

Leafy Spurge

Identification and Chemical Control

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Leafy spurge (*Euphorbia esula* L.) is a widely established perennial weed in North Dakota, infesting approximately 990,000 acres of land in 2005 (North Dakota Department of Agriculture survey). The leafy spurge infestation in North Dakota seems to have peaked at about 1.5 million acres in 2000 and 2001. The decline thereafter has been a result of an effective control program initiated in the early 1980s. Prior to this control program, leafy spurge acreage doubled every 10 years from 1950 to 1985. Despite the decline in acreage, the widespread infestation continues to cost the state more than \$75 million annually in lost production.

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Identification

Leafy spurge is a long-lived perennial plant that is native to Europe and Asia and was introduced in the United States in 1827. It first was identified in North Dakota in 1909, growing along a street in Fargo. Leafy spurge is a noxious weed, according to both the North Dakota Seed Law and North Dakota Noxious Weed Law.

Leafy spurge normally grows 2 to 3 feet tall as herbaceous stems from a woody crown that is below the soil surface. Each crown produces several erect stems, giving the plant a clumplike appearance. The plant bears numerous linear-shaped leaves with smooth margins. The leaves have a characteristic bluish-green color but turn yellow or reddish orange in the fall. Stems originating from crown buds and roots begin growth in late April, making leafy spurge one of the first plants to emerge in the spring. The early and rapid growth gives leafy spurge a competitive advantage over crop and pasture plants. All parts of the plant contain a milky juice called latex, which is a useful identifying characteristic.

Leafy spurge produces a flat-topped cluster of yellowish-green petal-like structures called bracts, which surround the true flowers (Figure 1). The showy, yellow bracts appear in late May and early June, giving the plant the appearance of "blooming." However, the **true flowers**, which are small and green, **do not develop until mid-June**. The distinction between bract appearance and true flowering is important for timing of herbicide applications. Spring-applied herbicides are more effective on plants with developing true flower parts than on plants with developed bracts but undeveloped flowers.

Seeds are borne in pods, which contain three gray-brown, oblong, smooth seeds. After the seed has matured, the seed pods burst explosively and throw seeds up to 15 feet from the parent plant. An average of 140 seeds is produced per stem, and seeds may remain viable in the soil at least eight years.

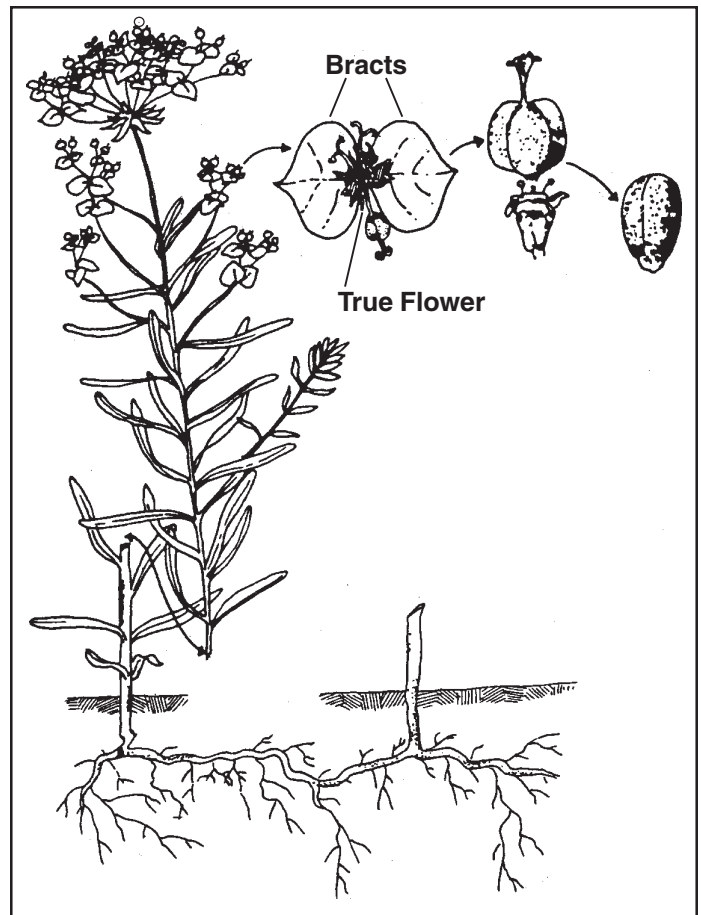


Figure 1. A leafy spurge plant in bloom. Shown in detail are vegetative buds on the roots, a leafy bract and true flower, a seed pod (capsule) and a seed.

