



Field Guide for Managing Leafy Spurge in the Southwest



Cover Photos

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Leafy spurge (*Euphorbia esula* L.; synonyms: *E. virgata*, *E. discolor*, *E. gemelinii*, *Tithymalus esula*, *Galarrhoeus esula* L.)

Spurge family (Euphorbiaceae)

Leafy spurge is listed as a noxious weed in Arizona and New Mexico. This field guide serves as the U.S. Forest Service's recommendations for management of leafy spurge in forests, woodlands, and rangelands associated with its Southwestern Region. The Southwestern Region covers Arizona and New Mexico, which together have 11 national forests. The Region includes four national grasslands located in northeastern New Mexico, western Oklahoma, and the Texas panhandle.

Description

Leafy spurge (synonyms: faitours-grass, wolf's milk) is an introduced, colony forming, creeping, perennial plant that emerges early during the growing season. It is native to Eurasia and has proliferated throughout much of the world. It is common in northern Great Plains states and is currently invading riparian and mountain plant communities in the higher elevations of Arizona and New Mexico.

Growth Characteristics

- Perennial, herbaceous, broadleaf plant growing erect to 3 feet tall. Seedlings and shoots emerge in early spring and are a distinct deep red to purple color.
- May become dormant in late summer and resume growing in the fall.
- Has a milky, latex-like sap that flows through all parts of the plant; sap may be irritating to the skin, eyes, and digestive tract of humans and other animals.
- Narrow, bluish-green leaves, 1 to 4 inches long; may be linear-lanceolate to oblong; first leaves are opposite, then become alternate. Stems are blue-green, hairless, erect, and tough; may be woody at base; forked branching.
- Has inconspicuous yellow-green flowers in umbel-like clusters consisting of many male flowers that surround a single female flower; each cluster embraced by a pair of heart or kidney-shaped,

yellow-green bracts; inflorescence showy from a distance (May to July and again in September to October). Bracts are often mistaken for flowers.

- Fruits form inside round capsules with three chambers, each containing a single, smooth seed; yellow-brown to grey, or mottled.
- Extensive root system with deep taproot (20 to 30 feet long).
- Reproduces via seed and adventitious buds at root crown and along lateral roots; buried root fragments will resprout; roots are long lived and seeds are viable for 5 to 8 years.

Ecology

Impacts/threats

Leafy spurge is a long lived, persistent plant that can develop dense, monotypic stands. It is a highly competitive plant that can: (1) reduce diversity of flora and fauna species; (2) degrade wildlife habitat; (3) reduce the availability of quality forage for cattle and horses; and (4) decrease land values.

Location

This weed grows in many soil types and habitats from streambanks to dry, upland sites. It invades disturbed and undisturbed areas including pastures, abandoned croplands, roadsides, woodlands, riparian communities, and mountain ridges and meadows. Early establishment often occurs on campsites, roadways, trails, and other sites disturbed by human traffic.

Spread

Once established, leafy spurge spreads rapidly. Flower capsules burst open when mature, and seed may land 13 to 15 feet away from the parent plant. Seed is easily dispersed by ants, birds, grazing animals, humans, and water. Seed is also spread over long distances by adhering to surfaces and undercarriages of road vehicles and road maintenance equipment. In addition to seed, leafy spurge spreads via adventitious root and crown buds or by regrowth from root fragments.

Invasive Features

Leafy spurge is highly competitive and has allelopathic properties that slow or prevent growth of other plant species. New shoots of spurge can emerge early in the spring before other plants, and adult plants are able to flower from May to July for production of seed. In hot and dry climates such as New Mexico and Arizona, leafy spurge can have a dormant period during summer that allows flowering and growth to resume in the fall.

Management

Early detection and eradicating populations soon after they are discovered is extremely important for leafy spurge control. Due to copious seed production and a widespread underground root system, spurge populations established over large areas are extremely difficult to eradicate; therefore, continuous aggressive management measures are needed to keep populations under control. Small populations of leafy spurge infesting otherwise healthy sites should be given high priority for treatment. Regardless of the approach followed, leafy spurge cannot be effectively controlled within a single year or by using only one method. Complete control will likely require at least 5 to 10 years or more of repeated management methods. The following actions should be considered when planning a management approach:

- Maintain healthy plant communities to limit leafy spurge encroachment.
- Check hay, straw, mulch, and especially excavated soil and gravel for presence of weed seed before using these materials in spurge-free areas. Certified weed-free hay or pellets should be fed to horses used in back-country areas.
- Detect, map, and eradicate new populations of leafy spurge as early as possible. Keep annual records of reported infestations.
- Implement monitoring and a followup treatment plan for missed plants and seedlings.

