

HERBICIDE CONTROL *of Leafy Spurge*

A comprehensive,
easy-to-read
manual on
using herbicides as an
effective leafy spurge
management tool.

A product of the USDA-ARS TEAM Leafy Spurge Area-Wide IPM Program



introduction

If you have fought leafy spurge, you already know it is one of the most difficult invasive weeds to control. Leafy spurge has been described as the nearly perfect weed because it rapidly invades new areas and it has an arsenal of defenses that make control and management difficult. A native of Europe and Asia, leafy spurge emerges early in the spring and gets a head start on other vegetation in a race for space, sunlight, nutrients and water.

Prolific seed production and an extensive root system give the plant a huge competitive advantage and make consistent, long-term control difficult.



Leafy spurge latex

The latex in leafy spurge is a deterrent to grazing by cattle and horses.

All parts of the plant contain a milky juice called latex, which prevents grazing by most animals and injury from most insects. Latex can be toxic and when consumed by cattle causes scours and weakness.

Leafy spurge will invade a wide variety of terrain from flood



“Space” invaders

Leafy spurge is difficult to control because it can grow in many different environments.



The problem

An extensive root system, capable of storing nutrient reserves and producing numerous shoots, makes leafy spurge extremely persistent.

plains to river banks, grasslands, ridges, and mountain slopes and grows in diverse environments from

dry to subhumid and from subtropic to subarctic.

Leafy spurge will displace native vegetation even in otherwise non-disturbed habitats. Leafy spurge is primarily found in untilled, non-cropland habitats such as abandoned cropland, pastures, rangeland, woodland, roadsides, and waste areas.

The extensive root system consists of numerous coarse and fine roots, occupying a large volume of soil. Roots are most abundant in the upper foot of soil, but some roots extend to a depth of 15 feet or more. The roots are woody and durable with numerous buds capable of producing new shoots.

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These 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 that can sustain the plant for years, allowing it to survive long periods of drought and most methods used to manage and control the weed.

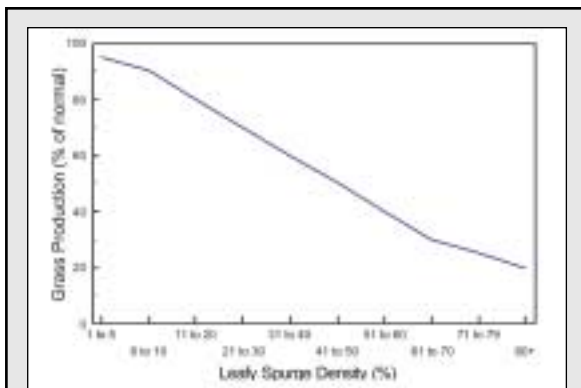
Herbage production can be decreased by as much as 75% when leafy spurge infests pasture and rangeland. Infestations in Wyoming, Montana and the Dakotas alone are estimated to cost agricultural producers and taxpayers more than \$144 million a year in production losses, control expenses, and reduction in native plant and wildlife diversity.

Herbicide control

Herbicides are the most commonly used leafy spurge management tool for containing and preventing the spread of existing infestations and for eradicating new infestations. Presently, herbicides can be used to control leafy spurge in nearly every habitat it is found. Several traditional auxin herbicides and recently introduced compounds from other chemical families can be effective

as part of a long-term management program. In addition, most experimental herbicides have been screened for leafy spurge control since the introduction of 2,4-D in the 1940s.

Top-growth control and a gradual decrease in the underground root system are possible with a persistent herbicide program. The most economical control method depends on the size and location of the infested area. Herbicides can eliminate small patches of leafy spurge with persistent treatments. Larger areas require additional (integrated) control measures, because long-term control is extremely difficult to achieve with any single control method. Thus, herbicides are an important component of any integrated pest management (IPM) program focused on leafy spurge control.



Costly competitor

As leafy spurge density increases, grass production decreases. This is the cost of leafy spurge.

This manual provides information concerning the use of herbicides and their integration with other weed control technologies. TEAM Leafy Spurge presents this information ONLY as a guide for potential leafy spurge management programs. You must ALWAYS read and follow the label instructions for registered uses of herbicides which are given on container labels. The label is the final guide and should be strictly followed. The information presented in this manual was current at the time of publication, but herbicide label requirements change as dictated by law and research results. Consult the current label for safety precautions including necessary protective clothing, reentry requirements, and grazing restrictions. **It is up to you, the end user, to always read and follow label directions for proper use of herbicides in the many environments leafy spurge grows.**

Our goal

The goal of this manual is simple: We want to provide you, the rancher, landowner or land manager, the information you need to evaluate the various herbicides available and determine how they can best be integrated into your management program.

We'll start by providing some basic information about herbicides, potential benefits and the kinds of results that can be expected. We'll

then move into more detailed information about timing, control in different habitats, the cost-benefit of using herbicides and integrating herbicides with other control techniques.

The key is STARTING. Herbicides are not a cure-all or an overnight solution; however, they are another tool that can contribute to a sustainable long-term leafy spurge management program. Control requires a well-planned program with consistent and careful follow-through. Herbicides won't work unless you use them, and the sooner you start, the sooner they can start working for you.

Remember...

When working with any herbicide, always read and follow label directions.



the basics

How herbicides work

None of the herbicides used to control leafy spurge were developed specifically for controlling invasive weeds on rangeland and wildlands. It costs too much for a company to develop and label a compound solely for the control of noxious weeds that only impact non-cropland acreage with limited economic return. Thus, all herbicides presently labeled for leafy spurge control were selected from cropland chemicals and labeled for

use on rangelands and grasslands. For example, Tordon (picloram) was labeled in the mid 1960s for weed control in wheat. Banvel (dicamba) is a corn herbicide, and the newly labeled leafy spurge herbicides Plateau (imazapic) and Paramount (quinclorac) were developed for weed control in peanuts and rice, respectively.

All herbicides used for leafy spurge control are safe for use around domestic animals and wildlife when applied as directed by

Herbicide origins

No herbicide is labeled exclusively for rangeland weed control. All have been adopted for rangeland use from herbicides targeting weeds in croplands.



Plateau was developed for use on peanuts.



Paramount was developed for use on rice.

the herbicide label. The auxin or auxin-like herbicides such as Tordon, Banvel, and 2,4-D control many broadleaf weeds but not grasses. Plateau controls a limited number of broadleaf plants, is safe to use under many shrubs and trees, but can injure certain grasses, especially when used at higher rates. Paramount controls a very limited number of broadleaf plants, but it is safe to use around virtually all trees, shrubs, and grasses. In contrast, Roundup (glyphosate) and its generic equivalents are non-selective and will injure nearly all plants.



By the numbers

A rule of thumb is for every year leafy spurge has been established in a location, two years of treatment will be needed for complete control.



Start small

Small patches of leafy spurge are the easiest to control, and are ideal targets for herbicide use.

Leafy spurge is persistent and land managers must be even more persistent and proactive in their management efforts to successfully control this weed. It is important to get an initial idea of how much leafy spurge you have and the size of the areas you wish to treat. Controlling leafy spurge is much like fighting a range fire. Small patches should be treated first to prevent spread. The edge of larger stands should be treated to prevent further spread and gradually reduce the size of the infestation.

