Council of Bay Area Resource Conservation Districts

Equine Facilities Assistance Program

"Working with horse owners to protect San Francisco Bay Area water resources."

Controlling Yellow Starthistle

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Participating Resource Conservation Districts

Alameda County RCD
Contra Costa RCD
Marin County RCD
San Mateo County RCD
Southern Sonoma County RCD

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Yellow starthistle, *Centaurea solstitialis*, is a summer-blooming weed that was accidentally introduced into California in the mid-1800s. Since its arrival from the Old World, this thistle plant has spread steadily and now inhabitants millions of acres. It has particularly spread at an explosive rate since the 1960s. Activities such as road building, suburban development, recreation, and ranching are capable of transporting yellow star thistle seed long distances and establishing new populations. Widely scattered satellite populations can produce enormous amounts of seed, which either fall to the ground or can be dispersed to produce yet another population. Successful control of yellow starthistle will not only require understanding of the plant's biology in order to apply appropriate control measures at the proper time, but also a long-term commitment to continued control efforts.

Life Cycle

A stand of starthistle may produce 50-200 million seeds per acre. The seeds germinate with fall rains, and it only requires about 2 million seeds per acre to repopulate a stand. During its young, rosette stage, the plant can be identified by the large, triangular lobe at the tip of each leaf. In May and June the plant 'bolts', sending up elongated stalks that produce spiny flower heads. The loss of bright yellow pigment of the younger flowers indicates that the seed has matured. When the flowers fade, large quantities of seed mature and quickly disperse. Once the seeds are scattered, they become part of the soil's "seed bank."

Yellow starthistle forms two separate sets of seeds, one which disperses as soon as the bright yellow flowers begin to fade, and another set which stays in the seed head until harsh weather or other disturbances break it up. There is a difference of opinion on the viability of starthistle seed. Idaho researchers found that it persisted for 10 years, while other researchers found that 99.5% germinated in three years. Exposure to sunlight increases germination. For this reason, disking an area can produce more starthistle seedlings, where as thatch and heavy litter decreases the number of plants observed.

This fact sheet is part of a series prepared and published by the Council of Bay Area Resource Conservation Districts in cooperation with the USDA Natural Resources Conservation Service and the University of California Cooperative Extension. The Equine Facilities Assistance Program's goal is to protect San Francisco Bay Area water resources by assisting in effective management of possible non-point source pollutants associated with horses. Resource Conservation Districts (RCD) are non-regulatory, special districts governed by a volunteer board of directors. In addition to educational programs, RCDs provide landowners and the general public with technical assistance in natural resource management.

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Define your Goal: Eradicate, Contain or Control?

Eradication of yellow starthistle requires that seed production is stopped and the soil seed bank is completely depleted. Although with diligence, yellow starthistle can be eliminated in a small area, it is not practical to plan to eliminate a wide-spread infestation of yellow starthistle.

Controlling yellow starthistle including decreasing plant densities, seed production, plant height and canopy is realistitic, but demands a systematic and persistent effort. In most cases it must become an ongoing land management activity. Long-term control of yellow starthistle requires minimizing seed production, eliminating new plants, and maintaining viable competitive plants. For maximum control, combining the following management measures may be necessary.

Review of Control Methods

Cultivation

When yellow starthistle seedlings emerge after fall rains, cultivation is an excellent means of removing young plants, provided that the appropriate implements and follow-up procedures are used. Any tillage will also bring buried seeds to the surface. These seeds will germinate under favorable conditions in any season. If follow-up measures are not taken to also remove these seedlings, the infestation can get worse. When cultivation is used to control yellow starthistle, multiple tillage is the most successful.

Mowing

Timing is the key to getting successful control with mowing. Ideally, all mowing should be done in the early flowering stage (when about 5% of the spiny buds have bright yellow flowers), prior to seed formation. Mowing too late, after may of the flowers have faded and seeds have been produced, removes the spines, but does not diminish the seed bank and may actually aid in seed dispersal. Mowing too early, before flowering, stimulates starthistle growth. Cutting the starthistle plant below any branches on the plant will increase control. Tall grass or litter will force the branching to occur above the normal cutting height, increasing the successful control by mowing.

