

Invasive Plant Management with Milestone® and Other Herbicides

*A PRACTICAL AND TECHNICAL GUIDE
FOR NATURAL AREA MANAGERS*



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Invasive Plants - Impacts on Rangeland and Natural Areas¹

Rangeland, pastureland, national parks, and other natural areas account for about 48% of the total land area in the United States. These lands are critical for livestock production, wildlife habitat, and protecting the integrity of ecological systems. More than 3,300 non-native plant species occur within natural areas in the 48 contiguous United States, and 60 of those are considered to have significant economic or ecological impacts.

Some of the most problematic species include downy brome (cheatgrass), Canada thistle, biennial thistles, leafy spurge, yellow starthistle and knapweeds. The majority of these invasive plants or “weeds” have been introduced from other continents and have few natural enemies to control populations, allowing these species to flourish.

The rate of introduction and spread of invasive plants has increased dramatically over the past 150 years with increases in human activities, trade, and commerce.

Weeds such as the knapweeds, starthistle, leafy spurge, and thistles infest millions of acres, primarily in the western United States (Table 1).

Invasive plants can have a significant impact on humans and the environment.

Their negative impacts may be associated with livestock production, native plant and animal communities, ecosystem processes (e.g. hydrologic cycles and fire regimes), land values, and human health.

- **Invasive non-native plants can alter structure, organization, and function of native plant communities** and are a threat to biodiversity. Changes in plant composition also impact wildlife by eliminating food sources or modifying critical habitats.
- **Invasive plants can also impact soil and water resources.** Tap rooted species such as the knapweeds increase surface runoff and sediment yield compared to grass-dominated sites, impacting water quality and lowering the production potential of the land. Yellow starthistle depletes soil moisture reserves and alters the water cycle by utilizing moisture reserves earlier than associated native plants. Riparian plants such as saltcedar impact hydrologic cycles by increasing sediment deposition thus restricting stream channels and increasing severity of subsequent floods.



Table 1: Acreage infested and spread rate of the most widespread and troublesome invasive plants in the United States.

Common Name	Scientific Name	Acreage infested in U.S (millions)	Avg. annual spread rate (%)
Downy brome (cheatgrass)	<i>Bromus tectorum</i>	56.5	14
Musk thistle	<i>Carduus nutans</i>	7.5	12-22
Knapweeds (diffuse, spotted)	<i>Centaurea diffusa</i> , <i>C. stoebe</i>	8.7	10-24
Yellow starthistle	<i>Centaurea solstitialis</i>	14.7	13-17
Canada thistle	<i>Cirsium arvense</i>	12.6	10-12
Leafy spurge	<i>Euphorbia esula</i>	4.6	12-16
Sericea lespedeza	<i>Lespedeza cuneata</i>	8.6	24
Saltcedar	<i>Tamarisk</i> spp.	3.6	12

- **Invasive plants on rangeland cost billions of dollars annually** in the United States based on cost of control, ecosystem losses, and direct impacts to the livestock industry. Weeds impact grazing lands by lowering yield and quality of forage for livestock, impeding access to desirable forage, poisoning animals, increasing costs of managing and producing livestock, and reducing grazing land value.

Integrated Invasive Plant Management and the Role of Herbicides¹

The spread of invasive plants is often considered analogous with a biological wildfire. As with wildfire management, a variety of techniques are available for management of invasive plants. These include prevention, early detection, timely control and site rehabilitation.

A successful long-term management program should be designed to include combinations of prevention and cultural, biological, mechanical, and herbicide management methods. This is particularly true in restoration programs where seedling establishment is dependent upon suppression of competitive species.

Developing and Implementing an Integrated Invasive Plant Management Strategy

The goal of any management plan should not be to just manage the invasive plant but to improve the desirable plant community and prevent reinvasion or invasion by other undesirable plants. Containing existing populations, restoring natural areas severely degraded by invasive plants, and preventing the establishment of invasive plants in non-infested lands is critical for maintaining the ecological health and economic integrity of rangeland and natural areas. This can be achieved by identifying management options that will promote a healthy, weed-resistant plant community that consists of diverse groups of species that occupy most of the niches.

Following are some guidelines and considerations for developing an invasive plant management strategy:

- **Identify the goal(s) you want to achieve** (e.g. enhance forage quantity and quality, restore native vegetation, improve wildlife habitat).
- **Identify desired management outcomes** that can be measured with long-term monitoring. For example, a desired outcome of “reduce spotted knapweed density by 95% over 5 years” can be measured.
- **Identify and accurately delineate lands infested** with invasive plants. Knowing the location and extent of infestation can determine the control/management method used, assist in prioritizing management strategies, and identify areas where eradication, containment or control can be achieved.
- **Gain a thorough understanding of the biology and ecology of the invasive weed(s)** you are managing including susceptible habitat, spread vectors, etc.
- **Identify management constraints** (environmental, financial, technological, social, and operational).
- **Review effectiveness of each management method** on the target plant including mechanical, cultural, biological, and herbicide methods and integrate management techniques that will optimize control.
- **Prioritize sites** where treatments will most effectively contain and control the infestation.
- **Coordinate effort among interested parties.**
- **Be flexible:** Use long-term monitoring and evaluation to identify strengths and weaknesses in your strategies and methods. Adapt management approaches to improve effectiveness and prevent reinvading populations from becoming established.
- **Establish an annual follow-up treatment program** to prevent re-infestation (e.g., spot treatments, modifying livestock grazing, burning, etc.)
- **Plan for a long-term commitment** to your management program. Many invasive plants have seed that remains viable in the soil for eight years or more, so long-term monitoring and follow-up management will be necessary for successful control.

¹References:

- DiTomaso, JM. 2000. Invasive weeds in rangelands: Species, impacts, and management. *Weed Science*, 48:255-265.
- Duncan, CA and JK Clark eds. 2005. *Invasive Plants of Range and Wildlands and Their Environmental, Economic and Societal Impacts*. Weed Science Society of America.
- Sheley, RL and JK Petroff (eds.) 1999. *Biology and Management of Noxious Rangeland Weeds*. Oregon State Univ. Press.

This guide provides information on selective herbicides as one tool for invasive plant management on rangeland, pastures, and natural areas. Information on herbicide use rates, herbicide selectivity on non-target plants, sprayer calibration, seeding guidelines, environmental considerations, and other useful tips are provided in this document.

Technical Facts About Integrated Plant Management with Herbicides

The following herbicides are in the pyridine chemical family with a synthetic auxin/growth regulator mode of action. Active ingredients include aminopyralid (Milestone®, Capstone® and Opensight®), triclopyr (Garlon® 3A, Garlon® 4 Ultra, Pathfinder® II, Capstone, PastureGard® HL), clopyralid (Transline®), picloram (Tordon® 22K), and fluroxypyr (Vista® XRT, PastureGard HL). These herbicides are absorbed by leaves, stems and roots and are translocated (moved) throughout the plant accumulating in meristematic tissue. All of them have soil residual activity except triclopyr and fluroxypyr.

HERBICIDES CONTAINING

AMINOPYRALID

Milestone®

HERBICIDE

Milestone herbicide

ACTIVE INGREDIENT

One gallon of Milestone herbicide contains 2 pounds (lbs) acid equivalent (ae) of aminopyralid.

USE RATE RANGE

3 to 7 fluid ounces of product per acre. Spot treatments may be made up to 14 fl oz/ac per annual growing season; however, not more than 50% of an acre may be treated.

ATTRIBUTES

Milestone provides excellent post-emergent and residual control of over 70 broadleaf weeds and woody plants, including knapweeds, hawkweeds, rush skeletonweed, and thistles, with proven tolerance to native grasses and many shrubs and forbs. The herbicide is an important tool for grassland restoration, habitat improvement. Can provide control or suppression of certain invasive winter annual grasses such as medusahead. Milestone is effective at low use rates and has a favorable ecotoxicology profile. It was registered under EPA's Reduced Risk Initiative. Milestone is approved for use on rangeland, permanent grass pastures, Conservation Reserve Program (CRP) acres, non-cropland areas (such as roadside and utility rights-of-way), non-irrigation ditch banks, seasonally dry wetlands, natural areas, and other sites as described on the label. There are no grazing restrictions for any class of livestock including lactating animals.

Capstone®

HERBICIDE

Capstone herbicide

ACTIVE INGREDIENTS

Capstone is a 1.1 lb ae/gallon product that contains 0.1 lb ae (1.6 oz ae) aminopyralid + 1 lb ae triclopyr amine.

USE RATE RANGE

4 to 9 pints of product per acre. Spot treatments may be made up to 18 pints per acre per annual growing season; however, not more than 50% of an acre may be treated.

ATTRIBUTES

Capstone combines residual broad spectrum control of problem weeds, including noxious and invasive broadleaf weeds and sensitive woody plants, and is safe to use on most desirable grasses. Capstone is approved for use on rangeland, permanent grass pastures (including grasses grown for hay), forests, Conservation Reserve Program (CRP) acres, non-cropland areas (such as roadsides and utility rights-of-way), non-irrigation ditch banks, seasonally dry wetlands, natural areas, and other sites as described on the label. There are no grazing restrictions for any class of livestock including lactating animals. Capstone is the workhorse for any weed and brush control program where the control of both broadleaf weeds and woody plants are desired. The herbicide is the ideal product for cut surface treatments to woody plants. This amine formulation is essentially non-volatile and features a Caution signal word.

