in between centers.
	triclopyr ester	8 to 12 lb	Water	Good	Directed foliage spray
	triclopyr ester	2 to 15% product in oil	Oil	Good to excellent	Basal treatment. Best to treat third-year sprouts.
Thimbleberry <i>Rubus parviflorus</i>	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Foliage spray. Re-treatment may be required. Site prep only.

2,4-D ester (Weedone LV 6 and many others)

Rate For conifer release apply 0.95 lb ae/A to 2.75 lb ae/A (22 to 64 oz/A product). For site preparation apply 2.75 lb ae/A to 3.78 lb ae/A (44 to 88 oz/A product).

Time For conifer release apply before conifer budbreak in spring. See remarks for Douglas-fir release. For site preparation apply when susceptible plants are leafed out and developing.

Remarks 2,4-D controls a large spectrum of broadleaved weeds and woody plants on forest sites. These include thistles, false dandelion, woodland groundsel, sow thistle, alder, madrone and manzanita species. Amine salt formulations can also be used, but ester products perform better in early spring and on woody species. For conifer release apply in spring before conifers break bud. To control alder only in Douglas-fir plantations apply 2-2.75 pints/A in the late spring as alder is leafing out and up until Douglas-fir bud break. Applications made after bud break are possible until two inches of conifer growth but with increased risk of Douglas-fir injury. Douglas-fir, hemlock, and Sitka spruce are tolerant. True firs, redwood and cedars can show injury at high rates. Larch and ponderosa pine can show variable injury. For site preparation apply in early spring into summer as alder and other plants are fully leafed out.

Caution Consult label to avoid exceeding maximum yearly and single application rate. 2,4-D esters are volatile and damaging vapors can move off site in warm temperatures.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

aminopyralid + metsulfuron (Opensight)

Rate 0.066 to 0.11 lb ae/A aminopyralid + 0.0118 to 0.0195 lb ai/A metsulfuron (2 to 3.3 oz/A product)

Time For site preparation only. Apply when brush plants and hardwoods are fully leafed out from summer through the fall but before leaf coloration. Avoid conifer foliage contact as severe injury will occur.

Remarks State supplemental labels for Oregon, Washington and Idaho for forest use must be in users possession. The combination of aminopyralid and metsulfuron controls a wide variety of deciduous shrubs and herbaceous plants prior to planting. *Rubus* species such as blackberries, salmonberry, thimbleberry, and blackcap are especially sensitive. Other species controlled include snowberry, cottonwood, cherry, willow, oak, and ocean spray. Scotch broom can be impacted and the soil activity may help control germinating seedlings. A number of broadleaf weeds are controlled, but thistles, bracken fern and sword fern are the major forestry targets. Consult labels for additional weeds controlled. Add surfactant as specified on the label.

Caution Both active ingredients in Opensight can be damaging to conifers and users should avoid contact with conifer foliage. In addition, aminopyralid has substantial soil activity and applications near conifer roots can result in injury through root uptake. Conifers planted sooner than two months after application west of Cascades or 4 months east of Cascades may be injured.

Site of action Group 4: synthetic auxin (aminopyralid); Group 2: acetolactate synthase (ALS) inhibitor (metsulfuron)

Chemical family Pyridine and Sulfonylurea

clopyralid (Transline and others)

Rate 0.19 to 0.49 lb ae/A (8 to 21 oz/A product)

Time Apply in the spring when susceptible weeds are present and during the growing season for shrubs like elderberry.

Remarks All conifer species appear tolerant to clopyralid at any growth stage for conifer release. For control of bull thistle and small woodland groundsel, use at least 8 oz/A product. In late spring higher product rates up to 21 oz/A may be needed to control larger plants. Canada thistle is best controlled at bud stage in late spring/early summer with rates at 16 oz/A product or higher. Additional sensitive weeds include other thistles, clovers, hawkweeds, yellow starthistle, vetches. Elderberry species can be effectively controlled at rates of 10-12 oz/A when fully leafed out in summer. Clopyralid can be an effective tank mix herbicide with soil active herbicides for herbaceous weed control in plantations. Grasses and many other broadleaved weeds are tolerant.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

glyphosate (Roundup Custom, Aquamaster and many others)

Rate 0.75 lb to 1.5 lb ae/A (0.75 to 1.5 quarts/A product) for release; 1.5 to 3 lb ae/A (1.5 to 3 quarts/A product) for site preparation.

Time For release apply over established conifers after dormant buds set in late summer or fall. For site preparation apply during the growing season from late June through September until leaf senescence.

Remarks There are many glyphosate products labeled for forestry use. Products that have no surfactant in the formulation may be safer over conifers for release in the fall. Most conifers have at least some tolerance to glyphosate when dormant. Western hemlock and larch can be injured. Glyphosate can control a wide variety of deciduous shrubs such as salmonberry, thimbleberry, hazel, ocean spray, ninebark, vine maple, cherry, elderberry, poison oak and many others. Perennial forbs like bracken fern and many grasses and broadleaved weeds are also controlled. For site preparation, apply any time plants are actively growing. Use higher rates and add

additional surfactant per label recommendations. Other site preparation herbicides like imazapyr or metsulfuron can be added to broaden activity on complex deciduous plant communities.

Caution Douglas-fir and other conifers can be injured by glyphosate as buds swell and budbreak occurs in the spring or before they harden off and set bud in the fall. Apply to dormant seedlings to mitigate risk of injury.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazapyr 4 lb ae/gal (Arsenal Applicators Concentrate and others)

Rate 0.5 lb ae to 0.75 lb ae/A (8 to 12 oz/A product) for Douglas-fir release. Site preparation rate is dependent on conifers to be planted. 0.75 lb ae/A to 1.5 lb ae/A (12 to 24 oz/A product) for Douglas-fir. See remarks for other species planted.

Time For release over Douglas-fir apply after final resting buds have formed in fall. For site preparation apply when brush plants and hardwoods are fully leafed out from mid-summer through leaf color in the fall. For evergreen plants apply spring through summer.

Remarks A wide variety of deciduous shrubs and some evergreen plants are sensitive to imazapyr. Bigleaf and other maples, hazel, ocean spray, cherries, oaks, cottonwood, willow, poison oak, madrone and chinkapin are sensitive.

