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Field Guide for Managing Dyer's Woad in the Southwest

Forest Service

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 includes four 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 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 preservative and inkjet printer fluid. Dyer's woad was accidentally introduced to the western United States as a contaminant in alfalfa seed during the early 1900s and has since proliferated throughout the arid West. It has been observed in Santa Fe and Sandoval Counties in New Mexico and Coconino County in Arizona.

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; each pod produces one seed. However, 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 available for cattle and horses, degrade wildlife habitat, lower flora and fauna species diversity, and decrease land value. Its dominant presence increases the potential for soil erosion.

Location

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.

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, dry-land invader 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 resprout from adventitious buds at its crown.

Management

Detecting dyer woad populations early and taking measures to manage the plant soon after discovery is important for control. Due to copious seed production and seed bank formation, large populations are difficult to eradicate once established. Continuous aggressive management measures are needed to keep populations under control. 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. Regardless of the management approach, it must be recognized that 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 repeated management methods. The following actions should be considered when planning an overall management approach:

- 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.
- Detect, report, and map known infestations. Keep annual records of reported infestations.
- 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 followup treatment plan for missed plants and seedlings.
- 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 back-country areas.

Table 1 summarizes some management options for controlling dyer's woad under various situations. Choice of individual control method(s) for dyer's woad depends on the degree and density of infestation, current land use, and site conditions (accessibility, terrain, microclimate, other flora and fauna present, 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

Although labor intensive, physical methods that are consistently and repeatedly used can be effective at controlling dyer's woad. 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 spot spraying herbicide upon remaining basal leaves is another effective management method; it reduces seed production and addresses root fragments.

Table 1. Management options*

Site	Physical Methods	Cultural Methods	Biiological Methods	Chemical Methods
Roadsides, fence lines, or noncrop areas	Repeatedly mow during summer after bolting but before seed set. Hand pull or grub; or cut stem, followed by herbicide on basal leaves.	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 (metsulfuron or chlorsulfuron 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 certified weed-free seed and hay. Reseed with plants that are desirable and will compete.	Use prescribed grazing strategy 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.	Educate the public to identify and report infestations. After passing through infested areas, in spect and remove any seed from animals, clothing, and vehicles.	Consider introducing a biological control 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 land resource.

Mechanical Methods

Mowing – Repeated mowing can reduce dyer's woad seed production in localized, accessible situations, such as along roadsides or in agronomic settings. However, if done improperly, it is possible that mowing will increase regrowth from the root crown. 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 limited 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. Local conditions dictate when reseeding should be accomplished. Typically, desired grass and forb seed are planted in late summer or early autumn in Arizona and New Mexico. If a spring herbicide application is used, allow dyer's woad to germinate and form rosettes before spraying (see table 3). *If machinery is used to manage dyer's woad, the equipment should be cleaned to prevent movement of seeds or root fragments into uninfested areas*.

Prescribed Fire

Burning is not well studied as a management method for controlling dyer's woad. Based on response to other methods which only remove top growth, dyer's woad is likely to rapidly regrow following a burn. Burning is acceptable as a means to dispose 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 from vehicles and livestock should be implemented to help stop dispersal. 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

Goats and sheep both graze dyer's woad. Sheep graze dyer's woad until mid-May but show preference for other more desirable forage species after that. Goats willingly eat dyer's woad regardless of growth stage and timing. In order to significantly impact seed production and plant mortality, 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, there is also a high potential for damaging desirable species. Managers need to carefully evaluate if using an intensive grazing approach might outweigh the management benefit.

Classical Biological Agents

The rust fungus, *Puccina thlaspeos,* is naturally occurring and targets dyer's woad specifically by suppressing or preventing seed formation. 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, and mixed in a solution for spraying. For further information on biological control of dyer's woad, see Jacobs and Pokorny (2007) in the "References and Further Information" section of this field guide.

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. 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

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

Table 2. Classical biological control agents

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).

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
Metsulfuron	Escort XP	0.75–1 ounce	1%	Rosette to bloom stage.	Selective broadleaf herbicide; noninjurious to most perennial grasses; absorbed through foliage; inhibits cell division. Best as a postemergent; add 0.25% v/v nonionic surfactant.
Chlorsulfuron	Telar XP	1–3 ounces	0.7–2%	Seedling to rosette.	Semiselective; safe for labeled grasses; growth inhibitor; absorbed by foliage and roots; best applied during warm, moist season. Preemergent or postemergent; use 0.25% v/v nonacidic adjuvant for postemergent application.
Imazapic	Plateau	8–12 ounces	1–3%	Rosette to bolting plants.	Selective broadleaf herbicide; noninjurious 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 upon sites with greater 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.	Under dry, dusty conditions, addition of 2,4-D can improve weed control. 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] 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 oz ÷ 128 oz/gal = 0.03 or 3 percent).