- Combine mechanical, cultural, biological, and chemical methods for most effective control.

Table 1 summarizes management options for controlling leafy spurge under various situations. Choice of individual method(s) for leafy spurge control depends on many factors including degree and density of spurge infestations, current land use, and site conditions (terrain, accessibility, microclimate, presence of nontarget flora and fauna, etc.). Other important considerations include treatment effectiveness, overall cost, and the number of years needed to achieve control. More than one control method may be needed for a particular site.

Physical Control

Physical methods (manual, mechanical, etc.) alone are generally ineffective at controlling leafy spurge, but these methods can be used to suppress seed production and growth. Methods that stress and/or attack the root system usually have to be repeated and must be timed properly to be most effective. Effectiveness of physical methods can be improved when used in combination with herbicide control.

Manual Methods

Because of the expansive root system of leafy spurge, hand pulling or grubbing are not effective and are not recommended control methods. Hand cutting or repeated mowing in localized situations can reduce leafy spurge's seed production and its competitive ability with desirable grasses and forbs (flowering plants), but these methods will only suppress growth. Plants should be clipped within 4 inches of the ground just before seed set and then repeated throughout the growing season. Flower material should be bagged or burned since seed will continue to mature if left onsite.

Mechanical Methods

Tillage can be effective on relatively level ground but only when coupled with a reseeding effort. Local conditions dictate when reseeding should be accomplished. Typically, seed from desired grass and forb species is planted during late summer or early autumn in Arizona and New Mexico.

Table 1. Management options*

Site	Physical Methods	Cultural Methods	Biological Methods	Chemical Methods
Roadsides	Mow every 3 weeks during growth season. Use mowing in combination with an autumn herbicide application.	Train road crews to identify and report infestations. Clean machinery following activity in infested areas.	Consider using flea beetles in combination with herbicides (see table 2). Effectiveness of agents may be limited due to possible disturbances in agent life cycles from roadside operations.	For ground application, use truck-mounted or tractor-pulled spraying equipment. Wash under vehicle after application to prevent spread.
Rangelands	Use repeat tillage only in areas to be reseeded. Combine with herbicide spraying. Use prescribed burning only as part of a combined method.	Use certified weed-free seed and hay. After passing through infested areas, inspect and remove any seed from animals, clothing, and vehicles before entering treated or uninfested areas. Reseed with plants that are desirable and can compete.	Use a strategy that combines prescribed grazing involving sheep or goats together with either herbicide control or flea beetles (see table 2). Closely manage grazing to prevent overuse.	For extensive and dense infestations, use ground or aerial broadcast spraying. For sparse infestations, use backpack spraying.
Riparian areas, wilderness and other natural areas	Hand removal is ineffective and is not recommended as a control method.	Use certified weed-free seed and hay. After passing through infested areas, inspect and remove any seed from animals or clothing before entering treated or uninfested areas. Educate the public to identify and report infestations. Post signs warning visitors to inspect for seeds and remove them from animals, clothing, and vehicles when leaving an infested area.	Same as above.	Use backpack or hand-held sprayers. Broadcast spraying by aerial or ground methods may be used on thicker stands if allowed.

* Choice of a particular management option must be in compliance with existing regulations for land resource.

Areas with suitable terrain should be tilled at 3-week intervals with a plow or disc to a depth of at least 4 inches beginning when leafy spurge shoots emerge in late winter. If combined with a spring herbicide application, allow leafy spurge shoots to grow 4 to 6 inches before spraying (see table 3). Wait at least 1 week after spraying before resuming cultivation. When combined with fall herbicide spraying, tillage should cease near the end of the growing season to allow enough regrowth to occur for translocation of herbicide into underground roots and stems. *If using machinery to manage leafy spurge, equipment should be cleaned immediately after field operations to prevent movement of seeds or root fragments into uninfested areas.*

Prescribed Fire

Burning is not recommended for leafy spurge control as spurge rapidly regenerates new shoots from adventitious buds on the crown and roots. However, fire may be used in combination with herbicide control or grazing to clear debris and litter.

