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Field Guide for Managing Dyer's Woad in the Southwest

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Southwestern Region
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Cover Photos

Top: Steve Dewey, Utah State University, Bugwood.org

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Dyer's woad (*Isatis tinctoria* L.)

Mustard family (Brassicaceae)

Dyer's woad is listed as a noxious weed in both Arizona and New Mexico. This field guide serves as the U.S. Forest Service's recommendations for management of dyer's woad 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 also administers 4 national grasslands located in northeastern New Mexico, western Oklahoma, and the Texas panhandle.

Description

Dyer's woad (synonyms: Asp-of-Jerusalem, glastum) is a member of the mustard family and grows as a winter annual, biennial, or short-lived perennial. It is native to southeastern Russia and was accidentally introduced into the western United States as a contaminant in alfalfa seed during the early 1900s. Although dyer's woad has historically been cultivated for use as a blue dye, it is currently being studied for its anti-cancer properties and potential as a less toxic alternative to wood preservatives and inkjet printer fluid.

Dyer's woad has generally been ignored in the Southwest because it is not yet a widespread problem in the region. However, dyer's woad offers an opportunity to be proactive in managing this invasive weed in its early stages of colonization. Success in keeping dyer's woad from becoming a more extensive and expensive problem in the Southwest will likely come from working collaboratively and in coordination with the public and other land managers.

Growth Characteristics

- Grows as a winter annual, biennial or short-lived perennial herbaceous plant depending on local environmental conditions; 2 to 4 feet tall.
- Produces a taproot (30 inches long) and lateral roots found mostly in the upper 12 inches of soil.
- Has fine-haired, basal leaves in the rosette stage that are twice as long as they are wide with a pale mid-vein; grows an erect upright woody stem (20 to 35 inches) during bolting.
- Stems leaves are 1 to 4 inches long, grayish-green, narrow, alternate, basally lobed; clasping stem.
- Yellow, 4-petalled flowers occur mostly in April to July in flat-topped bunches at branch tips.
- Fruits are a primary distinguishing feature. Thin, flat pods are initially green, turning black at maturity; the persistent, samara-like fruits hang from slender, short pedicels.
- Reproduces via seed. Although one pod has only a single seed, each plant produces an average of 300 to 500 seeds. Under certain conditions, a single plant may produce 10,000 seeds.

Ecology

Impacts/Threats

Dyer's woad develops dense, monotypic stands that crowd out native species. Established infestations reduce forage availability for cattle and horses, degrade wildlife habitat, lower flora and fauna species diversity, and decrease land values. A dominant presence can increase the potential for soil erosion.

Site/Distribution

This weed is common along roadsides and railway rights-of-way; upon dry, rocky foothills and hillsides; within both disturbed and undisturbed pastures and rangelands. It is a serious problem especially in intermountain sagebrush communities in Utah, Nevada, Wyoming, Montana, and California. It has been seen in Santa Fe and Sandoval Counties in New Mexico and Coconino County in Arizona.

Spread

Seed is easily dispersed by animals, human activity, and water. Seed is spread long distances as a contaminant in alfalfa hay or seed, and by adhering to surfaces and undercarriages of vehicles and road maintenance equipment.

Invasive Features

Dyer's woad is an aggressive invader of dry lands due to its prolific seed production, early emergence, and deep taproot. Initial invasion may occur in a disturbed area; however, it can rapidly expand into undisturbed rangeland and wooded areas. Dyer's woad produces a water-soluble chemical that inhibits germination of other plants and can delay its own germination until favorable precipitation levels are available. It grows rapidly between the rosette and flowering stages (up to 4 inches per week) and can re-sprout from adventitious buds at its crown.

Management

Due to copious seed production and seed bank formation, large populations of dyer's woad are difficult to eradicate once established. Detecting and managing dyer's woad soon after discovery are therefore important activities for control. Regardless of the management strategy used, components of a successful program for dyer's woad control should include (1) public education and involvement, (2) periodically repeating treatments, (3) monitoring of treated areas, and (4) measures taken to control missed plants and emerging seedlings.

