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Field Guide for Managing Yellow Starthistle in the Southwest

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Cover Photos

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Yellow starthistle (*Centaurea solstitialis* L.)

Sunflower family (Asteraceae)

Yellow starthistle is an invasive plant that has been 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 yellow starthistle in forests, woodlands, rangelands, and deserts 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

Yellow starthistle (synonyms: golden starthistle, St. Barnaby's thistle, yellow cockspur) is an early maturing winter annual. Native to Eurasia, it was introduced into North America as a seed contaminant in the mid-1850s and has persistently spread across the western United States. Yellow starthistle is similar in appearance to two closely related species: *C. melitensis* (Malta starthistle) and *C. sulphurea* (Sicilian starthistle).

Growth Characteristics

- Grey-green to blue-green herbaceous plant covered in fine, white cottony hairs; winter annual and occasional biennial.
- Stout, rapidly growing, vigorous taproot; may grow deeper than 36 inches.
- Germinates fall to spring; rosette in fall/winter, deeply lobed leaves with fine, cottony hairs appear ruffled; bolts May to June with stiff, openly-branched stems, 6 to 60-inches tall with large stem wings.
- Leaves alternate, linear to oblanceolate; margins smooth, toothed, or wavy.
- Flowers May to December, yellow flowers borne at tips or in axils of winged stems; flower heads with spiny bracts form in June or July; each bract has a central spine up to 2 inches long with 2 to 3 pairs of lateral spines.
- Reproduces solely via seed; two types of smooth seed—one type is lighter in color with a pappus of barbed bristles, the other is darker without a pappus.
- Leaves and stem become straw colored as seeds form; flower head becomes straw colored when seeds are mature; seeds are viable for up to 10 years.

Ecology

Impacts/Threats

Yellow starthistle is highly competitive and often develops dense, impenetrable stands that lower the diversity of desirable flora and fauna species. The presence of sharp, long spines on seed heads of yellow starthistle degrades livestock grazing, wildlife habitat, and recreational opportunities. When forced to graze mature yellow starthistle, livestock (especially horses) can be affected by an incurable neurological disorder known as "chewing disease." A neurotoxic sesquiterpene lactone in starthistle species called repin is believed to be the underlying cause of the disorder. However, animals typically avoid the weed because of the sharp spines and hairs.

Site/Distribution

Yellow starthistle prefers well-drained soils, hot dry summers, and 10 to 60 inches of precipitation. It occurs in open areas in woodlands, desert scrub, chaparral, rangeland, pastures, waste areas, cropland, and roadsides that generally lie below 7,500 feet in elevation. It is also common around residential subdivisions, agricultural land, and recreation areas. The species is found in foothill areas of southwestern New Mexico and elsewhere in deserts, uplands, rangelands, and mountains of the Southwest.

Spread

When unassisted, yellow starthistle seed rarely moves far from the parent plant. However, seed readily attaches to fur, hair, or clothing. The seed can be transported afar by adhering to tires and undercarriages of road vehicles and equipment. The seed may also be introduced into new areas through transported hay that is not certified to be weed free.

Invasive Features

Yellow starthistle is a prolific seed producer and in dense stands can produce 50 to 100 million seeds per acre. It grows rapidly and is highly adaptable to environmental variation. This allows yellow starthistle to out-compete native plant species for sunlight, space, water, and nutrients. Other features that facilitate invasiveness include a deep taproot that accesses available soil moisture, winged stems that dissipate heat, and formidable spines at maturity that deter grazing by livestock or wildlife.

Management

Due to its abundant seed production, early detection and eradication of yellow starthistle soon after discovery increases the chances for successful control. A commitment to repeated management actions is a must, and a combination of methods and repeated treatments will improve effectiveness. The following actions should be considered when planning a management approach to control starthistle:

- Maintain healthy plant communities to suppress or limit the impact of a starthistle infestation.
- Incorporate sound grazing management with any control strategy.
- Combine mechanical, cultural, biological, and chemical methods to control yellow starthistle populations whenever possible.
- Include monitoring and a follow-up treatment plan for missed plants and seedlings.
- Map large infestations and keep annual records of reported infestations.

Table 1 summarizes management options for controlling yellow starthistle under various situations. Further details on these management options are explained below. Choice of individual control method(s) for starthistle depends on many local factors including the extent of infestation, current land use, and site conditions (terrain, accessibility for treatment, microclimate, presence of non-target flora and fauna, etc.). Other important considerations include treatment effectiveness, overall cost, and the number of years needed to achieve control. Typically, more than one control method may be needed for a particular site.

Physical Control

Yellow starthistle reproduces solely by seed, so physical methods should focus on reducing seed production and preventing seed germination. These methods usually have to be repeated and must be properly timed to be effective.

Manual Methods

Hand pulling or hoeing are most effective in a maintenance program for an area where yellow starthistle is relatively sparse. Take care to remove as much of the taproot as possible. Anticipate that hand removal will need to be repeated in about 2 weeks to remove missed plants or those maturing at a later time. Care should be taken to minimize soil disturbance and to properly dispose of plant debris by bagging and/or burning.

Mechanical Methods

When using machinery to manage yellow starthistle, the equipment should be cleaned after use to prevent movement of seed into un-infested areas.

Tillage – In suitable terrain, tillage in early summer with a plow or disc that is repeated at a later time (about 4 to 6 weeks) can effectively bury yellow starthistle plant parts. A harrow or drag pulled behind a tractor can be used to cut and separate shoots from roots of larger mature plants. These methods are most commonly used in agronomic or roadside settings and should only be used when the soil surface is dry since fragmented plant segments in moist soils will regrow and possibly magnify the problem.

Mowing – Mowing is commonly used for yellow starthistle along roadsides and in recreational areas. Although it can be a cost-effective method for starthistle control, mowing is not feasible in many locations due to rocks or steep terrain. Some vegetation management experts do not recommend mowing since plants not cut closely to the surface often produce side branches that can form additional flowers, even with repeated mowing and proper timing.

Despite its limitations, mowing over a 3-year period has been reported to provide over 90 percent control when two

Table 1. Management options*

Site	Physical Control	Cultural Control	Biological Control	Chemical Control
Roadsides	Use repeated, shallow cultivation and/or mowing throughout germination and growing periods.	Use seed and mulch certified to be weed-free. Gravel and other road materials transported into un-infested areas should be weed free. Educate road crews to identify and report infestations along roads; implement requirements for vehicle operations in infested areas.	Consider using flies, weevils, or rust fungus as classical biocontrol agents (see table 2). Usefulness of biocontrol agents may be limited due to possible disturbances in agent life cycles from roadside operations.	Use truck spraying equipment to apply herbicide during early growth. Clean equipment to prevent spread.
Rangeland	Use repeated, shallow cultivation and/or mowing throughout germination and growing periods. If feasible, combine prescribed fire with herbicide spraying.	Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas. After passing through infested areas, inspect and remove any seed from animals, clothing, and vehicles before entering treated or un-infested areas.	Use prescribed grazing during spring with an intense, short-duration approach in combination with other control methods. Closely manage grazing to prevent overuse. Consider using flies, weevils, or rust fungus as classical biocontrol agents (see table 2).	For extensive and dense infestations, use ground or aerial broadcast spraying. For less dense infestations, consider ATV or backpack spraying. Clean ground equipment to prevent spread.
Wilderness and other natural areas	Hand methods can be used by starting at the edges of an infestation and working toward the center. Pull before plant reaches full bloom.	Use seed and forage hay certified to be weed-free; use pellets for horses in backcountry areas. After passing through infested areas, inspect and remove any seed from animals, clothing, and vehicles before entering treated or un-infested areas. Post signs warning visitors to inspect for and remove seeds.	Same as above.	Use backpack or hand-held sprayers. Broadcast spraying by aerial or ground methods may be used on thicker stands if allowed. Clean ground equipment to prevent spread.

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

timely, repeated mowings are made per year. Since timing is critical, best results occur when mowing is completed in the early flowering stage before viable seed production, i.e., when no more than 2 to 5 percent of the spiny heads are in bloom. After mowing, no leaves should be left below the level of the cut.