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

Imazapic (Plateau) with methylated seed oil (MSO) will also control dyer's woad when applied to rosettes or bolting plants. Dyer's woad tolerance to herbicide increases at later life stages; therefore, increased application rates are required.

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, one person or a small team can spot spray dyer's woad by wetting the foliage and stems without dripping using an adjustable spray nozzle attached to a backpack or hand-held sprayer. Generally, a 1 percent solution of metsulfuron or 5 percent solution of 2,4-D is an effective rate for spot treatment.

For all herbicide applications, it is important to read the herbicide label carefully, as different products will have different requirements and restrictions. Label instructions and guidelines for mixing, application, and grazing restrictions following treatment should always be followed. Consult the registrant if you have questions or need further detail.

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. When 2,4-D is used, early spring timing will reduce impact to nontarget plant species. Picloram and dicamba, applied alone, have not been found effective in controlling dyer's woad.

Control Strategies

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. A combination of strategies—as outlined in this guide—should always be considered as a long-term approach for dyer's woad control. For example, physical or biological control methods used in combination with chemical control are effective options. Regardless of the strategy used, components of a program for successful 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.

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

References and Further Information

Davison, J.C., E. Smith, and L.M. Wilson. 2007. Livestock Grazing Guidelines for Controlling Noxious Weeds in the Western United States. A Western Region Sustainable Agriculture, Research and Education Project. EB-06-05. Pp. 20–21. Available at http://www.cnr.uidaho.edu/rx-grazing/Livestock_Graizng_Guidelines%28Davison_et_al.%202007%29.pdf (accessed July 2010)

Duncan, K., K. McDaniel and M. Renz 2005. Chemical Weed and Brush Control for New Mexico Rangelands. New Mexico State University College of Agriculture and Cooperative Extension Service. Pp. 7. Available at http://aces.nmsu.edu/pubs/_circulars/CR_597.pdf (accessed July 2010)

Encycloweedia Datasheets by California Department of Food and Agriculture. Available at http://www.cdfa.ca.gov/phpps/ipc/weedinfo/isatis.htm (accessed July 2010)

Invasive Plant Atlas of the United States. Available at http://www.invasive.org/weedus/index.html (accessed July 2010)

Jacobs, J. and M. Pokorny. 2007. Ecology and Management of Dyer's Woad (Isatis tinctoria). USDA/NRCS Invasive Species Technical Note No. MT-10. Available at http://www.msuextension.org/ruralliving/Dream/PDF/Weed/dyers_woad.pdf (accessed July 2010)

Kedzie-Webb, S. R. Sheley and S. Dewey. 2000. Dyers Woad: A Threat to Rangeland in Montana. Montana State University Extension Publication No. MT199614. Available at http://www.co.yellowstone.mt.gov/extension/ag/pubs/mt9614.pdf (accessed July 2010)

McAdoo, J.K. and J. Carpenter. 2002. Woad Warriors Community Weed Awareness. University of Nevada-Reno Cooperative Extension Publication 02-62. Available at http://www.unce.unr.edu/publications/files/nr/2002/FS0262.pdf (accessed July 2010)

New Mexico State University. Weed Information. Available at: http://weeds.nmsu.edu/ (Accessed July 2010)

Pokorny, M.L. and J.M. Kruger-Mangold. 2007. Evaluating Montana's Dyer's Woad (Isatis tinctoria) Cooperative Eradication Project. Weed Technology 21:262–269 Available at http://www.weedcenter.org/inv_plant_info/docs/MT-Dyers_woad.pdf (accessed July 2010)

USDA Forest Service. 2006. Weed of the Week: Dyer's woad (Isatis tinctoria L.) Available at http://www.invasive.org/weedcd/pdfs/wow/dyers_woad.pdf (accessed July 2010)

USDA Plants Database. 2010. Available at http://plants.usda.gov/java/profile?symbol=ISTI (accessed July 2010)

Washington State Noxious Weed Control Board. 1999. Dyer's Woad: Written Findings. Available at http://www.nwcb.wa.gov/weed_info/Written_findings/Isatis_tinctoria.html (accessed July 2010)

West, N.E. and K.O. Farah. 1989. Effects of Clipping and Sheep Grazing on Dyer's Woad. Journal of Range Management 42(1):5–10.

Zouhar, Kris. 2009. Isatis tinctoria. In: Fire Effects Information System (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available at http://www.fs.fed.us/database/feis/ (accessed July 2010)

Suggested Web Sites

For information on invasive species:

http://www.invasivespeciesinfo.gov/

http://www.invasive.org/weedus/index.html

For information about calibrating spray equipment:

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

Herbicide labels online:

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

For more information or other field guides, contact:

USDA Forest Service
Southwestern Region
Forest Health
333 Broadway Blvd., SE
Albuquerque, NM 87102

Or visit:

http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies