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Managing Yellow and Dalmatian Toadflax

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Yellow toadflax (*Linaria vulgaris*) and Dalmatian toadflax (*Linaria genistifolia* spp. *dalmatica*) aggressively displace native vegetation in many habitats, including rangelands and riparian environments. In the mid 1800's, yellow toadflax was brought into the United States from Eurasia as an ornamental. It was grown to make yellow dye and reportedly for medicinal purposes. Its cousin, Dalmatian toadflax, was introduced a half century later. Both escaped cultivation and became troublesome weeds. They are often sold through catalogs and in nurseries as "wild snapdragon" or "butter and eggs." They are unknowingly recommended and illegally sold for use in Nevada gardens where they survive with little water and produce a showy landscape display (Fig. 1).

Unlike Dalmatian toadflax that is a weed primarily in the Midwest and West, yellow toadflax has invaded the entire U.S. from east to west, as well as the Canadian provinces and Mexico. These toadflaxes have tremendous impact on the ecosystems they invade. Their vigorous growth displaces native vegetation, promotes erosion, reduces ecological diversity and decreases the value of land, especially rangeland.

Identification and Habitat

Yellow and Dalmatian toadflax are herbaceous, short-lived perennials that emerge during April or May. They grow well in most soils, climates, elevations and water regimes. Open lands such as

pastures, rangeland, construction sites and roadsides are easily invaded by these toadflaxes.

Dalmatian toadflax grows to three feet tall while yellow toadflax is usually shorter. Both reproduce by seed and underground rootstocks.

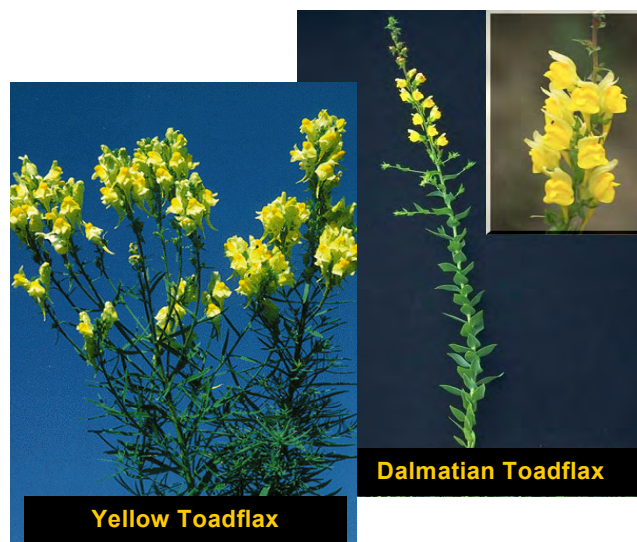


Figure 1. Yellow and Dalmatian toadflax are invasive because they can grow in harsh, dry sites with beautiful flowers and still produce viable seed.

Dalmatian toadflax is the coarser of the two, but they both have rough, woody stems at their base that become smooth near the top. Leaves of Dalmatian toadflax are waxy, blue-green, heart to lance-shaped, wide at their bases and have smooth margins. Yellow toadflax leaves are pale green, numerous, narrow, pointed at both ends, and grow to two and a half inches long or longer. Leaves of

both grow alternately and those of Dalmatian toadflax clasp the stem.

The flowers are borne in the axils of the leaves in a spike near the end of each stalk from May through September. They are yellow with an orange, bearded throat and a long spur. Dalmatian toadflax flowers are two-lipped and slightly larger than the one-inch yellow toadflax flowers. Dalmatian toadflax produces a two-celled fruit capsule with many small, black, irregularly angled seeds. Yellow toadflax seeds are also small but brown to black and flat with a papery circular wing.

Large plants can produce 500,000 seeds (Robacker, 1970) that remain viable in soil up to ten years. The seeds do not require dormancy to germinate and may sprout in the fall of the year they are produced. However, most seeds germinate the following spring, in April and May, or earlier in warm areas.

