



Leafy Spurge IDENTIFICATION AND CONTROL

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Leafy spurge (*Euphorbia esula* L.) is a widely established weed in North Dakota, infesting approximately 1 million acres of land. This is nearly the same number of acres as reported in 1987 and 300,000 acres less than reported in 1990. North Dakota has 13.1 million acres of untilled land on farms such as pastures, range, woodlands, roads, farmsteads, and houselots. Since leafy spurge is found primarily on untilled land, the present infestation is approximately 8 percent of the farmland most likely to be infested with leafy spurge.

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

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Identification

Leafy spurge normally grows 2 to 3 feet tall from a woody crown that is below the soil surface. Each crown area produces several upright stems, giving the plant a clump-like 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 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 bear 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.

Leafy spurge seeds may germinate and reinfest areas in which total control of leafy spurge tops and roots has been achieved. The peak period of germination is late May and early June, but seeds can germinate 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. The seedlings develop throughout the growing season but do not flower during the first year.

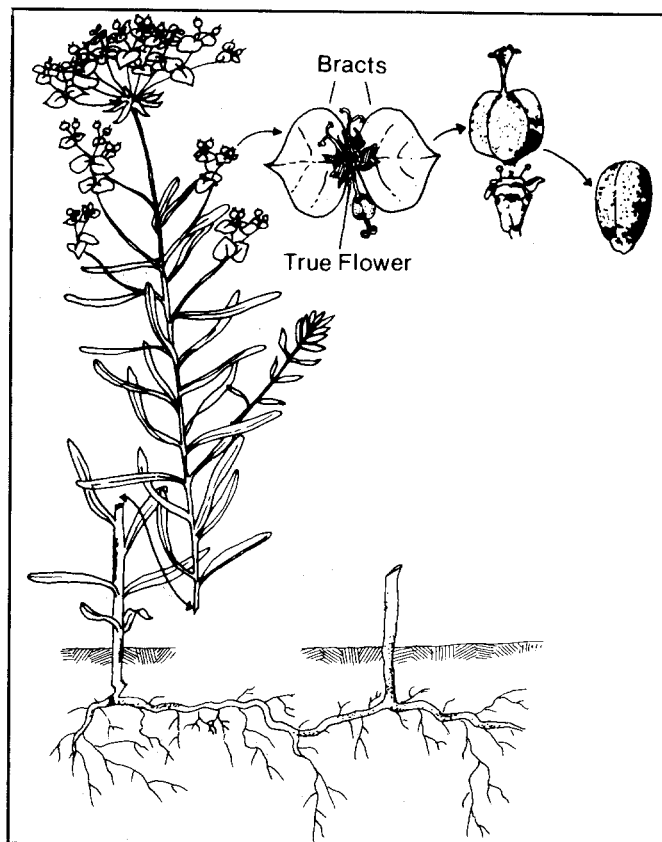


Figure 1. A leafy spurge plant in bloom. Shown in detail are vegetative buds on the roots, a leafy bract and true flower, a seed pod (capsule) and a seed.

Leafy spurge 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 which 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 which 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. The roots are woody and durable in structure with numerous buds capable of producing new shoots. Roots may be as large as one-half inch diameter in the upper foot of soil and decrease to the size of a pencil lead with increasing depth. 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 of sheep that grazed leafy spurge exclusively. However, sheep and goats will graze leafy spurge as a portion of their diet and can be used as a form of biological control. Animals will eat dried plants in hay, but livestock, particularly cattle, avoid eating live plants.

Grazing studies by North Dakota State University have shown that forage growing in leafy spurge-infested areas is poorly utilized by cattle (Figure 2). A fairly high stocking rate is required with sheep and goats 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 that continuous season-long grazing results in better leafy spurge control than rotational grazing programs.

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

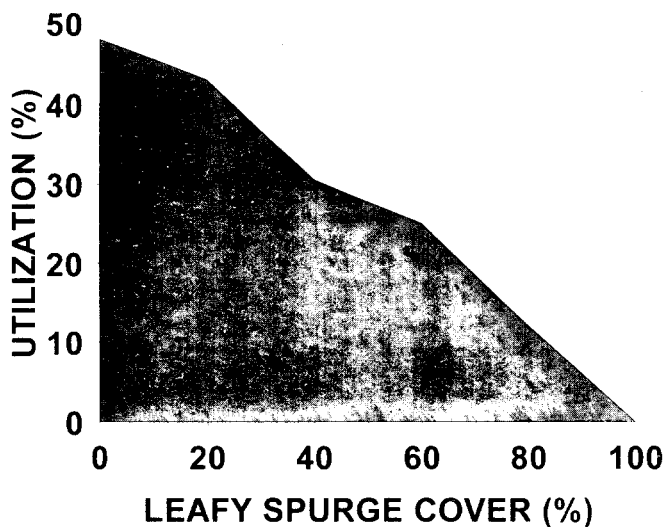


Figure 2. Forage utilization by cattle in pasture areas infested with leafy spurge.

