



Dyer's Woad

Integrated Pest Management for Home Gardeners and Landscape Professionals

Dyer's woad (*Isatis tinctoria*) (Figure 1) is a problematic, invasive weed in the intermountain west, including far northern California. It grows in both disturbed and undisturbed sites and can be commonly found along roadsides (Figure 2), fencerows, and ditch banks, as well as in pastures, rangeland, and natural areas. It is sometimes also found growing in field crops (Figure 3).



Figure 1. Mature plant of dyer's woad, *Isatis tinctoria*, showing upright growth habit.



Figure 2. Roadside infestation of dyer's woad in Siskiyou County, California.

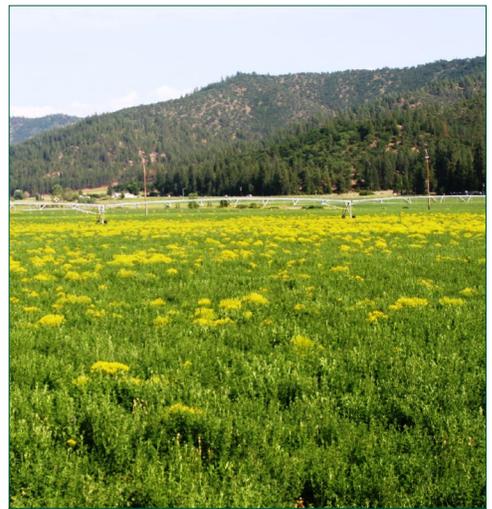


Figure 3. Springtime infestation of dyer's woad in an alfalfa field in Siskiyou County, California.

Dyer's woad is thought to have been introduced into California in the Scott Valley of Siskiyou County, where it is locally referred to as "Marlahan mustard." Until a couple of decades ago, it was primarily confined to Scott Valley, but it has subsequently spilled over into Shasta Valley. It

continues to spread throughout Siskiyou County and into Modoc, Shasta, and other northern California counties.

During medieval times, dyer's woad was one of the most valuable plant commodities in Europe, cultivated in southeastern Russia as a source of blue dye as early as the 13th century. Colonists first introduced it to the eastern United States late in the 17th century for the same purpose. Its dye is now only of very minor importance in the U.S., but the plant has successfully invaded and colonized extensive areas of California,

Oregon, Idaho, Utah, Wyoming, and Montana. Dyer's woad is a 'B' listed noxious weed in California.

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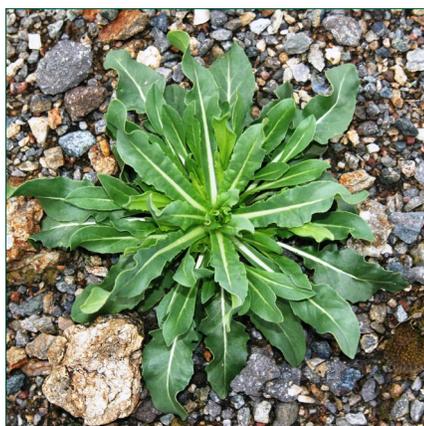


Figure 4. Basal rosette of dyer's woad plant.



Figure 5. Dyer's woad plant at early flowering, showing distinctive, white leaf veins.



Figure 6. A field infested with dyer's woad in full bloom.

IDENTIFICATION, BIOLOGY, AND IMPACT

Dyer's woad is a member of the mustard family and is a biennial or short-lived perennial. Dyer's woad seeds germinate in fall or early spring. The plant requires two growing seasons to produce seed. During the first growing season, plants remain in the rosette form (Figure 4), produce a deep taproot, and store nutritional reserves. During the following season, plants bolt, flower, and produce seed.

A mature dyer's woad plant ranges from one to four feet in height, but usually does not exceed three feet. All leaves have prominent whitish veins on the upper side of the blue-green blades, which makes plants easy to identify (Figure 5). Like many mustards, dyer's woad has small, yellow, attractive flowers, which appear during May and June in the intermountain west (Figure 5 and 6).