Mowing is most effective when soil moisture is low and no irrigation or rainfall follows. Under low moisture conditions, a single mowing may be sufficient, but plants should be monitored for regrowth and mowed again if significant growth and flowering occurs.

Competition

Perennial grass plantings like Harding grass have been observed to decrease starthistle populations. Most dryland perennial grasses will require at least two years to form dense enough stands to provide meaningful competition. Once established, some perennial grasses have late spring and summer growth similar to starthistle and will compete for available moisture and nutrients. Vigorous stands of annual legumes such as ’Lana’ vetch, subterranean clover and rose clover may also suppress yellow starthistle.

Fire

Sugarloaf State Park in Sonoma County has been experimenting with fire to control starthistle. A single year (July 7) burn treatment was unsuccessful at decreasing starthistle. The fire was fueled by the dry annual grasses and girdled the green starthistle plant. After the second year of burning there was an 85% reduction in starthistle plants coupled with an increase in native plants. After the third year of burning there was 96% less starthistle. Following three years of burning, one year without fire allowed the starthistle to rebound. Fire can be an effective tool to control yellow starthistle, but like other control programs will require a persistent, on-going approach.

Grazing

Grazing yellow starthistle is not a viable management option in horse pastures. Prolonged ingestion by horses (86-200% of the horse's body weight) can lead to a fatal nervous disease called *equine nigropallidal encephalomalacia* or "chewing disease". Horses are the only animals known to be affected. The majority of reported cases have been with horses under two years of age.

However, grazing with other livestock can be an effective way to manage starthistle. When green, starthistle can contains 11-28% crude protein depending on its stage of maturity. Goats are the best control grazers followed by sheep and then cattle. It is essential to graze during the plant's bolting, pre-spiny stage. Follow-up grazing to remove the regrowth is necessary.

Grazing while starthistle is in the rosette stage (approximately March through April) does NOT suppress starthistle, but grazing during the bolting stages (approximately May through June) reduces plant densities, height, and seed production.

Herbicides

Postemergence herbicides. Yellow starthistle is difficult to control with postemergence herbicides. This is primarily due to the ability of starthistle seeds to germinate continuously throughout the winter and spring and into the summer when moisture is available. As a result, a single application of 2,4-D, dicamba (Banvel), or triclopyr (Garlon 3A or 4) is typically insufficient to control season long seedling production. One late application, at the end of the rainy season, is not sufficient as many plants are too large and escape injury. The most effective strategy for yellow starthistle control with these compounds is to use repeated applications throughout the season. However, this is expensive, increases herbicide load in these sites, and may prove to be ineffective should late season rains occur. The rates of these herbicides which provides effective control are listed in the table below. Clopyralid (Transline) is also a very effective post emergence herbicide. However, it also has excellent pre-emergence activity. Thus, it is discussed separately below under the section *Preemergence and Postemergence Activity.* All pesticide use must be consistent with label and state and local regulations.

Herbicide	Trade name	Product per acre	Rate per acre (lb per acre)
2,4-D	Weedar 64 and many others	2 to 4 pts	1 to 2
dicamba	Banvel	1 to 2 pts	0.5 to 1
triclopyr	Garlon 3A or 4	1.5 to 3 pts	0.75 to 1.5
glyphosate	Roundup	2/3 to 2-2/3 qt	0.5 to 2

All these growth regulator herbicides are selective on only broadleaf species and can be used in late winter or early spring to control seedlings without harming grasses. Once plants have reached the bolting stage, most effective control can be achieved with glyphosate. The best time to treat with glyphosate is after annual grasses or forbs have senesced but prior to yellow starthistle seed production. Glyphosate is also an important tool in a follow-up control strategy to prevent yellow starthistle escapes from producing seed. Glyphosate provides excellent control of yellow starthistle at all stages of development, even when plants are in the early flowering stage. The use of glyphosate is not recommended when desirable perennial grasses or broadleaf species are present.