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

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 roots 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 withstand cultivation and frequent mowing. Control requires a well planned program with consistent and careful follow-through.

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), or picloram (Tordon) applied when the true flowers and seeds are developing in June, or in early to mid-September after the stems have developed new fall regrowth. Glyphosate + 2,4-D (Landmaster BW) provides good leafy spurge control when applied during seed set in late June or early July. Glyphosate + 2,4-D may slightly injure grasses when applied in early summer. Herbicides applied during the hot, dry weeks of summer when leafy spurge is somewhat dormant are less effective.

Glyphosate (Roundup) applied for leafy spurge control follows a different pattern than glyphosate + 2,4-D (Landmaster BW). Glyphosate is most effective for leafy spurge control either after seed filling in mid-summer or after fall regrowth has begun but before a killing frost (Figure 3). Glyphosate alone applied during spring growth stages generally provides poor long-term control.

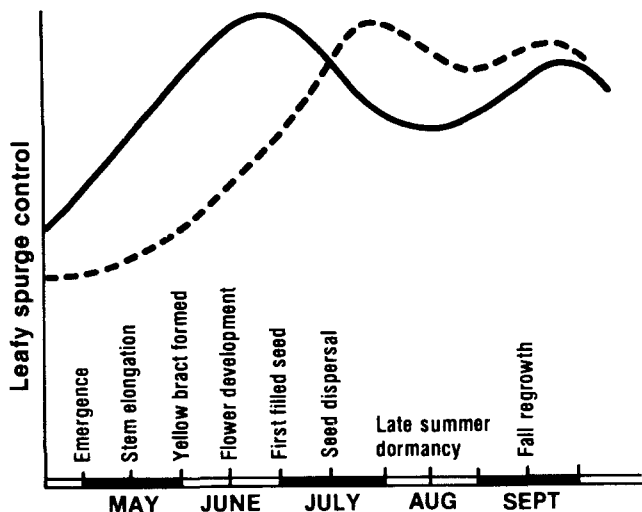


Figure 3. Susceptibility of leafy spurge to 2,4-D, dicamba, glyphosate + 2,4-D or picloram (—) and to glyphosate alone (-----) when applied at various times during the growing season.

CONTROL IN PASTURES AND RANGELANDS

Leafy spurge control must be considered a long-term management program. A land owner 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 allows the plant to regrow from depths of 15 feet or more for several years. **NO SINGLE TREATMENT WILL ERADICATE THIS WEED.** An annual treatment program 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.

Picloram (Tordon 22K) is the most effective herbicide for controlling leafy spurge. Picloram at 2 pounds per acre (1 gallon per acre) will give 90 percent or more leafy spurge control the first year after treatment (Table 2). Control will decline gradually to approximately 70 percent three years after treatment and much more rapidly thereafter.

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 |
| | ----- (% control) ----- | | |
| 95 or more | 85 | 70 | < 20 |
| 80 | 60 | < 20 | 0 |
| 70 | < 30 | 0 | — |
| 60 | 20 | 0 | — |

However, picloram is an expensive herbicide and a 2-pound-per-acre rate may not be economically feasible if a large area is infested with leafy spurge.

Research at NDSU has shown that a less expensive option for leafy spurge control is a tank mix of picloram at 0.25 to 0.5 pound per acre (1 to 2 pints per acre) + 2,4-D at 1 pound per acre (1 quart of a 4-pound-per-gallon concentrate) applied in June during flowering and repeated annually. Picloram + 2,4-D at 0.25 + 1 pound per acre has provided 85 percent leafy spurge control after four annual applications (Table 2) and was the most cost-effective treatment evaluated when averaged across several locations in North Dakota (Table 3).