Opensight®

HERBICIDE

Opensight herbicide

ACTIVE INGREDIENTS

Opensight is a dry formulation that contains both aminopyralid and metsulfuron methyl.

MODE OF ACTION

This product contains two modes of action – growth regulator and ALS inhibitor - which broadens the spectrum of weed and brush control and may reduce the development of weed resistant populations.

USE RATE RANGE

1.5 to 3.3 ounces of product per acre. Spot treatments may be made up to 6.6 oz/ac per annual growing season. The dry formulation requires the addition of a surfactant (NIS, MSO, COC) for effective control.

ATTRIBUTES

Opensight herbicide provides excellent post-emergent and residual control of over 160 broadleaf weeds and woody plants including many difficult to control invasive or noxious weeds such as wild parsnip, poison hemlock, houndstongue, hoary cress, and tansy ragwort. Opensight is a broad spectrum herbicide and does not have selectivity to many desirable forbs and shrubs while most native grasses are tolerant. The herbicide is approved for use on rangeland, permanent grass pasture, natural areas, Conservation Reserve Program (CRP) acres, non-cropland areas (such as roadsides and utility rights-of-way), non-irrigation ditch banks, seasonally dry wetlands, natural areas, and other areas as described on the label. There are no grazing restrictions for any class of livestock including lactating animals.

HERBICIDES CONTAINING

TRICLOPYR

Garlon® 4

HERBICIDE

Garlon® 3A herbicide

ACTIVE INGREDIENT

One gallon of Garlon 3A contains 3lb ae of triclopyr formulated in water as a water-soluble amine (triethylamine salt).

USE RATE RANGE

1 quart to 3 gallons of product per acre.

Apply no more than 2/3 gallon of Garlon 3A per acre per growing season on range and pasture sites or other grazing sites. On forestry sites, Garlon 3A may be used at rates up to 2 gallons of Garlon 3A per acre per year. For all terrestrial use sites other than range, pasture, forestry sites, and grazed areas, the maximum application rate is 3 gallons of Garlon 3A per acre per year.

ATTRIBUTES

Garlon 3A is a broad-spectrum herbicide with excellent activity on brush and some emerged broadleaf weeds. Garlon 3A will provide good control of undesirable woody plants as a cut stump application (either undiluted or mixed with water) and will provide good to excellent control when applied as a foliar treatment. The herbicide can be applied to aquatic sites, such as marshes, wetlands, and the banks of moving water, ponds and lakes. The herbicide is selective to grasses and is not soil active so may be used under desirable trees (<http://bit.ly/scro2011FAQs>)

Garlon® 3A

HERBICIDE

Garlon® 4 Ultra herbicide

ACTIVE INGREDIENT

One gallon of Garlon 4 Ultra contains 4 lb ae of triclopyr formulated in a plant-based oil carrier as a low volatile ester.

USE RATE RANGE

1 to 4 quarts of product per acre broadcast to foliage or mixed as a percent solution in water or basal oil for woody plant treatments (see label by species).

ATTRIBUTES

Garlon 4 Ultra contains a plant derived methylated seed oil rather than a petroleum oil carrier and can be mixed with water or oil for application. This herbicide controls many woody plants and can be applied to foliage of weeds or woody plants (mixed with water) or as a basal bark, cut stump, and modified cut stump application (mixed with basal oil). Garlon 4 Ultra is not harmful to grasses and many forbs and is an effective tool to release native grasses. It is not soil-active so may be applied under the canopy of desirable trees (<http://bit.ly/scro2011FAQs>).



Pathfinder® II

HERBICIDE

Pathfinder® II herbicide

ACTIVE INGREDIENT

One gallon of Pathfinder II herbicide contains 0.75 lb ae of triclopyr ester (13.6%) formulated in a plant-based oil carrier.

ATTRIBUTES

Pathfinder II herbicide is a ready-to-use (no mixing required) herbicide for low-volume basal and cut-stump application of woody plants in forests, rangeland, permanent pasture and non-crop areas. The herbicide controls more than 80 woody plant species. The carrier in Pathfinder II is derived from a naturally occurring, non-petroleum substance and has a low odor. Individual dormant-plant treatments allow for use year-round.

USE TYPE

Apply to woody material only—not intended for foliage applications.



PastureGard®

HERBICIDE

PastureGard® HL herbicide

ACTIVE INGREDIENT

One gallon of PastureGard HL herbicide contains 3 lb ae triclopyr ester and 1 lb ae fluoxypyr formulated as an oil soluble, emulsifiable concentrate.

USE RATE RANGE

3/4 pint to 4 pints of product per acre.

ATTRIBUTES

PastureGard HL provides excellent selective control of many woody plants and broadleaf weeds such as sericea lespedeza, blackberry rose, kochia, and many others. The herbicide is not harmful to most grasses and many forbs and offers crop rotation flexibility due to the lack of soil residual properties of the formulation. There are no composting restrictions for use of treated plants or manure from animals grazing treated forages. There are no grazing restrictions for any class of livestock including lactating animals.

The herbicide can be applied to rangeland, permanent grass pastures (including grasses grown for hay), Conservation Reserve Program (CRP) acres, fencerows, and non-cropland areas, and non-irrigation ditch banks. PastureGard HL can be applied as a foliar, basal bark or cut stump treatment for control of woody plants. It is absorbed through plant foliage and stems and because of its lack of soil activity can be used under the canopy of desirable trees.

[“TECHNICAL FACTS” continued on page 6]

HERBICIDE CONTAINING

CLOPYRALID

Transline®

HERBICIDE

Transline® herbicide

ACTIVE INGREDIENT

One gallon of Transline contains 3 lb ae of clopyralid.

USE RATE RANGE

1/4 pint to 1.33 pints of product per acre.

ATTRIBUTES

Transline offers excellent control of target invasive and noxious weeds and certain woody plants, while providing the greatest selectivity to many tree, brush, and grass species. It can be safely applied under and over many conifer and non-legume woody plants and hardwoods. Use sites include rangeland and permanent grass pastures (including grasses growth for hay), non-cropland areas (including roadside and utility rights-of-way), forest sites and tree plantations, and wildlife openings, including grazed areas on these sites. Transline is not harmful to desirable native grasses and is effective on key species including thistles, knapweeds, locust, kudzu and many others. There are no grazing restrictions for any class of livestock including lactating animals.

HERBICIDE CONTAINING

FLUROXYPYR

Vista® XRT

HERBICIDE

Vista® XRT

ACTIVE INGREDIENT

One gallon of Vista XRT contains 2.8 lb ae of fluroxypyr formulated with a nonpetroleum-based solvent derived from naturally occurring seed oil.

USE RATE RANGE

Maximum application of 22 fluid ounces product per acre per year.

ATTRIBUTES

Provides excellent post emergence control of kochia (including ALS and dicamba-resistant biotypes), lespedeza, prickly pear, and other hard-to-control broadleaf weeds and brush on rangeland and pasture, rights-of-way (roadsides, electric utility, pipelines, railroads and more), industrial sites, non-irrigation ditch banks, conifer and tree plantations, and grazed areas in and around these sites. The herbicide is rain-fast one hour after application. Vista XRT is selective to broadleaf plants, will not harm grasses, and is not soil-active so may be applied under the canopy of desirable trees. This herbicide is not harmful to seedling grasses and can be used to control kochia in grass restorations.

HERBICIDE CONTAINING

PICLORAM

Tordon® 22K

HERBICIDE

Tordon® 22K herbicide

ACTIVE INGREDIENT:

One gallon of Tordon 22K contains 2 lb ae of picloram.

USE RATE RANGE:

1 to 2 pints of product per acre for broadleaf weeds.

For control of noxious or invasive weeds, do not apply more than 2 quarts of Tordon 22K per acre per annual growing season as a broadcast treatment. Spot treatments may be applied at the equivalent broadcast rate of up to 2 quarts per acre.

ATTRIBUTES

Tordon 22K herbicide provides excellent economical control of leafy spurge and many broadleaf noxious and invasive weeds. The herbicide has soil residual for lasting perennial broadleaf weed and brush control, and is not harmful to use on desirable grasses. Tordon 22K can be used on rangeland and permanent grass pastures, fallow cropland, CRP acres and non-cropland (such as roadsides). There are no grazing restrictions except for lactating dairy animals.



Recommendations and Rates for Key Species

Field trials indicate that the following weeds will be controlled with the rates of herbicide indicated below. For best results, most weeds should be treated when they are actively growing and under conditions favorable for growth.

Use a higher rate in the rate range when growing conditions are less than favorable or when weed foliage is tall and dense. Milestone® herbicide also provides preemergence control of germinating seeds or seedlings of susceptible weeds following application. Some weed species, such as Canada thistle, biennial thistles, and Russian knapweed, can be effectively controlled with fall applications.



COMMON NAME SCIENTIFIC NAME	PLANT FAMILY LIFE CYCLE	HERBICIDE/RATE	APPLICATION TIMING/SPECIFICATIONS
BROADLEAF WEEDS			
buttercup, tall <i>Ranunculus acris</i>	Ranunculaceae Perennial	Milestone 4 to 7 fl oz/ac	Apply after complete plant emergence to flower or in the fall.
chamomile, scentless <i>Matricaria inodora</i>	Asteraceae Annual	Milestone 4 to 7 fl oz/ac	Apply after complete plant emergence to pre-bud. Optimum is 12 inches high or less.
cinquefoil, sulfur <i>Potentilla recta</i>	Rosaceae Perennial	Milestone 4 to 7 fl oz/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
common tansy <i>Tanacetum vulgare</i>	Asteraceae Perennial	Opensight® 2.5 to 3.3 oz/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
crownvetch <i>Securigera varia</i>	Fabaceae Perennial	Milestone 5 to 7 fl oz/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
daisy, oxeye <i>Leucanthemum vulgare</i>	Asteraceae Perennial	Milestone 4 to 7 fl oz/ac or Transline® 2/3 to 1 1/3 pt/ac or Opensight 2.5 to 3.3 oz/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
garlic mustard <i>Alliaria petiolata</i>	Brassicaceae Biennial	Garlon® 4 Ultra 1.25 to 2.5% v/v	Apply prior to bolting.
hawkweeds (yellow/orange) <i>Hieracium caespitosum</i> and <i>aurantiacum</i>	Asteraceae Perennial	Milestone 5 to 7 fl oz/ac or Transline 1 pt/ac	Apply from spring rosette to late bolting stage. For optimum results do not apply in the fall.
houndstongue <i>Cynoglossum officinale</i>	Boraginaceae Biennial	Opensight 2.5 to 3.3 oz	Apply to rosettes. As plant bolts, increase the rate to 3.0 to 3.3 ounces up to early bud stage. Add 1 quart of 2,4-D after the bud stage
knapweed, Russian <i>Acroptilon repens</i>	Asteraceae Perennial	Milestone 5 to 7 fl oz/ac or Opensight 2.5 to 3.3 oz/ac	Apply to plants in summer at early bud through the fall dormant stage.
knapweed, spotted and diffuse <i>Centaurea</i> spp.	Asteraceae Biennial / Perennial	Milestone 5 to 7 fl oz/ac or Transline 2/3 to 1 pt/ac or Opensight 2.5 to 3.3 oz/ac	Apply during active growth with the optimum time from rosette to the bolt- ing stage or fall regrowth.

["RECOMMENDATIONS" continued on page 8]

COMMON NAME SCIENTIFIC NAME	PLANT FAMILY LIFE CYCLE	HERBICIDE/RATE	APPLICATION TIMING/SPECIFICATIONS
lespedeza, sericea <i>Lespedeza cuneata</i>	Fabaceae Perennial	PastureGard® HL .75 to 1 pt/ac or Garlon® 4 Ultra 1 to 1.5 pt/ac or Garlon 4 Ultra 9 to 12 fl oz/ac + 4 to 6 fl oz/ac Vista® XRT	Begin treatment when plants are a minimum of 8 inches tall (May to June) and continue through summer. Use the higher labeled rate when plants are larger than 18 inches or in early fall.
poison hemlock <i>Conium maculatum</i>	Apiaceae Perennial	Opensight® 2.5 to 3.3 oz/ac	Apply when actively growing in early growth stage before bloom.
purple loosestrife <i>Lythrum salicaria</i>	Lythraceae Perennial	Milestone® 7 fl oz/ac + 1 to 2 pt/ac of 2,4-D or 1 to 2 qt Garlon 3A	For optimum control apply at mid bloom stage through late bloom using Milestone at 7 fl oz/ac plus 1 pt to 1 qt of 2,4-D amine or 1 to 2 qt of Garlon 3A. Spot treatments may also be made by applying Milestone at 14 fl oz with or without the addition of 2,4-D or Garlon 3A.
ragwort, tansy <i>Senecio jacobaea</i>	Asteraceae Perennial	Milestone 5 to 7 fl oz/ac or Transline® 1 pt/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
rush skeletonweed <i>Chondrilla juncea</i>	Asteraceae Perennial	Milestone 5 to 7 fl oz/ac	The best time for spring treatments is at the rosette to early bolt stage (1 to 4 inch flower stalks). Fall applications are also very effective. Wait as late as possible right before rainy season/winter.
spurge, leafy <i>Euphorbia esula</i>	Euphorbiaceae Perennial	Tordon® 22 K 1 to 2 qt/ac or 1 to 2 pt/ac + 1 lb ai/ac 2,4-D	Apply at the true flower growth stage (mid to late June) or during fall regrowth. Reapply herbicide when level of control drops below 80%.
St. Johnswort, common <i>Hypericum perforatum</i>	Clusiaceae Perennial	Milestone 5 to 7 fl oz/ac or Opensight 2.5 to 3.3 oz/ac	Apply when actively growing in early growth stage before bloom.
starthistle, yellow and malta <i>Centaurea solstitialis</i> ; <i>melitensis</i>	Asteraceae Annual	Milestone 3 to 5 fl oz/ac or Opensight 2 to 2.5 oz/ac or Transline ½ to 1 pt/ac	Apply at the rosette through bolting stages, when soil moisture is present and the plants are actively growing. Use higher rates when weeds are larger.
teasel <i>Dipsacus</i> spp.	Dipsacaceae Biennial	Milestone 4 to 7 fl oz/ac or Opensight 2 to 3.3 oz/ac	Apply in the spring and early summer to rosette or bolting plants. Use higher rates after bolting through early flower.
thistle, Canada <i>Cirsium arvense</i>	Asteraceae Perennial	Milestone 5 to 7 fl oz/ac or Transline 2/3 to 1 pt/ac or Opensight 2.5 to 3.3 oz/ac	Apply when plants have fully emerged in the spring up to early bud growth stage and fall before a killing frost.
thistle, Scotch <i>Onopordum acanthium</i>	Asteraceae Biennial	Milestone 5 to 7 fl oz/ac or Transline 2/3 to 1 pt/ac or Opensight 2.5 to 3.3 oz/ac	Apply in spring and early summer to rosette or bolting plants or in fall to seedlings and rosettes before ground is frozen. Use higher rates after bolting through early flower.
thistles, biennial <i>Cirsium</i> and <i>Carduus</i> spp.	Asteraceae Biennial	Milestone 3 to 5 fl oz/ac or Transline 1/2 to 2/3 pt/ac or Opensight 1.5 to 2.0 oz/ac	Apply in spring and early summer to rosette or bolting plants or in fall to seedlings and rosettes before ground is frozen. Use higher rates after bolting through early flower.
toadflax, Dalmatian <i>Linaria dalmatica</i>	Scrophulariaceae Perennial	Tordon 22 K 1 to 2 qt/ac	Apply at bud to flower growth stage or in fall when basal regrowth develops.
tropical soda apple <i>Solanum viarum</i>	Solanaceae Perennial	Milestone 5 to 7 fl oz/ac	Apply at any growth stage, but application by flowering will reduce seed production potential.

COMMON NAME SCIENTIFIC NAME	PLANT FAMILY LIFE CYCLE	HERBICIDE/RATE	APPLICATION TIMING/SPECIFICATIONS
vetch (cow and hairy) <i>Vicia</i> spp.	Fabaceae Perennial	Milestone® 3 to 7 fl oz/ac or Transline® ½ to 2/3 pt/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
whitetop (hoary cress) <i>Cardaria draba</i>	Brassicaceae Perennial	Opensight® 3.3 oz/ac	Apply early in the spring to actively growing rosettes or to regrowth before the bud stage. Treatment after bloom is generally less effective and the addition of 2,4-D at 2 pt/ac is recommended. Treatments can also be made to fall regrowth before the first killing frost.
wild parsnip <i>Pastinaca sativa</i>	Apiaceae Biennial	Opensight 2.0 to 3.0 oz/ac	Apply to vegetative stage prior to bloom. Use higher rate when weeds are larger.
wormwood, absinth <i>Artemisia absinthium</i>	Asteraceae Perennial	Milestone 6 to 7 fl oz/ac	Apply before wormwood is 12 inches tall. Remove old duff and litter by fire or mowing for best results.
VINES			
wisteria, Chinese and Japanese <i>Wisteria sinensis</i>	Fabaceae	FOLIAR: Milestone 7 fl oz/ac BASAL: 25% Garlon® 4 Ultra in basal oil or Pathfinder® II	Apply to the foliage during the growing season when plants are not under drought stress. This treatment can be applied any time of the year, including winter months, except when the bark is wet or frozen, better results are late winter and early spring.
kudzu <i>Pueraria montana</i> var. <i>lobata</i>	Fabaceae	Milestone 7 fl oz/ac or Transline 1 to 1 1/3 pt/ac	Applications are most effective between late June and early October as long as the kudzu are actively growing and not under drought stress. The ideal time to apply is during vigorous growth and just prior to or during flowering.
mile-a-minute <i>Persicaria perfoliata</i>	Polygonaceae	Capstone® 8 pt/ac or Garlon 4 Ultra or Garlon® 3A Foliar 3 to 5% v/v	Apply to the foliage during the growing season. Use Garlon 3A in hot conditions.
WOODY PLANTS			
blackberry <i>Rubus</i> spp.	Rosaceae	3.3 oz/ac Opensight or 5 fl oz/ac Milestone + 2 pt/ac Garlon 4 Ultra	Apply when leaves are fully expanded and the plant has stopped rapid spring and early summer growth. Application after bloom and before frost is optimal. It is recommend that after mowing, shredding, or burning, applications should be delayed until the next season and enough re-growth has occurred for good uptake and translocation.
Chinese tallowtree <i>Sapium sebifera</i>	Euphorbiaceae	Capstone 5 to 8% v/v or Garlon 4 Ultra 2.5% v/v BASAL: Garlon 4 Ultra 20 to 30% in basal oil or Pathfinder II	Applications should be made with uniform coverage but not to the point of runoff. Foliar applications can be made between full leaf and early October as long as the plants are actively growing and are not under drought stress. Basal applications can be made any time of year.
honey and black locust <i>Gleditsia triacanthos</i> , <i>Robinia pseudoacacia</i>	Fabaceae	FOLIAR: Milestone 7 fl oz/ac or 6 to 9 pt/ac of Capstone or Transline 1 to 1.3 pt/ac	Make foliar applications when plants are fully leafed and actively growing.
Japanese knotweed or other invasive knotweeds <i>Fallopia japonica</i>	Polygonaceae	Milestone 7 to 14 fl oz/ac in high volume foliar applications	Apply Milestone at 7 fl oz per acre broadcast using high volume per acre (100 gallons per acre) or apply as a spot treatment using 14 fl oz per acre. Optimum results for suppression of plant growth are obtained when applications are made to plants that are about 3 to 4 feet in height in early summer. Multiple applications/retreatments will be necessary for control of resprouting stems.

