

# RANGE SCIENCE REPORT

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## Yellow Starthistle Control

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Yellow starthistle, *Centaurea solstitialis*, is a plant of Old World origin that probably arrived in California in the mid-1800s as a contaminant in alfalfa seed. Since its arrival it has steadily spread and now inhabits nearly 8 million acres statewide. Yellow starthistle is one of California's worst noxious weeds, infesting rangelands, pastures, hayfields, orchards, vineyards, roadsides, canal banks, and parklands. It has many traits that make it a successful weed including: 1) a large seed output, 2) seeds that germinate over a long period of time, 3) a deep taproot, 4) late spring and summer growth, 5) an ability to quickly regrow after mowing or grazing, 6) and spines that discourage grazing in the reproductive stage.



### Yellow Starthistle in Horse Pastures

Yellow starthistle represents a special problem in horse pastures. When eaten in sufficient quantities it can lead to a fatal nervous symptom called "chewing disease." The nature of the disease is such that the plant may be ingested over a period of years before any symptoms are apparent, and at that point it is irreversible. According to studies by Cordy (1978), the symptoms set in when the horse has eaten from 86% to 200% of its body weight. Fifty-nine percent of the fatalities have been reported during October and November and twenty-two percent in June and July. These two peak periods correspond to the beginning and end of the growth season for most annual plants. Yellow starthistle's strong presence when other pasture and range vegetation is scant probably results in heavier consumption by horses during these periods. While many owners keep their horses in starthistle-infested fields without incident, there is a risk involved, and it is best to eliminate or reduce starthistle to avoid any problems.

### Life Cycle and Plant Description

Yellow starthistle has a very long life cycle for an annual plant. Germination is initiated by autumn rains, but plants mature long after most other annuals have completed their life cycle, sometimes not completing their life-cycle until late summer or fall. In addition, successive germination occurs long into the growing season.

The seedling stage is the most difficult time to identify the plants. A good way to recognize them is to first locate seedlings under older starthistle skeletons that remain in the field from the previous years growth. The winter and spring rosettes produce many deeply-

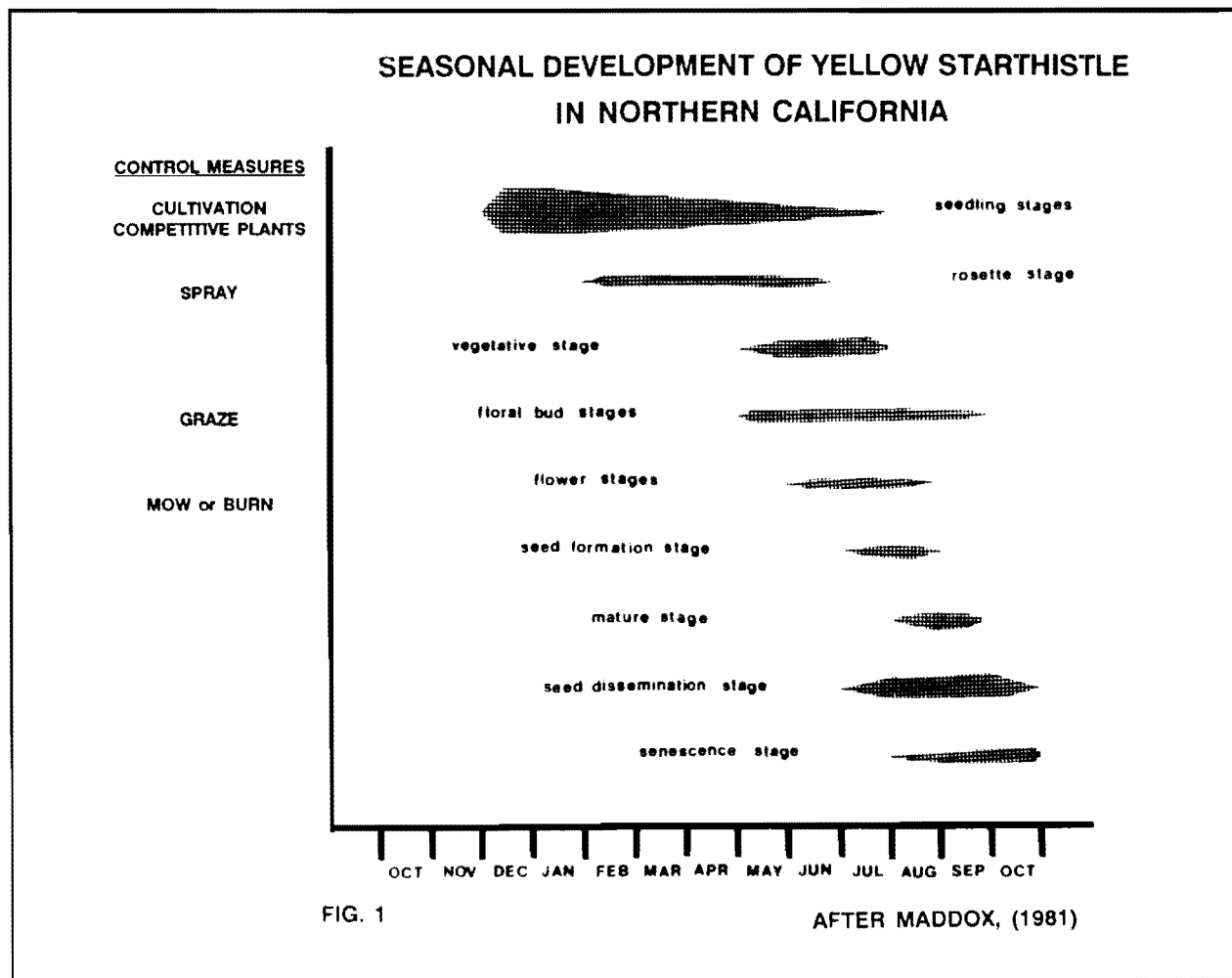
lobed leaves. Although there is variability in the size and lobing pattern of the rosette leaves, a good diagnostic character is the large terminal, triangular lobe at the tip of each leaf. In general, the rosettes tend to grow close to the ground in open places but assume an upright habit when there is an abundance of neighboring vegetation.