Cultural Control

Early detection and plant removal are critical for preventing leafy spurge establishment. Land managers, road crews, and the local public should be educated as to how to identify nonnative, noxious species so they can help report all suspected infestations. Vehicles, humans, and livestock

should be discouraged from traveling through infested areas; and a program to check and remove seeds from vehicles and livestock should be implemented to help stop dispersal. If possible, weed screens should be used on irrigation water intakes in infested areas to prevent seed transportation in irrigation canals.

Biological Control

Grazing

In combination with either herbicide or insect control, grazing with goats or sheep can lower seed production of leafy spurge and decrease its spread. Sheep and goats (especially Angora goats) will readily graze young leafy spurge plants and are ordinarily not as susceptible to poisoning as other livestock. Because of their ability to graze spurge closely, sheep have been widely used in management programs for leafy spurge control. Cattle and horses do not prefer spurge and are more susceptible to toxins in the plant. These animals should not be forced to ingest this weed since they may become weak with scours, which often results in illness and death.

To maximize stress on carbohydrate reserves in roots and provide higher suppression, leafy spurge should be grazed with sheep or goats at a moderate to severe rate of utilization. However, even light grazing can trigger a positive shift in a plant community since leafy spurge produces tannins in response to being clipped, which reduces energy spent on new growth. Research has shown that stocking rates of 3 to 6 sheep per acre per month, 1 to 2 ewes with lambs per acre per month, or 12 to 16 Angora goats per acre per month are appropriate. Grazing with sheep or goats should begin in spring when plants are 2 to 6 inches high and continued until all of the yellow bracts on the stem have been consumed. If using sheep or goats in combination with a biocontrol agent such as a flea beetle (*Aphthona* spp.), graze once in the spring and once in the fall; grazing should not occur during summer to allow the beetle to complete its life cycle on the plant. If using grazing in combination with herbicide, graze plants as above but remove animals early in the fall and allow 3 to

4 inches of regrowth; then apply a recommended herbicide. After grazing leafy spurge infested areas, animals should be quarantined 5 to 6 days to prevent spreading seed to spurge-free areas.

Classical Biological Control

Numerous biological agents for leafy spurge control have been tried throughout the United States with varying success. These agents include flea beetles, gall-making flies, and moths. Biological control agents known to be successfully introduced in the Southwest are shown in table 2. Many of the known leafy spurge populations in New Mexico have been treated with *Aphthona* flea beetles. Using a flea beetle in combination with grazing and/or herbicides has been found to be a better strategy for leafy spurge control than employing a single control method by itself. In a biocontrol study in northern New Mexico, *Aphthona* beetles released in excess of 22 beetles per square foot within a 30 to 45 ft² area were found to maintain a viable population while reducing spurge biomass by ≥ 95 percent.

Agents used for biological control in southwestern states should be adaptable to arid environments and local conditions. Public, tribal, and private land managers may obtain biological control agents for release directly from local offices of the USDA Animal and Plant Health Inspection Service (APHIS) when the agents are available. Other sources for biocontrol agents include private companies or locally developed insectaries. Adult *Aphthona* beetles may be collected and released within the interior of a given state without a permit from APHIS. A sweep net may be used around spurge plants to collect flea beetles for redistribution into spurge-infested areas that lack the insect and have at least a moderate spurge density. The beetles should be placed in a cooler for transport and then immediately released. To ensure adequate number of beetles for collection, beetles should be collected in the field during hot summer periods (e.g., late July through August). For further information on biological control of leafy spurge, see Bouchier et al. (2006) in the “References and Further Information” section of this field guide.

Table 2. Classical biological agents

Species	Type of Agent	Site of Attack/Impact	Use/Considerations for Release	Remarks
<i>Aphthona flava</i>	flea beetle	Adults feed on leaves and flowers; larvae feed on roots and root hairs.	May be hard to establish on clay or acidic soils.	Released in Arizona.
<i>Aphthona lacertosa</i>	flea beetle	Adults feed on leaves and flowers; larvae feed on roots and root hairs.	Generally associated with loamy-clay soils.	Established in New Mexico.
<i>Aphthona nigriscutis</i>	flea beetle	Adults feed on leaves and flowers; larvae feed on roots and root hairs.	Restricted to dry sites.	Established in New Mexico; released in Arizona.
<i>Oberia erythrocephala</i>	long-horned beetle	Adults feed on flowers, leaves, and stems; deposit eggs within stems. Larvae bore through stem to root; feed within crown and roots; pupate in May.	Best for sunny sites along streams. Less consistent results than <i>A. lacertosa</i> or <i>A. nigriscutis</i> above.	Introduced in New Mexico but not well established.
<i>Spurgia esula</i>	gall-forming midge (fly)	Midge feeds on shoot tips and forms galls.	This agent prefers specific genotypes of leafy spurge. Since leafy spurge has a high degree of genetic variability, the midge is more difficult to establish or sustain following introduction.	Introduced in New Mexico but not yet established.

A permit must be obtained from APHIS before biological control agents can be transported across state boundaries. Regulations and permit applications (PPQ Form 526 permit forms) pertaining to interstate shipment of biological control agents may be found at <http://www.aphis.usda.gov/ppq/permits/>. Although biological control agents may be collected and released within a given state without a permit from APHIS, the state's Department of Agriculture or Agricultural Extension Service should be consulted for any regulations relating to movement of these agents inside the state

Chemical Control

Herbicide spraying will reduce leafy spurge populations, but followup spot spraying should always be anticipated for a minimum of several years to attain long-term control success. Herbicide treatments are most effective when made in the fall than spring because the chemical is more easily transported to the root system after flowering. Picloram

(e.g., Tordon 22K) has long been used for leafy spurge control because the herbicide provides selective weed control while allowing native grasses to return naturally. However, picloram is a restricted-use pesticide and should not be used near waterways or wherever the water table is near the surface. A new herbicide active ingredient, aminocyclopyrachlor, is now commercially available as Perspective or Streamline and has been shown in university led testing to provide effective leafy spurge control. Other herbicides, including imazapic (e.g., Plateau), are also effective and should be considered for spurge treatment on permeable soils, around trees, or near surface water. For all herbicide applications, it is important to read the herbicide label carefully since different products will have different requirements and restrictions. Label instructions and guidelines for mixing, application, and grazing restrictions following treatment should always be followed.

Herbicides may be applied in several ways including backpack, ATV or UTV sprayers, or conventional boom sprayers that are pulled or attached to a tractor or truck. For sparse populations in an area, one person or a small team can spray spurge using individual plant treatment (IPT). Spray plants directly by wetting the foliage and stems without dripping while using an adjustable spray nozzle attached to a hand-held or backpack sprayer. Add a quality adjuvant as recommended on the herbicide label. Herbicides listed in table 3 may impact other desirable broadleaf and woody species, so caution should be taken if nontarget species need to be protected. Consult the appropriate labels.

Reseeding after spraying leafy spurge is typically unnecessary although it may be useful under certain situations. Experience with reseeding in combination with leafy spurge control is limited in New Mexico and Arizona. However, reseeding in northern states after spurge treatment has shown that planting a variety of desirable grasses that actively grow throughout the growing season will foster competition with leafy spurge for nutrients, soil, and water which can help further suppress the spurge. In areas where reseeding is planned, glyphosate (e.g., Roundup) may be used for site preparation. Glyphosate treatment is most effective when applied sequentially at 1-month intervals and is coupled with a fall grass seeding. The first application should be made in early summer (June) and the

second about a month later (provided there are green leafy spurge shoots to spray). If leafy spurge recovers from these treatments, spray 2,4-D (2 quarts per acre) in late summer to early September to control regrowth. Sow perennial grass seed in late autumn as a dormant seeding (i.e., grass seedlings will not emerge until the following spring).

Control Strategies

Any strategy adopted for managing leafy spurge over a particular area must involve careful planning. A combination of control methods, as outlined in this guide, should always be considered in a long-term strategy to control leafy spurge. As an example, biological control in combination with herbicide control can be an effective option under many situations. Regardless of the strategy used, components of a successful leafy spurge control program include: (1) maintaining repetitive treatment over multiple, consecutive years; (2) periodically monitoring treated areas and spot treating any seedlings or shoots that have emerged; and (3) using sound grazing practices. It is also important to monitor the return of desirable native plant species. Reseeding with native plants may be used if response of native plants after spurge treatment is inadequate.