[“RECOMMENDATIONS” continued on page 10]

COMMON NAME SCIENTIFIC NAME	PLANT FAMILY LIFE CYCLE	HERBICIDE/RATE	APPLICATION TIMING/SPECIFICATIONS
multiflora rose <i>Rosa multiflora</i>	Rosaceae	Opensight® 3.3 oz/ac or 7 fl oz Milestone® + 1 qt 2,4-D + 1 pt/ac Garlon® 4 Ultra	Foliar application can be made from spring leaf development through to plant senescence in the fall with optimum timing during flowering. Thoroughly wet all leaf and green stem tissue. Dense infestations are best controlled by spraying from both sides. Avoid application within 9 to 12 months after mowing or when plants have a high percentage of new growth.
Russian olive <i>Elaeagnus angustifolia</i>	Elaeagnaceae	Garlon 4 Ultra 25 to 30% Low volume basal, or Garlon® 3A 50 to 100% or Garlon 4 Ultra 25 to 100% cut surface or Garlon 4 Ultra 3 qt + Milestone 7 fl oz/ac on resprouts after cutting	Basal and cut stump applications can be made any time of year. For foliar broadcast to resprouting stems after cutting, then it is advisable to wait until the resprouts are at least 3 to 4 ft in height
saltcedar <i>Tamarix</i> spp.	Tamaricaceae	Garlon 4 Ultra 25 to 30% Low volume basal, or Garlon 3A 100% or Garlon 4 Ultra 25 to 100% cut surface or Garlon 4 Ultra 3 qt + Milestone 7 fl oz on resprouts after cutting	Basal and cut stump applications can be made any time of year. For foliar broadcast to resprouting stems after cutting then it is advisable to wait until the resprouts are at least 3 to 4 ft in height.
Scotch broom <i>Cytisus scoparius</i>	Fabaceae	Capstone® 6 to 8 pt/ac or Garlon 4 Ultra 2 to 3 qt/ac or Garlon 3A 3 to 4 qt/ac	Optimum results if applied when plants are in bloom.
silk tree <i>Albizia julibrissin</i>	Fabaceae	FOLIAR: 7 fl oz/ac Milestone or Capstone 9 pts/ac BASAL: 20 to 25% Garlon 4 Ultra in 75% basal oil or Pathfinder® II	Apply between late June and early October as long as the silk tree is actively growing and not under drought stress. Coverage should be thorough to wet all leaves. Basal applications can be made any time of year.
tree-of-heaven <i>Ailanthus altissima</i>	Simaroubaceae	FOLIAR: Capstone 8 to 9 pts/ac or 1 to 2% v/v of Garlon 4 Ultra or Garlon 3A BASAL: Garlon 4 Ultra 20 to 30% with oil or Pathfinder II	Apply between June and early October, as long as plants are actively growing and not under drought stress.
GRASSES			
microstegia (Japanese stiltgrass) <i>Microstegium vimineum</i>	Poaceae	Milestone 5 to 7 fl oz	Apply pre or post emergence

Native Forb Tolerance to Milestone® Herbicide

Milestone is a broadleaf herbicide that has reduced risk to the environment compared with other commercially available herbicides, making it a desirable alternative for invasive weed control on rangeland and wildland sites. Effect of Milestone on desirable native forbs is a consideration for land managers when making decisions about controlling invasive plants.



The following is a summary of experiments conducted at 16 locations in six states (Colorado, Idaho, Minnesota, Montana, North Dakota, and South Dakota) to determine long-term response of native forbs to Milestone applied in early summer (June) or fall (September or October), and to develop a tolerance/susceptibility ranking for native plants. Table 1 lists locations and researchers who conducted experiments. To obtain an electronic copy of the full report or for more information on invasive weed management, go to http://bit.ly/techline_tolerance.

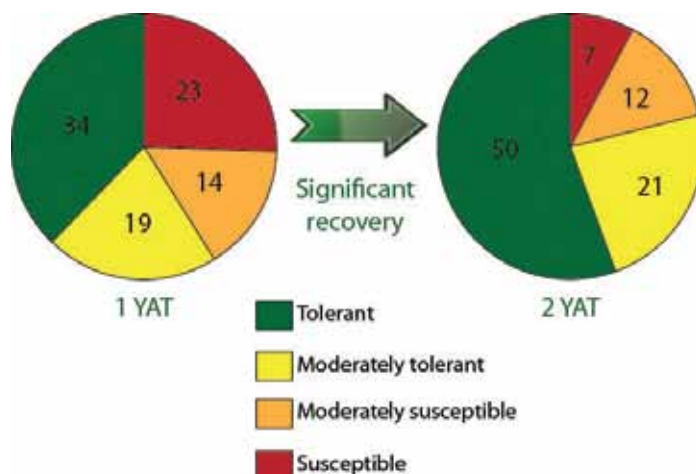
Table 1. Descriptions of codes, locations, and researchers for 16 experiments conducted in six states.

Location Code	Location Description / Name	Researcher
CO07 and CO09	Boulder Open Space, Western Colorado	K. George Beck and Jim Sebastian, Colorado State University, Fort Collins, CO
IDGreen	Open grassland North Central Idaho	Pat Green, US Forest Service Ecologist (Retired), ID
Glacial Ridge	Glacial Ridge Nature Conservancy (North Dakota)	Rodney G. Lym and Travis Almquist, North Dakota State University, Fargo, ND
MN2008 and MN Kuftrin	Two Kuftrin Waterfowl Production Area (USFWS) Rivers and Hedquist - MN Dept of Natural Resources (DNR)	Roger L. Becker, University of Minnesota, St. Paul, MN
MTRice and MTRice08	Larry Creek Bitterroot National Forest, Grant Creek Elk Refuge, Pattee Canyon Lolo National Forest	Peter M. Rice, University of Montana, Missoula, MT
MTDuncan	Native rangeland with good forb diversity	Celestine A. Duncan, Weed Management Services, Helena, MT
NDgreenhouse	Greenhouse study at North Dakota State University	Rodney G. Lym and Jonathan Mikkelson, North Dakota State University, Fargo, ND.
SD2009	South Dakota Fish and Game	Michael Moechnig, South Dakota State University, SD

Table 2: Four categories for ranking tolerance of forbs and shrubs to Milestone herbicide

Code	Category	Symptoms	Injury Level
T	Tolerant	Minimal symptoms – may exhibit slight injury and cupping of leaves.	<15% stand reduction
MT	Moderately tolerant	Cupping/yellowing and possible inhibited flowering, with recovery the first growing season after application.	15 to 50% stand reduction
MS	Moderately susceptible	Significant injury the first year and possible stand reduction.	51 to 75% stand reduction
S	Susceptible	Severe injury the season of application and stand reduction the year after treatment with possible death of established plants. Some plants may regenerate from seed bank.	>75% stand reduction

Figure 1. Comparison of tolerance rankings for 90 forb species 1 and 2 years after treatment, showing increase in tolerance by the second year following treatment with Milestone herbicide.



["TOLERANCE" continued on page 12]

Table 3: Tolerance rankings of forb species to Milestone® herbicide applied at either 5 or 7 fluid ounces per acre in summer and/or fall. Rankings are shown for 1 and 2 years after treatment (YAT). Forbs are listed alphabetically by common name within plant family (see Table 1 for location descriptions and Table 2 for category description).