Seedlings: Excellent control of seedlings can be achieved at 2/3 qt Roundup Pro per acre or spot application with 1% solution. No additional additives are necessary.

Mature plants: Plants in late rosette or bolting stage can be controlled with 1-1/3 to 2-2/3 qts per acre or complete coverage with 1% solution. No additional additives are necessary. Unlike seedlings, 2/3 qt Roundup Pro per acre will not effectively control large rosettes. Under optimum growing conditions, control of yellow starthistle in the spiny of early flowering (<5% of flower in bloom) stages can also be achieved at 2 qts per acre. All treatments should be made before plants exceed the 5% flowering stage. Beyond this stage, numerous viable seed will already have produced. Control is less effective when older plants show physical signs of drought stress.

Treatment Considerations: Roundup Pro is an ideal treatment for late season yellow starthistle control in annual grasslands. Its use is not advised when perennial grasses or desirable perennial broadleaf species are present, except when used as a spot application. When Transline has been previously applied, Roundup Pro can be used in a broadcast or spot treatment follow-up program to control escapes before they produce seed, or to prevent the proliferation of potential Transline resistant plants. Early season application of Roundup Pro to seedlings will not provide control of later germinating seeds. Under these conditions, repeated treatments are necessary.

Preemergence herbicides. A number of selective or non-selective preemergence herbicides will control yellow starthistle, including clopyralid (Transline), simazine (Princep), diuron (Karmex), atrazine (Aatrex), sulfometuron (Oust), chlorsulfuron (Telar), bromacil (Hyvar), tebuthiuron (Spike), and oxyfluorfen (Goal). All these compounds are registered for use on either right-of-ways or industrial sites, but only Transline can be used on rangelands and pastures.

Preemergence and Postemergence herbicides. Transline is a growth regulator herbicide registered for use in non-crop areas, including pastures and rangeland. It has been demonstrated to be very effective for the control of yellow starthistle, as well as other invasive composites (Sunflower family), and does not injure grasses. The increased efficacy of Transline on yellow starthistle can be partially attributed to its postemergence and preemergence activity. A few composites, such as spikeweed (Hemizonia pungens) are not injured by Transline. Transline at low rates will not injure most legumes, particularly annuals such as burclovers and vetches. Lupines and rose clover are relatively tolerant to Transline. Injury can be avoided on perennial legumes when Transline is applied during their dormant phase. Other plant groups which may be susceptible to Transline include some members of the nightshade family (Solanaceae), the knotweed or smartweed family (Polygonaceae), and teasel (Dipsacus spp.). In contrast, many other broadleaf species, including cruifers and filarees, appear to be relatively tolerant to the herbicide. Transline can be applied both aerially (helicopter or plane) or by ground equipment. Under optimal conditions, 1/4 pt/acre (1.5 oz ae/A) of Transline can provide excellent control of yellow starthistle from December through April. However, under drought conditions, higher rates are necessary. Thus, for consistent control of yellow starthistle, rates between 1/4 and 1/2 pt/acre are preferable. Aerial applications should be made with the higher rates. Even when previous years skeletons are present, similar rates will effectively control seedlings. When the desired objective is to enhance rangeland forage quantity while reducing yellow starthistle, earlier applications dates (January to February) are ideal. Although Transline will provide effect control of starthistle to the bolting stage (April or later), the competitive effects of starthistle this late in the season will result in low quantities of grass forage

Diseases

Aschocyta fungus This fungus was isolated in 1993 by Dale Woods, of CDFA, from roots of diseased starthistle seedlings that were found in field plot in Solano County. Experiments are in progress to determine environmental factors affecting infection, growth, and host specificity. Temperature appears to be critical for the host plant to avoid or recover from infection. Under certain temperature regimes (41 F at night and 59 F in the daytime) this fungus killed nearly 75% of seedlings by 21 days after inoculation. Since this is a native pathogen the permitting process for release should be quicker, as long as it does not impact other plants in the asterasae family.