Timing

Proper timing of herbicide applications is essential for good leafy

spurge control. Leafy spurge is most susceptible to 2,4-D, Banvel or Tordon applications when the plant is in the true flowering and seed production stage from mid- to late June, or in early to mid-September after the stems have developed new fall regrowth. Glyphosate plus 2,4-D (Campaign or Landmaster BW) provides good leafy spurge control when applied during seed set in late June or early July. Glyphosate plus 2,4-D may slightly injure grasses when applied in early summer. Herbicides applied during the hot and dry weeks of summer, when leafy spurge is somewhat dormant, are less effective. Fall-applied Plateau

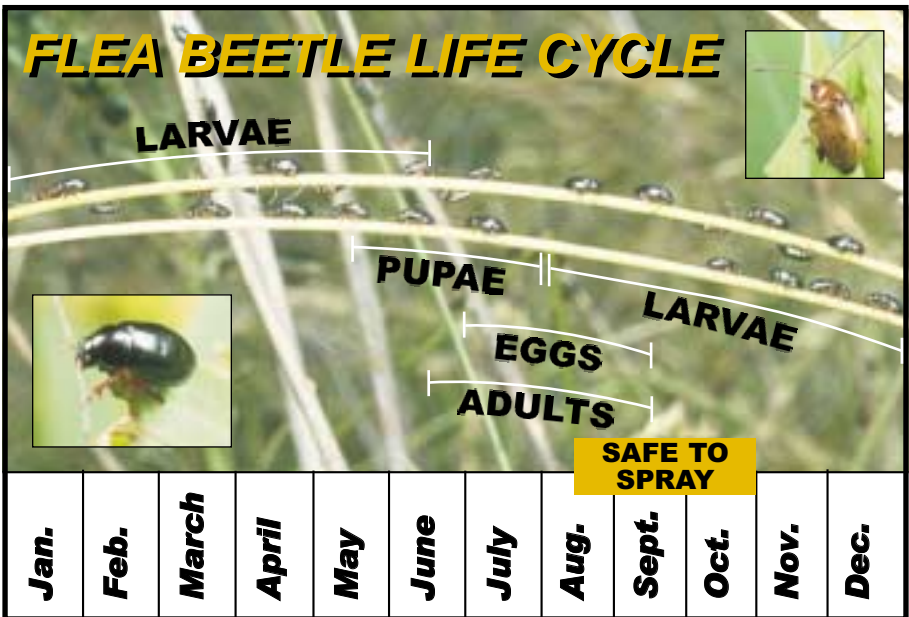


Table 1. Longevity of leafy spurge control if an infestation is not retreated.

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

and Paramount provide better long-term control than applications made earlier in the growing season. In the case of Plateau, fall applications also cause less grass injury.

Glyphosate (Roundup, various others) applied for leafy spurge control follows a different pattern than glyphosate plus 2,4-D. Glyphosate is most effective for leafy spurge control when applied either after seed filling, in mid-summer, or after fall regrowth has begun. Glyphosate applied in early spring or after a killing frost generally provides poor long-term control. **Consult your local Extension Service for the most recent information concerning leafy spurge control with herbicides.**

What should I expect?

The control of well-established leafy spurge stands must be considered a long-term management program. A landowner must develop a persistent annual program that will prevent the spread of larger

stands, eliminate smaller infestations, and prevent the spread of leafy spurge to uninfested areas. The extensive leafy spurge root system allows the plant to regrow from depths of 15 feet or more for several years. **No single treatment will eradicate this weed.** A consistent annual treatment program can provide long-term control. Do not skip a year until you have controlled at least 90 percent of the leafy spurge in an area. Leafy spurge reinfests rapidly (Table 1) and in a very short time you will have lost any benefits from previous treatments. This is a common and costly mistake. Once you have achieved a high level of control, remaining isolated patches can be spot-treated, resulting in a less costly control program. Be vigilant in your spray program. Environmental conditions that favor leafy spurge can result in a resurgence of the weed and require you to resume a more aggressive control approach.

the herbicides

Tordon (picloram)

Tordon (picloram) historically has been the most effective herbicide for controlling leafy spurge. Tordon applied at 2 quarts per acre can give 75 percent or more leafy spurge control the first year after treatment (Table 2). This is an expensive treatment and is generally used to control leafy spurge in small or isolated patches. Tordon

applied at 2 quarts per acre every other year can provide good leafy spurge control and significantly reduce annual application costs.

Research at North Dakota State University demonstrated the effectiveness of a less expensive option for leafy spurge control. Repeated annual treatments of Tordon at 1 to 2 pints per acre plus 2,4-D at 1 quart (4-pound-per gallon concentrate) applied in June, during flow-

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

Herbicide	Year 1	Years 2-4 as needed		Months after initial treatment			
	Rate (Product)	Herbicide	Rate (Product)	12	24	36	48
----- (% control) -----							
Tordon	1 qt	Tordon	1 qt	65	70	75	90
Tordon	2 qt	---	---	75	20	0	--
Banvel	2 qt	Banvel	2 qt	55	85	95	--
Banvel	8 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 pt	Tordon	1 pt	40	50	40	50
Tordon+2,4-D	1 pt + 1 pt	Tordon+2,4-D	1 pt + 1 pt	50	65	75	85
Tordon+2,4-D	1 qt + 1 qt	Tordon+2,4-D	1 qt + 1 qt	70	75	80	95
Glyphosate+2,4-D ^b	54 fl oz	Glyphosate+2,4-D ^b	54 fl oz	60	65	85	--
Glyphosate+2,4-D ^b	54 fl oz	Tordon+2,4-D ^b	1 pt + 1 pt	75	80	90	--
Glyphosate	2 pt	---	---	80	10	--	--
Plateau+MSO ^c	8 oz + 1 qt	Plateau+MSO	8 oz + 1 qt	85	90	95	--
Paramount+MSO ^c	1.3 lb + 1 qt	Paramount+MSO	1.3 lb + qt	55	75	95	--

^a 2,4-D at 1 qt/A applied twice per year in the fall.
^b Applied during the seed-set growth stage in late June to early July. Glyphosate + 2,4-D is a commercial mixture available as Landmaster BW or Campaign and was applied in years 1 and 3.
^c MSO = methylated seed oil.

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

Year 1		Years 2 and 3		Forage	Total
Herbicide	Rate	Herbicide	Rate	Yield	Cost
	(Product)		(Product)	(% of check)	(\$/A)
Tordon+2,4-D	1 pt + 1 pt	Tordon+2,4-D	1 pt + 1 pt	161	39
2,4-D	2 qt	2,4-D	1 qt	138	9
Banvel	2 qt	Banvel	2 qt	143	120
Glyphosate+2,4-D	54 fl oz	Glyphosate+2,4-D	54 fl oz	133	27
Glyphosate+2,4-D	54 fl oz	Tordon+2,4-D ^a	1 pt + 1 qt	161	31
Plateau+MSO	8 oz + 1 qt	Plateau+MSO	8 oz + 1 qt	104	60

^a Glyphosate+2,4-D was applied in years 1 and 3.

ering, can be quite effective. The research demonstrated that a mixture of Tordon at 1 pint and 2,4-D at 1 quart per acre could provide 85 percent leafy spurge control after four annual applications (Table 2). This combination was the most cost-effective treatment evaluated, when averaged across several locations (Table 3). Some land managers prefer to start a program using Tordon at 1 quart per acre plus 2,4-D the first year and then reduce the Tordon rate to 1 pint per acre in subsequent years.