During May and June the plant "bolts" and sends up stalks, which give rise to the flower heads. The mature plant reaches a height of one to three feet. The grey-green to bluish-green stems of the mature plant are widely branched, and the entire plant is covered with soft, appressed hairs. Rigid spines project from the bracts that surround the bright yellow flowers.

The seed development stage can be recognized by the absence of the bright yellow pigment that characterize the younger flowers. Two types of seed are produced. The light-colored disk (central portion of the flowerhead) seeds contain short bristly hairs and are dispersed quickly after maturity. The outer seeds lack hairs and persist for months, remaining in the flower heads until harsh weather or some other disturbance breaks them up. The number of seeds produced by individual plants vary widely according to conditions

and genetic factors. In studies of starthistle populations from Hopland, Woodland, and Concord, Maddox (1981) reported a range from about 700 to 10,000 seeds per plant. Thomsen and Williams (1990) have found that when densities are high and plants are crowded, small individuals may produce fewer than 100 seeds but larger plants produce seed numbers in the range that Maddox reported. Occasionally yellow starthistle assumes a biennial habit, and seed production is much greater. Plants were observed that had been sprayed with an herbicide while in the bolting stage. The plants died back but grew vigorously the following season and produced over 170,000 seeds per plant! Seedling densities in sites heavily infested with starthistle reflect the large number of seeds produced. Mean values for seedling data collected on research plots at the UC Agronomy Farm on land heavily infested with starthistle were 1,000 per square meter and 3,400 per square meter at a Colusa County ranch.

Nine other growth stages have been identified from emergence to senescence (Figure 1, modified from Maddox, 1981). Close attention to these various stages is important when planning and implementing a control program.



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## Control Considerations

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There is no simple recipe for controlling yellow starthistle, and any method requires a systematic and persistent effort that may take several years or more. The approach that is taken will depend upon such factors as the size of infestation, plant density, location, equipment available, and planned use for the site. Control methods are most effective when used in combination. Regardless of the control method used, monitoring and follow-up methods will be necessary. Timing your control efforts to various stages of plant growth is essential. Figure 1 lists some control measures placed according to stage of starthistle growth. Some of these can be used over a wider period, but all of them should occur before seed production. Be aware of what plants will replace starthistle if the control program is successful as well as other changes that will occur in the ecosystem from control activities. It may be necessary to seed in desirable species to help prevent reinvasion by starthistle or other unwanted resident plants.

When planning any control program determine whether you're aiming to **eradicate**, **manage**, or **contain** yellow starthistle. Eradicating means to eliminate from the site and requires that seed production is halted and the seed reservoir in the soil from previous years is depleted or managed in a way so new seedlings don't emerge. When infestations are large, eradication will not be possible, but managing dense stands to tolerable levels may be. Often, the main concern with yellow starthistle is the spiny canopies that persist through summer and fall, and reducing them on an annual basis may suffice.

Containment is done by delineating boundaries around large infestations and concentrating control efforts on the smaller occurrences that exist outside of the contained areas. By controlling isolated plants or small patches that are the "pioneers," the larger infestation is contained and further weed spread is prevented. As information and experience is gained from controlling small occurrences, better decisions can be made about whether larger areas can also be successfully controlled.

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## Control Methods

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There are five categories of control including **mechanical** (tillage, mowing, or grubbing), **fire**, **chemical** (herbicides), **biological** (insects, plant competition, and livestock grazing), and **preventative**. The various methods discussed below are based on established principles of weed control, anecdotal information, and research. Research is incomplete, but studies are underway to fill some of the information gaps.

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## Mechanical

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Cultivation with appropriate implements as the seedlings emerge in the fall is an excellent means of removing young plants, but expect more plants to germinate with subsequent rains. On sites where irrigation is available, infested areas can be pre-irrigated prior to autumn rains and then disked to remove germinating seedlings. If this sequence is repeated much progress can be made in reducing the seed bank. Cultivation in the spring will remove most starthistle for that season but the degree of control will vary according to local conditions.

Hand-weeding or "grubbing" with a hoe or a weed-eater to control yellow starthistle in small areas should not be overlooked as an important part of any integrated weed control program. The easiest time for this is during the seedling or early rosette stages before the taproot has become well-developed. As the plant develops, its potential to regrow from the taproot is increased, and the upper portion of the taproot will need to be dislodged. Periodically monitor the site for more germination or regrowth.

Mowing is a useful method in managing yellow starthistle provided it is well-timed and repeated as necessary. Although no replicated studies have been done, preliminary studies indicate that when starthistle is mowed during the early flowering stage regrowth is minimized. Mowing at this stage removes the aerial portion of the plants after much of their root reserves has gone into producing flowers; therefore, less reserve is available for regrowth. Under some conditions, this single-event mowing may be sufficient, but plants should be monitored for regrowth and mowed again if significant growth and flowering occurs. When mowed at earlier stages, regrowth should be expected and several additional mowings will be necessary.

All mowing should be done prior to seed production. As mentioned previously, flower pigmentation is a good way to monitor whether seed development has commenced, but if in doubt open a flower. If the flowers are bright yellow and have not faded, seed production has yet to occur. Mowing after seeds have been produced removes the hedge-like canopies but does not diminish the seed bank and may aid in seed dispersal. In general, mowing will be most effective when soil moisture is low and no watering or rainfall follows the mowing.

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## Prescribed Burns

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In some situations prescribed burns may be an appropriate management tool. The best time to burn is probably the same stage recommended for mowing.

Since starthistle is still green during this period, there must be enough dry biomass from other annual plants to carry a fire. Burning permits are available through the California Department of Forestry (CDF)

## Chemical

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There are many types of herbicides available, most requiring a permit from your County Agricultural Commissioner. If you are unfamiliar with herbicide use, we recommend Cooperative Extension publication, **Selective Chemical Weed Control** for specific information, or contacting your local Pest Control Advisor. Read and follow precautions on the label of any herbicide carefully before use. Herbicides should be used with an understanding that they are usually not a "one-shot" affair, particularly on large areas with dense stands of starthistle. Most studies have shown that repeated applications are necessary. Pay close attention to successive germination because starthistle will likely reappear.

Selective herbicides such as 2,4-D will help control yellow starthistle but leave grasses unaffected. However, they will also provide partial control of legumes, and other broad-leaved plants that may be useful to the ecosystem or production goals. If grazing is planned after spraying, a 30-day period following the application is necessary before resuming animal use.

Non-selective herbicides, like Roundup, are effective for spot treatments. However, since this kills nearly all other vegetation, treatment with Roundup is not usually suited for use over large areas.

Post-emergent herbicides are best applied in late winter through spring, when temperatures are warm, soil moisture is high, and plants are actively growing in the late seedling or rosette stage. Young seedlings are killed by herbicides but new plants will germinate with subsequent rains, so it is best to wait until early spring to reduce the likelihood of more germination. In studies conducted on a northern California ranch by Thomsen, et al. (1989), a 30 by 840 foot strip sprayed with 2,4-D was superimposed over replicated grazing treatments. Plants were sprayed in February when starthistle was in the early rosette stage. Reductions in plant densities were measured, but nearly six inches of rainfall during April-June boosted the surviving starthistle and many portions of the sprayed strip were so dense with starthistle that walking through was difficult. At another site where a similar strip (30 X 585 feet) was sprayed for two consecutive years and then left unsprayed the third year, starthistle was greatly reduced during the years of spraying but flourished the third year and produced flowerhead densities of nearly 450 per square meter. At approximately 35 seeds/head an

estimated 15,750 seeds were disseminated per square meter.