Family	Common Name	Genus species	1 YAT	2 YAT	Appl Time	Location(s)
Apiaceae	Golden Alexanders	<i>Zizia aurea</i>	T	T	Both	GlacialRidge, MNKufrin
	Heart-leaved Alexanders	<i>Zizia aptera</i>	T	T	Both	MN2008
	Nine-leaf biscuitroot	<i>Lomatium triternatum</i>	MT	T	Fall	MTRice, IDGreen
	Wyeth's biscuitroot	<i>Lomatium ambiguum</i>	T	T	Fall	MTRice
Apocynaceae	Spreading dogbane	<i>Apocynum androsaemifolium</i>	T	T	Fall	Glacial Ridge
Asclepiadaceae	Common milkweed	<i>Asclepias syriaca</i>	T	T	Fall	Glacial Ridge
Asteraceae	Arrowleaf balsamroot	<i>Balsamorhiza sagittata</i>	MS	MT	Both	MTRice
	Azure aster	<i>Symphotrichum oolentagiensis</i>	T	NA	Summer	NDgreenhouse
	Black-eyed Susan	<i>Rudbeckia hirta</i>	S	MS	Both	MN2008
	Blanket flower	<i>Gaillardia aristata</i>	MT	T	Both	MTRice, Glacial Ridge MTRice08
	Canada goldenrod	<i>Solidago canadensis</i>	MT+	T	Summer	SD, MN Kufrin
			MS	MS	Fall	Glacial Ridge, MNKufrin
	Cudweed sage	<i>Artemesia ludoviciana</i>	T	T	Summer	MTDuncan
	Cup plant	<i>Silphium perfoliatum</i>	MT	NA	Both	MN2008
	Gay feather	<i>Liatris punctata</i>	T	T	Summer	CO2007
	Giant goldenrod	<i>Solidago gigantea</i>	MT	NA	Both	MN2008
	Giant sunflower	<i>Helianthus giganteus</i>	S	MS	Fall	Glacial Ridge
	Gumweed	<i>Grindelia squarrosa</i>	MS	MT	Fall	MTRice
	Hairy golden aster	<i>Chrysopsis villosa</i>	MT	T	Both	MT Rice, MT Duncan
	Hound's tongue hawkweed	<i>Hieracium cynoglossoides</i>	MT	MT	Fall	MTRice
	Little sunflower	<i>Helianthus pumilus</i>	MS	MT	Summer	CO07, CO09
			T	T	Fall	CO09
	Maximilian sunflower	<i>Helianthus maximiliani</i>	S	S	Fall	Glacial Ridge
	Missouri goldenrod	<i>Solidago missouriensis</i>	MT	T	Fall	MTRice
	Nuttall's pussy-toes	<i>Antennaria parviflora</i>	MS	MT	Fall	MTRice
			S	MS	Summer	MTDuncan
	Orange arnica	<i>Arnica fulgens</i>	S	S	Fall	MTRice
	Panicled aster	<i>Aster lanceolatum</i>	MT	NA	Both	MN2008
	Prairie blazingstar	<i>Liatris aspera</i>	MT	NA	Both	MN2008
	Prairie goldenrod	<i>Solidago missouriensis</i>	MS	MT	Fall	Glacial Ridge
	Purple coneflower	<i>Echinacea purpurea</i>	T	NA	Summer	NDgreenhouse
	Rosy pussy-toes	<i>Antennaria microphylla</i>	MT	T	Fall	MTRice
	Shaggy fleabane	<i>Erigeron pumilis</i>	MT	T	Fall	MTRice
	Smooth Blue aster	<i>Aster laeve</i>	MT	NA	Both	MN2008
	Stiff goldenrod	<i>Solidago rigida</i>	MT	MT	Summer	MN2008
			S	MS	Fall	MNKufrin
	Stiff sunflower	<i>Helianthus pauciflorus</i>	MT	NA	Summer	SD2009
			MS	MT	Fall	Glacial Ridge
	Sweet smooth oxeye	<i>Heliopsis helianthoides</i>	MT	NA	Both	MN2008
	Tall sunflower	<i>Helianthus giganteus</i>	S	NA	Both	MN2008
	White panicle aster	<i>Aster simplex</i>	S	MT	Fall	Glacial Ridge

Family	Common Name	Genus species	1 YAT	2 YAT	Appl Time	Location(s)
	White prairie aster (Heath aster)	<i>Aster ericoides</i>	MS	MT	Summer	SD2009
			MT	T	Both	MN2008
			MT	MT	Fall	Glacial Ridge, SD
	Yarrow	<i>Achillea millefolium</i>	S	S	Both	MTRice, MTRice08
	Yellow prairie coneflower	<i>Ratibida pinnata</i>	S	NA	Both	MN2008
Boraginaceae	Wayside gromwell	<i>Lithospermum ruderales</i>	MT	MT	Fall	MTRice
Brassicaceae	Alyssum	<i>Alyssum alyssoides</i>	T	T	Summer	MTDuncan
	Nuttall's rockress	<i>Arabis nuttallii</i>	T	T	Fall	MTRice
Campanulaceae	Harebell	<i>Campanula rotundifolia</i>	S	NA	Summer	NDgreenhouse
	Palespike lobelia	<i>Lobelia spicata</i>	S	S	Fall	Glacial Ridge
Caryophyllaceae	Field chickweed	<i>Cerastium arvense</i>	MS	MT	Fall	MTRice
	Jagged chickweed	<i>Holosteum umbellatum</i>	S	T	Fall	MTRice
	Threadleaf sandwort	<i>Arenaria capillaris</i>	S	MT	Summer	MTDuncan
Commelinaceae	Prairie spiderwort	<i>Tradescantia occidentalis</i>	MS	NA	Both	MN2008
Convolvulaceae	Dwarf morning glory	<i>Ipomoea tricolor</i>	MT	T	Summer	CO2007
Equisetaceae	Equisetum	<i>Equisetum arvense</i>	T	T	Both	MN2008
Euphorbaceae	Flowering spurge	<i>Euphorbia corollata</i>	T	T	Both	MN2008
	Robust spurge	<i>Tithymalus brachyceras</i>	T	T	Summer	CO2007
Fabaceae	Lupine	<i>Lupinus sericeus</i>	T	T	Fall	MT Rice, IDGreen
			MT	T	Summer	CO09, MTRice08
	Purple prairie clover	<i>Dalea purpurea</i>	S	MS	Fall	Glacial Ridge, MNKufrin
			T	T	Summer	MNKufrin
	Round-headed bush clover	<i>Lespedeza capitata</i>	MS	NA	Both	MN2008
	Sheldon's milkvetch	<i>Astragalus sheldonii</i>	T	T	Fall	IDGreen
	Showy tickfoil	<i>Desmodium canadense</i>	MS	NA	Both	MN2008
	Silky prairie clover	<i>Petalostemum villosum</i>	MS	NA	Both	MN2008
	Slimflower scurfpea	<i>Psoralea lanceolata</i>	S	MT	Summer	CO2007
	Trailing wild bean	<i>Strophostyles helvola</i>	T	T	Both	MN2008
	Weedy milkvetch	<i>Astragalus miser</i>	S	MS	Fall	MTRice
	White prairie clover	<i>Dalea candida</i>	S	S	Fall	Glacial Ridge
	White wild indigo	<i>Baptisia alba</i>	MT	NA	Both	MN2008
Gentianaceae	Closed bottle gentian	<i>Gentiana andrewsii</i>	T	NA	Summer	NDgreenhouse
Lamiaceae	American water horehound	<i>Lycopus americanus</i>	T	T	Fall	Glacial Ridge
	Hedgenettle	<i>Stachys palustris</i>	T	T	Both	Glacial Ridge
	Horsemint	<i>Monarda fistula</i>	T	T	Fall	MTRice
	Spearmint	<i>Mentha spicata</i>	MT	T	Summer	CO2009
			S	MS	Fall	CO2010
	Wild bergamot	<i>Monarda fistulosa</i>	T	T	Both	Glacial Ridge, MNKufrin
	Wild mint	<i>Mentha arvensis</i>	T	T	Fall	Glacial Ridge
Lilaceae	Death camas	<i>Zigadenus venenosus</i>	T	T	Both	MTRice, MTRice08
	Yellow bell	<i>Fritillaria pudica</i>	T	T	Both	MTRice, MTRice08
	Prairie onion	<i>Allium stellatum</i>	T	T	Both	MN2008
	Sand lily	<i>Leucocrinum montanum</i>	MS	MT	Summer	CO2007

["TOLERANCE" continued on page 14]