Tordon at one quart per acre plus 2,4-D can provide greater control and does not need to be retreated as frequently, but the higher rate is initially more expensive than the lower rate Tordon at 1 pint per acre plus 2,4-D (Table 2). Tordon should be applied at one quart per acre in the fall because the one pint rate is ineffective. Spring or fall applications of Tordon at 2 quarts per acre or more achieved similar results;

however, Tordon plus 2,4-D is more effective when applied in the spring. The optimum time for the annual application of Tordon plus 2,4-D will be slightly later each year because the herbicide stress delays flowering.

Precautions

- 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 on a sandy porous surface or substrata overlaying groundwater 10 feet or less below the surface.
- Do not contaminate streams, ponds or irrigation ditches.
- Do not use on flood or sub-irrigated land.
- Do not use Tordon at the rates required for leafy spurge control on cultivated land.

Added notes:

- Do not transfer livestock from treated grass areas on to sensitive broadleaf crop areas for 12 months after application (or until Tordon has disappeared from the soil) without first grazing seven days on an untreated grass pasture. Otherwise, urine may contain enough herbicide to cause injury to sensitive broadleaf plants.
- Do not use Tordon near trees or other desirable broadleaf vegetation. Also careful application is necessary to prevent spray drift.
- Tordon is rainfast in 6 to 8 hours.

Banvel (dicamba)

Banvel (dicamba) will provide intermediate levels of leafy spurge control in pastures and rangeland but treatments with Banvel are generally not cost-effective. Banvel applied at 1.5 to 2 gallons per acre will give good leafy spurge control



1 week



2 weeks

Auxin injury

Typical auxin injury to leafy spurge one and two weeks after treatment.

for one year (Table 2), but control usually decreases rapidly the second year after treatment. Banvel is absorbed into the plant by the leaves and roots. The best results should be obtained with Banvel when applied to leafy spurge foliage in mid-June or early September. A follow-up treatment of 2,4-D at 1 quart per acre (four pound-per gallon concentrate) will be needed to prevent reinfestation by seedlings or root buds.

Banvel can provide 95 percent leafy spurge control after three applications, when applied annually at 2 pounds per acre (Table 2). The reduction in leafy spurge increased forage production by 143 percent (Table 3). However, annual Banvel treatments were not cost-effective because of the relatively high cost of the herbicide.

Precautions

- When using Banvel near water, precautions similar to Tordon 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 non-dairy animals when Banvel is used alone. Meat animals should be moved from treated areas 30 days prior to slaughter.

- Banvel is rainfast in 6 to 8 hours.

Campaign or Landmaster BW

Campaign or Landmaster BW (glyphosate + 2,4-D) can provide season-long, leafy spurge control, but there is a risk of grass injury, especially when applied in the fall. Glyphosate + 2,4-D at 3.38 pints applied once during early seed-set can provide 75 percent or better leafy spurge control (Table 2). Grass injury can range from 0 to 10 percent from this treatment. Glyphosate + 2,4-D costs approximately 40 percent less than 1 pint of Tordon plus 1 quart of 2,4-D per acre, and it provides better control the first year.

Severe grass injury can occur if glyphosate plus 2,4-D is applied to the same area in two consecutive years. Grass injury of 30 percent or more can result from fall applications of glyphosate plus 2,4-D even though the treatment can result in leafy spurge control of 60 to 70 percent. One approach that is typically affordable and less damaging to grasses is to apply glyphosate plus 2,4-D during leafy spurge seed-set, in late June, followed the next year by applications of Tordon plus 2,4-D during the true-flower growth stage of leafy spurge. Alternating the use of these two products can provide up to 95 percent leafy spurge control in three years (Table 2).

Precautions

- Spray coverage with glyphosate plus 2,4-D must be uniform. Grass injury can be minimized if the product is not sprayed to the point where runoff occurs.
- Glyphosate plus 2,4-D is not labeled for use in areas grazed by livestock. Treated areas cannot be grazed or hayed until eight weeks after the treatment. As always, read and follow labeled instructions.
- Campaign or Landmaster are rainfast in 6 to 12 hours.

Plateau (imazapic)

Plateau applied in the fall at 8 to 12 ounces per acre can provide up to 90 percent leafy spurge control one year after treatment (Table 2). The label recommends application from late-August to mid-October, but prior to a killing frost. Research in North Dakota found that the best leafy spurge control resulted from Plateau applications in mid-September. Plateau should be applied with a methylated seed oil, (MSO), at 1 quart per acre. The addition of 28 percent UAN liquid fertilizer to Plateau plus the MSO has occasionally increased long-term leafy spurge control. Plateau can reduce both warm and cool season grass production, but grasses will recover the season following treatment especially if Plateau is applied at 8 ounces or

less per acre. Plateau applied in the spring is generally much less effective for controlling leafy spurge than fall applications.

Plateau is safe to use near and around a variety of trees. Check the label for the specific plants you are concerned about. Conifer trees, especially young growth candles, can show temporary yellowing of stem tips. However, these injuries are generally not permanent and usually clear up without any long-term injury to the tree. Plateau applied in the fall can severely injure or kill lilac.

Precautions

- Do not use on turf being grown for sale or other commercial use.
- Do not apply to the foliage of desirable trees or ornamental plants.
- Do not exceed 12 ounces of Plateau per acre in one year.

- The use of this chemical in areas where soils are permeable, particularly when the water table is shallow, may result in groundwater contamination. Check the label to ensure the proper use of the herbicide and compliance with Federal law.
- Plateau is rainfast after one hour.

Paramount (quinclorac)

Paramount (quinclorac) is an auxin-type herbicide with moderate soil residual that will control both annual grasses and some broadleaf weeds, especially field bindweed and leafy spurge. Research has found that 1 to 1.33 pounds of Paramount (75% dry flowable) applied with an MSO will provide 90 percent or better leafy spurge control after two annual applications, without grass injury (Table 2). However, the current labeled application rate is only 8



Tree damage

Plateau can temporarily injure evergreen species.



Plateau injury

Leafy spurge plant two weeks after treatment with Plateau.

ounces (0.5 pounds) per acre, which will suppress leafy spurge but will not provide long-term control.

The manufacturer is currently working to increase the maximum-labeled application rate. Combining Paramount with Distinct, a combination of Banvel plus diflufenzopyr can increase long-term leafy spurge control. Diflufenzopyr is an anti-auxin compound that when added to Paramount can double leafy spurge control. Currently, diflufenzopyr is only available in combination with Banvel (Distinct). The maximum application rate for Paramount plus Distinct is 8 ounces of Paramount (DF) plus 6 ounces of Distinct per acre (70% water dispersible granule). Paramount or Paramount combined with Distinct has a wide window of application and can be applied to leafy spurge in the fall any time prior to a killing frost (September - October), or during the true-flower growth stage of leafy spurge (mid-to late June).

Precautions

- Use this product only in accordance with its labeling and worker protection standards.
- Do not enter treated areas prior to the restricted entry interval of 12 hours. Paramount is labeled for leafy spurge control only in non-cropland, industrial sites, and roadsides

that are not hayed or grazed.