Both of these toadflaxes are difficult to manage due to their deep, extensive root systems. The creeping roots of yellow toadflax produce vegetative buds that create new shoots. First year plants can produce 90 to 100 secondary shoots from roots. Lateral roots of Dalmatian toadflax spread out from the base of the plant approximately one to four inches below the surface of the soil. Sinker roots extend from the lateral roots four to ten feet deep. Vegetative buds are generally produced on lateral roots two to eight inches below the soil surface, but they have been found six and ten feet deep (Sheley, et al., 1999). These buds grow new plants especially if the mother plant is disturbed (trampled, grazed or mowed), the soil is tilled, or more moisture becomes available.

Both of these toadflaxes are competitive with winter annuals and shallow rooted perennials (Fig. 2), including many native and introduced grasses because they reproduce both sexually and vegetatively. With time they dominate the site, becoming the only plant growing in the area.

Overgrazing rangeland and pastures creates an ideal environment for Dalmatian and yellow toadflax to establish. They will use the space, limited moisture and nutrients to replace desirable vegetation. These toadflaxes contain a poisonous glucoside that is harmful to livestock if consumed in large amounts. Reports of livestock poisoning

from Dalmatian and yellow toadflax are rare because cattle eat other forage before they consume toadflax. However, if there is no other forage available, cattle will browse both. Dalmatian and yellow toadflax are not harmful to sheep and goats.

Valuable forage for wildlife is lost when either toadflax invades. In addition, many species lose their habitats. Some birds and small animals will feed on the seeds, but Dalmatian and yellow toadflax are not good forage for wildlife and should be eradicated to allow desirable vegetation to grow.



Figure 2. Yellow and dalmatian toadflax invade rangelands, crowd out native plants and modify whole plant communities.

Control and Management Strategies

Prevention

The most successful management strategy is prevention. By remaining alert and preventing infestations, time, money and resources can be used more productively. To help prevent the spread of yellow and Dalmatian toadflax consider:

- restricting access to infested lands,
- cleaning equipment before moving it from contaminated areas to uninfested sites, and
- corralling cattle for six days and sheep for eleven days while feeding them weed-free forage before turning them out in uninfested areas.

Holding corrals and equipment cleaning areas must be monitored for the presence of Dalmatian and yellow toadflax for years. If seedlings appear, immediately pull, cultivate or spray them with an herbicide to prevent their establishment.

Mechanical/Physical Controls

Pulling or cultivating young Dalmatian and yellow toadflax plants in small infestations before they go to seed will provide control, even eradication, if done consistently for several years. When pulling either weed, make sure to remove the lateral roots completely. The root can tear and underground portions can survive to grow new plants. The site will need to be revisited frequently (several times per season) to completely eradicate these toadflaxes if pulling, plowing or cultivating is used for control. Mechanical control is not recommended for management of medium to large stands of toadflax.

Mowing is not recommended as it stimulates more plants to grow from the roots. Many sites where these plants are found are not accessible with a mower. It is true that mowing before the plant produces seeds reduces the number of seeds available for germination, but the stand density may increase from root sprouting. Mowing can be used to promote uniform growth and improve the effectiveness of herbicide applications.

Burning is also not recommended because, like mowing, it does not kill the roots and may stimulate shoot growth. It also may promote the growth of Dalmatian and yellow toadflax by eliminating desirable competition. Propane torches can be used to kill stalks before they seed; this prevents seed production without harming non-target plants.

Cultural Control

Introducing and maintaining competitive plants thwarts these toadflaxes from establishing on rangelands. Healthy rangeland plant communities can remain free of Dalmatian and yellow toadflax if they provide season-long cover to prevent the establishment of toadflax seedlings.

Providing plant competition with desirable plants is also recommended as part of sound integrated weed management. Ideally, creating conditions favorable for desirable plants should follow after other control methods have eliminated or reduced a toadflax infestation. Rangeland that is in healthy condition should be consistently monitored, have spot treatments conducted to kill Dalmatian and yellow toadflax when necessary, and have the area seeded with competitive species to prevent a toadflax reinvasion.