Picloram at 0.5 pounds per acre + 2,4-D provides greater control, does not require retreatment as frequently, but is more expensive compared to picloram at 0.25 pound per acre + 2,4-D (Table 2). However, the high rate should be used for fall-applied treatments to obtain satisfactory control. Leafy spurge control with picloram at 1 pound per acre or more is similar whether spring or fall applied; however, picloram + 2,4-D is more effective when spring-applied than when fall-applied. The optimum time for the picloram + 2,4-D annual application will be slightly later each growing season because flowering is delayed as weed control increases.

Picloram 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 picloram where a sandy porous surface and substrata overlie groundwater 10 feet or less below the surface, and do not contaminate

Table 2. Leafy spurge control in pastures and rangeland with herbicides generally applied during the true-flower growth stage.

| Year 1 | | Years 2-4 | | Months after initial treatment | | | |
|-------------------------------|---------|--------------------|--------|--------------------------------|----|----|----|
| Herbicide | Rate | Herbicide | Rate | 12 | 24 | 36 | 48 |
| | (lb/A) | | (lb/A) | ----- (% control) ----- | | | |
| Picloram | 0.5 | Picloram | 0.5 | 65 | 70 | 75 | 90 |
| Picloram | 1 | --- | --- | 75 | 20 | 0 | — |
| Picloram | 2 | --- | --- | 95 | 80 | 75 | 25 |
| Dicamba | 2 | Dicamba | 2 | 55 | 85 | 95 | — |
| Dicamba | 8 | --- | --- | 80 | 35 | — | — |
| 2,4-D ^a | 2 | 2,4-D ^a | 2 | 20 | 30 | 35 | 20 |
| Picloram | 0.25 | Picloram | 0.25 | 40 | 50 | 40 | 50 |
| Picloram+2,4-D | 0.25+1 | Picloram+2,4-D | 0.25+1 | 50 | 65 | 75 | 85 |
| Picloram+2,4-D | 0.5+1 | Picloram+2,4-D | 0.5+1 | 70 | 75 | 80 | 95 |
| Glyphosate+2,4-D ^b | 0.4+0.6 | Picloram+2,4-D | 0.25+1 | 75 | 90 | — | — |
| Glyphosate | 0.75 | ----- | ---- | 80 | 10 | — | — |

^a 2,4-D applied twice per year in the spring and fall.

^b Applied during the seed-set growth stage in late June and early July.

Table 3. Comparison of forage production versus cost of several leafy spurge treatment programs after three years.

| Year 1 | | Years 2-4 | | Yield | Cost | Net return ^a |
|----------------|--------|----------------|--------|--------------|--------|-------------------------|
| Herbicide | Rate | Herbicide | Rate | | | |
| | (lb/A) | | (lb/A) | (% of check) | (\$/A) | (\$/A) |
| Picloram | 2 | — | — | 113 | 82 | -72 |
| Picloram+2,4-D | 0.25+1 | Picloram+2,4-D | 0.25+1 | 161 | 36 | 21 |
| 2,4-D | 2 | 2,4-D | 1 | 138 | 15 | 15 |
| Dicamba | 2 | Dicamba | 2 | 143 | 68 | -18 |

^a Value of extra forage production as pounds of beef minus herbicide costs, total for three years.

streams, ponds or irrigation ditches. Picloram cannot be used at the rates required for leafy spurge control on cultivated land.

NOTE

Do not transfer livestock from treated grass areas onto sensitive broadleaf crop areas for 12 months after application or until picloram has disappeared from the soil without first allowing seven days of grazing on an untreated grass pasture. Otherwise, urine may contain enough picloram to cause injury to sensitive broadleaf plants. Do not use picloram near trees or other desirable broadleaf vegetation. Careful application is necessary to prevent spray drift. When rates exceed 0.5 pounds per acre, the total area treated should not exceed 25 percent of a land owner's acreage in watershed.

Dicamba (Banvel) will provide an intermediate level of leafy spurge control in pastures and rangeland. Dicamba at 6 to 8 pounds per acre (1.5 to 2 gallons 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 pound per acre (1 quart of a 4-pound-per-gallon concentrate) may be needed to prevent reinfestation by seedlings or shoots from surviving roots. Dicamba at 2 pounds per acre applied annually provided 95 percent leafy spurge control after three applications (Table 2) and increased forage production 143 percent compared to the untreated control (Table 3).

However, annual dicamba treatments did not provide a positive net return because of the relatively high herbicide cost.

When using dicamba (Banvel) near water, precautions similar to picloram (Tordon 22K) should be observed.

Note

The waiting period after treatment for grazing dairy animals varies from seven to 90 days depending on the rate applied. Check the label for details before using. No waiting period is required between treatment and grazing for other than dairy animals when dicamba is used alone. Meat animals should be removed from treated areas 30 days prior to slaughter.