The following actions should be considered when planning an overall management approach for dyer's woad:

- Maintain healthy plant communities and encourage the presence of ground litter to help suppress germination of dyer's woad seedlings. This may involve using improved grazing management to prevent excessive grazing and reseeding areas with desirable grasses and forbs after disturbance.
- Check hay, straw, and mulch for presence of weed seed before using in areas where dyer's woad is not currently present; certified weed-free hay or pellets should be fed to horses used in backcountry areas.
- Eradicate new populations of dyer's woad as early as possible.
- Combine mechanical, cultural, biological, and chemical methods for most effective dyer's woad control.
- Implement a monitoring and follow-up treatment plan for missed plants and seedlings.
- Detect, report, and map large infestations. Keep annual records of reported infestations.

Table 1 summarizes management options for controlling dyer's woad under various situations. Further details on these management options are explained below. Choice of individual control method(s) for dyer's woad depends on the extent and density of infestations, current land use, and site conditions (accessibility, terrain, microclimate, other flora and fauna present, etc.). Other 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

Although labor intensive, physical methods can be effective at controlling dyer's woad if used consistently and repeatedly. By removing plants before seed set, seed production is reduced. Effectiveness of physical methods can be improved when combined with herbicide control.

Manual Methods

Hand removal – Hand pulling, hoeing or grubbing at least twice per year; once in May, just as flowers start to bloom and again 2 to 3 weeks later to eliminate any remaining plants. Montana's Dyer's Woad Cooperative Project has used hand pulling to attain high levels of control and to eradicate dyer's woad from 9 of 13 infested counties. If flowers or seed pods are present, plant debris should be bagged and disposed of in a landfill to prevent germination and spread. At rosette and bolt stages, plants may be pulled and left onsite.

Hand-cutting coupled with herbicide spot spraying upon remaining basal leaves is another effective management method; it reduces seed production and addresses root fragments.

Mechanical Methods

If using machinery to manage dyer's woad, the equipment should be cleaned after use to prevent movement of seeds or root fragments into un-infested areas.

Table 1. Management options*

Site	Physical Control	Cultural Control	Biological Control	Chemical Control
Roadsides, fence lines, or non-crop areas	Repeatedly mow during summer after bolting but before seed set. Hand pull or grub; or cut stem, followed by herbicide on basal leaves.	Use seed, mulch, and fill materials certified to be weed-free. Clean machinery following activity in infested areas. Train road crews to identify and report, infestations; map reported populations.	Use woad rust in combination with herbicides (chlorsulfuron or metsulfuron are compatible).	For ground application, use truck-mounted or tractor-pulled spraying equipment. Wash under vehicle after application to prevent spread.
Rangelands, pastures, or riparian corridors	Use early spring or late fall tillage where feasible; combine with herbicide. Prescribed burning is not recommended due to limited information on effects.	Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas. Reseed with plants that are desirable and will compete.	Use prescribed grazing with sheep or goats in combination with herbicide control. Closely manage grazing to prevent overuse.	For extensive and dense infestations, use ground or aerial broadcast spraying. For sparse infestations, use backpack or hand-held sprayer.
Wilderness, other natural areas, and/or small infestations	Hand pull or grub beginning in May and repeating every 2 to 3 weeks. Remove as much of the root as possible or dig up and sever root at least 2 inches below crown. Bag and dispose of debris appropriately.	Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas. Educate the public to identify and report infestations. After passing through infested areas, inspect and remove any seed from animals, clothing, and vehicles.	Consider introducing a biocontrol agent such as woad rust (see table 3).	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 the land resource.

Mowing – Repeated mowing can reduce dyer's woad seed production in localized, accessible situations, such as along roadsides or in agronomic settings. However, it is possible that mowing will increase regrowth from the root crown if done improperly. Consider repeated mowing (every 10 to 14 days) after plants have bolted, but before seed has set during the summer. Herbicide may be applied 2 weeks before mowing.

Tillage – Tillage can be effective against dyer's woad but likely is feasible only in a limited number of settings. Areas with suitable terrain should be tilled twice per year: once in the spring before seed production and again in the fall to capture late germinating plants. It is preferable to use tillage in combination with a reseeding effort.

Prescribed Fire

Burning is not well studied as a management tool for controlling dyer's woad. Based on response to other methods that only remove top growth, dyer's woad is likely to rapidly regrow following a burn. Burning is acceptable as a means for disposal of plant debris.