Dyer's woad seeds are distinctive. Single seeds are borne within 1/2- to 3/4-inch long seedpods (silicles) which gradually turn from yellowish-green (Figure 7) to purplish brown or black at maturity (Figure 8). Most plants are capable of producing 350-500 seeds or more per year.

Encased within the protective silicles, seeds have been estimated to survive eight years or longer. Dyer's

woad silicles are suspected of containing seed germination-suppressing compounds that may provide a competitive advantage in the field.

Dyer's woad plants have a taproot that can be more than five feet long, which enables the plant to access deep soil moisture not available to other plants. With its rosette growth habit, closely appressed to the soil,

plants severed above soil level can regrow.

Dyer's woad can thrive under a wide range of environmental conditions. It establishes first in disturbed areas, especially in light sandy and gravelly soils. It is also commonly found in riparian areas. It is primarily a weed of rangeland, woodlands, and non-crop sites, where it out-competes native



Figure 7. Dyer's woad silicles on a plant, mostly at the late green-seed pod stage. Testing has shown that some seeds on plants at this stage are capable of germination.



Figure 8. Mature, seed-containing silicles on a senescing dyer's woad plant.

grasses, but it also infests grain and alfalfa fields and pastures. It is an aggressive competitor and often forms dense monocultures (Figure 6).

It is not known to be toxic to mammals, but most livestock and wildlife do not readily graze on dyer's woad. Its spread can be facilitated by contamination of hay bales, grain lots, machinery, and so on. Dyer's woad is becoming increasingly common in forested sites, where it can be introduced by contaminated hay brought in to feed pack animals and through excavation work on roads.

MANAGEMENT

Like other perennial mustards, dyer's woad can be difficult to control because of its early rosette growth habit and deep root system.

Prevention

The most effective control measure for dyer's woad is prevention. Careful monitoring and sanitation, especially when moving animals or equipment from infested areas, are important.

In established infestations, it is critical to prevent plants from producing seed to prevent further spread. Germination assays have shown that some seeds are capable of germinating even when the seedpods are still green. Similarly, plants treated with an herbicide during the flowering period may still produce some viable seed. Therefore, ensure that spring-time control measures are in place before plants begin flowering.

Cultural Control

Hand roguing or digging individual plants is somewhat effective for small or scattered infestations. It may be necessary to continue removing new plants in an infested area periodically for at least two to three years. Hand removal is difficult because of the deep taproot, and the stems may break off when pulling allowing the plant to re-sprout new shoots. There-



Figure 9. A roadside dyer's woad infestation, showing mature silicles on senescing plants.

fore, depending on soil type, hand hoeing may be easier.

If flowers or seedpods are present, plants should be uprooted, bagged, and removed from the field. Cutting or mowing to prevent seed production can be effective, but this requires multiple passes. A single mowing event may delay flowering, but plants will usually re-sprout; cutting plants at least one or two more times is important to prevent seed production completely.

Depletion of plant root reserves using repeated cultivation may also be an effective way to control dyer's woad. However, many sites where plants are established may be rocky, uneven, or isolated; cultivation or mowing may not be feasible here.

Seed destruction. It is important to control new infestations of dyer's woad before they become serious and widespread. Deep burial, removal and disposal, and burning of senescent, seed-bearing "skeleton" plants may assist in minimizing spread from localized infestations. However, dry seeds are easily detached from senescent plants, and care must be taken not to scatter these seeds about during destruction activities (Figure 9).

Solar tenting. Another nonchemical tactic used to destroy seeds is solar tenting, a hydrothermal method of inactivating seeds on desiccated skeleton plants. Moistened seeds, enclosed within silicles, are susceptible to high temperatures, even though the silicle provides some protection to seeds, especially dry ones, against heat exposure. Germination can be greatly reduced or eliminated during summer months by immersing seeds in water-filled plastic bags for several weeks. This approach is useful for remote or isolated infestations of dyer's woad where on-site seed destruction is desirable to prevent spread.

Biological Control

Experimental trials evaluating a pathogenic rust fungus as a biological control agent of dyer's woad have been conducted. Rust fungi cause foliar diseases that rarely eradicate all host plants, so their effects on weeds may be restricted to reduced plant vigor and reduced seed production. Therefore, use of a rust fungus is likely to reduce, but not eliminate, dyer's woad populations. In the future, biological control may be a useful tool within an integrated pest management approach.

Chemical Control

Chemical control at appropriate growth stages is also effective. Fall treatments have worked well in other states, but these do not seem to be as effective in California, perhaps because our lack of late season rain and associated plant water stress do not allow for herbicide penetration and movement within plants.

The most effective herbicides for dyer's woad control are 2,4-D and chlorsulfuron. 2,4-D does not have soil activity and should be applied to seedlings or rosettes at 2 to 3 quarts per acre (3.8 pounds a.e./gallon) or at a 1% solution for spot treatments. 2,4-D does not inhibit seed set when applied to flowering plants. Chlorsulfuron is generally more effective than 2,4-D and has both post as well as pre-emergence activity, but is restricted to professional use only. The use rate of 1 to 1.33 ounces of product per acre (0.75 to 1 ounce

a.i./acre) is most effective when applied pre-emergence to rosette stage. A combination of 2,4-D with chlorsulfuron is also a highly effective treatment.

Oftentimes, people do not think to treat dyer's woad until they observe the conspicuous bright-yellow flowers. A field trial was conducted recently to determine whether treating dyer's woad with glyphosate or 2,4-D herbicide at bloom, early green-seedpod, or late green-seedpod stages had effects on seed production or seed viability. We found that treating at bloom stage or early green-seedpod stage reduced seed production markedly, but did not eliminate it.

Glyphosate also controls dyer's woad but it is usually not the herbicide of choice for broadcast applications because it is non-selective and kills desirable vegetation along with weeds. The use of glyphosate or other herbicides along with a marking dye

is an effective measure for tracking spot treatments in large areas.

Even when treating during appropriate seasons, multiple herbicide applications over multiple years may be required to attain control since plants in an infested area will continue to emerge each year until the soil seedbank has been depleted. The key objective of any dyer's woad control program is to prevent viable seed production and dissemination. Regardless of the management program used, several years of control will be needed.



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WARNING ON THE USE OF PESTICIDES

Pesticides are poisonous. Some pesticides are more toxic than others and present higher risks to people, nontarget organisms, and the environment. A pesticide is any material (natural, organic, or synthetic) used to control, prevent, kill, suppress, or repel pests. "Pesticide" is a broad term that includes insecticides, herbicides (weed or plant killers), fungicides, rodenticides, miticides (mite control), molluscicides (for snails and slugs), and other materials like growth regulators or antimicrobial products such as bleach and sanitary wipes that kill bacteria.

Always read and carefully follow all precautions and directions provided on the container label. The label is the law and failure to follow label instructions is an illegal use of the pesticide. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, and animals. Never place pesticides in food or drink containers. Consult the pesticide label to determine active ingredients, correct locations for use, signal words, and personal protective equipment you should wear to protect yourself from exposure when applying the material.

Pesticides applied in your garden and landscape can move through water or with soil away from where they were applied, resulting in contamination of creeks, lakes, rivers, and the ocean. Confine pesticides to the property being treated and never allow them to get into drains or creeks. Avoid getting pesticide onto neighboring properties (called drift), especially onto gardens containing fruits or vegetables ready to be picked.

Do not place containers with pesticide in the trash or pour pesticides down the sink, toilet, or outside drains. Either use all the pesticide according to the label until the container is empty or take unwanted pesticides to your local Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Hazardous Waste Collection site nearest you. Follow label directions for disposal of empty containers. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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