Leafy spurge seeds may germinate to re-establish infestations where total control of leafy spurge foliage and roots has been achieved. The peak period of germination is late May and early June, but seeds can germinate and seedlings become established throughout the growing season. Leafy spurge seedlings have a remarkable capacity for vegetative reproduction and can reproduce vegetatively within seven to 10 days after emergence. Seedlings typically do not flower during the first year.

Leafy spurge patches may have more than 200 stems per square yard in sandy soil and even higher densities in heavy clay soil. Patches of leafy spurge usually spread vegetatively from 1 to 3 feet per year and form dense stands that crowd out other plants by shading and competing for moisture and nutrients.

The root system of leafy spurge is extensive and consists of numerous coarse and fine roots that occupy a large volume of soil. Roots are most abundant in the upper foot of soil, but some roots can extend to a depth of 15 feet or more. Roots are woody and durable in structure, with numerous buds capable of producing new shoots. Leafy spurge has two types of roots – vertical and horizontal. Vertical roots may be as large as ½-inch diameter in the upper foot of soil and decrease to the size of a pencil lead with increasing depth. Horizontal roots are smaller in diameter than vertical roots and spread out from the crown up to 15 feet per year. The root system contains a large nutrient reserve capable of sustaining the plant for years.

Leafy spurge contains a toxic substance that, when consumed by livestock, is an irritant, emetic and purgative. It causes scours and weakness in cattle and may result in death. The toxin has produced inflammation and loss of hair on the feet of horses from freshly mowed stubble during haying, and has caused mortality in sheep that grazed leafy spurge exclusively. However, sheep and goats safely can graze leafy spurge as a portion of their diet, and grazing can be used as a form of cultural control. Ruminants will eat dried plants in hay, but many livestock, particularly cattle, avoid eating live plants.

Grazing studies by North Dakota State University have shown forage growing in leafy spurge-infested areas is poorly utilized by cattle (Figure 2). A fairly high stocking rate of sheep and goats is required to maintain a low leafy spurge density and limit its spread. Grazing should begin in the spring when leafy spurge is 2 to 6 inches tall. NDSU research has shown continuous season-long grazing results in better leafy spurge control than rotational grazing programs. See “Controlling Leafy Spurge Using Goats and Sheep,” NDSU Extension Service publication R-1093, available only on the Web at www.ext.nodak.edu/extpubs/weeds.htm.

Leafy spurge grows primarily in pastures and rangeland, tree rows and waste areas, and along roadsides. The plant occasionally occurs in cultivated areas but cannot tolerate intensive tillage.

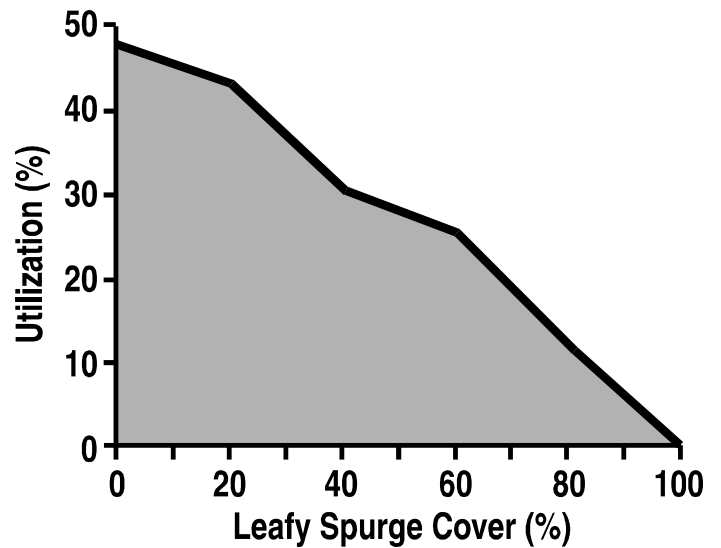


Figure 2. Forage utilization by cattle in pasture areas infested with leafy spurge.

Leafy spurge in cultivated land occurs most frequently where infested land has been broken for crop production or when producers practice reduced tillage methods.

Leafy spurge is persistent and difficult to eradicate. Roots scattered in the field by cultivation produce new plants in addition to those established by seeds. Pieces of roots as small as 0.5 inch long and 0.1 inch diameter will produce new roots. Pieces of root also will survive two or three hours of drying in the hot sun. The well-developed food storage system in leafy spurge roots enables the plant to tolerate some cultivation and frequent mowing.

