

SECTION X.

NONCROPLAND AND RIGHT-OF-WAY

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Vegetation Control

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Revised March 2019

Total vegetation control with soil-residual herbicides is a process in which the addition of chemicals renders the soil unfit for plant growth. Soil-residual herbicides do not kill all animal and micro-biological life in the soil.

Keep the following in mind when using soil-residual herbicides:

1. Identify the weeds that are to be controlled.
2. Know the area where the chemicals are to be used. Adjacent vegetation and terrain are important.
3. Develop a management plan. No single herbicide or other weed control practice will solve all weed problems.
4. Follow precautions when using soil-residual herbicides.
5. Prevent people, animals, and equipment from moving soil away from treated area. Avoid spray drift during application.
6. Avoid applying residuals where wind or water might move the treated soil.
7. Some herbicides vaporize easily. Reduce hazard by applying at lower temperatures and use low-volatile formulations.
8. Do not apply where roots of desirable vegetation may extend into treated area.
9. Some herbicides are poisonous to animals. Do not apply these to vegetation, fruit, or seed that might be eaten.
10. Apply soil-residual herbicides during late fall east of the Cascades to allow winter precipitation to move the herbicide into the soil. In the high-rainfall areas west of the Cascades, apply after the heavy winter rainy season but early enough to ensure adequate moisture to move the herbicide into the soil.
11. Ensure that these herbicides do not enter sources of irrigation water; some crops are extremely sensitive to some of these herbicides. Severe crop losses have been due to irrigation water contamination. Only use these herbicides on banks, canals, and streams if the label specifically allows that use.

Note Information in this handbook is not intended to be a complete guide to herbicide use. Before using any chemical, read the label recommendations on the container. Before a chemical can be recommended for a specific use, it must be thoroughly tested. Following the recommendation on the manufacturer's label can prevent many problems from the improper use of a chemical.

Grass and Broadleaf Weeds

asulam (Asulox)

Grass and brackenfern control only

Rate 3.34 lb ai/a (1 gal/a)

Time Crabgrass, paragrass, or Californiagrass: apply before seedheads form; Johnsongrass: apply when grass is 18 inches or taller; western brackenfern: apply when fern is in full frond.

Remarks A nonionic surfactant at 0.25% may be added to the spray solution.

Caution Do not graze treated areas.

Site of action Group 18: inhibits DHP synthase steps

Chemical family Carbamate borate sodium chlorate or mixtures (several products).

borate sodium chlorate or mixtures (several products)

Rate Refer to specific labels.

Time Apply either preemergence or postemergence.

Remarks These two materials are combined in several different proprietary herbicides. Most can be applied either dry or as a spray, depending on the formulation. For rates, application times, use restrictions, and precautions, consult label of each proprietary mixture.

Caution If used alone, sodium chlorate creates a fire hazard by increasing the flammability of any combustible material. The metallic salts of boron (borates) combined with sodium chlorate act as a fire retardant and overcome most of the fire hazards inherent in sodium chlorate. Sodium chlorate is toxic to livestock, because they like its salty taste. Do not allow livestock to come in contact with treated areas.

Site of action None generally accepted

Chemical family Inorganic

bromacil + diuron (Krovar I DF)

Rate 4.8 to 9.6 lb ai/a (6 to 12 lb/a)

Time Fall or late winter east of the Cascades, in March or early April west of the Cascades.

Remarks Rain is needed after application for weed control. Use higher rate where deep-rooted, hard-to-kill perennial weeds are dominant. Reduced rates may be used for maintenance re-treatment as needed.

Caution This material has a long soil residual. Do not use in areas where roots of desirable vegetation may extend.

Site of action (bromacil) Group 5: photosystem II inhibitor; (diuron) Group 7: photosystem II inhibitor

Chemical family (bromacil) uracil; (diuron) substituted urea

chlorsulfuron + sulfometuron + sulfentrazone (Throttle XP)

Rate 12.5 oz/a

Time Apply preemergence or early postemergence to weeds.

Remarks Not recommended for paved areas but for farmyards, fuel storage areas, fence rows and industrial sites.

Caution Do not apply to powdery, dry soil or sandy soil if there is little likelihood of rainfall soon after treatment because of dust particles that move the herbicide to sensitive plants. Do not tank mix with HYVAR X-L.

Site of action (chlorsulfuron, sulfometuron) Group 2: acetolactate synthase (ALS) inhibitor, (sulfentrazone) Group 14: protoporphyrinogen oxidase inhibitor

Chemical family Sulfonylurea, Triazinone

dichlobenil (Casoron)

Rate 4 to 8 lb ai/a

Time Apply during late fall through early spring when temperatures are cool. Thoroughly incorporate into the soil surface by applying irrigation water.

Remarks For preemergent and early postemergent (less than 2 inches) control only. Use 4 to 6 lb ai/a for annual weeds, 6 to 8 lb ai/a for perennial weeds, and 10 lb ai/a (250 lb/a) for yellow nutsedge. Do not disturb treated areas after applying.

Caution Do not apply on top of frozen soil.

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

Chemical family Nitrile

diquat (Diquat or Reglone)

Rate 0.25 to 0.5 lb ai/a for broadcast treatments, 0.5 to 1 lb ai/a for spot treatment

Time Apply when weeds are young.

Remarks Diquat is a contact herbicide that kills only the tops of most perennial weeds. Use 8 to 16 oz of a nonionic surfactant per 100 gal water.

Caution A moderately toxic herbicide that requires protective gear for handling and application. Do not let spray contact skin, eyes, or clothing. Do not breathe spray mist.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyridilium

dithiopyr (Dimension 2EW)

Rate 2 pints product/a

Time Apply preemergence to weeds, affects some grass and broadleaf species.

Remarks Activated by 1/2 inch or more of rainfall. Litter can reduce effectiveness. Forage cannot be used by livestock. Can be applied at 3 to 4 month intervals to extend preemergent control, but no more than 6 pints product/a per year should be applied.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Pyridine

diuron (Karmex DF)

Rate 4 to 12 lb ai/a

Time Apply in fall or late winter east of the Cascades and in spring west of the Cascades.

Remarks Use higher rates for perennial weed control, lower rates for annual weed control. Make maintenance applications on areas previously treated by applying 6 to 8 lb ai/a. Does not control certain tap-rooted perennial and biennial weeds such as buckhorn plantain, wild carrot, and dandelion.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

glyphosate

Rate 0.75 to 3.75 lb ae/a

Time Apply to foliage of actively growing weeds and grasses at growth stage label recommends.

Remarks Use lower rates for annual weed control, higher rates for perennial weeds. Use enough water carrier for complete coverage but not to the point of runoff. Established perennials may require retreating; glyphosate is highly translocated and has no soil activity. In wick or wiper equipment, mix 1 gal glyphosate in 2 gal water to prepare a 33% solution. Operate equipment no faster than 5 mph. Performance may be improved by reducing speed in areas of heavy weed infestations to ensure adequate wiper saturation. Results may be better with two applications made in opposite directions.

Caution Rain within 12 hours of application may reduce effectiveness. Do not mow or till before treatment. Do not use glyphosate in galvanized or mild steel tanks.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

glyphosate + 2,4-D (Landmaster BW)

Rate 104 oz/a product or 1% solution for spot spraying

Time Apply to foliage of actively growing weeds and grasses at growth stage label recommends.

Remarks To control labeled annual weeds and suppress perennials on farmsteads, along fence rows, and in dry ditches. For spot spraying, thoroughly cover target weeds but not to point of runoff.

Caution Do not let spray drift onto desirable vegetation. Control may be reduced if plants are stressed. Heavy dust on foliage or rain or irrigation within 6 hours after application may reduce effectiveness.

Site of action (glyphosate) Group 9: inhibits EPSP synthase; (2,4-D) Group 4: synthetic auxin

Chemical family (glyphosate) none generally accepted; (2,4-D) phenoxy acetic acid

hexazinone (Velpar L or Velpar DF)

Rate 1 to 3 lb ai/a

Time Apply before rain to fully activate. Provides some foliar activity.

Remarks Apply preemergence. Use low rates for annual weed control and high rates for perennial weeds. See label for susceptible weeds, use restrictions, and precautions.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

hexazinone + sulfometuron (Westar)

Rate 2 to 4 lb product/a

Time Apply before rain to fully activate.

Remarks Apply before or shortly after weeds emerge. Provides some foliar activity. Use the lower rate on coarse soils. Do not tank mix with bromacil (Hyvar). See label for susceptible weeds, use restrictions, and precautions.

Site of action (hexazinone) Group 5: photosystem II inhibitor; (sulfometuron) Group 2: acetolactate synthase (ALS) inhibitor

Chemical family (hexazinone) triazine; (sulfometuron) sulfonyleurea

imazapic (Plateau, Panoramic)

Rate 0.063 to 0.188 lb ai/a

Time Apply before or shortly after annual weeds emerge. For perennial weeds, follow label directions.

Remarks To control labeled annual and perennial weeds. See label for best time for perennial weeds. Effective on downy brome, African wiregrass, and medusahead wildrye. Effectiveness may be poor if dense litter is present.

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

Chemical family Imidazolinone

imazapyr (Arsenal, or Stalker)

Rate 0.25 to 1.5 lb ai/a

Time Apply before, or soon after, weeds emerge.

Remarks For postemergence control with residual control of many annual and perennial weed species. In most situations, best applied postemergence to vigorously growing weeds.

Caution Do not apply where chemical may contact roots of desirable trees or plants.

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

Chemical family Imidazolinone

indaziflam (Esplanade 200 SC)

Rate 3.5 to 7 oz/a

Time Apply preemergence to weeds.

Remarks Controls many annual grasses and broadleaf weeds.

Caution Do not apply more than 10 oz/a per year. Keep away from surface water, at least 25 feet, and areas below the mean watermark.

Site of action Group 29: cellulose biosynthesis inhibitor

Chemical family Alkylazine

isoxaben + trifluralin (Snapshot2.5TG)

Rate Consult labels.

Time Apply before weeds germinate.

Remarks Controls annual grass and broadleaf weeds. Areas treated should be free from established weeds. Overhead moisture required to move herbicide into soil.

Site of action (isoxaben) Group 21: inhibits cell wall synthesis Site B; (trifluralin) Group 3: microtubule assembly inhibitor

Chemical family (isoxaben) benzamide; (trifluralin) dinitroaniline

linuron (Lorox)

Rate 1 to 3 lb ai/a

Time Apply shortly before weed growth begins, or at early seedling stage.

Remarks For established annual weeds, add surfactant at 2 quarts/100 gal spray mixture. Apply when daily air temperatures exceed 70°F and before weeds are more than 8 inches high. Best results are with rain or irrigation within 2 weeks of application. See label about soil types.

Caution Do not enter treated area for 24 hours after applying unless wearing protective clothing.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

norflurazon (Solicam DF)

Rate 1.97 to 3.9 lb ai/a

Time Apply in fall to early spring before weeds germinate.

Remarks Adjust rates depending on soil texture and organic matter. Mechanically remove or control existing weeds with a suitable postemergent herbicide.

Site of action Group 12: bleaching; inhibits carotenoid biosynthesis

Chemical family Pyridazinone

organic arsenicals (MSMA)

Rate See labels.

Time See labels.

Remarks These are broad-spectrum contact herbicides with no soil-residual activity. Only the tops of most perennial weeds will be killed. Repeated re-treatments are necessary. Use 0.25% of a nonionic adjuvant to enhance weed control.

Caution **Not registered for use in Oregon.** Application at temperatures below 70°F usually results in poor weed control.

Site of action Group 17: not well understood

Chemical family Organoarsenical

oryzalin (Surflan Specialty Herbicide)

Rate 2 to 6 lb ai/a

Time Apply before weeds germinate and when moisture can move herbicide into the soil.

Remarks Length of control depends on rate applied. If weeds are present at time of treatment, tank mix with an approved postemergence herbicide.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

paraquat (Gramoxone SL 2.0)

Rate 1.5 to 3 pints/a

Time Apply when weeds are young and succulent.

Remarks Paraquat is a contact herbicide that kills only the tops of most perennial weeds. Re-treatments are necessary. Add a nonionic surfactant or crop oil concentrate as directed on the label to spray. Use enough water (usually at least 20 gal/a) to thoroughly cover weeds.

Caution A restricted-use herbicide. Do not use around homes or other areas contacted by children or pets. Do not breathe spray mist. Do not let spray contact skin or clothing.

Site of action Group 22: photosystem I electron diversion

Chemical family Bipyrilidium

pendimethalin (Pendulum 3.3 EC, Prowl H2O)

Rate 2 to 4 lb ai/a (2.4 to 4.8 quarts/a product)

Time Preemergence grass and broadleaf weed control.

Remarks Will not control established weeds. Treatments are most effective when it rains within 30 days after application or incorporated after application.

Caution Toxic to fish. Do not apply directly to water or to wetlands.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

penoxsulam + oxyfluorfen (Cleantraxx)

Rate 3 to 4.5 pints/a

Time Apply prior to emergence of weeds.

Remarks Apply for pre- and postemergent control of weeds. High rate for preemergent application will increase duration of control. Grass and broadleaf weeds are controlled, see label for weeds that require more than 3 pints/a. Requires 0.5 inches of precipitation to activate within 21 days of application.. Apply in 10 to 30 gallons of spray per acre.

Caution Do not apply more than 4.5 pints/a in a crop season. Keep application at least 25 feet from any water body.

Site of action Group 2, 14: acetolactate synthase (ALS) inhibitor, protoporphyrinogen oxidase inhibitor

Chemical family Triazolopyrimidine, Diphenylether

prometon (Pramitol)

Rate 10 to 15 lb ai/a

Time Apply at weed emergence or within 2 to 3 months after spring growth begins.

Remarks Prometon has foliage and root action and has been one of the most effective broad-spectrum herbicides for organic and alkaline soils. Prometon is formulated as a liquid for spray application and as a granular in combination with simazine, borate, and sodium chlorate for spot application.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

rimsulfuron (Matrix, Laramie)

Rate 2 to 4 oz /a

Time Apply before or soon after weeds emerge.

Remarks Controls many annual grasses, and some annual broadleaf species. Add a nonionic surfactant at 1 quart/100 gal spray to improve activity.

Caution Consult label if there are plans to seed grasses after application.

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

Chemical family Sulfonylurea

sulfometuron (Oust)

Rate 1 to 6 oz ai/a (1.33 to 8 oz/a product)

Time Apply before or soon after weeds emerge for nonselective control. Rain required to fully activate herbicide.

Remarks Controls many annual broadleaf weeds, some grasses, and certain perennial broadleaf species. Rates depend on weed species and desired duration of weed control. The 1-oz ai/a rate selectively controls certain grasses. Add a nonionic surfactant at 1 quart/100 gal spray to improve activity.

Caution If rain is limited, Oust may not satisfactorily control hard-to-kill perennials. Do not apply during periods of intense rain, or when soils are water-saturated. Do not treat powdery, dry soils and light, sandy soils unless rain is likely after treatment. Do not let spray drift to adjacent crops.

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

Chemical family Sulfonylurea

Broadleaf Weeds

aminocyclopyrachlor (Method)

Rate 4 to 18 oz/a

Time Apply preemergence or postemergence when weeds are actively germinating or growing

Remarks Do not apply where roots of woody plants extend unless injury or loss can be tolerated. The root zone can extend beyond the canopy. Even low rates can kill nontarget tree and shrub species. Sensitive trees include, but are not limited to, ponderosa pine, Douglas-fir, Norway spruce, white pine, aspen, Chinese tallow, cottonwood, honey locust, magnolia, poplar, redbud, silver maple, and willow. Individual plant treatments are allowed on sites transecting areas grazed by livestock.

Site of action Group 4 synthetic auxin

Chemical family Phenoxy acetic acid

aminocyclopyrachlor + chlorsulfuron (Perspective)

Rate 0.7 to 3.2 oz/a aminocyclopyrachlor + 0.3 to 1.3 oz/a chlorsulfuron (1.75 to 8 oz/a of product)

Time Apply to broadleaf weeds in fall or spring.

Remarks Adjuvants can be used; these include methylated seed oils 0.5 to 1% v/v, nonionic surfactants at 0.25 to 1% v/v, and crop oil concentrates at 1%v/v. Can be applied using an invert emulsion rather than water.

Caution Even low rates can kill nontarget tree and shrub species, so avoid application to sensitive species within a distance equal to their height. Do not allow spray to drift off target. Can injure several grass species including bromes, as well as basin wildrye.

Site of action Group 4 synthetic auxin (aminocyclopyrachlor)
Group 2: ALS inhibitor (chlorsulfuron)

Chemical family Phenoxy acetic acid (aminocyclopyrachlor);
sulfonylurea (chlorsulfuron)

aminopyralid (Milestone)

Rate 0.75 to 1.75 oz ae/a (3 to 7 fl oz/a Milestone)

Time Apply to actively growing weeds. Consult label for specific weeds.

Remarks Effective on knapweeds, biennial thistles, Canada thistle, perennial sowthistle, horseweed (marestalk) and hawkweed. A nonionic surfactant at 1 to 2 quarts/100 gal spray enhances control under adverse environmental conditions. Application rate depends on weed species and stage of growth.

Caution Do not allow drift to desirable vegetation. Do not exceed 7 fl oz/a Milestone per year.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

aminopyralid + metsulfuron (Opensite)

Rate 1 to 3.3 oz product/a

Time Postemergent to young, actively growing plants.

Remarks Effective on some species within Asteraceae, Brassicaceae, Boraginaceae, and Fabaceae but will control species from other plant families as well.

Caution Do not use plant residues for compost or mulch if the compost will be applied to susceptible broadleaf plants such as potato, tomato, and peas.

Site of action Group 4: synthetic auxin, Group 2: acetolactate synthase (ALS) inhibitor

Chemical family (aminopyralid) Pyridine ; (metsulfuron) Sulfonyleurea

aminopyralid + triclopyr (Capstone)

Rate 4 to 6 pints product/a

Time Postemergent to young, actively growing plants.

Remarks Effective on some species within Asteraceae, Brassicaceae, Boraginaceae, and Fabaceae but will control some species from other families as well.

Caution Do not use plant residues for compost or mulch if the compost will be applied to susceptible broadleaf plants such as potato, tomato, and peas

Site of action Group 4: synthetic auxin

Chemical family Pyridine

bromoxynil (Buctril)

Rate 0.25 to 0.5 lb ai/a

Time Postemergent, when weeds are actively growing.

Remarks Apply to broadleaf weeds before four-leaf stage or less than 2 inches high or 1 inch across, whichever comes first. Adding surfactant or crop oil concentrate may improve broadleaf weed burn down under cool, dry conditions.

Caution Do not allow grazing in treated areas. Do not apply through backpack or hand-held application equipment.

Site of action Group 6: photosystem II inhibitor

Chemical family Nitrile

chlorsulfuron (Telar)

Rate 0.75 to 2.25 oz ai/a (1 to 3 oz/a)

Time Apply preemergence or postemergence to weeds. For best results, apply postemergence to young actively growing weeds any time except when ground is frozen.

Remarks Adequate moisture (rain) is needed to activate herbicide. In postemergence applications, a nonionic surfactant must be added at 1 quart/100 gal spray.

Caution Agitation is required. Do not apply to soils saturated with moisture or during periods of intense rain. Degree of control and duration of effect varies with amount of chemical applied, soil texture, soil pH, soil organic matter, weed size, rain, and other factors.

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

Chemical family Sulfonyleurea

clopyralid (Transline)

Rate 0.09 to 0.5 lb ae/a

Time After weeds have emerged and, depending on species, up to bud stage.

Remarks Effective on weeds in the Asteraceae (sunflower), Polygonaceae (knotweed), and legume families. Plants should be actively growing at time of treatment. Wet foliage at time of treatment may decrease control.

Caution Do not contaminate irrigation ditches or water for irrigation or domestic use. Do not allow spray drift to contact potatoes, beans, or certain other crops.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

clopyralid + 2,4-D (Curtail)

Rate 2 to 4 quarts/a Curtail

Time Apply after most knapweed rosettes have emerged but before flower stem elongates. Apply to Canada thistle before bud stage.

Remarks Effective on diffuse and spotted knapweed and Canada thistle. Also controls many other weeds in the composite and legume families.

Caution Do not contaminate irrigation ditches or water for irrigation or domestic use. Do not allow spray drift to contact potatoes, beans, or certain other crops.

Site of action (both) Group 4: synthetic auxin

Chemical family (clopyralid) pyridine; (2,4-D) phenoxy acetic acid

dicamba (Banvel, Trooper, Vanquish, Rifle, or Clarity)

Rate 0.25 to 2 lb ai/a

Time Apply to actively growing vegetation.

Remarks Controls many annual and perennial broadleaf weed species as well as brush. Other herbicides often are combined and sold under a variety of trade names. Consult label for rates, times of application, use restrictions, and preparations for each of these proprietary mixtures.

Caution Do not use in areas where roots of desirable vegetation may extend.

Site of action Group 4: synthetic auxin

Chemical family Benzoic acid

diflufenzopyr + dicamba (Overdrive)

Rate 0.175 to 0.35 lb ae/a (4 to 8 oz/a)

Time Apply to actively growing broadleaf weeds.

Remarks Controls many annual, biennial, and perennial broadleaf weeds and vine species, including biennial thistle, Canada thistle, kochia, and marestalk (horseweed). Rate depends on weed species and growth stage at time of treatment. For improved uptake, use a nonionic surfactant or a methylated seed oil on

hard-to-control perennials and waxy-leaf species or when weeds are under moisture or temperature stress.

Caution Do not plant any crop within 30 days of application. Do not exceed 10 oz/a of Overdrive per season.

Site of action (diflufenzopyr) Group 19: inhibits indole-acetic acid transport; (dicamba) Group 4: synthetic auxin

Chemical family (diflufenzopyr) semicarbazone; (dicamba) benzoic acid

flumioxazin (Payload)

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

Time Preemergence, to bare soil, or postemergence.

Remarks Broadleaf weed control but weak on most grasses. Do not exceed 0.38 lb ai/a per application or 0.75 lb ai/a per year. Moisture is required to activate preemergence applications. Adding an adjuvant enhances postemergence applications; good spray coverage is required.

Site of action Group 14: protoporphyrinogen oxidase inhibitor

Chemical family N-phenylphthalimide

fluroxypyr (Vista XRT)

Rate 0.125 to 0.5 lb ae/a

Time Apply when weeds are small and/or actively growing.

Remarks Apply in spray volume of 3 gal/a or more by air or 5 gal/a or more by ground. Do not exceed 40 gal/a total spray volume. Spot treatments may be applied with a calibrated boom or hand sprayer. Only weeds emerged at treatment are controlled. Control may decrease if foliage is wet at time of application. Grasses are tolerant of fluroxypyr, but larger kochia is effectively controlled.

Caution Do not apply when weather conditions favor drift from treated areas. Do not exceed 0.5 lb ae/a (2.67 pints/a) per year.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

isoxaben (Gallery)

Rate 0.5 to 1 lb ai/a

Time Apply before germination.

Remarks Area should be free from established weeds before application.

Site of action Group 21: inhibits cell wall synthesis Site B

Chemical family Benzamide

MCPA (several products)

Rate 3 lb ai/a

Time Spray to wet weeds thoroughly when in bud to early bloom and again on fall regrowth.

Remarks Controls Canada thistle, whitetop, and meadow buttercup.

Caution Do not cut forage on treated areas within 7 days of treatment.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

metsulfuron (Escort)

Rate 0.3 to 1.8 oz ai/a (0.5 to 3 oz/a)

Time For best results, apply postemergence to young, actively growing weeds or brush. Selective to many grasses. May combine with other products to broaden weed-control spectrum.

Remarks For postemergence applications, include a nonionic or silicone surfactant at 0.25% by volume. Good coverage is essential for control.

Caution Agitation required. Do not allow spray to drift to crops or other valuable plants or trees.

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

Chemical family Sulfonylurea

picloram (Tordon)

Rate 0.125 to 1 lb ae/a

Time Apply to foliage of actively growing weeds and brush.

Remarks Picloram has soil-residual activity. It is formulated in several mixtures including combinations with 2,4-D.

Caution Most formulations are restricted-use herbicides. Follow all use restrictions and precautions on label.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

picloram + 2,4-D (Graslan)

Rate 0.66 to 2.66 pints/a

Time Apply to foliage of actively growing weeds. Use 0.66 to 1.25 pints/a in early to mid-spring when weeds are less than 3 inches tall and higher rates mid to late season when weeds are over 3 inches to flowering.

Remarks Picloram has soil-residual activity.

Caution Restricted-use herbicide: Follow all use restrictions and precautions on label.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

quinclorac (Paramount)

Rate 4 to 6 oz ai/a (5.3 to 8 oz/a)

Time Apply to actively growing weeds.

Remarks Timing and rate of application depends on target weeds. Controls field bindweed, leafy spurge, sowthistle, Canada thistle, and clovers. Must add methylated seed oil at 1 to 2 pints/a or crop oil concentrate at 2 pints/a. Plant uptake is through foliage and roots. Rain after application is important for soil uptake.

Caution Do not exceed 12 oz ai/a per calendar year. Do not allow to drift to sensitive crops. Do not apply to water or to irrigation ditches or areas that channel water entering cropland.

Site of action Group 4: synthetic auxin

Chemical family Quinoline carboxylic acid

tebuthiuron (Spike 80 DF)

Rate 1 to 4 lb ai/a

Time Apply in fall east of the Cascades and in spring west of the Cascades.

Remarks Use higher rates for perennial weed control, lower rates for annual weed control and maintenance treatments.

Caution Spike will kill trees, shrubs, and other desirable vegetation if roots extend into the treated area.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

triclopyr (Garlon 3A)

Rate 0.25 to 3 gal/a

Time Apply when woody plants and weeds are actively growing. The ester formulation may be used in the dormant season. See label for instructions.

Remarks Controls certain perennial broadleaf weeds and woody plants. Rates depend on weed species, stage of maturity, and environmental conditions. If using lower rates on hard-to-control species, they may resprout a year later.

Caution See label for grazing restrictions.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

triclopyr + 2,4-D (Crossbow)

Rate 1 quart to 4 gal/a, depending on weed species

Time Apply during warm weather, when brush and weeds are actively growing.

Remarks Controls most species of unwanted woody plants as well as annual and perennial broadleaf weeds.

Caution Application under drought conditions may provide less than desirable results. Use low spray pressures to minimize spray drift. Avoid contacting nearby susceptible crops or other desirable plants. Avoid contaminating water for irrigation or domestic use. Do not use or store near heat or open flame.

Site of action (both) Group 4: synthetic auxin

Chemical family (triclopyr) pyridine; (2,4-D) phenoxy acetic acid

Chemical family Pyridine

triclopyr choline (Vastlan)

Rate 1 to 2 quarts/a product

Time Apply when woody plants and broadleaf weeds are actively growing.

Remarks Adjust rate for type of vegetation to be controlled. Controls both emerged herbaceous and woody broadleaf plants. To control biennial thistles or other biennial species, apply before flower stalks appear. Add an approved nonionic surfactant to the spray mix and use at least a spray volume of 10 gal/a.

Caution Do not allow drift to desirable vegetation. Do not apply more than 2 quarts/a Vastlan in a growing season. Many forbs (desirable broadleaf plants) can be seriously injured or killed.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

2,4-D (several products)

Rate 1 to 4 lb ae/a

Time Apply when annual weeds are young and growing vigorously. Apply when perennial weeds are growing rapidly—generally, near the bud stage. Repeated applications may be necessary.

Remarks Controls many annual, biennial, and perennial broadleaf weeds.

Caution Do not apply when conditions favors drift from treated areas. Do not contaminate water for irrigation or domestic use.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

Brush

2,4-D LV ester (several products)

Rate 1.9 to 7.6 lb ae/a, depending on target species

Time Apply when woody plants are in full leaf and actively growing.

Remarks Use higher rates if plants are stressed. Adding oil or wetting agents and/or using high carrier volumes may enhance control.

Caution Applications to stressed plants may reduce control. Do not allow spray to drift off target.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

aminocyclopyrachlor (Method)

Rate 10-18 oz/a

Time Apply preemergence or postemergence when weeds are actively germinating or growing.

Remarks Do not apply where roots of woody plants extend unless injury or loss can be tolerated. The root zone can extend beyond the canopy. Even low rates can kill nontarget tree and shrub species. Sensitive trees include, but are not limited to, ponderosa pine, Douglas-fir, Norway spruce, white pine, aspen, Chinese tallow, cottonwood, honey locust, magnolia, poplar, redbud, silver maple, and willow. Individual plant treatments are allowed on sites transecting areas grazed by livestock.

Site of action Group 4 synthetic auxin

Chemical family Phenoxy acetic acid

aminocyclopyrachlor + metsulfuron methyl (Streamline)

Rate 3.8 to 4.5 oz/a aminocyclopyrachlor + 1.2 to 1.4 oz/a metsulfuron (9.5 to 11.5 oz/a of product)

Time Apply to actively growing woody plants.

Remarks Adjuvants can be used; these include methylated seed oils 0.5 to 1% v/v, nonionic surfactants at 0.25 to 1% v/v, and crop oil concentrates at 1% v/v. Can be applied using an invert emulsion rather than water. There are several application methods that dictate the amount of product to be mixed with the carrier, so consult the label. Controls woody and herbaceous species.

Caution Do not apply where roots of woody plants extend that you don't want injured. The root zone can extend beyond the tree canopy and for some trees, a distance equal to tree height will reduce chance of injury. Even low rates can kill nontarget tree and shrub species. Conifers can be injured including ponderosa pine, Douglas-fir, Norway spruce, and white pine. Other trees that can be injured include aspen, Chinese tallow, cottonwood, honey locust, magnolia, poplar, redbud, silver maple, and willow. Applications to stressed plants may reduce control. Do not allow spray to drift off target.

Site of action Group 4 synthetic auxin (aminocyclopyrachlor) Group 2: ALS inhibitor (metsulfuron methyl)

Chemical family Phenoxy acetic acid (aminocyclopyrachlor); sulfonyleurea (metsulfuron methyl)

dicamba (Banvel, Trooper, Rifle, or Clarity)

Rate 0.25 to 2 lb ai/a

Time Apply to actively growing vegetation.

Remarks Controls many annual and perennial broadleaf weed species as well as brush. Other herbicides often are combined and sold under a variety of trade names. Consult label for rates, times of application, use restrictions, and preparations for each of these proprietary mixtures.

Caution Do not use in areas where roots of desirable vegetation may extend.