Cultural Control

Early detection and plant removal are critical for preventing dyer's woad establishment. Land managers, the local public, and road crews 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

Table 2. Biocontrol agent approved for dyer's woad

Species	Type of Agent	Site of Attack/Impact	Use/Considerations for Release	Remarks
Puccina thlaspeos	Rust fungus	Systemic for whole plant. Infects rosettes the first year; significantly impacts flower and seed production the second year, self-replicating.	Apply inoculum in the spring. Once established, the rust spreads on its own.	Completes its life cycle on one host (autoecious).

from vehicles and livestock should be implemented to help stop dispersal. Seed and materials used for mulch, forage, or fill should be certified to be weed-free; pellets may be used for horses in backcountry areas. If possible, remotely monitor and develop GPS-based maps of infested areas. Public involvement and collaborative programs may be considered to address existing and future dyer's woad populations.

Biological Control

Grazing

Sheep and goats both graze dyer's woad. Sheep graze dyer's woad until mid-May but prefer other more desirable forage species after that. Goats willingly eat dyer's woad regardless of growth stage and timing. In order to impact seed production and plant mortality significantly, dyer's woad needs to be clipped to less than a 2-inch height toward the end of May. To attain this high utilization rate, desirable species may also be damaged. Managers need to evaluate if using an intensive grazing approach outweighs the benefit.

Classical Biological Control

The USDA-approved rust fungus, *Puccina thlaspeos*, is naturally occurring and targets dyer's woad specifically by suppressing or preventing seed formation (table 2). Complete seed destruction is rare, and viable seed can still be produced by diseased plants. Infected plants have a stunted growth appearance with curled, sickly leaves. The rust normally spreads slowly, but researchers have found that collected material containing the rust can be dried, ground up, and mixed in a solution for spraying. For further information on biocontrol of dyer's woad, see Jacobs and Pokorny (2007) in the "References and Further Information" section of this field guide.

Organisms (insects, pathogens, etc.) used as biocontrol agents in southwestern States should be adaptable to arid environments and local conditions. Public, tribal, and private land managers may obtain biocontrol agents for release directly from local offices of the USDA Animal and Plant Health Inspection Service (APHIS) when these agents are available. Other sources for biocontrol agents include locally developed insectaries or private companies.

A permit must be obtained from APHIS before biocontrol agents can be transported across State lines. Regulations and permit applications (PPQ 526 permit forms) pertaining to interstate shipment of biocontrol agents can be found at *https://www.aphis.usda.gov/aphis/ourfocus/planthealth/import-information/permits/regulated-organism-and-soil-permits/sa_apply/ct_plantpest_howtoapply*. Although biocontrol agents may be collected and released internally in a given State without an APHIS permit, the State's department of agriculture or agricultural extension service should be consulted for any regulations relating to movement of these agents within the State.

Chemical Control

Herbicides listed in table 3 can be an effective and economical management tool, but one always include monitoring and a follow-up treatment plan when developing a strategy to control dyer's woad. Single herbicide applications rarely provide complete control and, at a minimum, several years are needed to attain long-term control.

For all herbicide applications, it is important to read the herbicide label, as different products will have different requirements and restrictions. Label instructions and guidelines for mixing, application, and grazing

Table 3. Herbicide recommendations

Common Chemical Name (active ingredient)	Product Example[1]	Broadcast Treatment (rate per acre)	Spot Treatment (spray solution)[2]	Time of Application	Remarks
Metsulfuron	Escort XP	0.75–1 ounce	1%	Rosette to bloom stage.	Selective broadleaf herbicide; non-injurious to most perennial grasses; absorbed through foliage; inhibits cell division. Best as a post-emergent; add 0.25% v/v nonionic surfactant.
Chlorsulfuron	Telar XP	1–3 ounces	0.7–2%	Seedling to rosette.	Semi-selective; safe for labeled grasses; growth inhibitor; absorbed by foliage and roots; best applied during warm, moist season. Pre-emergent or post-emergent; use 0.25% v/v nonacidic adjuvant for post-emergent application.
Imazapic	Plateau	8–12 ounces	1–3%	Rosette to bolting plants.	Selective broadleaf herbicide; non-injurious to most perennial grasses; use higher rate at later life stages.
2,4-D[3]	several manufacturers	1.5–2 quarts	1–5%	Seedling to rosette stage.	Use higher rate on sites with high dyer's woad densities. In combination with a surfactant, may adversely impact woad rust.
Metsulfuron + 2,4-D amine[3]	tank mix	0.5 ounce Escort + 3 pints 2,4-D	1%	In spring; bud to early bloom.	Addition of 2,4-D improves weed control under dry, dusty conditions. Addition of 2,4-D with a surfactant may impact woad rust.
Chlorsulfuron + 2,4-D[3]	tank mix	1–3 ounces + 3 pints 2,4-D	1%	Same as above.	Same as above.