Family	Common Name	Genus species	1 YAT	2 YAT	Appl Time	Location(s)
Linaceae	Blue flax	<i>Linum lewisii</i>	S	MS	Summer	CO2007
Onagraceae	Common primrose	<i>Oenothera biennis</i>	S	NA	Both	MN2008
	Evening Primrose	<i>Oenothera howardii</i>	MS	MT	Summer	CO2007
	Scarlet beeblossum	<i>Gaura coccinea</i>	S	MT	Summer	CO2007
	Tall annual willow-herb	<i>Epilobium paniculatum</i>	S	MS	Fall	MTRice
Oxalidaceae	Common yellow woodsorel	<i>Oxalis stricta</i>	T	T	Fall	Glacial Ridge
Polemoniaceae	Narrow-leaf collomia	<i>Collomia linearis</i>	S	MS	Fall	MTRice
	Pink microsteris	<i>Microsteris gracilis</i>	T	T	Fall	MTRice
Polygonaceae	Douglas's knotweed	<i>Polygonum douglasii</i>	T	T	Fall	MTRice, IDGreen
	Pale dock	<i>Rumex altissimus</i>	S	NA	Both	MN2008
	Subalpine buckwheat	<i>Eriogonum subalpinum</i>	S	S	Summer	CO2009
			MT	MT	Fall	CO2010
	Water smartweed	<i>Polygonum amphibium</i>	MS	T	Fall	Glacial Ridge
	Winged buckwheat	<i>Pterogonum alatum</i>	S	S	Summer	CO2007
Primulaceae	Western androsace	<i>Androsace occidentalis</i>	MS	T	Fall	MTRice
Ranunculaceae	Purple meadow-rue	<i>Thalictrum dasycarpum</i>	MT	MT	Fall	Glacial Ridge
Rosaceae	Prairie cinquefoil	<i>Potentilla arguta</i>	S	NA	Both	MN2008
	Prairie smoke	<i>Geum triflorum</i>	MT	T	Fall	MTRice
	Soft cinquefoil	<i>Potentilla gracilis</i>	T	T	Both	CO2009
	Virginia strawberry	<i>Fragaria virginiana</i>	T	T	Fall	MTRice
	Wild rose	<i>Rosa sp.</i>	S	NA	Summer	MTDuncan
Saxifragaceae	Small-flowered fringe-cup	<i>Lithophragma parviflora</i>	S	MS	Both	MTRice, MTRice08
Scrophulariaceae	Yellow Paintbrush	<i>Castilleja occidentalis</i>	T	T	Both	CO2009
	Blue-eyed Mary	<i>Collinsia parviflora</i>	T	T	Both	MTRice, MTRice08
	One-sided penstemon	<i>Penstemon secundiflorus</i>	MT	MT	Summer	CO2007
Solanaceae	Clammy groundcherry	<i>Physalis heterophylla</i>	S	NA	Both	MN2008
Urticaceae	Stinging nettle	<i>Urtica dioica</i>	MT	NA	Both	MN2008
Verbenaceae	Blue vervain	<i>Verbena hastata</i>	T	T	Both	MN2008
	Hoary vervain	<i>Verbena stricta</i>	T	T	Both	MN2008
Violaceae	Nuttalls violet	<i>Viola nuttallii</i>	MS	T	Summer	CO2007

RESULTS SUMMARY

- Most native forb species were moderately tolerant to tolerant, or recovered following treatment with Milestone® herbicide.
- Land managers can use these data as a guideline to evaluate risk and benefits to native plant communities when using Milestone for invasive species management.
- Milestone herbicide can be used to manage invasive plants in mixed plant communities and can serve as a catalyst to manage invasive plants and facilitate recovery of desirable forbs.

Milestone® Herbicide Guidelines for Use Around Woody Plants



The following information provides guidelines for Milestone herbicide application around woody plants. In general, Transline® is the most selective herbicide to use for invasive plant control on sites where tree and shrub selectivity is important.

Can I use Milestone® herbicide for weed control under trees?

Aminopyralid, the active ingredient in Milestone herbicide, has limited activity on woody species, including trees, when applied to the soil under the canopy. While it would be unlikely for broadcast applications of labeled rates to actually kill a mature tree (except legume species), there could be some leaf curling/cupping or other damage typical of growth regulator herbicides. Therefore, Milestone should NOT be used over the top of desirable trees. Milestone can be used ONLY as a directed spray under the canopy, or within the dripline, of certain trees; but not under desirable legume trees/shrubs.

Milestone CAN BE USED as an under-canopy soil application for the following trees:

Common name	Scientific name
alder	<i>Alnus rubrus</i>
ash	<i>Fraxinus</i> spp.
aspen	<i>Populus</i> spp.
black cherry	<i>Prunus serotina</i>
cottonwood	<i>Populus</i> spp.
dogwood	<i>Cornus</i> spp.
eastern red cedar	<i>Juniperus virginiana</i>
eastern white pine	<i>Pinus strobus</i>
elm	<i>Ulmus</i> spp.
maple	<i>Acer</i> spp.
oaks	<i>Quercus</i> spp.
poplar	<i>Populus</i> spp.
southern yellow pine	<i>Pinus</i> spp. (southern)
sweetgum	<i>Liquidambar styraciflua</i>
sycamore	<i>Platanus occidentalis</i>
western white pine	<i>Pinus monticola</i>
willow	<i>Salix</i> spp.
yellow poplar (transient leaf curling)	<i>Liriodendron tulipifera</i>

Caution is suggested for use of Milestone® herbicide around these species:

Applications may be made to weeds and soil outside of the dripline, with wider margins of avoidance suggested on downward facing slopes immediately above sensitive trees. Be sure not to treat low hanging foliage and exposed roots.

Common name	Scientific name
birch	<i>Betula</i> spp.
cherry (except black cherry)	<i>Prunus</i> spp.
Chinese elm	<i>Ulmus parviflora</i>
crabapple	<i>Malus</i> spp.
Douglas fir	<i>Pseudotsuga menziesii</i>
fir	<i>Abies</i> spp.
hackberry	<i>Celtis</i> spp.
Japanese elm	<i>Zelkova serrata</i>
lodgepole pine	<i>Pinus contorta</i>
ponderosa pine	<i>Pinus ponderosa</i>
Virginia pine	<i>Pinus virginiana</i>

Do not use Milestone herbicide under desirable leguminous trees or the following listed species, if desired:

Common name	Scientific name
black locust	<i>Robinia pseudoacacia</i>
Caragana	<i>Caragana arborescens</i>
grapes	<i>Vitis</i> spp.
honey locust	<i>Gleditsia triacanthos</i>
junipers	<i>Juniperus</i> spp.
locust species	all species
mimosa	<i>Albizia julibrissin</i>
mulberry	<i>Morus</i> spp.
Pinyon pine	<i>Pinus edulus</i>
redbud	<i>Cercis occidentalis</i> or <i>canadensis</i>
rose	<i>Rosa</i> spp.
spruce	<i>Picea</i> spp.
western red cedar	<i>Thuja</i> spp.

CAUTION: Milestone herbicide can cause injury or death to desirable vegetation. Users are advised not to apply Milestone over the top of desirable trees or in the root zone of susceptible species where injury cannot be tolerated, especially at the 14 fl oz spot treatment.

Grasses, Revegetation, and Conservation Reserve Program (CRP) Guidelines



Can Milestone® be applied for invasive weed control with grasses planted after treatment?

Milestone can be applied in the spring through fall to control broadleaf weeds prior to grass planting. Grasses can be seeded as a dormant planting (in the late fall or early winter) in the year of application or grasses can be seeded the following spring. Grasses should be planted when soil temperatures are low enough to ensure that the seeds do not germinate and emerge for at least 60 days after application to allow for some Milestone® degradation.

When can Milestone be applied post-emergence over newly seeded perennial grass stands to minimize injury?

Over 33 species of warm- and cool-season grasses have been tested for tolerance to Milestone herbicide. Established grass stands have excellent tolerance at the maximum use rates. On newly seeded grass plantings, applications of Milestone should be made after seeded grasses have an established secondary root system (tillering and adventitious root development). A secondary root system is usually sufficiently developed by 45 to 60 days after emergence, depending on growing conditions. Most perennial grasses show improved tolerance to post emergence applications at this stage.

Increased injury to grass seedlings may result when Milestone is applied in tank mixes with other herbicides such as 2,4-D. Consult all labels for products used for guidance on recently seeded grass stands.

How long after treatments with Milestone® do I need to wait before planting forbs?

IN SUMMER RAINFALL AREAS: Milestone can be applied in the summer to control broadleaf weeds prior to forb planting. Forbs can be seeded 90 days after application as a dormant fall planting insuring that the seeds will not germinate and emerge until the following spring. Forbs can also be planted the following spring after an application the previous July.

IN AREAS WITH NO TO VERY LITTLE SUMMER RAINFALL (Mediterranean climate), forbs can be planted one year after a Milestone treatment.

What are the guidelines for planting in CRP?

MILESTONE LABEL STATEMENT FOR CROP ROTATION

- Do not rotate to any crop from rangeland, permanent pasture or CRP acres within one year following treatment.
- Cereals and corn can be planted one year after treatment.
- Most broadleaf crops are more sensitive and can require at least two years between treatment and planting, depending on the crop and environmental conditions.
- Do not plant a broadleaf crop until an adequately sensitive field bioassay shows that the level of aminopyralid present in the soil will not adversely affect that broadleaf crop.

ROTATION OUT OF CRP

- **Wheat:** When Milestone is sprayed in May or June one year, do not plant winter wheat that fall. Spring wheat may be planted the following spring and winter wheat the following fall. With fall applications of Milestone®, do not plant spring wheat the following spring but winter wheat may be planted the next fall.
- **Corn** can be planted the year following a spring/summer treatment.
- **Canola** may be planted two years after treatment
- **Alfalfa** may be planted three years after treatment or earlier after a positive bioassay.
- **Soybeans** are more sensitive than alfalfa or canola and should not be planted for at least three years and not before a soil bioassay is completed.
- For other sensitive crops such as **potatoes, lentils** and **peas**, a soil bioassay should be conducted before planting (see label for directions). Depending on environmental conditions, three years after treatment may be adequate for most crops.

Herbicide Sprayer Calibration Guidelines

How do I make the most of my herbicide spot treatments?

Accurate timing, careful measurements of herbicide and uniform spray motions are essential to proper, economical application. Consistent spray motions can help obtain good coverage of troublesome weeds. Soaking scattered weeds rather than using regular spray motions may result in excessive rates that could injure desirable species.

How much herbicide do I put in my tank?

The mix amount is dependent on your spray volume and your application rate. Therefore, this question cannot be answered until we know the volume that is being applied with your particular spraying style in gallons per acre (GPA). The following step-by-step procedure will allow you to calibrate your spray volume (see answer at end).

Sprayer Calibration: Six Simple Steps

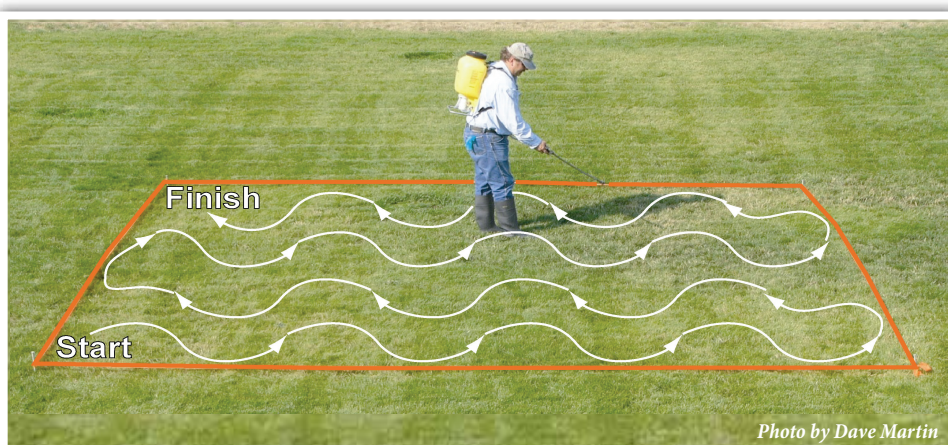
The following step-by-step method of calibrating a backpack or hand-gun sprayer involves very little math or formulas. It is based on the following principal:

One gallon = 128 fluid ounces and your calibration area to be sprayed is 1/128 of an acre, thus fluid ounces collected = gallons per acre.

1. Clean sprayer and nozzle thoroughly. Then, fill the spray tank with clean water. Spray with water only to check to see that the nozzle forms a uniform spray pattern. If the pattern is uneven, check to make sure the nozzle is clean and replace it if needed. Adjustable nozzles should be set and marked to permit repeated use of the selected spray pattern. If necessary, add a marker dye to the water to more easily see your spray pattern.

2. Measure an area 18.5 feet by 18.5 feet, which is equal to 1/128th of an acre. If possible, this should be done in the field on which you will be spraying.

3. Time the number of seconds it takes to spray the measured area uniformly with water using gentle side-to-side sweeping motion with the spray wand similar to spray painting a home or automobile. Record the number of



seconds required to spray the area. During application be sure to maintain a constant sprayer pressure and cover the entire area uniformly one time.

You should repeat step 3 at least twice and use the average of the two times.

4. Spray into a container for the average time calculated in step 3. Be sure to maintain constant sprayer pressure while you spray into the container.

Tip Use a syringe to measure herbicide if you are applying a low-rate product like Milestone (e.g., 5 to 7 fl oz/ac).

1 tsp=5cc
1/2 tsp=2.5 cc
1/4 tsp=1.3 cc



5. Measure the number of fluid ounces of water in the bucket. The number of fluid ounces collected from the bucket is equal to the number of gallons of water per acre the sprayer is delivering. Volume sprayed in fluid ounces = gallons of water per acre (GPA).

6. Add the proper amount of herbicide to the tank. For backpack sprayers, use Table 1 to determine how much liquid herbicide to add to each gallon of water. For large sprayer, use Table 2 to determine the amount of liquid herbicide to add to your spray tank.

Find your spray volume in gallons per acre (GPA - calculated above) and read across the tables (next page) to determine the amount of herbicide to add to each gallon of water based on the recommended herbicide application rate.

["CALIBRATION" continued on page 18]

Table 1: Backpack or Other Small-volume Sprayers

The amount of herbicide you need to add to each gallon of water based on the recommended rate for the weed you are treating.

Gallons/Ac (from step 5)	Recommended Herbicide Rate/Acre				
	5 fl oz/ac	7 fl oz/ac	1 pint/ac	1 quart/ac	2 quarts/ac
20	7.5 cc/gal	10.5 cc/gal	5 tsp/gal	10 tsp/gal	3 1/4 fl oz/gal
30	5 cc/gal	7.0 cc/gal	3 tsp/gal	6 tsp/gal	2 fl oz/gal
40	3.8 cc/gal	5.3 cc/gal	2 1/3 tsp/gal	4 3/4 tsp/gal	1 2/3 fl oz/gal
50	3.0 cc/gal	4.2 cc/gal	2 tsp/gal	3 3/4 tsp/gal	1 1/4 fl oz/gal
60	2.5 cc/gal	3.5 cc/gal	1 2/3 tsp/gal	3 1/4 tsp/gal	6 1/3 tsp/gal
70	2.1 cc/gal	3.0 cc/gal	1 1/3 tsp/gal	2 3/4 tsp/gal	5 1/2 tsp/gal
80	1.9 cc/gal	2.6 cc/gal	1 1/4 tsp/gal	2 1/3 tsp/gal	4 3/4 tsp/gal
90	1.7 cc/gal	2.3 cc/gal	1 tsp/gal	2 tsp/gal	4 1/4 tsp/gal
100	1.5 cc/gal	2.1 cc/gal	1 tsp/gal	2 tsp/gal	3 3/4 tsp/gal

Liquid conversions: tsp = teaspoons; TBS = tablespoons; fl oz = fluid ounces; 1 cc = 1 ml; 3 teaspoons = 1 tablespoon; 8 fluid ounces = 1 cup; 2 tablespoons = 1 fluid ounce; 1 cup = 16 tablespoons

Example for Backpack Sprayers: You have completed the calibration procedure and applied 30 fluid ounces in the measured area. Therefore, your spray volume is 30 GPA. Look at Table 1 above for the amount to mix in 1 gallon of water. Assume you want to apply 5 fluid ounces of Milestone® per acre; the amount listed for your volume (GPA) and this application rate is 5 cc in each gallon of water. If you are filling a 3-gallon backpack sprayer take this amount times 3 and you would need to measure 15 cc (with a syringe) or 3 tsp of Milestone® for your 3 gallon mix. It doesn't take much.

Table 2: Larger Hand-gun Sprayers

The amount of herbicide you need to mix in 100 gallons of water based on the recommended rate for the weed you are treating.

Gallons/Ac (from step 5)	Recommended Herbicide Rate/Acre				
	5 fl oz/ac	7 fl oz/ac	1 pint/ac	1 quart/ac	2 quarts/ac
20	25.0 fl oz	35.0 fl oz	5 pt	5 qt	10 qt
30	16.7 fl oz	23.3 fl oz	3.3 pt	3.3 qt	6.6 qt
40	12.5 fl oz	17.5 fl oz	2.5 pt	2.5 qt	5 qt
50	10.0 fl oz	14.0 fl oz	2 pt	2 qt	4 qt
60	8.3 fl oz	11.7 fl oz	1.6 pt	1.6 qt	3.2 qt
70	7.1 fl oz	10.0 fl oz	1.4 pt	1.4 qt	2.8 qt
80	6.3 fl oz	8.8 fl oz	1.25 pt	1.25 qt	2.5 qt
90	5.6 fl oz	7.8 fl oz	1.1 pt	1.1 qt	2.2 qt
100	5.0 fl oz	7.0 fl oz	1 pt	1 qt	2 qt

Conversions: 16 fluid ounces = 1 pint; 32 fluid ounces = 1 quart; 64 fluid ounces = 2 quarts

Example for Larger Sprayers: You calibrate your sprayer and the output is 50 GPA, and your sprayer holds 100 gallons. The area you can treat is 2 acres with your full spray tank. The label requires an herbicide application rate of 5 fl oz/acre for the target weed. You would add 10 fl oz of herbicide to your tank since you are treating 2 acres with each full tank mix.

Calibrating equipment with boomless nozzles (e.g., boom-buster or boom-i-nator) with a refill method

The refill method of calibration is simple and easy to understand. This should always be done in the field on terrain similar to where you plan to make the herbicide application. Field surface conditions can greatly affect sprayer speed, which in turn affects application rate. Basic steps for the refill method are as follows.

1. Park the sprayer on level ground, then fill the spray tank with water to an easily determined point (mark this on the tank).
2. Adjust the pressure to recommended level. Most nozzles work best between 30 and 35 psi (pounds per square inch).
3. Select a speed that can be easily maintained for field conditions. Field conditions will have a large effect on speed, which affects application rate. For example a sprayer calibrated at 4 mph but driven at 3 mph will over-apply by 33% potentially damaging non-target vegetation!
4. Spray a measured area (spray swath width and length). Measure a length to spray--such as 200 feet--and drive that length at a speed that negotiates terrain and minimizes drift. Measure the spray swath width during this step.
5. Return to the filling point. Be sure to park equipment in the same location to refill the tank.
6. Measure the amount of water required to refill the tank. Use a calibrated pail so you can accurately measure water required to fill the sprayer to the original mark.
7. Calculate the spray rate. The final step is to determine the spray rate; in this case it will be in gallons per acre (GPA).

$$GPA = \frac{\text{gallons sprayed [from Step 6]} \times 43,560 \text{ sq ft/acre}}{\text{swath width (ft)} \times \text{swath length (ft)} \text{ [as measured in Step 4]}}$$
8. Add the proper amount of herbicide to the tank. Example: Your spray tank holds 30 gallons total. If you want to apply one pint of herbicide per acre, and your spray rate is 15 gallons per acre (as calculated in Step 7), then you would add two pints of herbicide to the tank. The best way to mix is to add half of the amount of water to the tank, then add the herbicide, then fill the sprayer with water to the 30-gallon mark.

Technical Facts About Milestone® Herbicide

The Environmental Fate of Milestone® Herbicide

SOIL: Aerobic microbial degradation is the primary route of breakdown in soil. Average field soil half-life is 34.5 days for eight North American sites. There are no degradation metabolites of concern.

WATER: Photolysis (UV portion of the light spectrum) is the primary route of degradation in water. Photolysis half-life under standard conditions is 0.6 days. Groundwater contamination potential is low because of low use rates combined with moderate soil half-life.

AIR: Practically non-volatile

Where Milestone Herbicide Can Be Used

Milestone is labeled for use on rangeland, permanent grass pastures, Conservation Reserve Program (CRP) acres, non-cropland areas (such as roadsides), non-irrigation ditch banks, seasonally dry wetlands, natural areas (such as wildlife management areas, wildlife openings, wildlife habitats, recreation areas, campgrounds, trailheads and trails), and grazed areas in and around these sites.

The Runoff Potential of Milestone Herbicide

Milestone has a low risk of runoff in surface water compared to the current market standards. The runoff impact of Milestone® is mitigated by low use rate and rapid photolysis in water.

The Ecotoxicology Profile of Milestone Herbicide

Milestone exhibits low acute and chronic toxicity to mammals, birds, fish, aquatic and terrestrial invertebrates, algae and aquatic vascular plants in laboratory studies.

Risk of adverse effects is substantially below all of the EPA levels of concern (LOC) for non-target organisms.

Milestone produces no significant soil or water metabolites other than CO₂ and NH₃ and has a low bioaccumulation potential.

In EPA's assessment under the Reduced Risk Pesticide Initiative, Milestone was found to have reduced acute and chronic toxicity to mammals, birds, algae and aquatic vascular plants compared to market standards.

The Rainfast Period

Foliar absorption of Milestone® applied post emergence is relatively rapid. Milestone herbicide appears to be rainfast within two hours after application when applied at recommended label rates.

Using Milestone Herbicide in Water

Milestone can be used to the waters edge but do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark. Take precautions to avoid spray drift onto water. Do not spray on inner banks of ditches or canals used to transport irrigation water.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites.

Milestone Herbicide Can Be Used in Riparian Areas

Yes, under the following guidelines:

- The label does not allow applications directly to water (ponds, lakes, rivers, streams and irrigation canals).
- Avoid applications that may result in movement of Milestone into water used to irrigate crops.
- The non-target plant community should be considered (see forb and shrub tolerance section, page 11).

How Milestone® Herbicide Persists in the Soil

While Milestone herbicide will provide season-long residual control of emerging broadleaf weeds, this herbicide has a moderate field soil half-life.

Half-lives in U.S. and Canadian field

studies have averaged approximately 34.5 days. Ninety percent of Milestone applied at a rate of 7 fl oz/acre dissipated within 90 days.

In a large majority of studies, the herbicide has remained in the top six to 12 inches of the soil profile.

The Effect of pH on degradation of Milestone

Due to the low pKa (ionization constant) of the active ingredient, pH will have no impact on Milestone degradation in any matrix.

Milestone® Herbicide Can Be Applied with Spot Treatments

Yes, spot treatments may be made at an equivalent broadcast rate of up to 0.22 lb active ingredient (14 fl oz of Milestone) per acre per annual growing season; however, not more than 50% of an acre may be treated.

Do not apply more than a total of 0.1 lb active ingredient per acre (7 fl oz per acre of Milestone) per annual growing season.

(See spot treatment calibration guidelines on page 15.)

Milestone Herbicide and Surfactants

The addition of a high quality non-ionic surfactant (of at least 80% active ingredient) at 0.25 to 0.5% volume per volume (1 to 2 quarts per 100 gallons of spray) is recommended to enhance herbicide activity under adverse environmental conditions (such as high temperature, low relative humidity, drought conditions, dusty plant surfaces), when weeds are heavily pubescent, or with more mature plants.

Milestone Herbicide Remains Active in the Spray Tank Solution

Milestone herbicide is not degraded by the hydrolysis process like sulfonyleurea herbicides. Milestone® will break down in water when exposed to ultra-violet (UV) light from the sun. Provided the spray

["FAQ" continued on page 20]



TechLine Invasive Plant News provides tips, research, success stories, and other resources for on-the-ground invasive plant managers. Visit www.techlinenews.com for information to help you with your program.

["FAQ" continued from page 19]

tank is a UV resistant tank (most are), or if the sprayer or mix tank is parked inside, the solution would be stable for very long periods of time. Although once herbicides are mixed, it is advisable to use them as soon as possible.

There Sprayer Clean-Out Instructions to Avoid Damage to Sensitive Plants

Yes. It is important to not use spray equipment used to apply Milestone® for other applications to land planted to crops or desirable sensitive plants unless it has been determined that all residues of this herbicide have been removed by thorough cleaning of equipment. No exceptions! See label for detailed cleaning instructions.

Milestone Does Not Harm Grasses

Research was conducted on over 33 different grass species and both warm and cool season grasses show excellent

tolerance to Milestone herbicide. In fact, grass production increases significantly after weeds are removed.

Grazing or Haying Restrictions

Milestone passes through an animal's digestive system unchanged and is excreted in urine and manure. This occurs relatively rapidly, within about three days.

There are no restrictions on grazing (any livestock including lactating dairy and horses) or hay harvest following application of Milestone® at labeled rates¹.

Cutting hay too soon after spraying weeds will reduce weed control. Wait 14 days after herbicide application to cut grass hay to allow herbicide to work.

Milestone does not break down in plants. Therefore, hay from areas treated with Milestone may contain residues. Inform the recipient of hay or manure from

animals grazing pastures or feeding on hay from areas treated with Milestone of the label use precautions and restrictions.

Hay from grass treated with Milestone within the preceding 18-months can only be used on the farm or ranch where the product is applied unless allowed by supplemental labeling.

Do not transfer livestock from treated grazing areas to sensitive broadleaf crop areas without first allowing three days of grazing in an untreated pasture. Otherwise, urine and manure may contain enough Milestone® to cause injury to sensitive broadleaf plants. Refer to Milestone label for additional instructions.

¹Restrictions do apply to the transfer of grazing animals to sites intended to grow sensitive crops. Refer to the label for a complete list of transfer restrictions.

For more information, visit
www.MilestoneHerbicide.com

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Always read and follow label directions.

Milestone has no grazing or haying restrictions for any class of livestock, including lactating dairy cows, horses (including lactating mares) and meat animals prior to slaughter. However, label precautions do apply to forage treated with Milestone and to manure from animals that have consumed treated forage within the last three days.

Consult the label for full details. Some states require an individual be licensed if involved in the recommendation, handling or application of any pesticide. Consult your local Extension office for information regarding licensing requirements. Milestone is not registered for sale or use in all states. Contact your state pesticide regulatory agency to determine if a product is registered for sale or use in your state.

Capstone and Oversight specialty herbicides: When treating areas in and around roadside or utility rights-of-way that are or will be grazed,

hayed or planted to forage, important label precautions apply regarding harvesting hay from treated sites, using manure from animals grazing on treated areas or rotating the treated area to sensitive crops. See the product label for details.

State restrictions on the sale and use of **Captson**, **Garlon 4 Ultra**, **Opensight**, **Transline**, and **Vista XRT** apply. Consult the label before purchase or use for full details.

Tordon 22K is a federally Restricted Use Pesticide.