Site of action Group 4: synthetic auxin

Chemical family Benzoic acid

fosamine (Krenite S)

Rate 6 to 24 lb ai/a

Time Apply in late summer or early fall before fall coloration.

Remarks Apply as a foliar spray to brush. Can be used in either air or ground equipment. Susceptible treated plants fail to refoliate the following spring. Total spray coverage is required.

Site of action Not well understood

Chemical family Organophosphorus

glyphosate

Rate 1.5 to 3.75 lb ae/a, depending on target species

Time Apply to foliage of actively growing woody plants.

Remarks Results are best if applied in late summer or fall after fruit forms. In arid areas, results are best if applied in spring to early summer when brush species have high moisture content.

Caution Control may be reduced if applied to stressed plants or after a fall frost.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazapyr (Arsenal, Arsenal Applicator Concentrate, or Chopper)

Rate 0.25 to 1.5 lb ai/a

Time Apply postemergence to weeds or brush.

Remarks Controls most annual and perennial grasses, broadleaf weeds, vines, brambles, and woody brush and tree species for forest management site preparation and release.

Caution Do not apply where chemical may contact roots of desirable trees or other plants.

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

Chemical family Imidazolinone

metsulfuron (Escort)

Rate 0.6 to 1.2 oz ai/100 gal (1 to 2 oz/a)

Time Apply to brush when brush is fully leafed out until the beginning of fall leaf color.

Remarks Rate depends on species to be controlled. Adding a nonionic surfactant enhances activity. Complete coverage of all leaves and stems is required.

Caution Do not allow spray to drift to adjacent crops or other valuable plants or trees.

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

Chemical family Sulfonylurea

picloram (Tordon)

Rate 0.125 to 1 lb ae/a

Time Apply to foliage of actively growing weeds and brush.

Remarks Picloram has soil residual activity. It is formulated in several mixtures, including combinations with 2,4-D.

Caution Most formulations are restricted-use herbicides. Follow all use restrictions and precautions on label.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

tebuthiuron (Spike 20P)

Rate 3.75 to 5 lb product/a, (broadcast), 1/8 to 3/8 oz product per 100 sq ft (individual shrub)

Time East of the Cascades, apply in fall; west of the Cascades, apply in spring.

Remarks Rate depends on species to be controlled. Requires rain to move into soil.

Caution Kills desirable trees, shrubs, and other vegetation with roots in the treated area. Apply only once per year.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

triclopyr (Garlon 4 Ultra)

Rate 1 to 6 qt/a, depending on weed species, maturity stage, and environmental conditions

Time Apply when woody plants and weeds are actively growing. The ester formulation may be used in the dormant season. See label for instructions.

Remarks Controls certain perennial broadleaf weeds and woody plants. If lower rates are used on hard-to-control species, they may resprout a year later.

Caution On range and pasture sites use no more than 2 qt/a. See label for grazing restrictions.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

triclopyr + 2,4-D (Crossbow)

Rate 1 quart to 4 gal product/a

Time Apply during warm weather when brush and weeds are actively growing.

Remarks Controls most species of unwanted woody plants as well as annual and perennial broadleaf weeds. Rates depend on weed species.

Caution Application during drought may have less-than-desired results. Use low spray pressure to minimize spray drift. Avoid contacting nearby susceptible crops or other desirable plants. Avoid contaminating water for irrigation or domestic use. Do not use or store near heat or open flame.

Site of action (both) Group 4: synthetic auxin

Chemical family (triclopyr) pyridine; (2,4-D) phenoxy acetic acid

Under Asphalt

bromacil (Hyvar X)

Rate 4.8 to 12 lb ai/a

Time Apply immediately before paving to avoid lateral movement of the herbicide as a result of soil movement due to rain or mechanical activity.

Remarks Remove rhizomes, tubers, and other vegetative plant parts by scalping with a grader blade before application.

Caution Do not use under pavement in residential or recreational areas. Desirable plants may be injured if their roots extend into treated areas or if planted in treated areas.

Site of action Group 5: photosystem II inhibitor

Chemical family Uracil

bromacil + diuron (Krovar IDF)

Rate 17 to 30 lb product/a

Time Apply immediately before paving to avoid lateral movement of the herbicide as a result of soil movement due to rain or mechanical activity.

Remarks Before applying, use a grader blade to scalp and remove rhizomes, tubers, and other vegetative plant parts.

Caution Do not use under pavement in residential or recreational areas. Desirable plants may be injured if their roots extend into treated areas or if planted in treated areas.

Site of action (bromacil) Group 5: photosystem II inhibitor; (diuron) Group 7: photosystem II inhibitor

Chemical family (bromacil) uracil; (diuron) substituted urea

dichlobenil (Casoron or Barrier)

Rate 10 lb ai/a (Barrier or 12 lb ai/a (Casoron))

Time Apply after final grade is established.

Remarks Do not move soils after applying. Pave as soon as possible after applying. Forms a vapor barrier, preventing roots and shoots from penetrating. Reportedly, this product is safe to use near desirable vegetation. For resurfacing work, control existing weeds before applying dichlobenil.

Caution Herbicide will volatilize and be lost if not immediately covered by asphalt.

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

Chemical family Nitrile

imazapic (Plateau, Imazapic E 2SL)

Rate 0.1875 lb ai/a (12 oz/a product)

Time Apply to soil surface after final grade is established.

Remarks Incorporation improves control if soil is not moist at treatment. Incorporate imazapic 2 inches into soil using a rototiller or disc, or with 1 inch of rain or irrigation.

Caution Do not let treated soil wash or move into untreated area. Desirable plants may be injured if their roots extend into treated areas or if planted in treated areas.

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

Chemical family Imidazolinone

imazapyr (Arsenal)

Rate 1.5 lb ae/a

Time Apply after final grade is established.

Remarks Before applying, use a grader blade to scalp and remove rhizomes, tubers, and other vegetative plant parts. Apply in at least 100 gal/a water. Pave as soon as possible after application. If soil is not moist at application, use a rototiller or disc to incorporate 4 to 6 inches deep. Rain or 1 inch of irrigation also provides uniform incorporation. Use only in industrial sites or where the pavement has a suitable barrier along the perimeter to prevent root encroachment of desirable plants.

Caution Do not let treated soil wash or move into untreated areas. Desirable plants may be killed or injured if herbicide is applied where roots are or may extend. See label for areas where this product can be used.

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

Chemical family Imidazolinone

imazapyr + diuron (Sahara)

Rate 10 lb/a

Time Apply immediately before paving to avoid lateral movement of the herbicide as a result of soil movement due to rain or mechanical activity.

Remarks Before applying, use a grader blade to scalp and remove rhizomes, tubers, and other vegetative plant parts. If soil is not moist at application, incorporate herbicide mechanically. Use only in industrial sites or where pavement has a suitable barrier along the perimeter to prevent root encroachment of desirable plants.

Caution Do not use under pavement in residential or recreational areas. Desirable plants may be injured if their roots extend into treated areas or if planted in treated areas.

Site of action (imazapyr) Group 2: acetolactate synthase (ALS) inhibitor; (diuron) Group 7: photosystem II inhibitor

Chemical family (imazapyr) imidazolinone; (diuron) substituted urea

pendimethalin (Pendulum 3.3EC)

Rate 2 to 4 lb ai/a (2.4 to 4.8 quarts/a)

Time Apply after final grade is established.

Remarks Remove rhizomes, tubers, and other vegetative plant parts by scalping with a grader blade before application.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

prometon (Pramitol 25E)

Rate 7.5 to 10 gal/a

Time Apply after final grade is established.

Remarks Remove rhizomes, tubers, and other vegetative plant parts by scalping with a grader blade before application. Apply in at least 100 gal/a water. Pave as soon as possible after applying.