Biocontrol — Insects

Presently, five seed head feeding insects have been released in California. Given that starthistle populations have been growing in California for more than 100 years, it may not be realistic to expect biocontrol agents that have only been released during the past five years to provide satisfactory control. Dr. Joe Balciunas with USDA Agriculture Research Service surveyed for starthistle control agents Turkey, its native home. He found that the starthistle there is limited in size and number and is hard to locate. He found another insect, apions which he has petitioned to bring to the US for screening. Apions feed on other parts of the plant than the seed head. The larvae burrow in the root crowns and later in the stems. This insect could provide a cumulative impact on starthistle, since it could damage the plant and limit the number of seed heads formed. The five seed head feeding insects could then more effectively control the less seed heads that are left by the apions. Biocontrol of starthistle sould be considered a long term solution. This method may provide the only answer to starthistle control on rangelands where the costs of herbicides may be too expensive.

Current Seed Head Feeder Insects

Bud Weevil (*Bangnesternus orientalis)* Introduced in 1988, it has the widest distribution of any Starthistle pest. It has been released in 49 counties and has populated all of the sites. Siskiyou and Placer are the counties with the best collection sites. It lays its eggs on the starthistle bracts and the larvae eat the receptacle. They produce only one germination per season, which limits its ability to catch all the different flowering periods. They also do not destroy all the seed heads on a plant. A private company has been collecting them in Placer County and plans to market them. It is not recommended to purchase these pests, since they have a wide distribution and with time they will increase in number.

Gall Fly (*Urophora sirunaseva)* The gall fly was first released in Placer County in 1984. It is now in 40 counties. It is a good flyer and can move up to 16 miles per year. It has increased in population in Siskiyou and Placer counties. It lays its eggs on the seed head, which creates a gall that causes energy drain on the receptacles and fewer viable starthistle seeds are then produces. Field surveys have indicated that it is having a limited impact on starthistle.

Hairy Weevil (*Eustenopus villosus)* The adults feed on the buds and receptacles. It has one generation per year. It does well in hot, dry areas and doesn't do well in foggy areas. There is not much data on its impact on starthistle.

Seed Head Weevil (*Larinus curtus)* In 1992, 1270 Seed Head Weevils were released in Amador, Placer, Sonoma, Sutter, and Yolo Counties. The larvae feeds on the seed head. It is feared that this group may carry a Nosema infection when brought in from Greece. Due to the potential contamination with this insect disease, no new releases or evaluations have occurred.

Peacock Fly (*Cheatorellia australis)* It deposits its eggs on the seed head and when the larvae hatch it bores inside. They produce three generations per year. This is an added advantage to this pest. One problem is that it emerges early (April) before starthistle flowers. CDFA has had seven releases and seven recoveries. They have found them 100 miles away from the Trinity/Humboldt release site. It is no longer believed that the pest requires bachelor buttons as an intermediate host.

Some of these pest are produced commercially. Below are the names of retail outlets listed in Suppliers of Beneficial Organisms in North America by the Department of Pesticide Regulation (1994 edition).

Bangnesternus orientalis & Urophora sirunaseva

Bio Collect
5481 Crittenden Street
Oakland, CA 94601
Phone (510) 436-8052
Fax (510) 532-0288

Bangnesternus orientalis only

Biological Control of Weeds
1418 Maple Drive
Bozeman, MT 59772
Phone (406) 586-5111
Fax (406) 586-5111

Peaceful Valley Farm Supply
P.O. Box 2209
Grass Valley, CA 95945
Phone (916) 272-4769
Fax (916) 272-4794

Adapted by Sheila Barry, Alameda County Resource Conservation Distric,t from:

Star Thistle Control. University of California Cooperative Extension, Butte County by Glenn Nadar.
Range Science Report #33. University of California, Davis. Department of Agronomy and Range Science by Thomsen, Williams, Vayssieres, and Bell.