Control requires a well-planned program with consistent and careful follow-through. Although leafy spurge can be controlled using herbicides alone, the best long-term solution is an integrated approach that incorporates herbicides with grazing, competitive grass species and/or biological control agents (see “Integrated Management of Leafy Spurge,” NDSU Extension Service publication W-866R, also available on the Web).

Biological, cultural and physical control methods should be integrated with the best timing and rates for herbicides, as discussed in this publication, for specific management situations.

Timing Herbicide Applications

Proper timing of herbicide applications is essential for good leafy spurge control (Figure 3). Leafy spurge is most susceptible to 2,4-D, dicamba (Banvel and other trade names), Paramount (quinclorac) or Tordon (picloram) applied either when the true flowers and seeds are developing in June or after the stems have developed new fall regrowth in early to mid-September. Plateau (imazapic), fall-applied, provides better long-term control and less grass injury than spring or summer treatments. Combinations of Tordon plus Plateau or Tordon plus Plateau plus 2,4-D applied in June provide improved leafy spurge control, compared to Tordon plus 2,4-D or Plateau applied alone in June. The Tordon plus Plateau combination is not recommended for use in the fall.

Glyphosate (Roundup and many other trade names) applied for leafy spurge control has a different optimum application timing than the auxin herbicides (2,4-D, dicamba, Tordon and Paramount) or Plateau. Glyphosate is most effective for leafy spurge control when applied either after seed filling in midsummer or after fall regrowth has begun but before a killing frost (Figure 3).

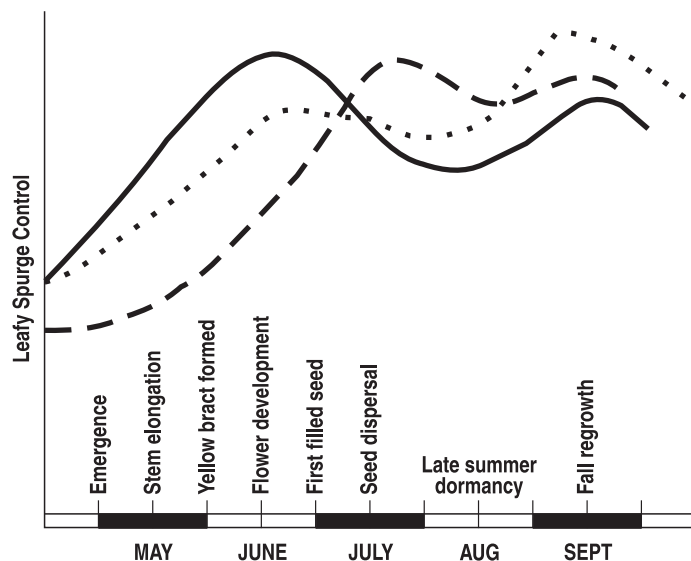


Figure 3. Susceptibility of leafy spurge to 2,4-D, dicamba, Paramount or Tordon (—) to glyphosate (---) and Plateau (■ ■ ■) during the growing season.

Glyphosate alone applied during spring growth stages generally provides poor long-term control.

Consult the current “North Dakota Weed Control Guide,” NDSU Extension Service publication W-253, for the most recent information concerning leafy spurge control with herbicides.

Control in Pastures and Rangelands

Leafy spurge control must be considered a long-term management program. A landowner should attempt to contain present infestations to keep the weed from spreading and design a long-term program to gradually eliminate dense infestations of leafy spurge. The well-established root system has a large nutrient reserve that allows the plant to regrow from deep depths for several years. **No single treatment will eradicate this weed.** An annual treatment program often provides the best long-term control. **Do not skip a year** until control reaches 90 percent or more; otherwise leafy spurge will reinfest rapidly (Table 1). After a high level of control is achieved, often only isolated patches remain that can be spot treated, or a less expensive herbicide, such as 2,4-D, can be applied for one or more years to maintain satisfactory control.

Historically, the most cost-effective herbicide treatment for controlling leafy spurge has been a tank mix of **Tordon** (picloram) at 1 to 2 pints per acre plus **2,4-D** at 1 quart of a 4-pound-per-gallon concentrate (0.25 to 0.5 pounds plus 1 pound per acre) applied in June during flowering and repeated annually (Table 2). Tordon plus 2,4-D at 1 pint plus 1 quart per acre has provided 85 percent leafy

Table 1. Longevity of leafy spurge control if an infestation is not retreated.