## Combining Chemical, Cultivation, and Plant Competition

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Yellow starthistle is not usually found on heavily cropped land where there is frequent cultivation and herbicides are used that prevent plants from ever reaching maturity. Consequently, seed production does not occur and seeds germinating from the seed bank are routinely eliminated.

Dr. Tom Lanini, UC Extension Weed Ecologist, is currently evaluating Telar, a pre-emergent selective herbicide that persists up to two years. The aim of the research is to use Telar in combination with native perennial grasses to suppress yellow starthistle and other weeds that occur in drainage ditches, along roadsides, and borders of agricultural lands in Yolo County. Dr. John Anderson, Veterinarian, UC Primate Center, and one of the collaborators on this project views this as a means to not only control weeds, but also to create wildlife habitat for quail and pheasant, improve the esthetics of the rural landscape, integrate biological diversity onto agricultural lands, and reduce the \$40,000 a year (\$100.00 per mile) spent on roadside weed control in Yolo County (Bugg, et al. 1991).

### Small Pasture Conversion

When dryland pasture is converted to a well-managed irrigated pasture, yellow starthistle becomes much less prominent and is sometimes eliminated entirely (Bryant, per. comm.). When infestations are severe, it is recommended to plant oats the first year and wait until good starthistle control is obtained before putting in a permanent pasture mix. Before planting, pre-irrigate and cultivate out starthistle seedlings to remove plants and draw down the seed bank. Repeat this step if possible. A good stand of oats provides a measure of competition against yellow starthistle, yet fields should be closely monitored and surviving plants should be controlled as necessary. If grazing is deferred, then the oats can be cut, baled, and utilized later for grazing. Within two weeks, the regrowth from surviving yellow starthistle plants will be visible and appropriate action to remove remaining plants can be taken.

The permanent pasture mix is best seeded after a substantial portion of the seedbank has been eliminated. This should result in better establishment because competition from starthistle will be less. When planting permanent pasture, seeding as much as twice the recommended seeding rate on smaller acreages can

help to further crowd out yellow starthistle. The "no-till" drill allows seeding without turning up the soil and helps keep deeply buried seeds from germinating. If herbicide use is planned to control yellow starthistle after the pasture mix is sown, then a seed mix without legumes is recommended. As indicated, selective herbicides used for yellow starthistle will also reduce medics and clovers.

Another approach that has been used with some success according to Bob Roan (per comm.) of SCS is fall seeding of infested pastures with Lana vetch. Roan reported that yellow starthistle was suppressed by the aggressive, sprawling growth of the vetch, and the starthistle that survived was thin and weak.

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### Biological/Grazing

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Insects to control yellow starthistle are currently being evaluated in the field to determine their effectiveness in controlling starthistle populations. Releases have been made and some appear promising, but no reductions in plant stature, density, or seed production have been measured. Individuals interested in biological control programs should consult their local agricultural commissioner's office or contact Dr. Charles Turner, Biological Control Laboratory, USDA-ARS, Albany, California (415) 559-5975.

Nutritional studies have shown that yellow starthistle is an acceptable component of a ruminant's diet. Well-timed controlled grazing with cattle (before plants produce spines) has been demonstrated to be an effective method for managing large stands of yellow starthistle in annual rangeland (Thomsen et al. 1989, 1990). For three consecutive years, intensive cattle grazing reduced plant densities and seed production in the dense starthistle stands under study. Spiny canopies persisted through summer and fall in the ungrazed paddocks but were greatly diminished in the grazed areas. Cattle will readily graze yellow starthistle at all stages before it produces spines but effective management requires that grazing occurs during the stem elongation and floral bud stages, and is repeated several times to remove the regrowth. Most defoliated plants recover quickly and animals should be put back about two weeks later to regraze the plants. The late-season grazing that targeted starthistle occurred after annual grasses, legumes, and most other resident annuals had completed their life cycle and produced seeds. Moreover, appreciable amounts of plant residue remained on the soil surface and favorable conditions for other plants were maintained.