Label restricts applications for site preparation to sites that will be planted to certain conifer species and adjusts rates by species. For Douglas-fir and western hemlock rates are 12 to 24 oz/A. Ponderosa pine, lodgepole pine, sugar pine and white pine are limited to 12 to 16 oz/A. Since labels can differ users should carefully read product labels for labeled conifer species and maximum rates. Some imazapyr products containing 2 lb ai/gal are available for forest management and are generally used for site preparation at twice the rate as 4 lb ae products. Imazapyr can be a good site preparation tank mix partner with glyphosate and other herbicides on deciduous brush. Add additional surfactant for site preparation as per label. Surfactants may increase injury in conifer release and should be avoided.

Caution Imazapyr has significant soil activity and high rates or overdosing can result in mortality or injury to conifers and non-target plants that have root systems extending into treated areas. Do not apply more than 1.5 lb ae/A per year. Avoid contact with conifer foliage that is actively growing or not dormant for release treatments. For Douglas-fir release risk of injury is reduced by treating after the formation of a firm dormant bud in fall.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Imidazolinone

metsulfuron (Escort XP and others)

Rate 0.6 to 1.2 oz ai/A (1 to 2 oz/A product)

Time Apply for site preparation when brush plants and hardwoods are fully leafed out from summer through the fall. Avoid conifer foliage contact as injury may occur.

Remarks For broadcast site preparation use in Oregon and Washington west of Cascades. Metsulfuron controls a wide variety of deciduous shrubs and herbaceous plants prior to planting. *Rubus* species such as blackberries, salmonberry, thimbleberry, and blackcap are especially sensitive to metsulfuron and lower rates effectively control these. Other species controlled include snowberry, cottonwood, cherry, willow, oak, and ocean spray. A number of herbaceous weeds are controlled, but bracken fern and sword fern are the major forestry targets. Consult labels for additional weeds controlled. Douglas-fir, Sitka spruce, Western red cedar, western hemlock, ponderosa pine and grand fir can be planted after application. Other species can be planted with prior tolerance experience. Metsulfuron can be added as a tank mix partner to mixes focused on deciduous brush communities. Metsulfuron mixed with sulfometuron (premixed as Oust Extra and others) can be a component in a broad spectrum site preparation application.

Caution Metsulfuron can be damaging to conifers and users should avoid contact with conifer foliage.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

triclopyr ester (Garlon 4 Ultra, Garlon 4, Triclopyr 4)

Rate 1 to 1.5 lb ae/A for conifer release (1 to 1.5 qts/A product); 3 to 6 lb ae/A for site preparation (3 to 6 qts/A product)

Time For conifer release apply in the spring before conifers break bud and start to grow or in late summer after conifers have set a dormant bud. For site preparation apply when deciduous brush plants and hardwoods are fully leafed out from summer through the fall. Treat evergreen plants from early spring into summer. Avoid contact with conifer foliage during active growth.

Remarks Triclopyr ester controls a wide variety of deciduous and evergreen shrubs as well as herbaceous plants prior to planting or in established plantations as a broadcast release spray. Species such as blackberries, poison oak, Scotch broom, gorse, snowbrush, ceanothus, madrone, tanoak, and myrtle are especially sensitive to triclopyr.

For conifer release treat blackberries in late summer into late fall for best control at lowest rates (1 qt/A product). Scotch broom can be reasonably suppressed in spring at a 1.25 qts/A of product without undue risk of conifer injury. Fall release rates may need to be higher and control may be less. Other evergreen species may need higher release rates. Oil type surfactants may improve control for site preparation but can increase potential for injury on conifers and should be used carefully. Other species controlled include cottonwood, alder, cherry, willow, and oak. A number of broadleaved herbaceous weeds are controlled but these uses are not generally used in the

Pacific Northwest on forest sites. Most conifers have good to moderate tolerance to at least the lowest rates for release, but ponderosa pine is extremely sensitive and should not be treated. Consult labels for additional weeds controlled.

Caution Avoid contact with new growing conifer foliage. Ponderosa pine is sensitive at all times and will be injured. Triclopyr ester is volatile and vapors can move off site during warm temperatures and damage conifers or other desirable plants. Products containing triclopyr salts may be used as an alternative to esters and are less volatile with less risk of off-site movement but control of some species may be reduced.

Site of action Group 4 synthetic auxin

Chemical family Pyridine

Recommendations for Broadcast Spraying For Control of Listed Species

This table lists herbicide rates for site preparation and conifer release. In most instances release rates are for Douglas-fir before bud break in spring or after bud set in the fall. Users should check tolerance of other conifer species in the table “Effectiveness of Major Forestry-registered Herbicides” earlier in this chapter and the product label.

Species	Herbicide	Active chemical/A	Carrier	Expected control	Application and remarks
Alder, red <i>Alnus rubra</i>	2,4-D ester	2 lb ae	Water	Good	Release during early foliar timing. Best on trees under 10 yr. old.
		2 lb ae	Oil	Good	Dormant spray before conifer bud break, Feb and March release
	picloram + 2,4-D	0.5 lb + 2 lb ae	Water	Good	Foliage spray. Badly injures conifers. Site prep only.
	glyphosate	0.75 to 1.5 lb ae	Water	Good	Release in Sept. Best on trees under 10 ft tall.
	glyphosate	2.25 to 3 lb ae	Water	Good	Site prep July-August
	triclopyr amine	3 to 6 lb ae	Water	Good	Midsummer foliage spray. Site prep only at this time.
	triclopyr ester	1.25 ae	Oil/Water	Good	Severely injures pines. Release. Use oil for dormant treatment. Use water only for early foliar treatments. See label for higher rates for site prep.
Birch <i>Betula</i> spp.	glyphosate and imazapyr	2 lb + .25 ae	Water	Good	Site prep summer- fall
Blackberry	triclopyr ester	1.0 lb ae	Water	Excellent	Fall release.
Bracken Fern	metsulfuron	.6 to 1.2 oz ai	Water	Excellent	Summer-fall site prep.
	glyphosate	1.1 to 1.5 lb	Water	Good	Fall release.
Broom, Scotch <i>Cytisus scoparius</i>	2,4-D ester	2 lb ae	Water + 5% oil	Good	Early spring release spray. Will reproduce from seed; some sprouting.
	2,4-D ester	2 lb ae	Oil	Good	Feb.–March dormant release spray. Will reproduce from seed; little sprouting.