The use of this chemical where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

- Do not apply using aerial equipment unless permitted by the special local need provision.
- Paramount is rainfast 6 hours after application.

2,4-D

2,4-D in the form of a low volatile ester, water soluble amine, or water soluble powder (applied at a rate of 1 quart per acre, 4-pound-per-gallon concentrate) gives short term control of leafy spurge top growth but has little effect on overall stand reduction (Table 2). The production of desirable forage can be increased when 2,4-D is applied in the spring (Table 3). Applying 2,4-D at rates even up to 1.25 gallons per acre generally provides less than 40 percent control after one year. Applying 2,4-D annually (spring or fall) or biannually (spring and fall) does not result in long-term leafy spurge control. The amine and ester formulations of 2,4-D provide similar leafy spurge control regardless of the application date or rate. The amine formulation is preferred over the ester formulation because it is less volatile and more economical.

Tordon and Banvel 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, Tordon + 2,4-D, and 2,4-D + glyphosate (Landmaster BW or Campaign) treatments are less expensive than Banvel and Tordon common use rates, but must be applied annually. Consider herbicide and application costs with the timeliness of a treatment when selecting a herbicide or a treatment program for leafy spurge control.

Precautions

- Amine formulations of 2,4-D at 1 quart per acre (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. Check the label to ensure the proper use of the herbicide and compliance with Federal law.

Glyphosate (e.g. Roundup)

Glyphosate (e.g. Roundup) applied at a rate of 1 quart per acre from mid-July to mid-September can result in 80 to 90 percent control of leafy spurge. Applications made prior to mid-June will not adequately control leafy spurge. A follow-up treatment with 2,4-D at 1 pint (4 pound-per gallon concen-



Glyphosate injury

Glyphosate (Rodeo or Roundup) injury one week after treatment.

trate) the following year (mid-June to mid-July) is necessary to prevent seedling reinfestation.

Glyphosate plus 2,4-D (Campaign or Landmaster BW) can be applied instead of glyphosate to increase leafy spurge control and decrease grass injury. Both formulations are safe for leafy spurge control under trees. Glyphosate plus 2,4-D can be applied two to four weeks earlier (early seed-set stage) than glyphosate alone and it can produce good leafy spurge control.

Glyphosate (Rodeo and similar formulations only) can safely be used on leafy spurge infestations near water. Rodeo applied at 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 must be added to the solution for best

results. Consult the manufacturer or dealer for approved surfactants for safe use near water.

Precautions

- Glyphosate is a water soluble and non-selective herbicide and it will kill grasses and other desirable plants. This product does not provide residual weed control. Direct spray or spray drift will cause injury to tree foliage and young trees with green bark.
- Do not treat weeds under poor growing conditions, such as, drought stress, disease or insect damage, as reduced weed control may result. For best results, spray coverage should be uniform and complete.
- Do not spray weed foliage to the point of runoff.

Norosac or Casoron 4G (dichlobenil)

Norosac, or Casoron 4G (dichlobenil) is a preemergence herbicide that will suppress leafy spurge for about one season. Dichlobenil 10G should be applied at 60 to 80 pounds per acre before leafy spurge emerges. Research in North Dakota indicates that dichlobenil applied in November at 80 pounds per acre can provide 80 percent suppression of leafy spurge the following June. However, control rapidly declines to around 20 percent by the end of the growing

season. Dichlobenil applied at 60 to 80 pounds per acre is an expensive treatment but is safe under trees. It may be a useful treatment in small shelterbelts or under trees, near buildings, etc.

Precautions

- Do not plant sensitive plants (fir, hemlock, pine, spruce) the following spring if the 8-pound rate is used.
- Do not apply directly to water.

Control for small patches

When leafy spurge is confined to small, well-defined areas, herbicide treatments should be used to prevent the spread of the stand. Don't just treat the leafy spurge plants. Treat an extra 10 to 15 feet around each patch to control spreading roots and seedlings. Biological control and grazing should not be used to manage small patches.

The most important thing to remember with small stands is to do everything possible to prevent seed production and spreading roots. Grazing and herbicide control can be used together to achieve this goal. Small stands of leafy spurge can be eradicated with herbicides when the right products are used in a persistent treatment plan.

Controlling these small areas needs to be a priority since this will probably be the best opportunity to eradicate the weed in an area. Persistence is the key. Follow-up

treatments will be needed for several years to control missed stems and seedlings. Many leafy spurge control efforts have failed because follow-up treatments were not applied or were skipped for one or more years. Commitment, vigilance, and persistence in controlling small stands will substantially reduce the cost and effort needed to control the weed once large stands have become well established.

Control near water

You will often find stands of leafy spurge along small drainages, streams and riverbanks. Leafy spurge control along open water is needed to prevent further spread of seed by water or animals. Since most herbicides cannot be used

near water and it takes large numbers of biological control agents moving into the area from dryer uplands, a multi-tool approach may be the most effective. Herbivores like sheep and goats will utilize leafy spurge in these areas, and specific herbicides (i.e. Krenite S and glyphosate - Rodeo or similar formulations only) can be used safely near water. However, leafy spurge control around open water is difficult. Which combination of tools will be acceptable and most effective depends upon the circumstances. Managers should work with area experts to effectively and affordably deal with leafy spurge near water.

Krenite S (fosamine)

Krenite S (fosamine) can be used safely near water. Krenite should be applied at 1.5 to 2 gallons per acre during the true flower growth stage. Control with Krenite has been inconsistent and should be applied when soil moisture is abundant and the relative humidity is high for best results. A follow-up treatment will be needed the next year to control seedlings when either Krenite or glyphosate is used. A 2,4-D formulation labeled for use near water at 1 to 2 pints (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



Think small

Commitment and persistence in controlling small stands of leafy spurge will save substantial dollars and labor down the road.



Water safety

Some herbicides, such as Rodeo, are labeled for use in or near water. However, most are not. Read the label carefully before using any herbicide near streams and riverbanks.



treatment to prevent seed-set and reduce expansion of a leafy spurge infestation.

Precautions

- Krenite can be applied to floodplains where surface water is

not present, terrestrial areas of deltas, and low lying areas where water is drained but may be isolated in pockets due to uneven or unlevel conditions. Do not apply Krenite through irrigation systems or use on food or feed crops.