Caution Do not allow treated soil to wash or move into untreated area. Do not apply under asphalt coatings less than 2 inches thick. Desirable plants may be killed or injured if herbicide is applied where roots are or may extend.

Site of action Group 5: photosystem II inhibitor

Chemical family Triazine

sodium chlorate + sodium metaborate tetrahydrate (Monobor-chlorate)

Rate 0.9 lb of Monobor-chlorate per 100 sq ft

Time After subgrade is finished and before asphalt paving.

Remarks Do not apply where tree roots extend into treated area. Do not let runoff water wash the herbicide away from treated area. Granules may be dissolved in water and sprayed on, or may be applied dry and followed with at least 2 gal water/100 sq ft. Reentry interval is 12 hours.

Site of action None generally accepted

Chemical family Inorganic

sulfometuron (Oust)

Rate 3 to 6 oz ai/a (4 to 8 oz/a)

Time Apply just before the asphalt or concrete coating to avoid possible lateral movement of the herbicide by rain or mechanical activity.

Remarks Use on parking lots, highway shoulders, median strips, roadways, and other industrial sites. Remove rhizomes, tubers, or other vegetative parts in the site. Will not control woody vegetation such as small trees, brush, or woody vines; their roots must be removed from the site before application.

Caution Do not use under pavement in residential areas such as driveways, or in recreational areas, jogging or bike paths, tennis courts, or golf cart paths. Avoid drift of spray into planters or ornamental bedding areas, or near the treated area, as injury may result. Desirable plants may be injured if their roots extend into treated area.

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

Chemical family Sulfonylurea

trifluralin (Treflan)

Rate 12 to 16 lb ai/a

Time Apply after final grade is established or after additions of base rock.

Remarks Remove rhizomes, tubers, stolons, or other vegetative plant parts by scalping with a grader blade deep enough to ensure their complete removal before application. After applying, do not move soils, and pave as soon as possible. Forms a vapor barrier, preventing roots and shoots from penetrating. Safe to use near desirable vegetation.

Caution Herbicide is volatile and will be lost if not immediately covered by paving. Do not apply to areas where asphalt will be laid directly on soil.

Site of action Group 3: microtubule assembly inhibitor

Chemical family Dinitroaniline

sulfometuron + chlorsulfuron (Landmark XP)

Rate Consult label; each formulation has a different use rate

Time Apply immediately before paving to avoid lateral movement of the herbicide that can result from soil movement caused by rain or mechanical activity.

Remarks Before applying, use a grader blade to scalp and remove rhizomes, tubers, and other vegetative plant parts.

Caution Do not use under pavement in residential or recreational areas. Desirable plants may be injured if their roots extend into treated areas or if planted in treated areas.

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

Chemical family (both) sulfonylurea

tebuthiuron (Spike 80DF)

Rate 1.6 to 4 lb ai/a

Time Apply immediately before paving to avoid lateral movement of the herbicide that can result from soil movement caused by rain or mechanical activity.

Remarks Before applying, use a grader blade to scalp and remove rhizomes, tubers, and other vegetative plant parts.

Caution Do not use under pavement in residential or recreational areas. Desirable plants may be injured if their roots extend into treated areas or if planted in treated areas.

Site of action Group 7: photosystem II inhibitor

Chemical family Substituted urea

Managing Unwanted Vegetation in Riparian Restoration Sites

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March 2019

There is increasing interest and activity around the Pacific Northwest in restoring native plant communities and habitats such as prairies, oak savannas and riparian forests. Restoration management aims at restoring habitat functions and processes on sites disturbed by human activities. To do so it is often necessary to remove a non-native plant community first, then replace it with native plants which are able to provide desired habitat structure and functions. With the increasing number and size of restorations being undertaken as well as the growing diversity of groups and individuals involved, it is increasingly recognized that many farm and forestry practices, including the use of herbicides, can have a useful role in this effort.

This section is meant to provide some guidance for managing unwanted vegetation in riparian area restoration projects. In particular it will address the selection and use of herbicides suitable and labeled for riparian restoration. For a broader discussion of controlling weeds in habitat areas, please see “Weed Control Methods Handbook: Tools & Techniques for Use in Natural Areas” (<http://www.invasive.org/gist/handbook.html>) or “A Guide to Riparian Tree and Shrub Planting in the Willamette Valley: Steps to Success” (<https://catalog.extension.oregonstate.edu/em9040>) for a more local discussion of riparian restoration approaches and methods.

Site preparation

The purpose of site preparation is to clear the planting area of existing vegetation that will get in the way of planting and weed control activities, and to kill established perennial weeds that will compete with the new planting for water, light, space and nutrients.

Many riparian restoration projects are done on former farm or pasture lands that are already infested with a robust and well-established community of invasive perennial weeds such as reed canarygrass, common tansy, blackberry and Scotch broom. These and many other herbaceous or woody perennials present both a physical obstruction and a competitive threat which is best addressed before planting.

There are many approaches and practices that can be used for site preparation. These include mechanical strategies such as repeated tilling or mowing with tractor mounted or hand held tools, and/or herbicides. While some of these same methods may also be used after planting, most can be applied more efficiently and effectively before planting, avoiding the risk and effort of working around sensitive young seedlings.

Effective site preparation is rarely achieved in a single step, and often takes one or more years to accomplish. Factors to consider in selecting methods and deciding how much time to allow for site preparation include the weed species present, the control methods available, the most effective treatment season for each species/control method combination, if time is needed to establish a cover crop, and if time is needed for an herbicide to break down before cover crops or tree seedlings can safely be planted.

If herbicides are used in site preparation, they should be chosen according to the plant community present, the materials that are effective on those weeds and the season or growth phase at which

a particular herbicide is most effective on a particular weed. When there are several problem weeds on site, effective control will often require sequential, targeted applications of specific herbicides at different times during the growing season and/or using two or more different herbicides targeting different species.

For example, a broad spectrum herbicide such as glyphosate can be effective on both herbaceous and woody species, although the optimal timing varies dramatically from early spring to late fall according to the plants targeted. Spring applications of glyphosate can readily control most perennial grasses, but not shrubs such as blackberries. But blackberries may be injured enough by a spring glyphosate application to prevent effective control treatments applied at the recommended time in late summer or fall. Thus it may take several applications directed at different species and areas of a site to effectively treat a given site.

Other herbicides are more selective. Some will kill woody plants like blackberries, Scotch broom and native hardwood trees and shrubs as well as broadleaf herbaceous weeds, while leaving grasses unharmed. Other herbicides have no activity on broadleaved plants, killing only certain grasses.

Selectivity and effectiveness is also a matter of the application method used. Cut stem or basal bark treatments may be most appropriate in some situations when foliar applications may not be practical such as for the control of larger woody plants, or when sensitive desirable plants are nearby. (See the Forestry Section K1 in this handbook or the Weed Control Methods Handbook for more information on these application methods).

The scope of site preparation activities needs to reflect conditions at the restoration site since not all sites will require aggressive broadcast applications for site preparation. If the site is actively farmed and occupied by a grass-seed crop or managed pasture, it may be suitable to treat individual planting spaces or planting strips rather than do a broadcast treatment. If transitioning from an annual crop rotation, it may be best to take time to first establish a grass cover crop and then create planting spots or strips prior to planting. An established cover will help suppress new weed establishment and control erosion. The reduced spray treatment area also reduces chemical use and costs.

Since it is often necessary to remove brush and other vegetation as part of site prep, it is important to do it in a way that does not compromise your ability to kill the targeted weeds. Blackberries and other woody species are generally best controlled by late summer to early winter foliar applications, using herbicides that are moved inside the plant from the leaves down to the roots. Mowing or other disturbances that remove or significantly reduce the canopy of the plant can make such applications less effective. In such cases, the smaller “target” may be unable to translocate sufficient herbicide to kill the roots. When vegetation prevents effective spraying or other management activities, mowing or grazing should be timed to allow plants to regrow adequately prior to the planned herbicide treatment to allow effective control of the target weed species.

Most herbicides used for site preparation need to be applied directly to growing plants at the appropriate rate and time of year to

be effective in weed control. Still, soil activity must be considered before seeding or transplanting native species. Some herbicides used for site preparation do have soil activity and may be absorbed by roots to injure existing native plants, or may persist for months, preventing new seedlings from emerging or harming transplanted vegetation. So it may be necessary to allow additional time for those materials to break down before planting in order to avoid injury to seeded cover crops or transplanted tree and shrub seedlings. Pesticide labels describe the amount of time needed between herbicide application and planting to avoid carryover of herbicides that will injure desirable plants (crop rotation intervals).

Site maintenance

Once native trees and shrubs are planted, it will be necessary to prevent growth of annual and perennial weeds for several years while the seedlings get established. Left unchecked, weeds emerging from the seed bank or encroaching from adjacent lands can rapidly reestablish. A rebounding weed community can compete with seedlings and reduce both survival and growth and also build up cover for voles, which can be very destructive to young plantings.

While tree and shrub seedlings are becoming established on a restoration site, weeds may be controlled by careful spot treatment with some of the same foliar herbicides labeled and used in site preparation, including glyphosate and triclopyr, or by using physical weed control such as mulch. The objective is generally to keep an area near each transplanted seedling free of weeds to reduce competition and also limit cover for voles, thus preventing their damage. Spot spray treatments with foliar herbicides will likely need to be applied several times a season over a few years, adding to the cost of the restoration effort and with the knowledge that these applications bring an associated risk of injury to transplanted species. Managers need to plan their planting accordingly.

There are many herbicides commonly used in horticulture and forestry that prevent weeds from emerging and recolonizing cleared ground in site preparation. In new plantings, preemergent herbicides can provide season-long and cost-effective weed control. While many have good environmental profiles, with low impacts on humans, fish and other wildlife, currently only one has a label for use in restoration of riparian hardwood forests. Remember to exercise care and only use herbicides registered for the site!

Even after desirable trees and shrubs are well established, it may still be desirable to keep particular weeds such as blackberry or reed canarygrass in check for a much longer time in order to keep growing space open and allow expansion or reintroduction of native species. This can be done with a less frequent but regular spot spray program of approved herbicides. Mowing has limited value in preventing competition and near-ground cover for rodents, but can be effective in keeping areas open and passable.

The following herbicide summaries are provided as a quick reference of materials with labels allowing use in restoration. It is the project manager's responsibility to consult an approved label for complete information on target efficacy, rates, use patterns and to determine if a particular herbicide is approved in their state for the intended use and site situation. Some of these herbicides have very narrow uses and the situation at a particular restoration site must be matched with the intended use as described on the label.

Site Preparation—Grasses

fluazifop (Fusilade DX)

For control of grassy weeds in prairie and riparian conservation and restoration sites west of the Cascade Crest

Rate 0.25 to 0.375 lb ai/a (1 to 1.5 pints/a)

Time Apply to actively growing weeds in the spring or fall that have 2 to 4 leaves and are less than 3 inches tall.

Remarks SLN: OR-120016. Apply with 1% v/v crop oil concentrate or 0.25% v/v nonionic surfactant. Acts very slowly, taking at least 2 weeks and often 4 weeks to show effectiveness. Do not apply to stressed grasses. If weeds regrow repeat application. Best control of perennial grasses can be obtained if rhizomes or stolons are cut up by tillage operations (disking or plowing) to stimulate maximum emergence of grass shoots before applying Fusilade. Target species include reed canarygrass, quackgrass, perennial ryegrass, ripgut brome, red brome, and soft brome.

Caution Do not apply if rain is expected within 1 hour.

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

Chemical family Aryloxyphenoxy propionate

Site Preparation—Perennial and Annual Broadleaves

aminocyclopyrachlor (Method)

General weed control for non-crop producing and uncultivated agriculture lands and natural area such as wildlife management areas, wildlife openings, and wildlife habitat

Rate 0.125 to 2.5 lb ai/a (8 to 16 oz/a).

Time Apply to broadleaf weeds in spring. Preemergence activity, but should be applied postemergence for perennial weed control.

Remarks Use MSO as an adjuvant at 1%v/v. May be applied to the water edge but not directly to water.

Caution Sensitive species include conifers, cottonwoods, silver maple, yew, and willow species. Even low rates can kill non-target tree and shrub species so avoid application within a distance equal to the tree height of sensitive species. Do not allow spray to drift off target. Can injure several grass species including bromes and wildrye. Do not use more than 18 fl oz/a per year.

Site of action Group 4: synthetic auxin

Chemical family Phenoxy acetic acid

aminopyralid (Milestone)

Control of herbaceous broadleaf weeds and woody plants in wildlife habitats including seasonally dry wetlands and around standing water in riparian areas

Rate 0.047 to 0.11 lb ae/a (3 to 7 fl oz/a Milestone) depending on species

Time Apply to actively growing plants in the rosette.

Remarks Target species include sunflower family (Asteraceae) including Canada thistle and hawkweeds; St. Johnswort, wild carrot, suppression of common tansy, and many woody species at higher use rates. A nonionic surfactant at 1 to 2 quarts per 100 gal of spray enhances control under adverse environmental conditions. Can be applied up to water's edge in seasonally dry wetlands.

Caution Do not apply directly to water and take precautions to minimize spray drift onto water. Do not exceed 7 fl oz/a Milestone per year. Hay from treated areas cannot be removed from the site and used for forage for 18 months. Do not apply near the base of desirable trees unless some injury can be tolerated. Roots may pick up aminopyralid and translocate it to aboveground shoots of sensitive species. Consult label for a list of species that may be controlled or injured.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

chlorsulfuron (Telar)

Broadleaf annual and perennial weed control in uncultivated and non-crop producing areas such as soil bank land

Rate 0.75 oz ai/a (1/4 to 2.6 oz/a of the 75% Telar)

Time Apply preemergence or early postemergence to actively growing plants.

Remarks Can be used on public and private land to control weeds that are listed as invasive. Permissible to treat intermittent drainage areas, intermittently flooded low lying sites, seasonably dry flood plains, and transitional areas between upland and lowland sites when no water is present. Using a nonionic surfactant increases effectiveness. Target species includes wild carrot, wild garlic, Canada thistle, common tansy, poison hemlock, puncturevine and many others.

Caution Many grasses are tolerant if well established. Exceptions are perennial ryegrass and fescue. Off-site movement via drift may cause excessive damage to sensitive plants. Do not apply to natural or man-made bodies of water including ponds, streams and rivers. Chlorsulfuron is persistent with a half-life of 40 days. Soil bioassays or test strips are recommended before replanting crops sensitive to chlorsulfuron.

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

Chemical family Sulfonylurea

clopyralid (Transline or Spur)

Herbaceous broadleaf weeds and woody brush species in forest sites and wildlife openings including tree plantations

Rate 0.09 to 0.5 lbs ae/a (1/4 to 1 1/3 pts/a) depending on species

Time When most of basal shoots have emerged up to early bud.

Remarks A nonionic surfactant at 1 to 2 quarts per 100 gal of spray enhances control under adverse environmental conditions, but may also increase crop response. Target species include Canada thistle, knapweeds, weeds of the sunflower family (Asteraceae).

Caution Do not apply in the first year after transplanting. Do not apply directly to water or to areas where surface waters are present. Do not exceed 1 1/3 pts oz/a/year. Do not apply near the base of desirable trees unless some injury can be tolerated. Consult label for a list of species that may be controlled or injured.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

dicamba (Vision)

For control of a wide spectrum of annual, biennial, and perennial broadleaf weeds and brush.