Prescribed Fire

Burning from January to May can eliminate yellow starthistle in the seedling to early bolting stages. However, burning during this time is often limited since there generally is insufficient fine, dry fuel available to carry the intense, uniform fire required for starthistle control. Yellow starthistle may also be burned in early to mid-summer (late May to early July) during the early flower stage. Despite its effectiveness in selected situations, risks associated with burning should be thoroughly assessed in a specific management plan for prescribed fire.

Cultural Control

Educational programs focused on the biology and identification of nonnative weed species should be sponsored for local land managers and others to help find, report, and monitor suspected infestations. Vehicles,

humans, and livestock should be discouraged from traveling through infested areas. A program to check and remove seed from vehicles and livestock should be implemented to help stop dispersal. Hay, straw mulch, seeds for planting, and other similar materials should be certified to be weed free before use in unaffected areas or areas previously treated for starthistle. Gravel and other road materials transported into un-infested areas should also be weed free.

Biological Control

Grazing

In California, properly timed spring grazing with cattle, goats, or sheep has been shown to reduce yellow starthistle's growth, canopy cover, survivability, and reproductive capacity. This approach is based on intensive livestock grazing of yellow starthistle after stems on rosettes have begun to bolt but before spiny seed heads develop. Cattle and sheep avoid starthistle once the flower heads produce spines, whereas goats continue to browse plants even during the flowering stage. For this reason, goats are popular for controlling yellow starthistle in relatively small infestations.

Although grazing can reduce starthistle presence, owners of horses and other livestock should ensure that suitable alternative forage is available. Owners should also look for signs of toxicity or so-called "chewing disease" in starthistle stands that have flowering heads. Prescribed grazing with an intensive, short-duration approach can be part of an effective control strategy to manage starthistle, especially when combined with other control methods (see "Integrated Control Methods" at the end of this section for more information). A system using short periods of intense livestock grazing has been adopted in other countries for starthistle control. In this system, infested pastures are intensively grazed for 3 to 5 days, often by using electric fencing. After livestock have been moved to another part of the pasture, the grazed area is allowed to recover for at least a month before grazing is repeated. The system typically results in more uniform and complete forage utilization. In addition, desirable forage is not completely grazed and can rapidly recover. Ultimately, this increases seasonal forage production and stocking capacity.

Classical Biological Control

Control with classical biocontrol agents (insects, pathogens, etc.) is most suitable for sites where other control methods are impractical. Biocontrol agents should be used only if infestations are large enough to sustain agent populations. Needs of the biocontrol agent should be considered before implementing other weed treatments.

USDA-approved biocontrol agents listed in table 2 have been found to establish well in the western United States and contribute significantly to reduce seed production. Several biocontrol agents have been released in Arizona and New Mexico for control of yellow starthistle, but experience with these agents is still limited. For further information on biocontrol of yellow starthistle, see Wilson et al. (2003) 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

Yellow starthistle is best controlled with a selective, post-emergent, broadleaf herbicide since these chemicals have little or no effect on grass species. The primary entry point for herbicide into the plant is through the leaves with only