In this research intensive grazing management (high stocking densities with short grazing periods fa-

cilitated by portable electric fencing) was used and highly uniform defoliation of starthistle was obtained. However, observations from other sites where continuous low-density grazing is practiced indicate that if cattle are present during the late stages of growth and grazing pressure is maintained, animals utilize the plant and also suppress it. On the other hand, if grazing occurs when starthistle is in the rosette stage but is not continued during bolting yellow starthistle tends to be favored. This was demonstrated by experiments conducted at the UC Agronomy Farm using sheep (Thomsen, Williams and George 1990). In addition to grazing yellow starthistle, neighboring plants are defoliated and the competition they provide is eliminated. Yellow starthistle's ability to regrow following defoliation surpasses most, if not all other annual plants on California ranges

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### Preventative

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Preventative weed control measures generally refer to doing what is necessary to prevent the introduction of new weed species to a specific area. As in containment programs, this includes detection and control of "pioneer" plants before they go to seed along roadsides, fields, pastures, etc. and develop into large infestations. Because spot occurrences and small colonies seem harmless, the tendency is to overlook them; however, this is the way most large infestations begin. Even though yellow starthistle is widespread, there are still many portions of the state where it has yet to invade but is well-adapted.

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### Conclusion

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Since 1958 it has been estimated that yellow starthistle infested land has increased from 1.2 to 7.9 million acres, an increase of 640% (Maddox 1985). Yellow starthistle will continue to increase statewide and will be particularly prominent in years with abundant late-season rainfall.

Ongoing research efforts on yellow starthistle control includes seed bank studies, mowing, and goat grazing at the UC Davis Agronomy Farm; seed bank studies at Sierra Field Station; cattle grazing at a Colusa County ranch; and the use of native grasses in combination with herbicides along roadsides in Yolo County.

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## References and Literature

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- Ashton, F. M. 1987. Selective Chemical Weed Control. Coop. Ext. Leaflet #1919
- Bryant, D. 1990. Per. comm. Dept. of Agron. & Rg. Sci., UC Davis
- Bugg, R.L., J.H. Anderson, J.W. Menke, J.W. Compton, and W.T. Lanini. 1991. Perennial grasses as roadside cover crops to reduce agricultural weeds in Yolo County. In (Kephart, ed.): Grasslands, the Newsletter of the California Native Grass Association Vol. 1(1).
- California Weed Conference Committee. 1985. Principles of Weed Control in California. Thompson publications. 474 pp.
- Cordy, D. R. 1978. *Centaurea* species and equine nigropallidal encephalomalacia. In: (eds.) Keeler, R.F., Van Kampen, K.R., and L.F. James, Effects of Poisonous Plants on Livestock. Academic Press, pp. 327-336.
- Fischer, B.B., and W.B. McHenry. 1971. Yellow starthistle control. Coop. Ext.: one-sheet answers #47.
- Fowler, M., A.L. Craigmill, B.B. Norman, and P. Michelsen. 1982. Livestock Poisoning Plants of California. University of California Division of Agriculture and Natural Resources, Leaflet 21268.
- Maddox, D.M., A. Mayfield, and N.H. Poritz. 1985. Distribution of yellow starthistle (*Centaurea solstitialis*) and Russian Knapweed (*Centaurea repens*). Weed Science 1985. Vol 33: 315-327.
- Maddox, D.M. 1981. Introduction, phenology and density of yellow starthistle in coastal, intercoastal and central valley situations in California USDA-ARS, W-20. 33 p.
- McHenry, W.B., R.B. Bushnell, M.N. Oliver, and R.F. Norris. 1990. Three Poisonous Plants Common in Pastures and Hay Fiddleneck, Groundsel and Yellow Starthistle, University of California Division of Agriculture and Natural Resources, Pub. 21483.
- Roan, B. 1991. Pers. comm. SCS, Auburn, Calif.
- Thomsen, C.D., Williams, W.A., George, M.R., McHenry, W.B., F.L. Bell, and R.S. Knight. 1989. Managing yellow starthistle on rangeland. Calif. Agric. 43(5):4-6.
- Thomsen, C.D., and W.A. Williams. 1990. Data on file.
- Thomsen, C.D., W.A. Williams, and M.R. George. 1990. Managing yellow starthistle on annual range with cattle. Knapweed. Coop. Ext. Newsletter, Washington State University 4(2).
- Thomsen, C.D., W.A. Williams, and M.R. George. 1991. Preliminary results using sheep grazing to manage yellow starthistle. Knapweed. Coop. Ext. Newsletter, Washington State U. 4(3).

Figure 2