Species	Herbicide	Active chemical/A	Carrier	Expected control	Application and remarks
	picloram + 2,4-D	0.5 lb + 1 to 1.5 lb ae	Water	Good	Site prep only; summer to fall.
	triclopyr ester	1.25 lb ae	Water	Good to excellent	Douglas-fir release, spring
	aminopyralid + metsulfuron (Opensight)	0.11 ae + 0.31 ai (3.3 oz product/A)	Water	Good	Site prep only or directed spray. Manages germinants. Planting sooner than 4 months may injure conifers.
	aminopyralid + triclopyr amine (Capstone)	0.075 to 0.11 + 0.75 to 1.12 lb ae (6 to 9 pints product/A)	Water	Good to Excellent	Site prep only or directed spray. Keep spray from contacting trees.
<i>Ceanothus</i> spp., evergreen	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Foliage spray. Site prep only.
	triclopyr ester	1.25 to 1.5 lb ae	Water/oil	Fair to excellent	Release. See label for rates above 1.5 lb and for timing for dormant applications. Do not use on pines.
	2,4-D ester	2 to 2.75 lb ae	Water	Fair to excellent	Early foliar release. 2,4-D rates above 2 lb may injure some conifers.
	2,4-D + triclopyr ester	2 lb + 1 lb ae	Water	Good to excellent	Can control some associated species; spring, late summer. See label for timing. Do not use on pines. Good conifer release treatment in spring.
	fluroxypyr	7.7 oz ae	Water	Excellent	Site prep for pine only. Reduced rates suitable for release.
<i>Ceanothus</i> spp., deciduous	glyphosate	1.1 lb ae	water	Good to Excellent	For deerbrush and redstem. Fall release rate for Douglas-fir and other conifers
Cherry, bitter <i>Prunus emarginata</i>	imazapyr + glyphosate	.25 to .4 + 1.5 to 2 lb ae	Water	Excellent	Site prep only.
Elderberry <i>Sambucus</i> spp.	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Excellent	Foliage spray. Site prep only.
	glyphosate	0.75 to 1.1 lb ae	Water	Excellent	Sept. foliage release spray. Higher rate for site prep. Add 2 to 2.5 oz/A imazapyr to broaden spectrum.
	triclopyr ester	1.25 lb ae	Water	Good to excellent	Site prep. See label for application timing. Do not use on pines.
	clopyralid	4 to 5 oz ae	Water	Good to excellent	Use when plants are actively growing. June - September release.
Gorse <i>Ulex europaeus</i>	picloram + 2,4-D	2 gal (1.08 + 4 lb ae)	Water	Good	Good enough control for reforestation but not for eradication. Site prep only.

Species	Herbicide	Active chemical/A	Carrier	Expected control	Application and remarks
	metsulfuron	2 oz ai	Water + 0.15% silicon-based surfactant	Excellent	New Zealand data. Site prep only. Wait at least 6 mo. before planting.
	triclopyr ester	1 to 1.5 lb ae	Water	Excellent	Spring release.
Madrone <i>Arbutus</i> spp.	2,4-D ester	2.75 lb ae	Water	Good to excellent	Associated species may be difficult to control. Rates above 2 lb (1 lb 2,4-D for pines) may injure conifers. Spring treatment best. Release
	triclopyr ester	1.25 lb ae	Water	Fair to excellent	Use lower rate before conifer bud swell for release. Do not use over 2- or 3-needle pines.
	picloram + triclopyr ester	1 lb + 1 to 2 lb ae	Water	Good to excellent	Site prep only. Not recommended in ID.
	triclopyr ester + 2,4-D	1 lb + 2 lb ae	Water	Good to excellent	Early spring before conifer budbreak. Can control some associated species. Do not use on pines.
	fluroxypyr	7.7 oz ae	Water	Excellent	Pine plantations only; use highest rates only for site prep.
Manzanita <i>Arctostaphylos</i> spp.	2,4-D	2 lb ae	Water	Good	Release. See label for timing.
	triclopyr ester	1.25 lb ae	Water	Poor	Early foliage spray release. Erratic. See label for timing. Do not use over pines.
	fluroxypyr	7.7 oz ae		Good	Highest rates for site prep only. Should be safe at reduced rates on pine plantations.
Maple Bingleaf <i>Acer macrophyllum</i> Vine <i>A. circinatum</i> Rocky Mountain <i>A. glabrum</i>	imazapyr	0.25 lb ae	Water	Good	Release late summer. May injure conifers.
	imazapyr	0.25 to 0.5 lb ae	Water	Good to excellent	Site prep summer. Add glyphosate to broaden spectrum.
	glyphosate	0.75 to 1.5 lb ae	Water	Fair to good	Sept. foliar release for vine maple. Adding imazapyr will improve control but may injure conifers.
	glyphosate	2 to 3 lb ae	Water	Good	Summer-fall site prep
	imazapyr	0.25 lb ae	Water	Good to Excellent	September release for Douglas-fir.
	glyphosate + imazapyr	0.75 to 1.5lb ae + 0.1 to 0.4 lb ae	Water	Excellent	Summer – fall site prep.
	picloram+ 2,4-D	2 gal (1.08 + 4 lb ae)	Water	Fair	Site prep only.
	triclopyr ester	1.25 to 1.5 lb ae	Oil	Excellent	Dormant release spray, spring. Do not use on pines. Higher rate may injure Douglas-fir.