Table 2. Classical biocontrol agents approved for yellow starthistle

Species	Type of Agent	Site of Attack	Impact on Host	Use/Considerations for Release
Bangasternus orientalis	weevil	Flower buds/ seed heads	Larval feeding in the head can reduce the number of seeds by 40 to 60 percent.	*B. orientalis* is a good flier and disperses well. It is difficult to establish at sites where *E. villosus* is already established.
Chaetorellia australis	fly	seedheads	Internal larval feeding reduces the number of developing seeds in the bud by 80 to 100 percent.	Disperses very well, thus it is widespread in most areas it was established.
Eustenopus villosus	weevil	Young flower buds and seedheads	Adult feeding and oviposition can destroy young buds, which appear as brown, dry and tilted heads. Larval feeding in the head can reduce the number of seeds by 90 to 100 percent.	It is now widely established in California, Oregon, Washington and Idaho and is abundantly available for collection and redistribution.
Larinus curtus	weevil	Pollen, flowers, seedheads	Adult feeding on pollen and flowers does little to damage the plant; larval feeding in seed heads results in seed reduction of 75 to 100 percent.	*L. curtus* is a strong flier and is expected to disperse well on its own.
Urophora sirunaseva	fly	Seedheads	Internal larval feeding reduces the number of developing seeds in the head by about 50 percent. Heads infested with this gall fly produce fewer seeds than heads infested with *Chaetorellia* flies.	The presence of high densities of *U. sirunaseva* at a site does not appear to interfere with survival of other seed head-infesting agents.
Puccina jaceae var. *solstialis*	rust fungus	leaves and stem	Stress caused by agent reduces production of flower heads and seed.	Released in 2004 in California, the rust has not demonstrated a strong record of persistence

minor entry through roots.

All herbicides shown in table 3 will effectively control yellow starthistle when properly applied. Of the compounds recommended, picloram and clopyralid are the most commonly used since they provide some residual activity in the soil and will control seedling emergence for a few months after spraying. Aquatically approved herbicide formulations and surfactants must be used in or near water. Each herbicide product has specific requirements and restrictions; therefore, it is important to read the label carefully and follow all instructions when mixing and spraying.

Herbicide Application

The most effective time to spray yellow starthistle is usually late autumn to early spring during the seedling to rosette stage. Spraying is also effective later in spring when plants have 4 to 6 inches of growth and good growing conditions exist. Since yellow starthistle is an annual, it should not be sprayed during or after flowering as these treatments will be ineffective. Yellow starthistle establishment is closely tied to rainfall events, which can complicate herbicide spraying. New plants can be produced throughout the year, and propagation from year to year can be highly variable. Therefore, infested areas should be checked closely for seedling abundance before deciding to spray.

Herbicides may be applied by backpack or hand-held sprayers, ATV or UTV sprayers, or conventional boom sprayers that are pulled or attached to a tractor or truck. Aerial application via fixed-wing airplane or helicopter may be warranted for large, monotypic infestations. Any equipment used to spray herbicide should be calibrated. Because herbicides listed in table 3 may impact desirable broadleaf and woody species, precautionary measures should be taken if nontarget species need to be protected.

Table 3. Herbicide recommendations

Common Chemical Name (active ingredient)	Product Example(s)[1]	Broadcast Treatment (rate per acre)	Spot Treatment (spray solution)[2]	Time of Application	Remarks
Clopyralid	Reclaim Stinger Transline	0.25–0.67 pints	1–3%	Fall to early spring during early rosette stage.	Selective broadleaf herbicide. Most perennial grasses are tolerant; residual.
Clopyralid + 2,4-D[3]	Curtail	0.25–1 pint	1–3%	After most rosettes have emerged, but before flower heads form.	Same as above.
Aminocyclopyrachlor + chlorsulfuron	Perspective	3–4.5 ounces	Consult label for spot applications.	Lower rate for rosette; higher rate at bolting. Fall or spring.	Selective herbicide used on non-crop sites; may cause temporary injury to some grass species.
Aminocyclopyrachlor + metsulfuron methyl	Streamline	4.75–9.5 ounces	Same as above.	Same as above.	Same as above.
Aminopyralid	Milestone	3–5 ounces	3–5%	Rosette through bolting stage.	Labeled for use in natural areas such as wildlife management areas. No grazing restrictions.
Picloram[4]	Tordon 22K	1–1.5 pints	1–3%	Fall to early spring, at early rosette stage.	Selective broadleaf herbicide; may pose a risk to groundwater in permeable soils or in areas where the water table is near the surface.
Picloram[4] + 2,4-D[3]	Grazon P+D	2 quarts (1:4 mixture)	1–3%	Same as above.	Same as above.
Metsulfuron methyl	Escort XP	1 ounce	NA	Same as above.	Selective broadleaf herbicide. Most perennial grasses are tolerant; residual.
Metsulfuron methyl + 2,4-D[3] + dicamba	Cimarron Max	Rate III (1 ounce Part A + 4 pints Part B)	NA	Same as above.	Same as above.
Dicamba + diflufenzopyr	Overdrive	4 ounces	1–3%	Same as above.	Selective broadleaf herbicide; not for use where surface water is present.
Triclopyr	Remedy	3 pints	1–1.5%	Best on seedlings to early rosette stage.	Selective broadleaf herbicide; little residual.
2,4-D[3]	several manufacturers	1 quart	5–10%	Rosette to early bud in the spring.	Non-persistent; growth regulator; may be less effective alone.

Table 3. Herbicide recommendations (cont.)

Common Chemical Name (active ingredient)	Product Example(s)[1]	Broadcast Treatment (rate per acre)	Spot Treatment (spray solution)[2]	Time of Application	Remarks
Imazapyr	Arsenal	1 pint	1%	All stages.	Nonselective herbicide. In addition to spray drift, nontarget plants may also be killed or injured by imazapyr through runoff, residue movement in soil, or root exudates from treated plants. Use only in areas where total plant control is desired such as roadsides.
Glyphosate	Rodeo Round Up	Rodeo: 4.5–7.5 pints Round Up: 1.5–4 quarts	Rodeo: 0.75–2% Round Up: 1–2%	One week before reseeding.	Nonselective herbicide. Use only for site preparation in a reseeding program.

[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 yellow starthistle.

[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.

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

Integrated Control Methods

Using a combination of control methods will improve treatment effectiveness for yellow starthistle. The following treatment combinations may be used to manage infestations:

- **Herbicide–burn** – As an initial treatment, use herbicide in a broadcast spray for seedlings and young plants in the rosette stage during fall or early spring. The treatment will eliminate the majority of the yellow starthistle population and allow grasses to become established. The herbicide treatment can then be followed the next year (or possibly in 2 years) with prescribed fire, which may require authorization from local air quality authorities. Burning is best performed when non-target grasses have dried but before yellow starthistle produces seed which is likely to occur during late May or June in New Mexico and Arizona. This treatment combination can benefit the range plant community by increasing species diversity and enhancing the quality and quantity of forage. Consider introducing biocontrol agents after the last burn.
- **Herbicide–reseed–graze** – While experience in New Mexico and Arizona is limited, a herbicide–reseed–graze treatment sequence has been used in California with some success. In this approach, a broadcast application of glyphosate is made to the infested site in late winter. The area is then reseeded one week later with a variety of appropriate perennial grasses by using a no-till drill. Two weeks after seeding, a broadcast application of clopyralid is made to control pre-emergent and post-emergent yellow starthistle plants. Light fall grazing is recommended for several years after planting until perennial plants are well established. Treated areas should be closely monitored to determine if further herbicide application is necessary.

Management Strategies

Strategies to contain, reduce, or eradicate yellow starthistle require long-term planning, integrated management, and follow-up monitoring. Due to yellow starthistle's prolific seed production, initial treatment should attempt to eliminate live plants and disrupt flower production as much as possible. A high priority should be treatment of small or sporadic infestations on otherwise healthy sites, which can then be shifted to larger infestations.

Regardless of the strategy employed, the key to successful yellow starthistle control is persistent, long-term management. In many cases, 3 or more years of intensive management may be necessary to reduce a starthistle infestation significantly. 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 especially important that resources are also available to respray or retreat treated areas as necessary. Treated areas should be monitored, and secondary treatment made to control newly emerged or missed plants. Always encourage growth of perennial grasses and other desirable plant species that will compete with yellow starthistle for soil moisture, light, nutrients, and space.

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Suggested Web Sites

Invasive Plant Atlas of the United States. Available at: http://www.invasive.org/weedus/index.html.

For information about calibrating spray equipment: NMSU Cooperative Extension Service Guide A-613, *Sprayer Calibration*. Available at http://aces.nmsu.edu/pubs/_a/A-613.pdf

Herbicide labels online:

http://www.cdms.net/

USDA Plants Database. 2010. Available at: http://plants.usda.gov/index.html.

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