Control 12 months after last treatment	Years without retreatment		
	1	2	3
95 or more	85	70	< 20
80	60	< 20	0
70	< 30	0	—
60	20	0	—

Table 2. Leafy spurge control in pastures and rangeland with herbicides applied at optimal timings for the specific herbicide.

Year 1		Years 2-4		Months after initial treatment			
Herbicide	Rate product/A	Herbicide	Rate product/A	12	24	36	48
				————— (% control) —————			
Tordon	1 qt	Tordon	1 qt	65	70	75	90
Tordon	2 qt	—	—	75	20	0	—
Dicamba	2 qt	Dicamba	2 qt	55	85	95	—
Dicamba	4 qt	—	—	80	35	—	—
2,4-D ^a	1 qt + 1 qt	2,4-D ^a	1 qt + 1 qt	20	30	35	20
Tordon	1 pint	Tordon	1 pint	40	50	40	50
Tordon+2,4-D	1 pint + 1 qt	Tordon + 2,4-D	1 pint + 1 qt	50	65	75	85
Tordon+2,4-D	1 qt + 1 qt	Tordon + 2,4-D	1 qt + 1 qt	70	75	80	95
Plateau + MSO ^b	8 oz + 1 qt	Plateau + MSO ^b	8 oz + 1 qt	75	90	95	—
Tordon + Plateau + 2,4-D + MSO ^b	1 pint + 4 oz + 1 qt + 1 qt	—	—	92	83	75	—
Tordon + Overdrive + MSO ^b	1 pint + 4 oz + 1 qt	—	—	92	56	—	—
Paramount + MSO ^b	1 + 1 qt	Paramount + MSO	1 + 1 qt	55	75	95	—
Glyphosate	0.75	—	—	80	10	—	—

^a 2,4-D at 1 quart (pounds/acre) applied twice per year in the spring and fall.

^b MSO = methylated seed oil.

spurge control after four annual applications and was the most cost-effective treatment evaluated when averaged across several locations in North Dakota. Some land managers prefer to start a program using Tordon plus 2,4-D at 1 quart per acre the first year and then reduce the Tordon rate to 1 pint per acre in subsequent years. Leafy spurge control 12 months after the initial treatment with the Tordon at the 1-quart-per-acre rate averaged 70 percent, compared with 50 percent with Tordon at 1 pint per acre. The optimum time for the Tordon plus 2,4-D annual application will be slightly later each growing season because flowering is delayed as weed control increases.

Tordon plus 2,4-D at 1 quart plus 1 quart per acre provides greater control, and does not require retreatment as frequently, but is more expensive, compared with Tordon at 1 pint per acre plus 2,4-D (Table 2). However, in the fall, Tordon at 1 quart plus 2,4-D at 1 quart per acre is needed to obtain satisfactory control because Tordon is more effective on leafy spurge when spring-applied than when fall-applied.

A second combination treatment of **Tordon plus Plateau plus 2,4-D**, which has become known as the North Dakota three-way mix, provides better long-term control than Tordon plus 2,4-D or Plateau alone (Table 2). This treatment should be applied during the true-flower growth stage with Tordon at 1 pint plus Plateau at 4 ounces plus 2,4-D at 1 quart per acre plus a methylated seed oil (MSO) at 1 quart per acre. 2,4-D is not required when the only target weed is leafy spurge, but can be included at a comparatively modest cost for a wider spectrum of weed control. Although this treatment costs nearly twice as much as Tordon plus 2,4-D, long-term control is improved enough that annual retreatments generally are not required, which results in a net savings for application expense and time. Consult the respective herbicide labels and follow the most restrictive label when using Tordon plus Plateau and/or plus 2,4-D.

The combination of **Tordon plus Overdrive** also will improve leafy spurge control, compared with Tordon used alone (Table 2). Overdrive contains dicamba plus diflufenzopyr, which is an anti-auxin

compound that often improves broadleaf weed control when applied with auxinlike herbicides such as Tordon, dicamba and 2,4-D. Diflufenzopyr is not available alone, so land managers should use Overdrive. Tordon at 1 to 2 pints per acre (0.25 to 0.5 pound per acre) plus Overdrive (dicamba plus diflufenzopyr) at 4 to 6 ounces per acre (0.125 to 0.188 plus 0.05 to 0.08 pound per acre) should be applied with an MSO or nonionic surfactant during the leafy spurge true-flower growth stage.

Tordon can be applied at up to 2 quarts per acre (1 pound) as a spot treatment and will give 75 percent or more leafy spurge control for at least one year (Table 2). This is an expensive treatment and generally is used to control leafy spurge in small or isolated patches. Tordon at 2 quarts per acre is the highest labeled rate.

Tordon is a restricted-use herbicide because it is phytotoxic to most broadleaf plants, has a relatively long soil residual and is water soluble with the potential to move into underground water. Do not use Tordon where a sandy porous surface and substrata overlie groundwater 10 feet or less below the surface, and do not contaminate streams, ponds or irrigation ditches. Do not use on flood- or subirrigated land. Tordon at the rates required for leafy spurge control cannot be used on cultivated land.

Note: Do not transfer livestock from Tordon-treated grass areas onto sensitive broadleaf crop areas for 12 months after application or until Tordon has disappeared from the soil without first allowing seven days of grazing on an untreated grass pasture. Otherwise, urine may contain enough Tordon to cause injury to sensitive broadleaf plants. Do not use Tordon near trees or other desirable broadleaf vegetation. Careful application is necessary to prevent spray drift.

Dicamba (Banvel and other trade names) will provide an intermediate level of leafy spurge control in pastures and rangeland. Dicamba at 1.5 to 2 gallons per acre (6 to 8 pounds per acre) will give good leafy spurge control for one year (Table 2), but control usually decreases rapidly the second year after treatment. Dicamba is absorbed by leaves and roots, is translocated throughout the plant and should be applied to foliage in mid-June or early September for best results. A follow-up treatment in the spring with 2,4-D at 1 quart per acre of a 4-pound-per-gallon concentrate may be needed to prevent reinfestation by seedlings or shoots from surviving roots. Dicamba at 2 quarts per acre applied annually provided 95 percent leafy spurge control after three applications.

When using dicamba near water, precautions similar to Tordon should be observed.

Note: The waiting period after dicamba treatment for grazing dairy animals varies from seven to 90 days, depending on the rate applied. Check the label for details before using. A waiting period is required between treatment and grazing only for dairy animals when dicamba is used alone. Meat animals should be removed from treated areas 30 days prior to slaughter.

Paramount is a narrow-spectrum broadleaf herbicide that will control leafy spurge when applied in the spring or fall (Table 2). However, the treated area **cannot be grazed or hayed for 309 days** after treatment, so Paramount is most useful in wildlands or other areas where domestic livestock are not grazed and the forage is not cut for hay. Paramount at 8 ounces per acre alone (0.38 pound per acre) or with **Overdrive** (dicamba plus diflufenzopyr) at 6 ounces per acre (0.188 plus 0.08 pound per acre) should be applied with a MSO at 1 quart per acre during the leafy spurge true-flower growth stage or in the fall prior to a killing frost. Paramount alone will not injure many desirable broadleaf plants, such as wild raspberry and anemone, and is safe near many tree species. However, this selectivity is negated

when Paramount is applied with Overdrive, which contains dicamba. Consult both herbicide labels and follow the most restrictive label when using Paramount in combination with Overdrive. Paramount cannot be applied aerially.

Plateau (imazapic) fall-applied at 8 to 12 ounces per acre (0.125 to 0.188 pound per acre) will provide 70 percent to 80 percent leafy spurge control one year after treatment (Table 2). Research at NDSU has shown Plateau should be applied in mid-September for best leafy spurge control. Apply Plateau with a MSO at 1 quart per acre. The addition of 28 percent urea-ammonium nitrate liquid fertilizer at 1 quart per acre to Plateau plus an MSO occasionally has increased long-term leafy spurge control. Plateau applied at rates of 8 ounces per acre or more often reduces both warm- and cool-season grass production, but research at NDSU has shown the grass stands will recover the season following treatment, especially if the Plateau rate is 8 ounces per acre or less. Plateau spring-applied will control leafy spurge, but the plants will remain green during the growing season and injury to both warm- and cool-season grasses is increased, compared with the fall-applied treatment.

2,4-D as low-volatile ester or water-soluble amine at 1 quart of a 4-pound-per-gallon concentrate (1 pound per acre) gives short-term control of leafy spurge top growth but has little effect on reducing leafy spurge stands (Table 2). Although 2,4-D does not provide long-term control of leafy spurge, forage production is increased when 2,4-D is spring-applied and will allow cattle or horses to graze the area. Applying 2,4-D at rates up to 4 pounds per acre generally provides less than 40 percent control after one year, and 2,4-D applied annually (spring or fall) or biannually (spring and fall) does not give long-term leafy spurge control. The amine and ester formulations of 2,4-D provide similar leafy spurge control regardless of application date or rate. The amine formulation is preferred because it is less volatile and more economical, compared with ester formulations.