Species	Herbicide	Active chemical/A	Carrier	Expected control	Application and remarks
	picloram + triclopyr ester	1 lb + 1 to 2 lb ae	Water	Good to excellent	Site prep only, summer. Not recommended in Idaho.
Ninebark <i>Physocarpus</i> spp.	glyphosate	1.5 to 3 lb ae	Water	Excellent	Summer – fall site prep.
Poison-oak <i>Toxicodendron diversilobum</i>	imazapyr	0.2 lb/A	Water	Excellent	Apply in fall for release. Erratic, may injure conifers
	glyphosate	0.75 to 1.5 lb ae	Water	Excellent	Aug. -Sept. release. May be mixed with imazapyr but increases risk of conifer injury.
	aminopyralid + triclopyr amine (Capstone)	6 to 9 pints product (0.075 + 0.75 to 0.11 + 1.12 lb)	Water	Good	Site prep or directed spray only. Keep spray from contacting conifers.
Salmonberry <i>Rubus spectabilis</i>	picloram + 2,4-D	1 gal (0.54 + 2 lb ae)	Water	Good	Site prep only.
	glyphosate	0.75 to 1.1 lb ae	Water	Excellent	Aug.–Sept. release spray.
	metsulfuron	0.5 oz ai	Water	Excellent	Site prep.
Sword fern <i>Polystichum munitum</i>	metsulfuron	0.6 to 1.2 oz ai	Water	Good	Summer – fall site prep only.
Tanoak <i>Lithocarpus densiflora</i>	triclopyr ester	1.25 lb ae	Water/Oil	Good	Apply prebud swell for conifer release. Do not use on pines.
	2,4-D	2 to 2.75 lb ae	Water	Fair	Spring. Summer treatment may injure conifers after bud burst.
	picloram + triclopyr ester	1 lb + 1 to 2 lb ae	Water	Good	Site prep only, summer. Not recommended in Idaho.
Willow <i>Salix</i> spp.	2,4-D	2 lb ae	Water	Fair to good	Release. Retreatment of sprouts necessary. See label for release timing.
	glyphosate	0.75 to 1.5 lb ae	Water	Good	Release Aug-Sept.
	imazapyr + glyphosate	0.2 to 0.4 lb + 1.5 to 3 lb ae	Water	Excellent	Site prep only.
* 10% oil in carrier					

Grass and Herb Control for Conifer Plantation Establishment

Planting conifers on fields or harvest units with heavy grass and weeds usually reduces plantation survival and growth. A moderately dense stand of grass in an open field in western Oregon can be

expected to remove virtually all available moisture in the top 12 inches of soil by the end of June. The advantage of herbicides is that a single treatment can give nearly complete weed control during the first season after planting and may give partial weed control in later seasons.

The method chosen should apply herbicide evenly for uniform weed control near planted seedlings. Many products can be applied over the top of existing dormant conifer seedlings for release applications when done in a calibrated broadcast manner. Hand application equipment or aircraft such as helicopters are the only types of equipment suitable for application on rough terrain. Tractor-mounted sprayers equipped to spray a strip of herbicide down the plantation row have had some success on flat ground. When doing this, it is quite important that a wide enough strip be sprayed on each side of the planted row so that lateral roots do not draw down moisture supply too rapidly. In most situations, a strip at least 4 ft wide should be adequate for some habitat improvement for seedlings.

If spot spraying for release over the top of conifer seedlings, it is important to calibrate backpack sprayers and use nozzles similar to flat fan type nozzles, such as a Spraying Systems 9502E. This will make a uniform swath, about 5 ft wide when held 4 ft from the ground. As you pass over a seedling, a quick on-off will create square patches with uniform dosage very quickly. Using a solid-cone nozzle in a circular motion around the tree risks overdosing in the center and possible conifer damage. Treating spots less than 3 ft in diameter has not generally proven very satisfactory.

Good resources describing backpack sprayer calibration can be found at online videos including the video “Calibrating and Using Backpack Sprayers”

(https://media.oregonstate.edu/media/t/0_hf9le2ii) or the older archived publication at <https://ir.library.oregonstate.edu/downloads/x633f134b?locale=de>

Large scale broadcast spraying with a backpack sprayer can be accomplished using a calibrated mini-boom set up with multiple nozzles or waving wand techniques with adjustable cone nozzles or off-center nozzles like OC-12 or similar. For directions on this technique, read Handbook of Weed and Insect Chemicals for Forest Resource Managers, by M. Newton and F.B. Knight (Timber Press). A publication describing the waving wand method appears in <https://ir.library.oregonstate.edu/downloads/rf55z810k?locale=en>

2,4-D ester (Weedone LV 6 or LV 6 and many others)

Rate 1 to 2 lb ae/A (22 to 44 oz/A LV 6 product)

Time Apply preplant or post plant before conifer budbreak when susceptible plants are developing.

Remarks 2,4-D controls a large spectrum of broadleaved weeds and woody plants on forest sites including thistles, false dandelion, woodland groundsel, sow thistle, alder, manzanita species and many others. Amine salt formulations can also be used, but ester products perform better in early spring and on woody species. For best herbaceous control, apply in spring while plants are small and before conifers break bud. Douglas-fir, hemlock, and spruce are tolerant. True firs, redwood and cedars can show injury at high rates. Larch and ponderosa pine can show variable injury. 2,4-D can be a good foliar herbicide tank mix partner with soil residual herbicides, depending on the conifers treated.

Caution Consult label to avoid exceeding maximum yearly and single application rate.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

ammonium nonanoate (Axxe)

Rate 6 to 15 percent in water v/v to make 30 to 125 gal of spray solution per acre depending on weed height

Time Apply to target green foliage and vegetation any time on use sites.

Remarks Ammonium nonanoate is a nonselective contact burndown herbicide that controls only green foliage and vegetation. Mature, taller or perennial vegetation requires higher concentrations and spray volumes than smaller succulent foliage. It provides no residual

control and repeat applications to recovering foliage is necessary to maintain weed control. Complete coverage of foliage is needed for best results. Apply as a site preparation treatment or as a spot or directed spray to weed and grass foliage around conifer seedlings.

Caution Avoid overspray or spray drift onto conifer foliage, green stems or other non-target vegetation to reduce potential injury. Do not apply when rainfall is expected. Do not apply to wet foliage.

Site of action Organic herbicide; C9 saturated-chain fatty acid

Chemical family Unknown

clopyralid (Transline and others)

Rate 0.19 to 0.49 lb ae/A (8 to 21 oz/A product)

Time Apply any time of the year, but especially in the spring when susceptible weeds are present and developing.

Remarks All conifer species appear tolerant to clopyralid at any growth stage. For control of bull thistle and small woodland groundsel, use at least 8 oz/A product. In late spring higher product rates up to 21 oz/A may be needed to control larger plants. Canada thistle is best controlled at bud stage in late spring/early summer with rates at 16 oz/A product or higher. Additional sensitive weeds include other thistles, clovers, hawkweeds, yellow starthistle, vetches and elderberry species. Clopyralid can be an effective tank mix herbicide with soil active herbicides. Grasses and many other broadleaved weeds are tolerant.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

flazasulfuron (Mission)

Rate 0.033 to 0.045 lb ai/A (2.14 to 2.85 oz/A product) per application; no more than two per year at 2.85 oz or 9.6 oz total per year.

Time Apply after transplanting conifers and before budbreak in the spring or after buds have hardened off.

Remarks Federal label for use in Oregon and Washington. There is limited experience with flazasulfuron in Pacific Northwest forests. Numerous herbaceous broad-leaved weeds and grasses are controlled with both a pre- and post-emergence application. Apply over the top of dormant conifers or as a directed spray to seedlings that have new growth. For newly planted seedlings wait for soil to settle around roots before applying. Conifer species labeled as non-sensitive to flazasulfuron include Douglas-fir, noble fir, grand fir and white fir. Other conifer species can be treated providing experience or other data indicates tolerance. Rainfall is required within two weeks after application for best results. Labeled weeds found on forest sites include tall fescue, Italian ryegrass, bentgrass, annual bluegrass, cheatgrass, bedstraw, false dandelion, groundsel species, mare's tail, mustards, spurge species, annual sowthistle, willowweed, bull and Canada thistle. Flazasulfuron also controls cottonwood seedlings. Post-emergent applications benefit from the addition of a surfactant. Other tank mix partners may be needed to obtain best weed control and avoid developing weed resistance.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

flumioxazin (Lock Down SC and others)

Rate 0.255 to 0.3825 lb ai/A (8 to 12 oz/A product)

Time Apply preplant or over established seedlings before conifer budbreak.

Remarks Flumioxazin controls many broadleaved weeds and certain grasses both pre- and postemergence. Apply before budbreak over seedlings established for at least one year. Douglas-fir, Sitka spruce, grand fir, noble fir, ponderosa pine and lodgepole pine are tolerant. Other species may be treated with local experience. For site preparation wait 3 months after treatment to plant seedlings. The addition of a tank mix foliar herbicide such as glyphosate may be needed to effectively control existing plants for site preparation.

Caution Do not mix with any adjuvant for conifer release.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

glyphosate (Roundup Custom, Aquamaster and many others)

Rate 0.75 lb ae/A (0.75 quarts/A product) for spring release; 1.5 to 3 lb ae/A (1.5 to 3 quarts/A product) for site preparation.

Time Apply preplant or over established Douglas-fir seedlings before conifer bud swell or budbreak in the spring or after buds set in late summer or fall.

Remarks There are many glyphosate products labeled for forestry use. Products that have no surfactant in the formulation may be safer over conifers for release in the spring. To control many grasses and broadleaved weeds, apply in the spring over Douglas-fir that has been established for at least one year. Additional surfactant may increase risk of injury. Glyphosate controls existing plants growing on the site and provides no residual soil activity. For site preparation, apply any time plants are actively growing. Use higher rates and add additional surfactant per label recommendations. For directed spraying around seedlings anytime most product labels allow a 1-2 percent concentration of product in water sprayed to cover vegetation. Avoid contact with conifer foliage or stems.

Caution Douglas-fir can be injured by glyphosate as buds swell and budbreak occurs in the spring. Apply to dormant seedlings to mitigate risk of injury.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

hexazinone (Velpar DF VU)

Rate 1.33 to 4 lb/A of DF formulation)

Time Apply preplant or post plant before conifer budbreak.

Remarks Hexazinone product labels are changing and users should carefully check if forest use is allowed on their product container. Hexazinone is a soil active product; apply in mid-late spring on high rainfall sites or spring or fall on high elevation, high snowfall sites. Too much precipitation can dilute or negate effectiveness. Hexazinone controls a wide variety of germinating and established grasses and broadleaved weeds. Some woody plants like manzanita and *A* species can be killed or partially controlled on drier sites. Best results occur when they are small. For herbaceous weed control over conifers, rates less than 2 lb ai per acre have been adequate and less damaging. Rates above 2 lb ai/A can injure or kill conifers and are best suited to established ponderosa pine and Douglas-fir where shrub control is wanted on drier sites. Not all conifer species are tolerant. Cedars, redwood, sequoia, larch, white pine, and sugar pine can be severely injured or killed. A suitable foliar herbicide may be needed as a tank mix partner to achieve the best weed control.

Caution Newly planted seedlings, especially container seedlings, can be more sensitive to hexazinone and can be injured or killed. Use lower rates on coarse soils and apply after soils have settled around the roots to help mitigate risk of injury.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

indaziflam (Esplanade 200 SC)

Rate 0.73 to 1.46 oz ai/A (3.5 to 7 oz/A product)

Time Apply preplant as a site preparation treatment or after planting and before conifer budbreak or after bud set.

Remarks Indaziflam is a preemergent herbicide that controls certain broadleaf weeds and grasses such as downy brome (cheatgrass). It requires at least 0.25 inches of rainfall to activate. Emerged plants at the time of spraying will not be controlled and may require an additional tank mix herbicide active on those species. Best results can be expected on clean sites free of existing vegetation and slash. Conifer species tolerant to broadcast, over the top applications include Douglas-fir, ponderosa pine, sugar pine and coast redwood. White and red fir may be injured or killed. The previous listed conifers plus western larch can be planted into areas sprayed as a site preparation. Other conifer species can be treated or planted if prior experience indicates tolerance.

Caution Total Esplanade F rate applied in a 12-month period must not exceed 10 oz/A. For aerial applications, a 25-foot buffer must be established around lakes, streams, rivers, marshes, estuaries and fish ponds. Do not apply to frozen or snow-covered soil or soil with standing water except as stated on the label.

Site of action Group 29: cellulose biosynthesis inhibitor

Chemical family Alkylazine

pelargonic acid (Scythe)

Rate 3 to 10 percent solution v/v in water to make 75 to 200 gal spray solution per acre.

Time Apply to green foliage any time it is present on use sites.

Remarks Scythe is a non-translocated contact herbicide for burndown of green weed and grass foliage. Woody stems, seeds and root systems are not controlled and repeat applications on recovering foliage will be needed to maintain vegetation control. Apply as a site preparation treatment prior to planting or as a directed spray to weeds and grasses around conifer seedlings. Use lower concentrations on small succulent weeds and higher concentrations for maximum burndown on perennial species. Overspray on conifers or other desirable vegetation may result in injury. Best control results from complete coverage of target foliage. Pelargonic acid can be used as a tank mix partner with other foliar and soil residual herbicides at reduced concentrations.

Caution This product will damage desirable conifer seedling foliage or other non-target vegetation if they are contacted with any overspray or droplet drift.

Site of action Group 26: unknown

Chemical family Carboxylic acid

penoxsulam + oxyfluorfen (Cleantraxx)

Rate 0.031 to 0.046 lb ai/A penoxsulam + 1.47 to 2.21 lb ai/A oxyfluorfen (3 to 4.5 pints/A product)

Time Apply preplant for site preparation or post plant before conifer budbreak between early fall and late winter.

Remarks Available for use through Special Local Need labels for Oregon, Washington and Idaho. These labels must be in possession of the user at the time of application. Provides both preemergent and some early postemergent control of certain broadleaf weeds like woodland groundsel and false dandelion, as well as grasses. Germinating seeds of woody plants like manzanita and Ceanothus spp. (deer brush, snowbush, and squaw carpet) are also controlled. Activation by at least 0.5 inch of rainfall within 21 days of application is needed. Best results occur when applications are made prior to weed germination or when weeds are less than 4 inches tall. Postemergent applications require additions of a surfactant, and when applied over conifers, shown to be tolerated by those conifer species. Tolerant conifer species include Douglas-fir, ponderosa pine, sugar pine, incense cedar, coast redwood, white fir and grand fir. Other conifers may be treated with prior experience indicating tolerance. Any soil disturbance after application such as tree planting or machine traffic can disturb the treated layer in the soil and reduce effectiveness. For site preparation, split applications of 2.25 pints/A in the fall and spring along with additional tank mix herbicides have shown good results.

Caution Buffers of 25 ft must be maintained around lakes, streams and other water sources and commercial fish ponds. For aerial applications, buffers of 150 ft must be maintained around non-targeted vegetable fallow beds, crops, or desirable vegetation. Do not graze or feed treated vegetation to domestic livestock. Do not treat frozen or snow-covered ground or irrigation ditches. Maximum application rate is 4.5 pints/A per year. Check individual state labels for additional precautions.

Site of action (penoxsulam) Group 2: acetolactate synthase (ALS) inhibitor; (oxyfluorfen) Group 14: protoporphyrinogen oxidase inhibitor

Chemical family (penoxsulam) Triazolopyrimidine; (oxyfluorfen) Diphenylether

sethoxydim (Segment II)

Rate 0.281 to 0.468 lb ai/A (1.5 to 2.5 pints/A product)

Time Apply preplant or after planting conifers any time of the year when susceptible grasses are small, but especially in the spring when grasses are actively growing and less than 12 inches tall.

Remarks Sethoxydim controls only select annual and perennial grass weeds after emergence, preferably before they are 12 inches tall and optimally less than 6 inches tall. Susceptible grasses include cheatgrass, tall fescue seedlings, orchardgrass seedlings, annual ryegrass, witchgrass, bentgrass and velvetgrass. Fine fescues are tolerant. To control other grasses and broad leaved weeds other tank mix herbicides will need to be added. For broadcast applications, add a crop oil concentrate at 2 pints per acre or a methylated seed oil at 1.5 pints per acre. Consult label for rates of herbicide and surfactant for spot or directed spray applications. Conifer species listed on the label that are tolerant include Douglas-fir, noble fir, grand fir, white fir, Shasta red fir, lodgepole pine, ponderosa pine and coast redwood. Other conifer species can be treated with prior small scale experience or other data indicating tolerance.

Site of action Group 1: acetyl CoA carboxylase (ACC) inhibitor

Chemical family Cyclohexanedione

sulfometuron (Oust XP and others)

Rate 1.5 to 3 oz ai/A (2 to 4 oz/A product)

Time Apply preplant or post plant before conifer budbreak.

Remarks As a soil active product apply in spring on high rainfall sites or spring or fall on high elevation, high snowfall sites. Sulfometuron controls a wide variety of germinating and some established grasses and broadleaved weeds. Applications made to small or less established weeds result in best control. Some species are poorly controlled such as bull thistle, bedstraw, maretail, and woodland groundsel (*Senecio sylvaticus*). Additional tank mix herbicides such as clopyralid may be needed to achieve best results. Most conifer species like Douglas-fir, hemlock, spruce, true firs (*Abies* spp.), and pines are tolerant. Ponderosa pine, cedars, and true firs may show delayed budbreak and shoot growth in the first year.

Caution Use lower rates on cedar species (see label).

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

Hybrid Cottonwood (Hybrid Poplar) Grown for Pulp

Ed Peachey

Revised March 2022

2,4-D amine (many trade names)

Rate 0.24 to 1.43 lb ae/A (0.5 to 3 pints/A)

Time May be applied before or after planting. Apply when weeds are actively growing, preferably before bud stage on annual weeds and at bud stage for perennials. Repeat treatments may be required for less susceptible weeds. Some labels restrict use to one broadcast application per year.

Remarks Controls emerged broadleaf weeds. Glyphosate may be tank-mixed in preplant applications to broaden weed control. May be applied through wick applicators or conventional ground sprayers.

Caution Do not let 2,4-D contact leaves or green tree bark. Avoid drift. Do not apply within 2 days after an overhead sprinkler irrigation or rain, and do not irrigate for 3 days after treatment.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

clopyralid (Transline, Stinger, Bite, and other trade names)

Rate 0.125 to 0.25 lb ae/A (0.33 to 0.66 pint/A)

Time Apply to new plantings only after they have several inches of new, healthy growth. Apply as a broadcast spray over the trees, or as a banded or directed spray.

Remarks Mustards, henbit, chickweed, kochia, groundsel, lambsquarters, pigweed, Russian thistle, and bindweed will not be suppressed or controlled. Multiple applications may be made as long as total does not exceed 0.5 lb ae/A (1.33 pints/A). Make application to new plantings only after they are well established as indicated by several inches of new healthy growth.

Caution Avoid drift. Rain or irrigation within 6 to 8 hr of application may reduce efficacy. Carefully follow all rotation crop restrictions and other precautions.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

dichlobenil (Casoron 4G and CS)

Rate 2 to 4 lb ai/A (50 to 100 lb/A 4G, 1.4 to 2.8 gal/A CS)

Time Apply to soil surface from mid-November through mid-February to trees established at least 6 months.