Biological Control

Grazing can control or promote the spread of invasive weeds. In arable lands, Dalmatian and yellow toadflax have adapted to the disruptions of grazing and agriculture. The proper timing of grazing and of rotational grazing is key to successful weed abatement. Over-grazed range and season-long grazing predispose range to a yellow and Dalmatian toadflax invasion. However, if grazing by sheep is timed to eliminate seedlings, the establishment of toadflax can be prevented. Grazing mature plants does not kill the root system and may stimulate new plants to develop from the roots. Intense rotational grazing several times a year may weaken the roots and contain an infestation, particularly if used in combination with other controls.

In the United States (but not in Nevada), there are eight insects being used for biological control with varying success on Dalmatian and yellow toadflax. Three of the insects substantially impact yellow and Dalmatian toadflax: an ovary feeding beetle, *Brachypterolus pulicarius*, and two weevils that feed on the seed-capsule, *Gymnaetron antirrhini* and *Gymnaetron netum*. In addition to these three, a moth (*Calophasia lunula*) introduced from Eurasia defoliates up to 20 percent of the leaves on a single plant (M.S.U., 2000). The beetle was released in Nevada, but did not become established. Using disease organisms as a biological control method is not currently available.

There are plans for a comprehensive weed survey in Lincoln County that will document the use and establishment of bio-controls on Dalmatian toadflax. Biological controls may effectively reduce an infestation of an invasive weed, but if used alone will not lead to eradication. However, used in combination with other methods, they may contain or effectively control an infestation below an economic threshold depending on the use of the area.

Chemical Control

Chemical control of Dalmatian and yellow toadflax is erratic because of the genetic variability of the plants, their ability to grow in many sites and climates, and the waxy leaves and stems of Dalmatian toadflax affect the coverage and uptake of selected herbicides. Due to the soil longevity of viable seed, it may be necessary to treat infested

areas for many years (twelve or more) to eradicate these toadflaxes completely.

Dicamba controls Dalmatian and yellow toadflax in rangelands when applied during the pre-bloom stage (spring). Repeated area or spot applications may be needed over a season at a rate of 4 to 6 pounds of active ingredient per acre for satisfactory control.

A tank mix of a half-pound of *picloram* plus one pound *2,4-D amine* per acre applied pre-bloom may yield good results.

Picloram at 1 to 2 quarts per acre applied to actively growing toadflax through full bloom is effective. Fall applications at two-quarts to one pound *picloram* per acre have given 98 percent control for three years (M.S.U., 2000). Best results occurred when applied after the first killing frost. Sunny, hot conditions and sandy soils affect the performance of *picloram*. It is degraded by sunlight and can leach below the root zone in sandy soils, reducing its effectiveness.

Chlorsulfuron at 1.5 to 2.25 ounces active ingredient per acre, sprayed to wet, at bud to full bloom suppresses yellow toadflax. Use a nonionic surfactant at 0.25 percent by volume. This chemical kills broadleaved plants and is selective to many grasses. It is very persistent in high pH soil. Use with caution.

Imazapic effectively controls toadflax when applied in the fall at 8 to 12 fluid ounces with one quart of mentholated seed oil per acre. Do not harvest hay for seven days; however, there are no grazing restrictions. Use the lower rate when cool-season grasses (bluegrass and smooth brome) are present.

Since these toadflaxes grow in sandy soils, apply herbicides at the lower recommended rate on the label whenever possible to prevent over application and pollution of the environment, especially surface and ground water.

Always read and follow the labeled directions, it's the law! Doing so reduces health and environmental risks and liability. Failure to do so makes the applicator responsible for damage to non-target plants and after-effects. Herbicide

applicators have legal and financial responsibilities each and every time they purchase and use chemicals. The applicator must be certified to use restricted use products and be knowledgeable if applying chemical combinations. Do not allow spray to drift onto crops, non-target species, or waterways.

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