Control in Trees

Amine formulations of **2,4-D** at 1 quart per acre of a 4-pound-per-gallon concentrate acid equivalent (1 pound per acre) may be used to control leafy spurge top growth among trees. Avoid contacting tree foliage with direct spray or spray drift because 2,4-D can injure trees; 2,4-D must not contact the green bark of young trees.

Glyphosate (Roundup and other trade names) at 1 quart of a 3-pound-per-gallon acid equivalent concentrate (0.75 pound per acre) applied from mid-July to mid-September will give 80 percent to 90 percent control of leafy spurge (Figure 1 and Table 2). Treatments made earlier in the season have not given satisfactory leafy spurge control. A follow-up treatment with 2,4-D at 1 pint of a 4-pound-per-gallon concentrate (0.5 pound per acre) between mid-June and mid-July of the next year is necessary to prevent seedling reinfestation because glyphosate does not have soil residual activity. Glyphosate is nonselective and will kill grasses; avoid contacting tree foliage and green bark of young trees with either direct spray or glyphosate spray drift as tree injury will result.

Dichlobenil (Norosac 10G and other trade names) will suppress leafy spurge for about one season. Dichlobenil at 60 to 80 pounds of Norosac 10G (6 to 8 pounds per acre active ingredient) must be applied before leafy spurge emerges in early spring, either in late November when above-freezing temperatures no longer are expected or in late March to early April, as soon as possible after snow melt. NDSU studies have shown dichlobenil applied at 8 pounds per acre in November provided 80 percent suppression of leafy spurge the following June, but control declined to 20 percent suppression by September. Dichlobenil only will suppress leafy spurge emergence and does not affect emerged plants. Dichlobenil at 6 to 8 pounds per acre is an expensive treatment but is safe under trees. It may be a useful treatment in small shelterbelts or under fruit and shade trees.

Control for Small Infestations, Noncropland and Near Water

When leafy spurge is confined to small, well-defined areas, herbicide treatments should begin immediately to avoid spread of the weed. Treat an extra 10 to 15 feet around leafy spurge patches to control spreading roots and seedlings around the established stand. A careful follow-up program is necessary for several years to control missed stems and seedlings. Many attempts to control leafy spurge have failed because follow-up treatments were not applied.

Any of the herbicide treatments mentioned previously can be used on noncropland. Consult the specific herbicide label for use rates.

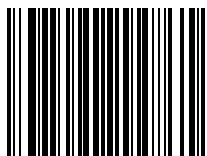
Leafy spurge control along water (streams, lakes, ponds, etc.) is desirable to prevent further spread of seed by water. However, most herbicides used for leafy spurge control cannot be used near water. **Krenite (fosamine)** and **glyphosate** (Aquamaster, Glypro, Rodeo or other formulations for aquatic use only) can be used safely near water. Krenite at 1.5 to 2 gallons per acre (6 to 8 pounds per acre) should be applied during the leafy spurge true-flower growth stage. Do not apply Krenite directly to water. Krenite can be used to control leafy spurge growing on the berm and outer slope of a drainage ditch,

for instance, but not on the inside downward slope where the herbicide may enter the flowing water. Control with Krenite has been inconsistent in NDSU research and best results occurred when soil moisture was abundant and the relative humidity was high.

Glyphosate (Aquamaster, Glypro, Rodeo or other formulations for aquatic use only) at 1.5 pints per acre of a 4-pound acid-equivalent per-gallon concentrate (0.75 pound per acre) will provide 80 percent to 90 percent leafy spurge control when applied from mid-July to mid-September. A nonionic surfactant approved for aquatic sites must be added to the spray solution for best results. Consult the manufacturer or dealer for surfactants approved for safe use near water. Glyphosate is nonselective and will kill nearly all vegetation; avoid contacting desirable vegetation with either glyphosate or glyphosate spray drift.

A follow-up treatment will be needed the next year to control leafy spurge seedlings when either Krenite or glyphosate is used. A **2,4-D formulation labeled for use near water** at 1 to 2 pints of a 4-pound-per-gallon concentrate applied from June to mid-July will kill emerged seedlings. A 2,4-D formulation labeled for use near water can be applied as an annual treatment to prevent seed-set and reduce expansion of a leafy spurge infestation.

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



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