Common Leafy Spurge Herbicides

Product	Application Rates	Time of Application	Potential Level of Control	Precautions	More Info.	Comments
Tordon (Picloram)	4 to 8 pt (1 to 2 lb/A)	Leafy spurge: True flower growth stage or fall regrowth.	85 to 95% control after 1 year.	Restricted use, long soil residual.	See pages 10-12	Commercial mixture with 2,4-D available, Grazon P+D.
Banvel (Dicamba)	4 to 16 pt (2 to 8 lb/A)	Leafy spurge: True flower growth stage or fall regrowth.	95% control after 3 annual treatments.	No grazing for 7 to 90 days.	See pages 12-13	Consult label for grazing restrictions. Surfactant improves consistency of control. Re-treatment necessary.
Plateau (Imazapic)	8 to 12 fl oz/A (2 to 3 oz/A)	Early to mid-September.	90% control 1 year after treatment.	Can injure or kill lilacs. Do not exceed 12 oz/A in 1 year.	See pages 13-14	May be used on CRP, pasture, rangeland, industrial sites, roadside right-of-way or non-cropland. Apply with methylated seed oil (MSO) type adjuvant plus 28% urea ammonium nitrate (UAN) each at 1 qt/A. Rates above 8 fl oz. can reduce grass production, especially cool season species. Safe undermost tree species but will cause temporary yellowing of spruce candles. See label for additional information.
Paramount (Quinclorac)	0.5 lb DF (0.375 lb/A)	Fall: Prior to frost Leafy spurge: true flower or growth stage actively growing.	90% control after 2 annual applications.	The current maximum labeled rate is 0.5 lbs/A.	See pages 14-15	Do NOT use on pasture and rangeland areas to be grazed or cut for hay. Use an MSO type adjuvant at 2 pt/A. Provides only suppression of leafy spurge at the current labeled rate.
Roundup or similar formulations (Glyphosate)	2 pt of a 3 lb ae/gal conc. or 1.6 pt of a 3.7 lb ae/gal conc. or 1.5 pt of a 4 lb ae/gal conc. or 18.5 oz of a 65% SG (0.75 lb/A)	Leafy spurge: After July 1 to actively growing plants.	80 to 90% control.	Non-selective.	See pages 16-17	Other vegetation will also be killed. Avoid spraying tree foliage. Non-selective, non-residual herbicide. Retreat the following spring with 2,4-D at 1 to 2 qt/A to control seedlings and escapes. Refer to label for adjuvant use. Add ammonium sulfate (AMS) fertilizer.
Campaign or Landmaster BW (Glyphosate + 2,4-D)	54 fl oz or 3.38 pt. (0.38 + 0.63 lb/A)	Leafy spurge: Seed set stage or actively growing in fall.	95% control if applied in late June and followed by Tordon + 2,4-D the next year.	Severe grass injury if applied in the fall and if applied for 2 consecutive years.	See page 13	Some grass injury and stunting may occur. Injury is greater with fall than spring treatments. Not to be used in consecutive years.
Tordon + 2,4-D (Picloram + 2,4-D)	1 to 2 pt + 2 pt of a 4 lb/gal conc. (0.25 to 0.5 + 1 lb/A)	Leafy spurge: True flower growth stage or fall regrowth.	85 to 95% control after 4 annual treatments.		See pages 10-12	Retreatment at the same rate will be necessary for several years regardless of herbicide or rate. Annual control was greater and years of retreatment needed were less with the 2 pt/A Tordon rate. Use 2 pt/A rate for fall application.
2,4-D	2 to 4 pt of a 4 lb/gal conc. (1 to 2 lb/A)	Leafy spurge: actively growing.	<40% control.	Ester formulation is volatile.	See pages 15-16	A 2,4-D formulation labeled for use in or near water, such as PBI Gordon Amine 400 is available for use near streams or ditches.
Rodeo or similar formulations (Glyphosate)	2 pt of a 4 lb/gal conc. (0.75 lb/A)	Mid-July to mid-September.	80 to 90% control.	Consult with dealer for surfacants that are safe to use near water.	See page 18	Apply with a non-ionic surfactant (NIS) approved for use near water. Control seedlings with a 2,4-D formulation near water in subsequent years.
Norosac 10G or Casoron 4G (Dichlobenil)	60 to 80 lb 10G or 150 to 200 4G (6 to 8 lb/A)	Leafy spurge: Late November to early March - before emergence.	80% control.	Do not plant sensitive plants the following spring if applied at 8 lbs/A.	See page 17	Season long suppression only. Must be applied before leafy spurge emerges. No POST control.
Krenite S (Fosamine)	12 to 16 pt (6 to 8 lb/A)	True flower growth stage or early fall for leafy spurge along streams or ditches.	80 to 90% for 1 season.	Do not apply through irrigation systems or use on food or feed crops.	See pages 18-19	Inconsistent control. Best control with high humidity and good soil moisture at application. Do not contaminate water during application.

calibration

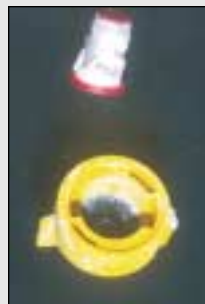
Sprayer calibration

Proper sprayer calibration is critical to accurate herbicide application. Sprayers that are not calibrated result in poor weed control from under-application, or non-target plant damage from over-application. To properly calibrate your sprayer you need to know spray tank capacity, nozzle type, pressure setting, pumping arrangement and operating speed.

Prior to calibrating your sprayer, service the sprayer by fixing leaks, cleaning lines, strainers, and nozzles, and replace any

worn spray tips. Nozzles should only be cleaned with a soft-bristled brush such as a toothbrush, never with a metal object. Spray tanks should be rinsed carefully and filled with clean water prior to calibration.

There are several methods for calibrating a sprayer. Included here are simple calibration techniques for boomless spray equipment such as backpack sprayers, high-pressure hand guns, and boom-buster or boom-i-nator nozzles mounted on off-road equipment. Consult the manufacturer for calibration of large multi-nozzle spray equipment.



Getting it right

Often treatments fail because of improper calibration and plugged nozzles.



Spraying options

A variety of spray equipment is available for use in different topographies.

Calibrating backpack sprayers or high-pressure hand guns

Backpack or hand gun spray equipment with one nozzle are used for spot treating small infestations or in rugged terrain where other application methods are not possible. Over-application with this equipment is a common occurrence so calibration is critical. When calibrating your sprayer, select an application style that gives the best coverage. This is normally a gentle, side-to-side, sweeping motion that covers the ground as you walk backward away from the spray solution. You may want to practice on a hard, clean surface that will show your application pattern before actually calibrating the sprayer. Remember to keep pressure constant during calibration and field application. **Note: You must use the same application technique during calibration as you use during a field application. If you vary speed or pressure, it**

will affect your sprayer output and thus the herbicide application rate.

This method of calibrating backpack or hand gun equipment involves very little math or formulas. It is based on the following principal: one gallon = 128 ounces and the test area to be sprayed is 1/128 of an acre, thus ounces collected = gallons per acre.

Step 1. Measure an area 18.5 by 18.5 feet which is equal to 1/128th of an acre. This should be done in the field on weed-infested terrain similar to where you plan to make the herbicide application.

Step 2. Spray the measured area uniformly with water, recording the number of seconds required to spray the area. During application be sure to maintain a constant sprayer pressure. A metronome is very helpful in maintaining a constant walking speed and the use of a marker dye helps the applicator apply a uniform spray pattern. Repeat several times and

use the average time.

Step 3. Spray into a container for the same amount of time it took to spray the measured area. Be sure to maintain constant sprayer pressure.

Step 4. Measure the number of ounces of water in the bucket.

Step 5. The number of ounces collected from the bucket is equal to the number of gallons per acre the sprayer is delivering.

Volume Sprayed _____ ounces =
Gallons Per Acre (GPA)

Step 6. Add the proper amount of herbicide to the tank. For backpack sprayers, use the table on page 25 to determine how much liquid herbicide to add to each gallon of water. Find your spray volume in gallons per acre and read across the chart to determine the amount of herbicide to add to each gallon of water. **Example:** You calibrate your sprayer and the output is 30 GPA, and your sprayer holds 3 gallons. The label requires an herbicide application rate of 1 pint/acre for the target weed. Go to the chart and read across from 30 gal/A. The amount of herbicide to add to each gallon of water is 3 teaspoons (15 ml). Since your sprayer holds 3 gallons of total solution you would add a total of 9 teaspoons (45 ml) of herbicide to 3 gallons of water in each backpack tank.



Boom sprayer

Precise measuring of chemicals and water is critical in any herbicide application.

Calibrating boom-buster or boom-i-nator spray equipment 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.

Step 1. Park the sprayer on level ground, then **fill the spray tank with water to an easily determined point** (mark this on the tank).

Step 2. Adjust the pressure to recommended level. Most nozzles work best between 30 and 35 psi (pounds per square inch).

Step 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!

Step 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.

Step 5. Return to the filling point. Be sure to park equipment in the same location to refill the tank.

Step 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.

Step 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).

$$\begin{aligned} \text{GPA} &= \text{gallons sprayed} \\ &\quad [\text{from Step 6}] \\ &\quad \times 43,560 \text{ sq/ft/acre} \\ &\quad \times \text{swath width (ft)} \\ &\quad \times \text{swath length (ft)} \\ &\quad [\text{as measured in Step 4}] \end{aligned}$$

Step 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 and fill with water to the 30-gallon mark.

Spray Volume Gal/A	Amount of Herbicide to Add to Each Gallon				
	Recommended Herbicide Rate/Acre				
	1 pint	1 quart	2 quarts	3 quarts	4 quarts
15	6 tsp	2 fl oz	4 fl oz	6 1/4 fl oz	8 1/2 fl oz
20	5 tsp	10 tsp	3 1/4 fl oz	4 3/4 fl oz	6 1/3 fl oz
30	3 tsp	6 tsp	2 fl oz	3 1/4 fl oz	4 1/4 fl oz
40	2 1/3 tsp	4 3/4 tsp	1 2/3 fl oz	2 1/3 fl oz	3 1/4 fl oz
50	2 tsp	3 3/4 tsp	1 1/4 fl oz	2 fl oz	2 1/2 fl oz
60	1 2/3 tsp	3 1/4 tsp	6 1/3 tsp	1 2/3 fl oz	2 fl oz
70	1 1/3 tsp	2 3/4 tsp	5 1/2 tsp	1 1/3 fl oz	1 3/4 fl oz
80	1 1/4 tsp	2 1/3 tsp	4 3/4 tsp	7 1/4 tsp	9 1/2 tsp
90	1 tsp	2 tsp	4 1/4 tsp	6 1/3 tsp	8 1/2 tsp
100	1 tsp	2 tsp	3 3/4 tsp	5 3/4 tsp	7 2/3 tsp
120	3/4 tsp	1 1/2 tsp	3 tsp	4 3/4 tsp	6 tsp

Liquid conversions: tsp = teaspoons; TBS = tablespoons; fl oz = fluid ounces; 1 fl oz. = 29.57 ml.
 1 teaspoon = 5 ml 3 teaspoons = 1 tablespoon 8 fluid ounces = 1 cup
 1 tablespoon = 15 ml 2 tablespoon = 1 fluid ounce 1 cup = 16 tablespoons

economics

Economics of using herbicides

Traditionally, an economically feasible weed control practice is deemed one in which the benefits of treatment exceed the costs.

While this view is certainly true, quantifying treatment benefits resulting from improved grassland health and alternative land uses is difficult, making economic thresholds difficult to determine. Consequently, the following discussion assumes that leafy spurge must be controlled regardless of the size or location of the infestation (i.e. there is no economic threshold below which weed control should not be attempted). Based on this assumption, economically feasible weed

control depends on minimizing costs. To the rancher it is one of three things:

- (1) saving on treatment costs and obtaining the same or a better degree of weed control;
- (2) improving the quality and/or quantity of a marketable commodity; and
- (3) improving land quality and sustainability (economic value and ecological health).

Economic control at the federal, state or local level includes increased revenue from sales and/or taxes, reduced expenditures for weed control and increased consumer satisfaction and utilization of the land for non-agricultural activities.



Big, bigger, biggest

Early detection of leafy spurge infestations and implementation of a well-planned control program are your best weapons in battling leafy spurge. The longer you wait, the bigger your problem will become.

In general, we can say that economically feasible control practices are those that expend less cash for the same or better weed control and/or an increase in the amount of cash returned for every dollar spent on weed control at the local, state, and federal levels.

What factors should I consider?

Perhaps the single most important factor to consider when determining if herbicide treatments are economically feasible is the size of the infestation. Large, well-established stands of leafy spurge will require a significant economic commitment. Treatments on infestations greater than 2 acres in size on rangeland with carrying capacities less than 0.5 Animal Unit Months (AUMs) per acre are almost never economically sustainable. In this instance, it may be better to spray only the leading edge or perimeter of the infestation (ring) to contain its spread, while also employing other pest management tools like leafy spurge flea beetles or sheep. Another approach is to, again, ring the infestation with herbicide applications and, as it is controlled in the treated area, progressively spray more of the untreated stand. This approach will take longer, but leafy spurge will be contained and you should eventually control larger infestations. The approach reduces

annual expenditures on herbicides, but the cost of application will have to be sustained over many years. Failure to follow through with the treatment for one or two years will allow leafy spurge to repopulate the area and many benefits of the spray program will be lost. Therefore, you must be committed to follow through with the program or the approach will fail.

The most economical use of herbicides is in controlling small patches. If single plants or small stands can be identified and treated early, larger infestations can be PREVENTED and the need for long-term applications will be reduced dramatically. In this instance, the intensity of the spray program is greatest during the first few years. It is more economical in the long term to expend more dollars for fewer years during the beginning of a weed invasion than to try to contain and control large, well-established infestations. Again, it is imperative that managers are vigilant and the annual spray program is carried through without fail. Failure to spray or missing a previously treated stand for even one year can result in the loss of much of your economic investment. One important consideration to remember when treating small stands is that eradication of the weed may be possible. The possibility of eradication is an added incentive to commit more resources and take a more aggressive approach since it

can potentially eliminate the need for future herbicide expenditures.

Economic considerations when herbicides are integrated with other control tools

Integrating herbicide control with other tools can often reduce the cost of control. However, herbicides are still an essential part of a comprehensive control program. Other control tools that should be considered include biological control (using insects) and sheep grazing. Each of these tools are often only effective when dealing with large leafy spurge infestations.

Biological control has proven to be very effective in reducing leafy spurge populations, however, it takes several years for the population to produce sufficient numbers

of insects to achieve sustainable levels of control. Therefore, biological control should initially be used with other tools capable of rapidly impacting the magnitude of the infestation and preventing further spread. The advantage of combining herbicides with biological control is that the insects will eventually be able to maintain infestations at an acceptable level with little or no use of herbicides. The cost of long-term maintenance is dramatically reduced, which is a huge, long-term economic advantage.

Sheep grazing of leafy spurge has also proven to be an effective method of reducing leafy spurge foliar cover, stressing the weed's root system and opening up areas where native grasses can grow. However, the practice will not eliminate leafy spurge and regrowth will



IPM benefits

Incorporation of herbicides with biological control and multi-species grazing provides better control than either used alone.



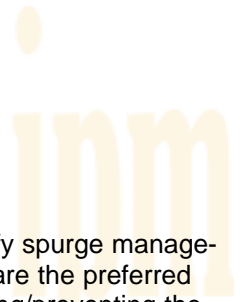
occur as soon as sheep are removed as a treatment. The cost of sheep grazing can also be high, especially if new fencing and care facilities are needed, but costs can be reduced using a number of innovative approaches (See TEAM Leafy Spurge's "Multi-Species Grazing and Leafy Spurge" manual). When starting a control program some herbicides can be used in combination with sheep grazing to more rapidly achieve acceptable leafy spurge densities. At this point herbicide use may be discontinued or substantially reduced as long as the sheep are maintained in the pasture.

Leafy spurge flea beetles have also proven to be an effective control method (as described above). Combining herbicides, flea beetles and sheep can rapidly reclaim heavily invested areas. This practice combines the quick-kill capabilities of herbicides (to contain existing infestations and prevent the establishment of new colonies) with the selective grazing of new shoots by sheep. Flea beetles, in turn, attack and kill leafy spurge roots. This three-pronged attack is possibly the most effective method of quickly reclaiming large areas heavily infested by leafy spurge (3-5 years depending on your situation); however, there is a substantial upfront economic investment in herbicide use and preparing pastures for sheep grazing. The silver lining is that once flea beetle popu-

lations are established across the pasture and leafy spurge has been dramatically reduced, the flea beetles should be able to maintain leafy spurge at acceptable levels. Again, sustained control is achieved by the no-cost and self-perpetuating biological component and investments in other treatments can be reduced or eliminated altogether.

Economic summary

An integrated control program combining two or more methods will provide a more successful and cost-effective, long-term solution to the leafy spurge problem than a single method used alone. Herbicides are most cost-effective and the best option to control small patches and newly infested areas. Leafy spurge can be eradicated with herbicides at this stage. Biological control with insects, or control with grazing animals, is most cost-effective for large infestations. Both methods have been improved when combined with fall-applied herbicides. The key to controlling leafy spurge is early detection and treatment of the initial invading plant. A persistent management program is needed to control top growth and to gradually deplete the nutrient reserves in the root systems of well-established stands. A successful control program requires a well-planned strategy with consistent and timely follow through.



Integrated pest management

As mentioned earlier, there are no “silver bullets” or cure-alls for managing and controlling leafy spurge – simply put, there just isn’t any single tool that will work every time in every situation.

TEAM Leafy Spurge believes biologically based **Integrated Pest Management (IPM)**, provides the most effective, affordable and flexible approach for controlling leafy spurge. IPM works because it combines the best elements of different tools, and because it enables ranchers and land managers to tailor management programs to fit their specific needs and goals.

In most IPM scenarios, a tool like herbicides, grazing, biological control or mowing is used to reduce leafy spurge densities and open up the canopy, giving more desirable plants a chance to re-establish. The stress and damage that occurs during this process weakens leafy spurge, thus making it more susceptible to damage by other tools.

In many cases, herbicides can provide a solid foundation for other tools to build on.

Herbicides are the most com-

monly used leafy spurge management tool, and are the preferred tool for containing/preventing the spread of infestations and for eradicating new invasive weeds.

Unfortunately, herbicides are generally expensive, and use on large infestations may not be economically feasible. In addition, most herbicides are non-selective and may adversely impact non-target species. Use in some areas may also be restricted by environmental regulations or inaccessibility to infestations.

Consequently, the addition of other IPM tools such as biological control and multi-species grazing to a spraying program are becoming more popular.

The following are brief summaries on combining herbicides with other leafy spurge management tools.

Biological control

In ideal situations, biological control can maintain leafy spurge densities below economically significant levels.

But flea beetles aren’t going to work every time at every site, and integration with other management



Endangered species and herbicides

Leafy spurge infestations threaten the western prairie fringed orchid, a perennial herbaceous plant on the federal endangered species list. While it is unlawful to use herbicides within the habitat areas of endangered plant species, demonstration sites in southeastern North Dakota are providing evidence that herbicides can be used to control leafy spurge without harming the orchid. Other native plants, endangered by leafy spurge, include the Canada anemone and the wild prairie rose.



tools, or simply using other tools, may be required.

Research has shown that herbicides and biological control can be complementary if properly used. Timing is the most important factor. Fall herbicide applications (after Aug. 15) are compatible with flea beetle survival, and can enhance population establishment. Spring and summer applications, however, will remove top growth needed by adult flea beetles to complete their life cycle, and should be avoided.

It should be stressed that herbicide use **SHOULD NOT BE ABANDONED** simply because other tools are being used. Herbicides should **ALWAYS** be considered as the first line of defense when small, scattered patches are found, and when attempting to contain the spread of larger infestations.

TEAM Leafy Spurge demonstrations and other research have shown that multi-species grazing and biological control can also be an effective combination. Sheep grazing reduces leafy spurge densities, giving flea beetles improved chances of establishing large populations capable of providing significant control.

Multi-species grazing

Studies have shown that herbicides and grazing can be combined to provide excellent leafy spurge control. Again, timing is the most important factor. General recommendations call for grazing leafy

spurge infestations as normal (mid-May through mid-August, for example), then applying herbicides in the fall after some regrowth of the leafy spurge has occurred.

Grazing may be restricted following the application of certain herbicides; as always, read the herbicide label and follow recommended guidelines.

Burning

Prescribed burns can be used to reduce leafy spurge densities and remove ground litter that can inhibit foliar cover of herbicides.

If sheep production is a primary goal, timing of burns needs to be considered – burns should generally be performed in the fall or early spring so that leafy spurge top growth is available for sheep or



Burning as a cultural control effort

Prescribed burning combined with other tools can help control leafy spurge by reducing ground litter, thereby allowing better coverage of herbicides.

goats.

Similarly, if burning is being used in combination with biological control, burns should not be conducted from mid-May through mid-August to avoid interference with the adult phase of the flea beetle life cycle.

Reseeding

Regardless of the tool or tools being used to reduce leafy spurge infestations, reseeding can be used to speed range recovery. Desirable grasses can re-establish more quickly after reseeding, thus providing competition for less desirable species that may emerge as reductions in leafy spurge infestations occur.

Seed mixes for range recovery can be expensive and will vary depending on geography, climate, long-term management goals and other factors, so careful planning will pay off in the long run.

Consultation with local experts, such as Cooperative Extension Service range specialists, USDA-Natural Resource Conservation Service personnel and/or other range specialists is recommended to help select seed mixes and plan reseeding strategies.

In some cases, financial assistance for reseeding and range recovery may be available from various state and federal programs and agencies. Check with local sources to see if your weed management/range recovery program qualifies.

Mapping a Control Strategy

Several methods are currently available for leafy spurge control and should be used together in an integrated long-term management plan.

Topgrowth

Herbicides
Grazing
Insects:
Flea Beetles
Pathogens
Mowing
Fire



Topgrowth



Flower



Stem



Roots

Flower

Insects:
Gall Midge
Leaf Tier

Stem

Stem-Boring
Insects:
Long-horned
Beetle

Roots

Insects:
Flea Beetles
Pathogens
Cultivation
Competition/
Reseeding
Herbicides

Summary

At this point, it should be obvious that TEAM Leafy Spurge recognizes that herbicides are an important part of an effective, affordable and sustainable leafy spurge management program. Herbicides can be used as a stand-alone tool, or combined with other tools such as biological control or multi-species grazing.

TEAM Leafy Spurge program participants have supplemented existing research with new data, then applied those findings to on-the-ground demonstrations that people can actually see. These demonstration sites clearly show that herbicides and herbicides + biological control works, and that both approaches can be used in an economically beneficial manner.

Keep in mind that there are no easy solutions or “silver bullets” to help solve the leafy spurge problem. It will take time, work and a long-term commitment.

As always, prevention is the best solution for avoiding problems with leafy spurge and other invasive weeds. Prevention, combined with hard work and persistence, will help return your rangelands to a more productive and natural state.

It is also important to recognize the benefits of WORKING TOGETHER. The war against leafy spurge and other noxious weeds will not be won individually – it will take a collaborative, integrated and area-wide approach to ultimately solve a costly problem that is shared by all.



Herbicide field tour

Field day tours are a good source of information on new weed management techniques and products including new herbicides and IPM measures.

Q. How far into the fall (according to the temperature) can you spray leafy spurge and have good results?

A. The best timing varies by herbicide. Plateau should be applied in mid-September for best results as control may drop 50 percent or more if Plateau is applied in August or October. Tordon plus



Fall colors

Leafy spurge has a second growth season in late August and continues until the temperatures cool, changing foliage color from yellowish-green to orangish hues.

2,4-D has a wider application window and can be applied from late-August to early September. Paramount has provided good leafy spurge control even when applied in late October following several hard frosts. Leaf color can vary from green to yellow and red. The key is to make sure the leafy spurge leaves are still firmly attached to the stem so the herbicide can be translocated to the roots. If leaf drop has begun, it is best to wait until the following growing season before applying herbicides for leafy spurge control.

Q. Can I spray over an area that has biocontrol agents?

A. Yes, as long as the herbicide is applied in the fall after the adults have finished egg laying. Avoid herbicide application in June and July when the adults are feeding on leafy spurge. No herbicide used for leafy spurge control directly affects *Aphthona* spp. adults or larvae.

Q. How much water do I use?

A. Proper calibration of the sprayer and uniform coverage is much more important than spray

volume. Typically, applicators using multi-nozzle spray booms apply herbicides at 10 to 20 gallons per acre. Herbicides applied with a single-nozzle back-pack sprayer typically use 60 gallons or more per acre.

Q. When is the best time to spray?

A. Proper timing depends on the herbicide you are using. See the text and flea beetle life cycle chart on page 8.

Q. How long before cattle and sheep are allowed to graze after a chemical application?

A. Tordon and Banvel can be applied even if the pasture has grazing cattle present. However, do not transfer the livestock from treated areas to pastures or cropland with sensitive broadleaf plants for at least 12 months without first allowing seven days of grazing on an untreated grass pasture. Otherwise urine may contain enough herbicide to cause injury to sensitive plants. The waiting period after treatment with Banvel varies from seven to 90 days, so consult the label before using.

Q. How many applications of chemical are recommended if used as an IPM method?

A. The number of applications will vary depending on the success

of the other control method used in the IPM program. When used with *Aphthona* spp. flea beetles, excellent control has been achieved with as few as one application, but sometimes two to three annual applications are needed. If used in conjunction with grazing animals, three annual treatments worked best.

Q. How close can I spray to water?

A. Long residual herbicides such as Tordon and Banvel should not be used within 50 feet or less of a body of water, depending on the terrain. Other leafy spurge herbicides can be used near or in water. See pages 18-19, which describe specific herbicides to control leafy spurge near water.

Q. What size of a leafy spurge patch generally is too big for chemical treatments?

A. This is really dependent on budget (see pages 26-27). Herbicides should be applied around the perimeter of even very large infestations to prevent spread. It is never too early to begin a treatment program, but it can be very costly to start years after the program should have begun.

Team Spurge

The “TEAM”

TEAM Leafy Spurge is a USDA-Agricultural Research Service research and demonstration program focused on the Little Missouri River drainage in Wyoming, Montana and the Dakotas, and other leafy spurge-infested drainages in the region. Its goal is to research, develop and demonstrate ecologically based Integrated Pest Management strategies that can be used to achieve effective, affordable and sustainable leafy spurge control.

TEAM Leafy Spurge is built on three important concepts:

- **Integrated Pest Management (IPM)** – IPM combines management tools to provide more effective control than any single tool could produce. Biological control provides the foundation: Biocontrol agents like the flea beetle are used with other tools – multi-species grazing, herbicides, etc. – for effective, affordable and ecologically sustainable control. IPM offers the flexibility landowners need to devise different strategies for different situations.

- **Teamwork** – TEAM Leafy Spurge has assembled some of the

nation’s most experienced leafy spurge researchers into a focused, goal-oriented team. This collaboration allows participants to share expertise, data and resources to more effectively work toward a common goal.

TEAM Leafy Spurge stresses that EVERYONE, from private ranchers and landowners to local, state and federal agencies, work together to solve the problem.

- **Regional Approach**

- TEAM Leafy Spurge is an area-wide program, and as such, is evaluating the leafy spurge problem on a regional rather than a local, or place-by-place, basis.



Partnerships!!!

TEAM Leafy Spurge is funded by USDA-ARS and managed in conjunction with USDA-APHIS. Other team members include the U.S. Forest Service, National Park Service, Bureaus of Land Management and Reclamation, U.S. Geological Service, state departments of agriculture and other state agencies, Cooperative Extension Services, land grant universities, county weed managers, ranchers and landowners.

The approach

TEAM Leafy Spurge research and demonstration projects are designed to build on existing data and explore promising new areas of leafy spurge research. These projects cover a range of topics, including biological control, multi-species grazing, herbicides, range management, and the integration of various control tools.

TEAM Leafy Spurge demonstration sites (Medora, ND; Ekalaka, MT; Buffalo, SD and Devil's Tower, WY) give ranchers, landowners and land managers a first-hand look at the results produced by various IPM

strategies. Tours of the sites have been held periodically to provide updates about new and improved management strategies.

The bottom line

Leafy spurge is a formidable opponent that cannot be controlled or eliminated by any single entity or management practice – a collaborative, integrated and area-wide approach is essential to solving this costly program. TEAM Leafy Spurge exists to promote these concepts, and to serve as a clearing house for proven management strategies.

information

TEAM Leafy Spurge

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Websites

The following websites provide good information and links to other informational sites.

- **TEAM Leafy Spurge**
(<http://www.team.ars.usda.gov>) for information on integrated pest management of leafy spurge, related topics and an extensive listing of other informational sources and websites.
- **USDA-APHIS Noxious Weeds Home Page**
(<http://www.aphis.usda.gov/ppq/weeds/facts.html>) for general information about noxious weeds and APHIS management programs.
- **NDSU-Department of Agribusiness and Applied Economics**
(<http://agecon.lib.umn.edu/index.html>) for information on the economic impacts of leafy spurge and various management tools.
- **Colorado Weed Management Association**
(<http://www.cwma.org>) for information on noxious weeds, weed control techniques and weed management programs.

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