Rate Up to 2 lb ae/a (2 quarts/a)

Time When annual weeds are less than 6 inches tall, when biennial weeds are in the rosette stage, and to perennial weed regrowth in late summer or fall following a mowing or tillage treatment.

Remarks The most effective control of such weeds as Canada thistle occurs if applied when the majority of weeds have at least 4 to 6 inches of regrowth or for weeds such as field bindweed and hedge bindweed that are in or beyond the full bloom stage. Typically applied with 2,4-D or other phenoxy herbicides to significantly broaden spectrum and to kill well established brush species.

Caution This product will injure or kill sensitive broadleaf plants. Allow a minimum of 30 days after application before planting sensitive species. Do not contaminate water.

Site of action Group 4: synthetic auxin

Chemical family Benzoic acid

metsulfuron (Patriot, Escort and others)

Used for general weed and brush control on noncrop sites, and conifer and hardwood plantations

Rate 0.075 to 0.3 lb ai/a (0.5 to 2 oz/a)

Time For best results, apply postemergence to young, actively growing weeds or brush. Selective to many grasses

Remarks Good control of Himalayan blackberry. May combine with other products to broaden weed-control spectrum. Using a nonionic or silicone surfactant will increase effectiveness. Application sites differ between products; consult label.

Caution Agitation required. Do not allow spray to drift to crops or other valuable plants or trees.

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

Chemical family Sulfonylurea

picloram (Tordon 22K)

For control of susceptible broadleaf weeds, woody plants and vines on forest planting sites and on wildlife openings in forest and non-crop areas.

Rate 0.25 to 0.5 lb ai/a (1 to 2 pints/a Tordon)

Time Apply in spring when actively growing before full bloom, or in late summer.

Remarks Tank mix 1 lb ae/a of 2,4-D with the lower rate of picloram to improve control spectrum and reduce potential for offsite damage and soil persistence. Apply no more than 2 quarts/a within a period of 2 annual growing seasons.

Caution A restricted-use herbicide. Do not apply if circumstances favor movement from treatment site. This product will readily volatilize, move off-site and damage neighboring vegetation. It is also persistent in the soil. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark.

Site of action Group 4: synthetic auxin

Chemical family Pyridine

triclopyr ester (Garlon 4 or Remedy) or triclopyr amine (Garlon 3A)

For site preparation and release in forested sites

Rate 0.5% to 2% concentration for application with a handgun sprayer.

Time Apply to actively growing plants in midsummer.

Remarks Adding 0.25% to 0.5% of a suitable surfactant to Garlon 3A improves results. No surfactant is needed with Garlon 4 or Remedy.

Site of action Group 4: synthetic auxin

Chemical family (triclopyr) Prydine; (2,4-D) Phenoxy acetic acid

Site Preparation—Broad-spectrum Control**glyphosate (Rodeo, Touchdown, Buccaneer and others)**

For control of annual and perennial weeds and woody plants in natural areas including wildlife management areas, wildlife openings, wildlife habitats and in and around aquatic sites and wetlands

Rate 1% solution with hand-held equipment

Time Apply to actively growing plants at full to late flowering stage. Weed seedlings may be effectively treated early in the season or after a fall application to mature plants.

Remarks Use 0.5% v/v nonionic surfactant. Thoroughly wet foliage but avoid runoff.

Caution Glyphosate is nonselective. It will injure or kill any vegetation it contacts.

Site of action Group 9: inhibits EPSP synthase

Chemical family None generally accepted

imazapic (Plateau)

For conifer plantation site preparation

Rate 0.031 to 0.188 lb ai/a (2 to 12 oz/a)

Time Before transplanting for residual weed control

Remarks Some grass species are tolerant. Add 1 quart/a methylated seed oil; do not exceed 25 gal/a spray volume.

Caution Before using, note crop rotation restrictions.

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

Chemical family Imidazolinone

imazapyr (Habitat)

For control of undesirable vegetation growing within aquatic sites including wetlands and riparian areas

Rate 0.25 to 0.5 lb ae/a

Time Apply when vegetation is growing vigorously.

Remarks Controls many grass and broadleaf species including brush and vine species. Always apply with an adjuvant.

Caution Before use, note rotation and other restrictions on label.

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

Chemical family Imidazolinone

Site Maintenance—Postemergent Grass Control

clethodim (Arrow and others)

For control and/or suppression of tall fescue in native prairie warm-season grass restoration projects

Rate 0.156 to 0.1875 lb ai/a (10 to 12 fl oz/a) depending on growth stage of grass.

Time Usually before weeds are 4 to 6 inches tall, but depends on grass species present. Apply to actively growing grasses that are not stressed by drought.

Remarks Annual and perennial grass control. Always add crop oil concentrate at 1% v/v and spray grade ammonium sulfate at 2.5 to 4 lbs./a.

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

Chemical family Cyclohexanedione

fluazifop (Fusilade DX)

Oregon only. For control of grassy weeds in prairie, riparian, and habitat restoration projects

Rate 0.375 lb ai/a (24 oz/a) Maximum use rate is 72 oz/a per year.

Time Apply spring or fall to actively growing grasses 2 to 4 inches tall.

Remarks Apply with 1% v/v crop oil concentrate or 0.25% v/v nonionic surfactant. Repeat application may be needed to control perennial weeds such as quackgrass. Cultivate perennial weeds to break up roots to produce more shoots before spray. Do not cultivate within 7 days of application. Acts very slowly, taking at least 2 and often 4 weeks to show effects. Do not apply to stressed grasses. Apply with 20 to 40 gal/a water; thorough spray coverage is important. SLN OR-120016

Caution Do not graze treated fields. Do not tank mix with triclopyr or aminopyralid containing products as reduced grass control may occur.

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

Chemical family Aryloxyphenoxy propionate

sethoxydim (Poast)

Natural areas including wildlife management areas and wildlife openings and wildlife habitats

Rate Maximum single application is 0.47 lb ai/a (2.5 pints/a); maximum annual rate is 7.5 pints/a

Time Apply to actively growing grasses.

Remarks Apply with 2 pints/a crop oil concentrate. Sethoxydim acts very slowly, taking at least 2 weeks and often 4 weeks to show herbicide effectiveness. Do not apply to stressed grasses. Grasses such as fescue are tolerant.

Caution Do not apply if rain is expected within 1 hour. Do not graze.

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

Chemical family Cyclohexanedione

Site Maintenance—Preemergence Control of Grass and Broadleaf Weeds

flumioxazin (SureGuard)

Control of non-native grass and broadleaf weeds in native restoration habitats in order to enhance survival and growth of native woody tree and shrub species in riparian areas

Rate 0.375 lb ai/a (12 oz/a SureGuard)

Time Apply to dormant trees and shrubs; after transplanting or to established plants.

Remarks For use in conservation, restoration and related research projects. SLN OR-130006. Make application as a directed spray to the base of the plants. Avoid contact with green tissue. Plants must be at least one year from seedling at application. Newly transplanted trees and shrubs must be watered prior to application with a volume sufficient to settle the soil around the new transplant.

Caution While research has been conducted in Oregon to ensure tolerance to the listed plants when applied as directed, users are encouraged to test this use pattern on a small number plants as growing conditions, plant varieties and localized conditions may cause differences in plant response.

Site of action Group 14: protoporphyrinogen oxidase (PPO) inhibitor

Chemical family Diphenylether

Useful Premixes

Several premixed herbicides are available as listed above. These premixes will broaden the weed control spectrum and may reduce the cost of the overall program.

- Aminocyclopyrachlor + chlorsulfuron (Perspective)
- Aminocyclopyrachlor + metsulfuron (Streamline)
- Aminocyclopyrachlor + metsulfuron + imazapyr (Viewpoint)
- Aminopyralid + metsulfuron (Opensight)