[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 dyer's woad.

[2] Spray solution is the herbicide/water ratio in a spray mix that may be used for spot treatment with backpack or hand-held sprayers. The amount of product applied during an annual growing season must not exceed the maximum application rate per acre as specified by the product label – refer to the product label for the site type and application.

[3] 2,4-D is a restricted use pesticide in New Mexico only. A certified applicator's license is required for purchase and use.

restrictions following treatment should always be followed. Consult the registrant if you have questions or need further detail.

Herbicide Application

Dyer's woad is most susceptible to metsulfuron (Escort®) or chlorsulfuron (Telar®) applied alone or in combination with 2,4-D or dicamba (i.e., Cimarron Plus® or Cimarron Max®). A nonionic surfactant should be added to these spray mixtures as specified on the herbicide label. These herbicides are most effective when applied during the seedling to rosette stages up to bolting and flowering. Spraying during the early flower stage and before seed formation prevents viable seed production. Imazapic (Plateau®) with methylated seed oil (MSO) will also control dyer's woad when applied to rosettes or bolting plants. If 2,4-D is used, early spring timing will reduce impacts to non-target plant species. However, dyer's woad should be allowed to germinate and form rosettes when spring herbicide applications are used. Dyer's woad tolerance to herbicide increases at later life stages; therefore, increased application rates should be anticipated.

Herbicides may be applied with backpack or hand-held sprayers, ATV or UTV sprayers, or conventional boom

sprayers that are pulled or attached to a tractor or truck. Equipment used to spray herbicide should be calibrated. For sparse populations, one person or a small team can spot spray dyer's woad by wetting the foliage and stems without dripping with the use of an adjustable spray nozzle attached to a backpack or hand-held sprayer. Generally, a 1 percent solution of metsulfuron or a 5 percent solution of 2,4-D is an effective rate for spot treatment.

Management Strategies

Small or isolated infestations on otherwise healthy sites should be given high priority for treatment, followed by treatment of corridors with a high likelihood for spread, such as roadsides and waterways. A combination of control methods—as outlined in this guide—should always be considered as a long-term approach for dyer's woad control. For example, methods for physical or biological control used in combination with herbicide application can be effective options.

Typically, reseeding is not necessary after spraying dyer's woad. Treatments with metsulfuron and chlorsulfuron will selectively control dyer's woad and allow native grasses to return naturally. If reseeding is necessary (especially after tillage), local conditions should dictate when the reseeding is accomplished. In Arizona and New Mexico, seed of desirable grasses and forbs is generally planted in late summer or early autumn.

Because each treatment situation is unique, the strategy adopted for dyer's woad control must involve careful planning and a long-term commitment to management actions. Dyer's woad cannot be effectively controlled within a single year or by using only one method. Complete control will likely require 3 to 10 years of repetitive treatment. Since it is ordinarily useless to treat an area only one time without retreatment, sufficient resources must be allocated for the area where control is attempted. After initial treatment, it is important that resources are also available to respray or retreat the treated area as necessary. Previously treated areas should always be continuously monitored and retreated when necessary to control recovering dyer's woad. Failure to perform follow-up management may result in a return of the infestation to pretreatment levels.

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Suggested Web Sites

For information on invasive species:

National Invasive Species Information Center:

http://www.invasivespeciesinfo.gov/

Center for Invasive Species and Ecosystem Health

https://www.invasive.org/species.cfm

For information about calibrating spray equipment:

NMSU Cooperative Extension Service Guide A-613, *Sprayer Calibration*. Available at http://aces.nmsu.edu/pubs/_a/A613

Herbicide labels online: Available at http://www.cdms.net/

For more information or other field guides, contact:

USDA Forest Service
Southwestern Region
Forest Health
333 Broadway Blvd., SE
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Or visit the Southwestern Region's website for invasive species:

http://www.fs.usda.gov/goto/r3/invasivespecies