Glyphosate + 2,4-D (Landmaster BW) will provide season-long leafy spurge control, but there is a risk of grass injury, especially when fall-applied. Research at NDSU has shown a single treatment of glyphosate + 2,4-D at 0.4 + 0.6 pounds per acre (3.38 pints of Landmaster BW) applied during the early seed-set growth stage will provide 75 percent or better leafy spurge control (Table 2) with 0 to 10 percent grass injury. Glyphosate + 2,4-D costs approximately 40 percent less than the standard picloram + 2,4-D at 0.25 + 1 pound per acre treatment and provides better control the first year.

Glyphosate + 2,4-D should not be applied to the same area two consecutive years because grass injury could be severe. Also, glyphosate + 2,4-D fall-applied will provide 60 to 70 percent leafy spurge control but grass injury often increases to 30 percent or more. A typical cost-effective treatment program would be glyphosate + 2,4-D applied during the seed-set growth stage in late June of the first year, followed by picloram + 2,4-D during the true-flower growth stage of the second year.

Spray coverage with glyphosate + 2,4-D must be uniform, but **do not** spray to the point of runoff to minimize grass injury. Livestock must be removed from a field to be treated prior to application, and the forage cannot be grazed or hayed for **8 weeks after treatment**.

2,4-D as low volatile ester, water soluble amine, or water soluble powder formulations at 1 pound per acre (1 quart of a 4-pound-per-gallon concentrate) 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 (Table 3), but 2,4-D fall-applied did not increase forage production. Applying 2,4-D at rates up to 5 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 to ester formulations.

Picloram and dicamba at high rates may provide acceptable control for two or more years, but the cost is high except for treatment of small patches. The 2,4-D, 2,4-D + picloram, and 2,4-D + glyphosate treatments are less expensive than dicamba and picloram at common use rates but must be applied annually. Herbicide and application costs and timeliness of treatment should be considered when selecting a herbicide or a treatment program for leafy spurge control.

CONTROL IN TREES

Amine formulations of 2,4-D at 1 pound per acre (1 quart per acre of a 4-pound-per-gallon concentrate) 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) at 0.75 pound per acre (1 quart per acre) applied from mid-July to mid-September will give 80 to 90 percent control of leafy spurge. Treatments made earlier in the season have not given satisfactory leafy spurge control. A follow-up treatment with 2,4-D at 0.5

pound per acre (1 pint of a 4-pound-per-gallon concentrate) 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.

Glyphosate + 2,4-D (Landmaster BW) can be applied instead of glyphosate to increase leafy spurge control and decrease grass injury under trees. Also, glyphosate + 2,4-D, which is applied at the early set-set stage, can be applied two to four weeks earlier than glyphosate alone to obtain good control.

Dichlobenil (Norosac 10G) will suppress leafy spurge for about one season. Dichlobenil at 6 to 8 pounds per acre (60 to 80 pounds Norosac 10G) must be applied before leafy spurge emerges in early spring; either in late November when above-freezing temperatures are no longer expected or in early to mid-April, as early as possible after snow melt. NDSU studies have shown that 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 must be applied late in fall or very early in spring because it will prevent leafy spurge emergence only 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, NON-CROPLAND, 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 non-cropland. Consult the specific herbicide label for use rates.

Leafy spurge control along open water is desirable to prevent further spread of seed by water. However, most herbicides used for leafy spurge control cannot be used near water. **Fosamine (Krenite S)** and **glyphosate (Rodeo formulation only)** can be used safely near water. Fosamine should be applied at 6 to 8 pounds per acre (1.5 to 2 gallons per acre) during the true flower growth stage. Control with fosamine has been inconsistent in NDSU research. Application should be made when soil moisture is abundant and the relative humidity is high for best results.

Glyphosate (Rodeo) at 0.75 pound per acre (1.5 pints per acre) will provide 80 to 90 percent leafy spurge control when applied from mid-July to mid-September. A nonionic surfactant approved for aquatic sites should be added to the spray solution for best results. Consult manufacturer or dealer for approved surfactants for safe use near water. Glyphosate is non-selective and will kill 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 seedlings when either fosamine or glyphosate is used. A **2,4-D formulation labeled for use near water** at 0.5 to 1 pound per acre (1 to 2 pints of a 4-pound-per-gallon concentrate) applied from June to mid-July will prevent seedling establishment. 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.

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