Remarks Spot treatments to control emerged weeds may be made as late as mid-May. Rain is required to move herbicide into the soil. Use is restricted to desert areas of Oregon (2 counties) and Washington (3 counties).

Caution Do not use on trees established less than 6 months. Do not allow granules to stick to tree leaves or to accumulate at soil line around base of stem.

Site of action Group 20: inhibits cell wall synthesis Site A

Chemical family Nitrile

dimethenamid-P (Tower)

Rate 1 to 1.5 lb ai/A (21 to 32 fl oz/A)

Time Apply to new plantings only after they have been watered and the soil has been packed and settled well around the tree roots. Apply as a broadcast spray over the trees or as a banded or directed spray.

Remarks May be applied during site preparation and establishment or to established trees. Make sure planting slit is well closed and herbicide does not contact tree roots. Apply prior to weed emergence.

Caution Do not apply during budbreak.

Site of action Group 15: inhibits cell growth and division

Chemical family Chloroacetamide

dimethenamid-P + pendimethalin (Freehand 1.75G)

Rate 1.75 to 3.5 lb ai/A (100 to 200 lb product/A)

Time Apply to new plantings only after they have been watered and the soil has been packed and settled well around the tree roots. Apply prior to weed emergence.

Remarks May be applied during planting and or after trees are established. Make sure planting slit is well closed and herbicide does not contact tree roots. Rain or overhead irrigation is necessary to move the herbicide into soil.

Site of action (*dimethenamid-p*) Groups 15: inhibits cell growth; (pendimethalin) Group 3: microtubule assembly inhibitor

Chemical family (*dimethenamid-p*) Chloroacetamide; (pendimethalin) Dinitroaniline

diuron (Direx and other trade names)

Rate 0.8 to 2.4 lb ai/A. Use lower rates (0.8 to 1.6 lb ai/A) on coarse soils.

Time Apply before weeds emerge, or while they are small, before or after planting trees

Remarks Labels may differ among products. Use lower rates on coarse soil. Rain or overhead irrigation is necessary to move the herbicide into soil. May apply prior to or after planting. If applying before planting, prevent treated soil from coming in contact with roots during the planting operation. If buds are beginning to swell, direct application, and use shields to keep spray off of buds and any green tissue. If weeds are present at time of treatment, add a surfactant at 1 to 2 quarts/100 gal of solution.

Caution Do not use on gravelly soils, or on any soil with less than 0.5% organic matter. Injury may result from applications to poplar plantings grown on sandy soil with low organic matter with sprinkler irrigation Do not apply to stressed trees; injury may occur. Do not apply to frozen soils.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

flumioxazin (SureGuard)

Rate 0.25 to 0.38 lb ai/A (8 to 12 oz/A product)

Time Apply during site preparation prior to transplanting, or over the top of trees prior to budbreak in the spring or after dormancy in fall (release treatment).

Remarks Rain or overhead irrigation is necessary to move the herbicide into soil. Mechanical incorporation is not recommended. For optimal weed control, apply before weed emergence or after a burndown herbicide has controlled existing vegetation.

Caution Transplant operations must take place at least 3 months after application. Do not apply this product over the top of trees after budbreak or leaf spotting and defoliation may occur.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

glufosinate (Finale VU)

Rate 0.5 to 1.5 lb ai/A, depending on weed species and size.

Time Apply before planting, for site preparation.

Remarks May be used to control weeds before planting. Prepare ground early to allow maximum weed emergence. May include methylated seed oil (MSO) at 1% v/v or non-ionic surfactant (NIS) at 0.25% v/v spray solution. The addition of 8.5 to 17 pounds of ammonium sulfate (AMS) per 100 gal of water may result in better weed control.

Caution May plant as early as 12 hours after application.

Site of action Group 10: inhibits glutamine synthetase

Chemical family Phosphinic acid

glyphosate (many trade names)

Rate 1.5 to 3.75 lb ae/A, depending on weed species.

Time Apply before planting, for site preparation.

Remarks May be used to control weeds before planting. Prepare ground early to allow maximum weed emergence. Mix 1 quart or more nonionic surfactant per 100 gal of spray solution. Use surfactant with more than 50% ai. Surfactants with less than 50% ai require a higher surfactant volume per 100 gal of spray solution. Add ammonium sulfate to spray solution to prevent hard water tie-up of herbicide.

Caution Using this product without surfactant may reduce performance. Avoid contact of spray, drift, or mist to green bark or foliage. Desirable trees may be protected by using shields or protective coverings to keep spray solution off bark and foliage. Do not use as an over-the-top broadcast spray.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

hexazinone (Velpar L and DF, and others)

Yellow poplars

Rate 0.68 to 2 lb ai/A (0.9 to 1.125 lb/A Velpar DF); 4 to 6 pints/A (1.0 to 1.5 lb/A Velpar L), depending on soil texture and tree age.

Time Over the top of planted seedlings after the soil has settled around the root systems but before the seedlings have broken dormancy (budbreak). A subsequent application may be made before dormancy break in the spring of the second year.

Remarks Applications of Velpar DF must only be made after adequate rainfall has closed the planting slit and settled the soil around the roots following transplanting. The use of surfactant with Velpar DF VU Herbicide is not advised for applications made over the tops of seedlings. Requires some moisture to activate in soil but less than required for atrazine.

Caution A restricted-use herbicide in Washington. Label cautions that this herbicide may contaminate ground water if soil is permeable, or water table is close to the soil surface.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazinone

metsulfuron methyl (Omni MSM60, Alligare MSM, and other trade names)

Rate 0.3 to 1.2 oz ai/A (0.5 to 2 oz/A product)

Time Apply prior to planting or over the top after planting, before seedlings have broken dormancy (prior to bud break), and after soil has settled around the roots.

Remarks Rain or overhead irrigation is required to move herbicide into soil. Weed control is best when applying just prior to, or shortly after weed emergence.

