W-1097 (Revised)

The information in this guide provides a brief review of weed control methods plus a summary of herbicide uses for many of the tree species grown for conservation purposes in North Dakota.

The information is based on federal and state herbicide labels, research at North Dakota Agriculture Experiment Stations and other information from the North Dakota Department of Agriculture.

Weed Control in Tree Plantings

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Establishing and maintaining healthy trees in the northern Great Plains can be a challenge. Average annual rainfall varies from 13 to 20 inches across North Dakota, and moisture is a critical factor for survival and establishment of newly planted trees and shrubs. More than 2.5 million trees are planted each year in conservation plantings.

In North Dakota, several million dollars are spent on trees each year for conservation and landscape plantings. This value does not consider site preparation costs and annual maintenance. Once established, field windbreaks can increase crop yield by up to 33 percent, and shelter and landscape trees reduce home cooling and heating costs and increase property values. Because weeds lower aesthetic value and seriously compete with trees, weed control is critical for tree survival, establishment and growth.

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ALWAYS READ AND FOLLOW LABEL DIRECTIONS

Instructions for registered uses of herbicides are given on container labels.

The label is the final guide and should be followed strictly.

The information in this guide only applies to North Dakota because many herbicide uses are allowed only by supplemental or specific labeling for North Dakota.

Persons are required to have the necessary supplemental or specific labeling in their possession at the time of application.

Because labels can and do change frequently, applicators should ensure they are following the most recent label.

What is a Weed?

A weed is a plant growing where it is not wanted, competing with more desirable plants for water, nutrients, sunlight and space. Any vegetation growing between tree rows and between trees within the row will reduce available moisture and nutrients in the soil. Weeds compete with trees by quickly developing root systems in the top several inches of soil, which reduce water and nutrient availability to tree roots. Bromegrass and quackgrass form prolific root and rhizome systems that form dense mats. These grasses severely compete with trees for water and nutrients even when the trees are taller than the weeds and competition for light is not a factor. Tall and vining weeds reduce growth of small trees by blocking sunlight that would reach tree leaves. Examples of tall weeds include common cocklebur, burdock, common ragweed, marshelder and volunteer sunflowers. Vining weeds include field bindweed and wild buckwheat. Other weeds that are particularly detrimental to trees include deep-rooted species such as sweet clover, alfalfa and switchgrass.

Understanding growth cycles and the most vulnerable growth stage of weeds is important for effective control strategies.

Annual weeds are plants that germinate from seed in the spring of the year, grow quickly, flower and set seed during the growing season, and die. Early weed control is critical to reduce competition with trees and to prevent weed/seed production. Control becomes increasingly difficult as weeds develop past the seedling stage.

Biennials require two growing seasons to complete their life cycle. They usually form rosettes the first year and reproduce the second year by bolting or growing a flower stalk. Controlling the rosettes the first year is the easiest and most effective way to control biennials.

Perennial weeds are plants that grow from roots, rhizomes, stolons, tubers, tillers, or seed in the spring, then flower and set seed. Unlike annual plants, they do not die but continue to grow and spread each year through specialized roots and stems. The ability to reproduce from rhizomes makes smooth bromegrass one of the most competitive weeds, and leafy spurge and Canada thistle the most invasive weeds, in North Dakota tree plantings. Control can be difficult, requiring greater and more consistent efforts than for annual weeds.

Mechanical Weed Control

Mechanical weed control, such as cultivation or mowing, is one of the oldest agricultural practices. The object of mechanical weed control is to limit competition by uprooting, separation of the green stem and leaves from the root system, or a total maceration of the weed plant. This activity either kills the weed completely or causes sufficient injury to render the plants noncompetitive.

Mechanical weed control is quite effective for control of annual weeds, especially in the seedling stage. However, cultivation may bring weed seeds to the soil surface where they can germinate. Seed dormancy may be broken by exposure to light during tillage or by other changes in the environment around the seed. Therefore, shallow cultivation is encouraged to reduce the number of dormant weed seeds brought to the surface. Repeated tillage may be required throughout the growing season as new weeds emerge. Cultivation actually propagates and spreads a perennial weed problem throughout the tree planting when rhizomes, stolons, tillers, tubers or roots are spread by the tillage tool. Chemical weed control through use of the proper herbicide(s) is the most effective method to control perennial weeds.

After young trees are established and growing, mechanical cultivation deeper than two to three inches can damage tree roots resulting in stunted growth. Tractors and equipment can injure lower branches, root collars or tree trunks, providing entry wounds for insect and disease pests. Excessive tillage can expose the soil to wind erosion that can cause sandblast damage to young trees, but a cover crop between tree rows is a solution to eliminate sandblasting. Excessive tillage also can increase soil erosion.

Tillage practices adjacent to suckering shrubs must be modified as the planting matures. Many shrubs begin suckering (sending up new shoots from the root system) within two to five years after planting. Tillage should be modified to prevent damage or removal of these newly emerged shrub stems. Tillage may need to be done intermittently or performed farther from the row to encourage healthy and vigorous sucker production.

Mechanical weed control implements

A variety of hand tools and tractor-mounted implements are available for mechanical weed control. The size of the tillage implement should be determined by the particular tree planting, width of the rows and spacing in the row. Equipment used in yards must be smaller than that used in nursery and tree plantations.

Hoes and hand cultivators are some of the oldest tools used for cultivation of trees and crops. Although effective, especially in closely spaced tree plantings, these methods are laborious and time-consuming in larger tree plantings. Over the years, many designs of hand cultivators have been developed for home gardens and most of these work equally well around trees.

Line trimmers have become increasingly popular with homeowners for grass trimming around trees. When line trimmers are used near trees, plastic tree guards should be placed around the base of young trees and trees with thin bark. These guards protect the tree from accidental wounding and possible girdling of trees. Bark and cambium on larger trees are often severely damaged by careless line trimmer usage. Perennial weeds will develop multiple stems after existing stems are removed by any mechanical tool or implement.

Equipment is an important consideration when planning row spacing of a new tree planting. As trees grow, close cultivation can cause mechanical injury to roots. Cultivation should be used no closer than the edge of the tree crown. To minimize root damage, cultivation depth should be consistent.

In yards, use of a rototiller around trees should be limited to soil preparation for tree planting. Rototillers should not be used around larger trees but can be effective in providing weed control for young plantings. However, caution is necessary to avoid extensive root damage to the tree. Do not allow the tines or the drag bar of a walk-behind tiller to penetrate deeper than two inches. Tractor-mounted tillers provide more uniform depth control than walk-behind tillers, but require greater caution to prevent damage to trunks, root collars and branches. These same precautions apply to larger, farm-scale rotary tillage implements.

A specialized small rotary tiller has been effective for weed control between trees within the rows (e.g., Weed Badger®). The cultivator is mounted on a retractable arm to allow movement in and out of the tree row. Several models can be mounted on a tractor or small skid-steer loader. The arm is controlled manually or reacts to a contact bar; i.e., when a tree is contacted the arm automatically pulls out of the row. The contact bar does not work when seedlings are small or weeds are tall. Many conservation districts and private individuals use these machines for in-row weed control services. A small rigid-shank field cultivator works well between tree rows in young windbreaks and forest plantations.

Mulches

Mulches can be either organic material or artificial fabric sheets. They are placed around the trees to serve as physical barriers to weed emergence. Mulches also prevent sunlight from reaching weed seeds or small plants. Decreased weed competition means more moisture and nutrients for tree growth. Mulches conserve soil moisture by preventing evaporation from wind and they keep soils cooler through shading during the growing season. Also, mulches reduce rainfall runoff and increase water infiltration into the soil. Mulches also maintain warmer soil temperature later into the autumn by insulation, allowing for an extended period of root growth for the tree.

Organic mulches include straw, woodchips, chopped corn cobs, grass clippings, various composts, and other organic material. These are most effective when placed around the tree to the edge of the tree crown. A minimum three-foot circle of mulch is recommended around individual trees, and the diameter of the circle should be increased as the tree grows. Organic mulch must be maintained at three to four inches deep to prevent weed emergence. Sufficient depth must be maintained because control of weeds through mulch may be more difficult than controlling weeds without mulch. Finer-mulch materials are effective at thinner depths while a greater thickness is needed for coarse materials to prevent weed emergence.

Organic mulches are commonly added to improve soil structure by increasing organic matter content. This practice is effective in heavy clay soils, where added organic matter improves porosity, which in turn increases water permeability and oxygen exchange. In light sandy soils, organic matter improves water- and nutrient-holding capacities of the soil. Organic mulches also provide slow release of nutrients to encourage growth.

Caution should be taken when using fresh sawdust or woodchips around trees. Fresh sawdust and chips from certain trees may contain chemicals that inhibit growth of other trees. Sawdust and woodchips of redwood, cedar, Douglas-fir, larch, black walnut and spruce have inhibited tree growth when used as fresh mulch.

Another problem with fresh woodchips and sawdust is that nitrogen is depleted from the soil as the wood decomposes. Nitrogen loss is only temporary until the initial decay processes have occurred. Woodchips and sawdust can be kept in an outside pile for at least a year so exposure to the environment will leach the harmful chemicals and begin the decay process. When fresh woodchips are used as mulch, ammonium nitrate at one-fourth pound per 100 square feet should be applied.

Artificial mulches, especially various grades and colors of plastic mulches, were first used around trees in home landscaping to control weed growth and conserve soil moisture. Solid plastic sheets did not allow sufficient oxygen exchange between the tree roots and open air. Newer forms of plastic mulches are manufactured with an interwoven or spun fiber to allow more porosity for better water and oxygen exchange. The weed barrier mulches currently being used in windbreak and conservation plantings are sold as three- by three-foot or four- by four-foot squares, or in rolls 4, 6 and 12 feet wide by 300 to 500 feet long.

An artificial weed barrier is normally installed with a specialized machine that unrolls the fabric over the top of the newly planted trees. People or weights are needed to temporarily anchor the starting end of the fabric. Coulters or moldboards open a trench under the edges of the fabric; press wheels push the fabric to the bottom of the newly formed trench; and covering devices place soil on top of the fabric edges to anchor them in place. A person follows behind the machine to cut a short slit at each tree location and pull the tree through the opening. The slit can be C-, J-, L- or X-shaped, leaving one or several flaps of fabric, and should be large enough to allow future growth of the tree without girdling it. A rock, brick or long staples should be placed between trees during application to help hold the weed barrier down.

Several words of caution are necessary about the use of weed barrier fabrics.

1. During initial application, trees should not be left under the weed barrier for more than five minutes, especially when temperatures are above 70 degrees. Tree foliage can burn or completely dry out if the trees are not quickly pulled through the weed barrier fabric.
2. As trees grow, the openings in the fabric must be enlarged, to avoid girdling the trees. Newer fabric types may overcome this drawback.
3. Organic matter and soil should not be allowed to accumulate on the fabric as weeds can become established here, destroying the effectiveness of the fabric.
4. Where suckering from shrubs is desired, consider weed control other than fabric, as fabric reduces or eliminates suckering in many shrub species.

Cover Crops

Cover crops are commonly used in fruit orchards, Christmas tree plantings and other forest plantations to reduce muddy conditions and allow access between tree rows for harvest and maintenance activities. When planted between tree rows, they can reduce the spread of invasive weed species by minimizing their establishment. If weeds do become established, cover crops can control them by shading and competing for water and nutrients at critical times of growth. Cover crops planted between tree rows allow better rainwater penetration into fine-textured soils. More importantly, cover crops can reduce soil erosion and eliminate the drying effects from tillage. However, a weed-free zone should be maintained within the rows or for three feet around individual trees to minimize competition for water and nutrients.

Annual cover crops (three- to six-feet tall) such as flax, corn or sunflower, can be used as temporary small-scale windbreaks to protect sensitive tree species from drying winds. Tall cover crops collect snow for winter cover and add moisture to soils. They reduce wind erosion and sandblasting on light-textured soils. However, despite these benefits, annual cover crops may compete for water, reducing tree growth.

Cover crops are particularly beneficial when used between tree rows that are mulched, especially with synthetic weed barrier mulches, because they eliminate the need for close cultivation and possible disturbance of the mulch. Close tillage can damage synthetic weed barrier mulches by snagging or tearing the fabric. When patches of perennial weeds become established, spot treatment with an approved herbicide may be necessary. As tree canopies expand, the cover crop will gradually be shaded out and weed competition reduced.

Some cover crops and their residues contain allelopathic chemicals that suppress growth of certain plants. Allelopathic cover crops include oats, rye, fescue grasses and hairy vetch. The best way to take advantage of allelopathic cover crops is to control the top growth by mowing or herbicide treatment and retaining the vegetation as a mulch over the soil surface. Allelopathic weed suppression may vary from 30 to 75 days after destruction, depending on the plant species and amount of biomass produced.

University of Minnesota researchers found that a late summer-early fall seeding of rye between five- to eight-foot-tall nursery trees provided control or suppression of many weed species. The rye was sprayed with glyphosate the following summer before seed head formation (early- to mid-June). The rye residue formed an organic mulch that provided weed control and moisture conservation through the rest of the summer.

Seeding a cover crop

Prior to seeding a cover crop, the soil should be lightly cultivated and packed. Seed with a grass or grain drill designed for seeding lightweight seed. If a drill is not available, broadcast the seed by hand or with a spreader, harrow or rake, and pack for good soil contact with the seed. Use the highest rates in **Table 1** for broadcast seeding.

Warm-season grasses establish better when seeded in mid- to late-spring (May 10-June 25) while cool-season grasses can be sown in the spring (before May 20) or late summer (August 10-September 10). Fall sowing allows cool-season grasses to establish and grow more rapidly with fall moisture and cool temperatures. Most annual crops need to be reseeded annually to maintain a ground cover, but some, like black medic, may reseed themselves. Several cover crop species, their various growth characteristics, seeding rates and planting depths are presented in Table 1.

Timing, depth of seeding, seeding rate, firmness of seed bed and variety selection all are critical to a successful seeding. Depending on the cover crop, seeds should be planted ½- to 1½-inches deep. A poor stand will allow weeds and unwanted grasses (bromegrass, quackgrass, etc.) to establish, which defeats the purpose of cover planting.

Table 1. Cover crops: Growth characteristics, seeding rates and planting depths.

Cover Crop	No. of Seeds/lb.	Pounds of Pure Live seed/acre	Sowing Depth	Sowing Date	Bunch	Sod	Annual	Perennial
		(inches)						
WARM SEASON GRASSES								
Blue grama 'Bad River' *Bouteloua gracilis* (cultivar)	825,000	2-5	0.25-0.5	May 10- June 25	X			X
Side-oats grama 'Pierre' 'Killdeer' 'Butte' *Bouteloua curtipendula* (cultivar)	191,020	8-15	025-.5	May 10 - June 25	X			X
Buffalograss 'Bowie' 'Titonka' 'Cody' *Buchloe dactyloides* (cultivar)	56,000	3-6	0.25-0.5	May 10 – June 25		X		X
COOL SEASON GRASSES								
Perennial ryegrass *Lolium perenne*	18,000	3.5-7	0.25-0.5	Before May 20 Aug. 10 – Sept. 10	X		X	
Crested wheatgrass 'Parkway' 'Ruff' 'Hycrest' Ephraim' 'Nordan' *Agropyron cristatum* (cultivar)	175,057	10-25	0.25-0.5	Before May 20 Aug. 10 – Sept. 10	X		X	
LEGUMES								
Black medic *Medicago lupulina*	300,000	6-12	0.25-0.50	Before May 20 Aug. 10 – Sept. 10	X		X	

Cover crop species provide the benefits of cover with limited competition to tree growth. If the cover becomes aggressive, a herbicide may be applied selectively to achieve the desired amount of cover. If a cover crop is used in tree plantings without artificial weed barrier mulch, weed control must continue within the tree row.

Chemical Weed Control

Herbicides are widely used for weed control in tree plantings because they provide selective and rapid control of weeds. Some are especially effective on hard-to-control perennial weed species such as quackgrass, bromegrass and Canada thistle where tillage and other control options are limited. A herbicide must be applied at the proper growth stage for effective control. The herbicide selected will vary with application preference, weed type and species or growth stage of the tree. Problem weeds should be controlled before site preparation.

Many herbicides are labeled for use in tree plantings. Some herbicides can be applied directly over the trees, while others must be applied as a directed spray to minimize spray contact or to avoid the trees entirely.

Herbicides are applied in various stages of tree growth. Correctly identify the existing weeds and use herbicides designed to control those weeds. Several publications to help identify weeds correctly are available through the NDSU Extension Service. Select herbicides that are safe for the desired trees and shrubs and apply at the optimum stage for effective weed control.

Site preparation. Prior to planting trees, the site is usually prepared by one of two methods: 1) a nonselective herbicide is applied to kill existing vegetation, followed by a preplant incorporated or pre-emergent herbicide to provide residual weed control; or 2) tillage is used to remove existing vegetation and a preplant or pre-emergent herbicide is used to provide residual weed control.

After planting. During the first season after planting, spot treatment of hard-to-kill perennial weeds may be required. Spray only the weed and avoid drift or spraying young tree bark and foliage. A hand sprayer with a shield or a pail placed over nearby trees will help prevent spray drift damage. **Table 2** includes information on mixing and spraying with handheld sprayers.

Fall and early spring application. Weed control during the following growing season can be achieved by applying residual granular herbicide in the fall after trees are dormant or in early spring before trees break dormancy.

In mature trees. Grass weed (bromegrass, quackgrass, etc.) competition can reduce tree growth and vigor. A translocated herbicide applied selectively can remove competition of unwanted weed plants.

In native river stands. Water quality and runoff are major concerns. Some herbicides have a restricted use classification because of water quality concerns, and many general use herbicides cannot be applied in open water. Use only herbicides that are labeled for use near water.

Herbicide Application with Hand-Held Sprayers

Hand-held sprayers are often used for spot treating patches of weeds or for treating small areas in tree plantings. Spray coverage should be uniform but not to the point of runoff. Calibrating a hand-held sprayer can be difficult because of irregular size and dimension of the area to be sprayed and difficulty in attaining a uniform spray coverage with a single nozzle. The following calibration information may be useful in determining the proper amount of spray volume to mix for an area of known dimension.

Calibrate hand-held sprayers by 1) spraying a known area using water, 2) measuring the amount of water applied, and 3) calculating the number of gallons applied per acre (gpa). For example, 1.5 gallons on 1,000 sq. ft. is the same as 65 gallons per acre.

(43,560 sq. ft. per acre / 1,000 sq. ft.) x 1.5 gallon = 65 gpa.

The desired rate in lb/A or pt/A is used to calculate the amount of herbicide to add to the spray solution. If 3 pt/A is desired:

3 pt/A / 65 gpa = 0.046 pt. or 0.74 fl. Oz. or 1.5 tablespoons per gallon of spray solution (16 fl. oz. = 1 pt.; 2 tablespoons = 1 fl. Oz.).

When calibration of a hand-held sprayer is not possible and the herbicide used is safe to the environment and non-target plants, a volume of 50 to 70 gpa can be assumed. However, the actual volume applied can vary considerably with the type of sprayer, spray pressure and technique of the applicator, so calibration is strongly encouraged.

Some herbicide labels specify a percent solution for use in hand-held sprayers. **Table 2** provides mixing instructions to obtain solutions of varying percent concentrations on a volume/volume basis.

Table 2. Calibration table.

Desired solution volume	Concentration of herbicide (%)				
	0.5	1.0	1.5	2.0	5.0
(gal)	Amount of herbicide to add — fl. oz.				
1	0.6	1.3	1.9	2.6	6.4
2	1.3	2.6	3.8	5.2	12.8
5	3.2	6.4	9.6	12.8	32.0
10	6.4	12.8	19.2	25.6	64.0
100	64	128	192	256	640

Abbreviations used in Table 3

ae	Acid equivalent
ai	Active ingredient
DF	Dry flowable
DG	Dry granular
EC	Emulsifiable concentrate
G	Granular
gpa	Gallons per acre
L	Liquid
S	Solution
SL	Soluble liquid
WDG	Water dispersible granules

1 pt. = 16 fl. oz.
1 Tbsp. = 3 tsp.
1 Tbsp. = 15 ml.
2 Tbsp. = 1 fl. oz.
16 Tbsp. = 1 cup
1 fl. oz. = 30 ml.

Table 3. Description of herbicides used in windbreaks, forestation plantings and native forest stands.

Prior to Weed Emergence

Trade name	**Casoron**
Common name	dichlobenil
Formulations	4G
Rate range (lb ai/A)	4 to 8
Product/A	100 to 200 lb.
Product/1,000 sq. ft.	2.3 to 4.6 lb.
Weed control spectrum	Many grasses and broadleaf weeds.
Leaching potential	Slightly mobile.
Relative persistence	One year or less.
Application information	Pre-emergence herbicide applied in early spring or late fall to new plantings at least 4 weeks old. Apply 4 to 6 lb. ai/A for control of annual weeds and 6 to 8 lb. ai/A for control of perennial weeds like Canada thistle or leafy spurge. Avoid use on light, sandy soil.
Labeled combinations	No combinations are labeled or specifically prohibited.
Comments	Tree tolerance is good. Do not remove old weed growth or apply when soil temperature is above 50 degrees. This strictly a pre-emergence herbicide, so fall application provides more consistent weed control than spring application. Do not apply more than 6 lb. ai/A to plantings less than one year old, or to Euonymus, Forsythia and lilac. Studies in North Dakota indicate that this product may harm spruce trees. Pines are susceptible to injury when treatment applied within two years after transplanting.
Trade name	**Gallery**
Common name	isoxaben
Formulations	75DF
Rate range (lb. ai/A)	0.5 to 1
Product/A	0.66 to 1.33 lb.
Product/1,000 sq. ft.	0.25 to 0.5 oz.
Weed control spectrum	Annual broadleaf weeds and some grass suppression.
Leaching potential	Low leaching potential and low water solubility.
Relative persistence	Soil half-life is 5 to 6 months.
Application information	Apply pre-emergence in late summer, early fall or in early spring prior to weed germination. Treated areas should be free of weeds or weeds should be controlled before application. Use a minimum of 10 gpa of water.
Labeled combinations	Compatible with other herbicides labeled for use on ornamentals.
Comments	Very active on broadleaf weeds. Wait for soil to settle after planting. Planted species should be well rooted before application. Conifers: only apply to established plantings.

Trade name	**Goal**
Common name	oxyfluorfen
Formulations	2EC
Rate range (lb. ai/A)	1 to 2
Product/A	4 to 8 pints
Product/1,000 sq. ft.	1.8 to 3.7 fl. oz.
Weed control spectrum	Some annual grass weeds including foxtail and several annual broadleaf weeds including kochia.
Leaching potential	Nearly immobile.
Relative persistence	Slightly persistent. Will control some weeds for one year or less.
Application information	Do not incorporate. Use pre-emergence or postemergence. Pre-emergence is most effective when applied to soil free of plant residue and soil surface is not disturbed. For postemergence, apply with nonionic surfactant at 2 pints/100 gallons of water and make thorough coverage. Apply before grasses are larger than the 2-leaf stage and broadleaf weeds are larger than 4-leaf stage. Use 2 lb. ai/A in areas of high weed competition for longer residual herbicide activity.
Labeled combinations	May be applied with other pre-emergence herbicides registered for use in windbreaks.
Comments	**Conifers** – Apply pretransplant, postemergence or post-directed prior to budbreak or after new foliage has hardened off. Follow label "specific use restrictions" carefully. **Hardwoods** – Apply pretransplant or post-directed prior to budbreak. Spray only the base of deciduous trees and **not over-the-top**. Oxyfluorfen applied after budbreak may injure deciduous species. If a nondormant application is required, apply after new tree foliage has fully expanded and hardened off and not during periods of new growth. Avoid direct or indirect spray contact with foliage of deciduous trees. User must possess North Dakota 24(c) SLN label for Goal 2XL at time of application.

Trade name	**Pendulum, Prowl**
Common name	pendimethalin
Formulations	Pendulum 60DG, Prowl 3.3EC
Rate range (lb. ai/A)	2 to 4
Product/A	3.3 to 6.6 lb. DG, 2.4 to 4.4 qt. EC
Product/1,000 sq. ft.	1.2 to 1.8 oz. DG, 1.8 to 3.2 fl. oz. EC
Weed control spectrum	Annual grasses including foxtail and some small-seeded annual broadleaf weeds.
Leaching potential	Immobile.
Relative persistence	Moderately persistent. Will provide 3 to 5 months of weed control.
Application information	Pre-emergence weed control. Slight herbicide loss will result from photodecomposition and volatility.
Labeled combinations	No combinations are labeled or specifically prohibited.
Comments	Rainfall or mechanical incorporation will improve weed control. Controls germinating weeds, not established plants. Treated area should be free of any weedy plant material prior to application. Directed application to uniformly cover desired area will result in optimum weed control. Most woody species have excellent tolerance.

Trade name	**Princep**
Common name	simazine
Formulations	Princep Caliber 90DF, Princep 4L
Rate range (lb. ai/A)	2 to 4
Product/A	2.2 to 4.4 lb. DF, 2 to 4 qt. 4L
Product/1,000 sq. ft.	0.8 to 1.6 oz. DF, 1.5 to 3 fl. oz. 4L
Weed control spectrum	Some grasses, suppression of quackgrass and control of many annual broadleaf weeds.
Leaching potential	Slightly mobile.
Relative persistence	Persistent. Will provide weed control for 1 to 2 years depending on rate used and soil pH.
Application information	Pre-emergence herbicide applied in spring or late fall. Fall application provides best weed control. Only Princep formulations listed above are labeled for use on shelterbelts. Use lower rate on first year plantings. Delay application to new plantings until trees are established 6 weeks or preferably until late fall. Do not use on light sandy soil. Use high rates on heavy, high organic matter soil and for full season weed control in established plantings. Risk of injury is greater on high pH soils (above 7.5).
Labeled combinations	Glyphosate herbicides. No combinations are specifically prohibited.
Comments	Avoid application where herbicide may be concentrated into planting furrow. Tree tolerance is fair to good. New plantings are less tolerant. Emerged weeds are not controlled. Quackgrass requires the maximum rate applied in the fall or apply as a split application with half applied in the fall and half applied in the spring after quackgrass growth begins. Remove plant residue before application. Apply after leaf drop in deciduous tree species.

Trade name	**Snapshot**
Common name	trifluralin + isoxaben
Formulations	2% trifluralin + 0.5% isoxaben = 2.5G
Rate range (lb. ai/A)	2.5 to 5
Product/A	100 to 200 lb.
Product/1,000 sq. ft.	2.3 to 4.6 lb.
Weed control spectrum	Annual grass and broadleaf weeds.
Leaching potential	Nearly immobile.
Relative persistence	Moderately persistent.
Application information	Apply pre-emergence in late summer, early fall or in early spring prior to weed germination, or immediately after cultivation that removes existing plant material. Requires 0.5 to 1 inch of water for activation.
Labeled combinations	No herbicides are recommended nor restricted.
Comments	Product should not be mechanically incorporated. Repeat applications at 150 lb/A should not be made sooner than 60 days after initial treatment. Optimum weed control is achieved when herbicides are activated by rain or irrigation within three days after application. Do not apply to newly transplanted trees.

Trade name	**Many products and manufacturers**
Common name	trifluralin
Formulations	4EC, 10G
Rate range (ai lb/A)	0.5 to 2
Product/A	1 to 4 pt. 4EC, 5 to 20 lb. 10G
Product/1,000 sq. ft.	0.4 to 1.5 fl. oz. EC, 1.8 to 7.3 oz. 10G
Weed control spectrum	Annual grasses including foxtail and some small-seeded broadleaf weeds.
Leaching potential	Immobile.
Relative persistence	Persistent. Will provide 1 to 2 years weed control depending on rate.
Application information	Preplant incorporated for new plantings or established trees. Usually used prior to planting due to difficulty in incorporating in the row after trees are planted. Must be incorporated into the top 2 to 3 inches of soil. Immediate incorporation preferred. A second incorporation ensures uniform mixing in treated soil.
Labeled combinations	No combinations are labeled nor specifically prohibited.
Comments	Trifluralin is available in many formulations. Use only those formulations labeled for use in tree plantings. Trifluralin is safe (for human exposure, the environment, and to most woody plant species), effective, nonleaching, reliable and provides several months of residual grass and some small-seeded broadleaf weed control depending on rate used. Many woody species are not specifically listed on the trifluralin label, however, the user can use trifluralin on nonlabeled species by assuming all responsibility for plant damage or loss.

Postemergence

Trade name	**Fusilade, Ornamec**
Common name	fluazifop-P
Formulations	2EC, 0.5EC
Rate range (lb ai/A)	0.25 to 0.38
Product/A	1 to 1.5 pt. 2EC, 4 to 6 pt. 0.5EC + 0.25% v/v nonionic surfactant
Product/1000 sq ft	0.37 to 0.55 fl. oz. 2EC, 1.47 to 2.20 fl. oz. 0.5EC + 3 fl. oz. nonionic surfactant
Weed control spectrum	Annual and perennial grasses.
Leaching potential	Nearly immobile.
Relative persistence	Nonpersistent.
Application information	Postemergence, translocated herbicide with no soil residual. Can be applied over-the-top of all tree species.
Labeled combinations	No combinations are labeled. Should be used in combination with a broadleaf weed control program.
Comments	Fusilade use in trees is a specialty product and covered by special labeling. Agricultural formulations do not include these uses. Fusilade and Ornamec provide excellent control of emerged grasses. Repeat applications give fair to good control of quackgrass. Oil additive is required at 1 qt/A. Fusilade and Ornamec do not control broadleaf plants.

Trade name	**Poast, Vantage**
Common name	sethoxydim
Formulations	Poast 1.5EC, Vantage 1EC
Rate range (lb ai/A)	0.33 to 0.5
Product/A	1.5 to 2.5 pt. 1.5EC, 2.25 to 3.75 pt. 1EC
Product/1000 sq. ft.	0.5 to 1 fl. oz. Poast + 2 fl. oz. oil additive, 0.8 to 1.4 fl. oz. Vantage + 2 fl. oz. oil additive
Weed control spectrum	Annual and perennial grasses.
Leaching potential	Nearly immobile.
Relative persistence	Nonpersistent.
Application information	Postemergence, translocated herbicide with no soil residual. Can be applied over-the-top of most all woody species.
Labeled combinations	Poast and Vantage can be applied with several herbicides labeled for use in tree plantings.
Comments	Sethoxydim provides excellent control of emerged grasses and only suppresses quackgrass. Oil additive is required at 1 qt/A. Sethoxydim does not control broadleaf plants.

Trade name	**Select**
Common name	clethodim
Formulations	2EC
Rate range (lb ai/A)	0.095 to 0.25
Product/A	6 to 16 fl. oz. + 1 qt/A crop oil concentrate or oil additive
Product/1000 sq ft	0.14 to 0.37 fl. oz. + 0.75 fl. oz. oil additive
Weed control spectrum	Annual and perennial grasses.
Leaching potential	Nearly immobile.
Relative persistence	Nonpersistent.
Application information	Postemergence, translocated herbicide with no soil residual. Can be applied over-the-top of most woody species.
Labeled combinations	No combinations are labeled nor specifically prohibited.
Comments	Select provides excellent control of emerged grasses including quackgrass. Oil additive is required at 1 qt/A. Select does not control broadleaf plants.

Postemergence – Directed Spray Only

Trade name	**Finale**
Common name	glufosinate
Formulations	1EC
Rate range (lb ai/A)	0.75 to 1.5
Product/A	3 to 6 qt.
Product/gallon of water	1.5 to 4 fl. oz.
Weed control spectrum	Emerged annual grass and broadleaf weeds.
Leaching potential	Nearly immobile.
Relative persistence	Nonpersistent.
Application information	Nonselective, postemergence, contact herbicide with no soil residual.
Labeled combinations	Labeled for application with Gallery and Pendulum.
Comments	Herbicide symptoms may appear in 2 to 4 days after application. Avoid drift and all contact with desirable vegetation. Weeds should be actively growing at time of application. Gives better control in hot weather than does glyphosate.

Trade name	**Many products and manufacturers**
Common name	glyphosate
Formulations	3 lb. ae/gal., 4 lb. ae/gal., 4.5 lb. ae/gal.
Rate range (lb. ae/A)	0.75 to 1.5
Product/A	2 to 4 pt. of a 3 lb. ae/gal. conc., 1.5 to 3 pt. of a 4 lb. ae/gal conc., or 20 to 40 fl. oz. of a 4.5 lb. ae/gal. conc.
Product/gallon of water	1.3 to 2.6 fl. oz./gal. for annual weeds and 2.6 to 5.2 fl. oz./gal. for perennial weeds (3 lb. ae/gal. conc.)
Weed control spectrum	Annual and perennial grass and broadleaf weeds.
Leaching potential	Immobile.
Relative persistence	Nonpersistent.
Application information	Nonselective, postemergence, translocated herbicide with no soil residual. May be direct applied anywhere soil covers tree roots, but do not allow spray to contact bare or exposed roots of trees. Spray may contact hardened, mature bark of trees.
Labeled combinations	Several combinations are labeled that provide residual broad-spectrum weed control.
Comments	Effective treatment to control annual and perennial weeds before planting or in established plantings. Retreatment is necessary. Certain formulations can be used in watersheds, riparian areas, and in and around water. Avoid drift and all contact with desirable vegetation. Weeds should be actively growing at application. Use low pressure and coarse droplets to reduce droplet drift. Apply only in calm weather. Refer to label for adding surfactants and ammonium sulfate adjuvants to enhance weed control.

Trade name	**Stinger, Transline**
Common name	clopyralid
Formulations	3SL
Rate range (lb. ai/A)	0.094 to 0.50
Product/A	0.25 to 1.33 pt.
Product/gallon of water	0.25 fl. oz.
Weed control spectrum	Annual and perennial broadleaf weeds including Canada thistle and knapweeds.
Leaching potential	Moderately mobile.
Relative persistence	Moderately persistent.
Application information	Translocated, postemergence herbicide. Can be safely applied to several conifer species. Apply only to trees transplanted at least one year. Can injure or kill deciduous trees. Apply 0.25 to 0.5 pt/A for annual weeds and 0.5 to 0.67 pt/A for perennial weeds. Do not exceed 0.5 pt/A for blue spruce. For poplar and cottonwood plantations, apply to new planting only after they are well-established as indicated by several inches of new healthy growth.
Labeled combinations	No other combinations are labeled or specifically prohibited.
Comments	Effective on weeds in the Polygonum (e.g., wild buckwheat, smartweed) and Composite (sunflower) families. Apply to actively growing weeds. Avoid drift and all contact with desirable broadleaf vegetation. Do not apply over-the-top of actively growing conifers. Also, will severely damage or kill boxelder trees.

Table 4. Susceptibility of grass weeds to herbicides.

Trade name or common name when there are multiple formulations	Barnyardgrass	Bromegrass	Cheat	Crabgrass	Fescue	Field sandbur	Foxtail species	Quackgrass	Ryegrass, Annual	Wild oat
Casoron		C		C	C		C	C		
Finale	S	S	S	S	S	S	C	N	C	S
Fusilade/Ornamec	C	C	C	C	N	C	C	C	C	C
Gallery	S	N	N	C	S	N	S	N	S	N
glyphosate	C	C	C	C	C	C	C	C	C	C
Goal	C	N	N	S	N	N	S	N	N	S
Pendulum/Prowl	C	N	C	C	N	C	C	N	C	N
Poast/Vantage	C	S	C	C	N	C	C	S	S	C
Princep	C	C	C	S	C	S	C	S	S	C
Select	C	C	C	C	N	C	C	C	C	C
Snapshot	C	N	N	C	N	C	C	N	C	N
trifluralin	C	N	C	C	N	C	C	N	C	N

C = Control; S = Suppression; N = No control; Blank = No information available.

Table 5. Susceptibility of annual broadleaf weeds to herbicides.

Trade name or common name when there are multiple formulations	Common cocklebur	Common lambsquarters	Common ragweed	Curly dock	Fleabane	Kochia	Marestail	Mustard species	Nightshades	Prickly lettuce	Purslane	Redroot pigweed	Russian thistle	Smartweed	Sunflower	Wild buckwheat
Casoron	C	C	C	C				C	N		C	C	C	C	N	S
Finale	C	C	C	C		C	C	C	C	C	C	C	C	C	C	C
Gallery	N	C	C	S	C	C	C	C	C	C	C	C	C	C	N	N
glyphosate	C	C	C	C	C	C	C	C	S	C	C	C	C	C	C	S
Goal	C	C	S	C	S	C	C	C	C	C	C	C	C	C	S	C
Pendulum/Prowl	N	C	N	N	N	N	N	N	N	N	C	C	S	N	N	N
Princep	C	C	C	C		S		C	C	C	C	C	C	C	C	C
Snapshot	N	C	C	S	C	C	C	C	C	C	C	C	C	C	N	N
Stinger/Transline	C	S	C	C		N	C	N	C	C	N	N	N	C	C	C
trifluralin	N	C	N	N	N	N	N	N	N	N	S	C	S	N	N	N

C = Control; S = Suppression; N = No Control; Blank = No information available.

Mustard species include wild mustard, flixweed, field pennycress, shepherd's purse, and tansy mustard.

Table 6. Susceptibility of perennial broadleaf weeds to herbicides.

Product	Absinth Wormwood	Canada Thistle	Dandelion	Field Bindweed	Leafy Spurge	Common Milkweed	Perennial Sowthistle	Spotted Knapweed
Casoron		C	C	N	C	S	S	C
Finale	S	N	C	N	N	N	N	N
Gallery	N	N	C	S	N	N	N	N
glyphosate	C	C	C	S	S	C	S	C
Goal	N	N	N	N	N	N	N	N
Snapshot	N	N	C	S	N	N	N	N
Stinger/Transline	C	C	C	N	N	N	S	C
trifluralin	N	N	N	N	N	N	N	N

C = Control; S = Suppression; N = No Control; Blank = No information available.

Table 7. Herbicide names and formulations.

Product	Company	Common name	Concentration and formulation
Casoron	Uniroyal	dichlobenil	4% G
Finale	Bayer	glufosinate	1 lb/gal EC
Fusilade II	Syngenta	fluazifop-P	2 lb/gal EC
Gallery	Dow AgroSciences	isoxaben	75% DF
Goal	Dow AgroSciences	oxyfluorfen	2 lb/gal EC
Ornamec	PBI Gordon	fluazifop-P	0.5 lb/gal EC
Pendulum	BASF	pendimethalin	60% WDG
Poast	BASF	sethoxydim	1.5 lb/gal EC
Princep	Syngenta	simazine	4 lb/gal L, 90% DF
Prowl	BASF	pendimethalin	3.3 lb/gal EC
Select	Valent	clethodim	2 lb/gal EC
Snapshot	Dow AgroSciences	trifluralin + isoxaben	2.5% G
Stinger	Dow AgroSciences	clopyralid	3 lb/gal EC
Transline	Dow AgroSciences	clopyralid	3 lb/gal EC
Vantage	MicroFlo, Inc.	sethoxydim	1.5 lb/gal EC
glyphosate	-Many	glyphosate	3, 4, 4.5 SL
trifluralin	-Many	trifluralin	4 EC, 10 G

Table 8. Herbicides registered for use around various woody plants. Species list based on those approved by the Natural Resources Conservation Service for conservation plantings.

	Casoron	Finale	Fusilade/Ornamec	Gallery	glyphosates	Goal	Pendulum/Prowl	Poast/Vantage	Princep	Select	Snapshot	Stinger/Transline	trifluralins
▼ SMALL DECIDUOUS TREES													
Apricot	(x)		(x)	(x)		X	(x)	(x)	(x)		X	(x)	(x)
Flowering crabapple	X		X			X	X	X	X		X	X	X
Arnold hawthorn				(x)			X				(x)		(x)
Downy hawthorn				(x)			X				(x)		(x)
Amur/Tatarian maple	X		X	X			(x)	(x)			X		X
Russian-olive	X		X	X		X	(x)	X	X		X	X	X
Harbin/Ussurian pear	X		(x)	X		X	(x)	X	X		X		
▼ MEDIUM DECIDUOUS TREES													
Boxelder	X								X				
Black walnut	(x)			X		X	X	X	X		X	X	
Laurel willow	X		(x)	(x)			(x)	(x)			(x)		(x)
Missouri River willow	X		(x)	(x)			(x)	(x)			(x)		(x)
Peachleaf willow	X		(x)	(x)			(x)	(x)			(x)		(x)
▼ TALL DECIDUOUS TREES													
Green ash	X		X			X	X	X				X	(x)
Black ash	X		(x)			X	(x)	(x)				(x)	(x)
Manchurian ash	X		(x)			(x)	(x)	(x)				(x)	(x)
Quaking aspen	X					X	X	(x)					
Cottonwood	X			X		X	X	(x)			X	X	X
Siberian elm				(x)					X		(x)		(x)
Hackberry	X		X					X				X	
American linden / basswood	X						X	X					X
Bur oak	X		(x)	(x)		(x)	(x)	(x)	(x)		(x)	X	(x)
Hybrid poplars	X			(x)		X		X				X	
White poplar	X			(x)		X		X					
White willow	X		X	(x)			(x)	(x)			(x)		X
▼ SMALL CONIFERS													
Rocky Mountain juniper	X		X	X		X	X	X	X		X		X
Eastern redcedar	X		X	X		X	X	X	X		X	X	X
▼ MEDIUM/TALL CONIFERS													
Siberian larch								(x)				(x)	(x)
Black Hills spruce/White spruce			X	X		X	X	X	X		X	X	X
Colorado spruce			X	X		X	X	X	X		X		X
Scotch pine	X		X	X		X	X	X	X		X	X	X
Ponderosa pine	X		X	(x)		X	(x)	X	(x)		(x)	X	(x)

Table 8. – ***continued***

	Casoron	Finale	Fusilade/Ornamec	Gallery	glyphosates	Goal	Pendulum/Prowl	Poast/Vantage	Princep	Select	Snapshot	Stinger/Transline	trifluralins
▼ **DECIDUOUS SHRUBS**													
Russian almond	(x)		(x)	X		X	(x)	(x)	(x)		X	(x)	(x)
Silver buffaloberry													
Caragana / Siberian peashrub	X								X				
Chokecherry	X			(x)		X	X	(x)	(x)		(x)	X	(x)
Mongolian cherry	X			(x)		X	(x)	(x)	(x)		(x)	X	(x)
Nanking cherry	X			(x)		X	X	X	(x)		(x)	X	(x)
Black chokeberry			(x)	(x)			(x)	X			(x)		(x)
European cotoneaster	X		(x)	(x)			(x)	(x)	X		(x)		(x)
Peking cotoneaster	X		(x)	(x)			(x)	X	X		(x)		(x)
Cranberrybush			X					X			X		X
Golden currant				X				(x)			X		
Redosier dogwood	X		X	X		(x)	X	X	X		X		X
Forsythia, 'Meadowlark'	X		X	(x)			(x)				(x)		X
Honeysuckle, Amur	X		(x)								(x)		(x)
Honeysuckle, 'Freedom'	X		(x)								(x)		(x)
Honeysuckle, Tatarian	X		(x)								(x)		(x)
False indigo													
Juneberry				X			(x)	X					
Common lilac	X		(x)	X		X	X	X			X		X
Late lilac	X		X			(x)	(x)	(x)			(x)		(x)
Nannyberry			X				(x)	X			(x)		X
American plum	(x)		(x)	(x)		X	(x)	X	X		(x)	(x)	(x)
Rose, Hansen Hedge	X		X	X			X				X		X
Rose, Woods	X		X	(x)			X				(x)		(x)
Western sandcherry	(x)		(x)	(x)		X	(x)	X	(x)			X	(x)
Sea-buckthorn													
Silverberry	(x)		(x)	(x)		(x)	(x)	(x)	(x)		(x)	(x)	(x)
Snowberry													
Skunkbush sumac			(x)	(x)				(x)			(x)	X	(x)
Smooth sumac			(x)	(x)				(x)			(x)	X	(x)
Bebbs willow	X		(x)	(x)			(x)	(x)			(x)		X
Purple-osier willow	X		X	(x)			(x)	(x)			(x)		X
Sandbar willow	X		(x)	(x)			(x)	(x)			(x)		X

Notes: X = Tree species (or genus) is listed on the label.
(x) = This species or variety is not specifically listed on the label, but other related species are listed.
Blank = Not listed on the label and no related species listed.

Any vegetation growing between tree rows
and between trees within the row
will reduce available moisture and nutrients in the soil.

Weeds compete with trees by
quickly developing root systems
in the top several inches of soil,
which reduce water and nutrient availability
to tree roots.

Cover photo: Joe Zeleznik, NDSU Extension Service

For more information on this and other topics, see: www.ag.ndsu.edu

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