Adaptive Management

Leafy spurge is difficult to control, and a persistent commitment to spurge treatment will be required for many

Table 3. Herbicide recommendations

Common Chemical Name (active ingredient)	Product Example ¹	Product Example Rate per Acre (broadcast)	Backpack Sprayer Treatment Using Product Example ²	Time of Application	Remarks
Picloram ³	Tordon 22K	1–2 quarts	1–3%	Use lower herbicide rate in fall; higher in spring.	Persistent, selective herbicide; higher rate may impact grasses. Retreatment for several years may be required.
2,4-D + picloram ⁴	Grazon P+D	2 quarts	3–5%	Use for spring applications.	Persistent; selective; will not harm many grass species but will affect broadleaves.

Table 3. Herbicide recommendations (continued)

Common Chemical Name (active ingredient)	Product Example ¹	Product Example Rate per Acre (broadcast)	Backpack Sprayer Treatment Using Product Example ²	Time of Application	Remarks
Aminocyclopyrachlor + chlorsulfuron	Perspective	4.75–8 ounces Consult label for mixing directions and use of a quality adjuvant.	Add 5–9 grams of dry flowable powder to 1 gal water.	Spray actively growing leafy spurge.	Labeled for noncrop use (includes natural areas such as wildlife management areas, wildlife habitats, recreation areas, campgrounds, trailheads, and trails). May also be used on public, private, and tribal lands as part of an early detection and rapid response (EDRR) in treating infestations of invasive weed species. Persistent; selective; may cause temporary injury to some grass species.
Aminocyclopyrachlor + metsulfuron methyl	Streamline	4.75–9.5 ozs	Same as above.	Same as above.	Same as above.
Dicamba	Clarity, several manufacturers	2–4 quarts	1–3%	At flowering and on regrowth in the fall. Use higher rate for older or denser stands.	Selective; damages most broadleaf species but will not harm most grasses. Not as effective as picloram but is less expensive and is not restricted.
2,4-D + dicamba	Weedmaster	2–4 quarts	2–5%	Use for spring applications.	Check label for grazing restrictions.
Imazapic	Plateau	8–12 ounces + 1.5–2 pints methylated seed oil	0.25–1.5% + 1% v/v methylated seed oil	Apply in very late summer or in fall after first light frost.	Persistent; selective; rates that exceed 8oz/A rate may retard growth of desirable cool season grasses if applications are made in late summer.
Glyphosate	Rodeo, RoundUp	1 quart each application; 2 quarts total	2–5%	Apply sequentially with one application in early June and a second application 1 month later.	Nonselective herbicide; overspray can injure surrounding plants and open more area to weeds. Recommended only when combined with later grass seeding.

¹ Trade names for products are provided for example purposes only, and other products with the same active ingredient(s) may be available. Individual product labels should be examined for specific information and appropriate use with leafy spurge.

² Herbicide/water ratio - As an example, a gallon of spray water with a 3 percent mixture is made by adding a sufficient volume of water to 4 ounces of liquid herbicide until a volume of 1 gallon is reached ($4 \text{ oz} \div 128 \text{ oz/gal} = 0.03$ or 3 percent). For dry formulations, particulates should be added to sufficient water as specified by the label until the required concentration or volume of spray water is reached.

³ Restricted use pesticide - A certified applicator's license is required for purchase and use.

⁴ 2,4-D is a restricted use pesticide in New Mexico only. A certified applicator's license is required for purchase and use.

years. Therefore, realistic goals and objectives should be established to manage leafy spurge infestations occurring extensively throughout a given landscape. To improve long-term success, consider using an adaptive management strategy with the overall goal of restoring desirable plant communities. The stepwise process for adaptive management involves:

1. Assessment of the overall weed problem,
2. Establishing management goals and objectives,
3. Implementation of control strategies,
4. Monitoring the effectiveness of management actions,
5. Evaluating actual outcomes in relation to expected results, and
6. Adjusting practices as necessary.

Steps of this process should be repeated in sequence as part of a continuous learning cycle that improves management planning and strategy by learning from the outcomes of previous management actions. In general, an adaptive management strategy may be considered to be successful if:

1. Stakeholders are actively involved and remain committed to the process,
2. Monitoring and assessment are used to adjust and improve management decisions, and
3. Management goals and/or objectives for the resource are being achieved.

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Suggested Web Sites

Purge Spurge: Leafy Spurge Database (includes free how-to manuals and information links).

<http://www.team.ars.usda.gov/v2/infoproducts.html>

Pesticide information online:

<http://www.cdms.net/LabelsMsds/LMDefault.aspx>

USDA Plants Database. 2010.

<http://plants.usda.gov/index.html>.

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