Caution Do not apply after bud break. Surfactant is not recommended when applying over the tops of trees. When applying after planting, make sure adequate rainfall has occurred to close planting slit and close soil around the roots. Do not apply to trees under stress from low fertility, disease, insect damage, severe weather conditions, or water-saturated soils; tree injury or death may occur.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

oryzalin (Surflan AS, Surflan Flex)

Rate 2 to 6 lb ai/A

Time Apply to weed-free soil.

Remarks Apply only to established plantings, which the Surflan label defines as those that have been transplanted into their growing location long enough that soil has firmly settled around the roots from packing and rain or irrigation; 0.5 inch of moisture (rain or sprinkler irrigation) needed to activate. Lower rate controls for 2 to 4 months, higher rates for 4 to 12 months. May apply up to 12 quarts/A per year. Allow 2.5 months or more between applications. May apply by chemigation if the irrigation system keeps water under the leaf canopy.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

oxyfluorfen (Goal 2XL, Galligan 2E, and other trade names)

Rate 1 to 1.5 lb ai/A (4 to 6 pints/A)

Time Apply after planting to dormant cottonwood cuttings.

Remarks Direct spray to base of cottonwood tree. For best control, apply before weeds emerge. Adding 1 quart/100 gal spray mix of nonionic surfactant enhances control of emerged weeds.

Caution Applications after bud break may injure crop.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Diphenylether

paraquat (Gramoxone, Firestorm)

Rate 0.5 to 1 lb ai/A

Time Apply before planting, for site preparation.

Remarks May be used to control weeds before planting. Prepare ground early to allow maximum weed emergence. Good spray coverage is essential for good weed control. Plant with minimal soil disturbance. Add 1 pint of nonionic surfactant or 2 pints of crop oil concentrate to 100 gal of spray mix. Apply in at least 20 gal/A spray volume.

Caution **Restricted use pesticide** due to acute toxicity. For retail sale to and use only by certified applicators – not to be used by uncertified persons working under the supervision of a certified applicator.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyrilidium

pendimethalin (Pendulum Aquacap, Pendulum 3.3, and other trade names)

Rate 2 to 4 lb ai/A (2.1 to 4.2 quarts/A Pendulum Aquacap)

Time Apply after planting tree seedlings, before weed seed germinates.

Remarks Will not control established weeds. Apply after planting when soil around trees has settled. Rate applied determines the length of residual control. One-half inch of rainfall or its equivalent in sprinkler irrigation following application of this product improves weed control.

Caution Do not let pendimethalin contact developing roots, because roots may be stunted.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

quizalofop P-ethyl (Assure II)

Rate 0.034 to 0.068 lb ai/A (5 to 10 fl oz/A)

Time Apply to annual or perennial grasses listed on label at optimum use rates based on weed size.

Remarks May be applied over poplars at planting, to aid in establishment. Always use either a nonionic surfactant at 1 quart/100 gal or a petroleum-based crop oil at 1 gal/100 gal.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Aryloxyphenoxy propionate

saflufenacil (Detail)

Rate 0.022 to 0.13 lb ai/A (1 to 6 fl oz/A product)

Time Apply at least 2 months prior to planting trees.

Remarks Include methylated seed oil (MSO) at 1% spray volume. Does not control grass weeds. Rain or overhead irrigation is required to move herbicide into soil. Rate used will determine the length of residual control. Can be applied with glyphosate to improve speed of burndown and control of some glyphosate-tolerant species, such as horseweed.

Caution Do not apply over the top of non-dormant trees or severe injury will occur. Observe buffer zones on label to avoid drift injury to sensitive crops and other vegetation.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Pyrimidinedione

sethoxydim (Segment, Segment II)

Rate 0.28 to 0.47 lb ai/A (2.25 to 3.75 pints/A Segment, 1.5 to 2 pints/A of Segment II)

Time Apply to susceptible annual or perennial grasses listed on label at optimum use rates based on weed size.

Remarks Identify susceptible grass species. Tolerant grasses include annual bluegrass and all fine fescues. Control often is erratic on grasses stunted or stressed from drought, high temperatures, or low fertility. Segment does not require addition of an adjuvant. Segment II requires crop oil concentrate or methylated seed oil at 2 or 1 pint/A, respectively.

Site of action Group 1: acetyl CoA carboxylase (ACCase) inhibitor

Chemical family Cyclohexanedione

sulfometuron (Spyder, Oust XP and other trade names)

Rate 0.375 to 0.94 oz ai/A (0.5 to 1.25 oz/A product)

Time Apply to soil surface at least 3 days before transplanting or to dormant trees established for at least 1 year.

Remarks Rain or overhead irrigation required to move herbicide into soil.

Caution Avoid applications from bud swell to leaf drop when trees are actively growing. Do not let spray contact green bud or leaf tissue; injury may result. Limit first use to determine selectivity on specific clone. Do not apply to trees under stress from low fertility, disease, insect damage, severe weather conditions, or water-saturated soils; injury may occur.

Site of action Group 2: acetolactate synthase (ALS) inhibitor

Chemical family Sulfonylurea

terbacil (Sinbar, Sinbar WDG)

Rate 0.8 to 1.6 lb ai/A

Time Apply in late winter or early spring before weeds emerge, or while weeds are small. May apply before or after planting, but prior to bud swell. If applying after planting, allow soil to settle well around roots before application. May use only as a directed spray after bud swell.

Remarks Use lower rates on coarse soil. Rain or overhead irrigation is needed to move herbicide into soil. If weeds are present at time of treatment, add a surfactant at 1 to 2 quarts/100 gal of solution.

Caution Do not use on gravelly soils, or on any soil with less than 0.5% organic matter. Sprinkler irrigation might injure trees in coarse soils. Do not apply to frozen soils. If applying after bud swell, keep spray off of foliage, and apply as a directed spray only. Do not plant treated areas to any other crop for 2 years after last application.

Site of action Group 5: photosystem II inhibitor

Chemical family Uracil

trifluralin (Treflan HFP, Trust and other trade names)

Rate 0.5 to 1 lb ai/A

Time Apply before planting and thoroughly incorporate into top 2 to 3 inches of soil by cross-disking or rototilling.

Remarks Apply to trash-free and clod-free soil. Rate of application depends on soil type and organic matter. Incorporate into soil within 4 hours of application using equipment that ensures thorough soil mixing. Granular formulations may be activated with 0.5 inches rainfall or sprinkler irrigation without the need to mechanically incorporate. Will not control established weeds.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline