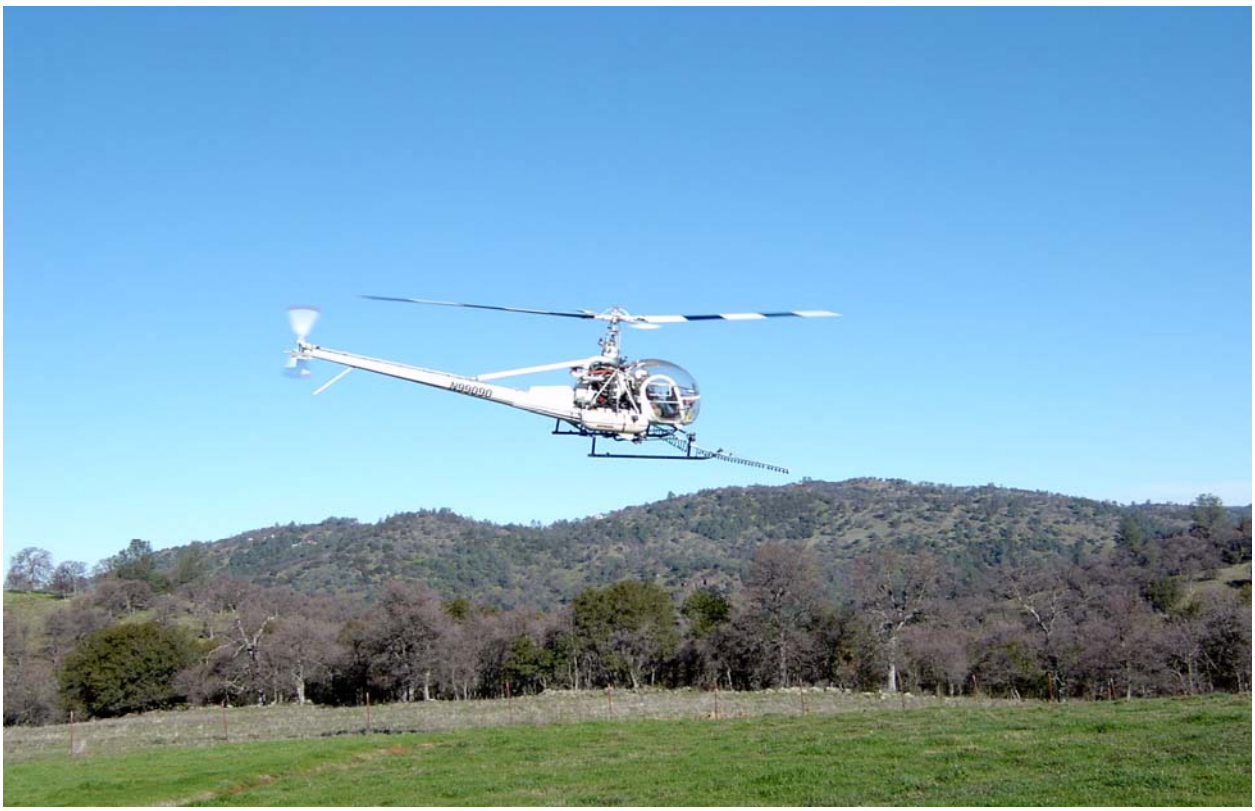
PRACTICAL METHODS FOR YELLOW STARTHISTLE MANAGEMENT



AUGUST 14, 2004

UNIVERSITY OF CALIFORNIA

AGRICULTURE & NATURAL RESOURCES

SIERRA FOOTHILL RESEARCH & EXTENSION CENTER

COOPERATIVE EXTENSION

PRACTICAL METHODS FOR STARTHISTLE MANAGEMENT

AUGUST 14, 2004

PARTIALLY SPONSORED BY YUBA/SUTTER WEED MANAGEMENT AREA

Example of starthistle composition
in untreated field-June 2002

Prescribed burn in Scott 12 field-July 2, 2000

YELLOW STARTHISTLE

Integrated Pest Management for Land Managers, Landscape Professionals, and Home Gardeners

Yellow starthistle, *Centaurea solstitialis*, is native to Eurasia and was introduced to California around 1850 via South America. It is now common in open areas on roadsides, rangeland, wildlands, hay fields, pastures, and waste areas. Recent reports indicate that yellow starthistle infests between 10 and 15 million acres in California. Disturbances created by cultivation, poorly timed mowing, road building and maintenance, or overgrazing favor this rapid colonizer. It forms dense infestations and rapidly depletes soil moisture, thus preventing the establishment of other species. It is also poisonous to horses, causing a nervous disorder called "chewing disease" (nigropallidal encephalomalacia), which is fatal once symptoms develop. Horses are the only animal known to be affected in this manner and should not be allowed to graze on yellow starthistle.

IDENTIFICATION

Yellow starthistle is a gray-green to blue-green plant with a deep, vigorous taproot. It produces bright, thistlelike yellow flowers with sharp spines surrounding the base. Yellow starthistle grows to heights varying from 6 inches to 5 feet. The stems of mature plants are rigid, spreading, and typically branching from the base in open areas. Stems and leaves are covered with a loose, cottony wool that gives them a whitish appearance. Stems appear winged due to leaf bases that extend beyond the nodes. Basal leaves are 2 to 3 inches long and deeply lobed. Upper leaves are short (0.5 to 1 inch long) and narrow with few lobes.

BIOLOGY

Yellow starthistle is a long-lived winter annual that is usually found below 7,000 feet elevation in dry, light-intensive areas where average annual rainfall is between 10 and 60 inches. Seed output can be as high at 30,000 seeds per square meter, with about 95% of the seed being viable soon after dispersal. Most seeds germinate within a year of dispersal, but some can remain viable in the soil for more than 3 years.

Yellow starthistle seeds germinate from fall through spring, which corresponds to the normal rainy season in California. After germinating, the plant initially allocates most of its resources to root growth. By late spring, roots can extend over 3 feet into the soil profile, although the portion above ground is a relatively small basal rosette. This allows yellow starthistle to out-compete shallow-rooted annual species during the drier summer months when moisture availability is limited near the soil surface. It also helps explain why yellow starthistle survives well into the summer, long after other annual species have dried up, and why it can regrow after top removal from mowing or grazing.

The competitive ability of yellow starthistle also depends on light intensity at the soil surface during the seedling and rosette stages of development. Yellow starthistle proliferates at high light intensity and does poorly in low light. High light conditions often occur along roadsides, in disturbed sites, grasslands, and on south-facing slopes at higher elevations.

MANAGEMENT

Control of yellow starthistle cannot be accomplished with a single treatment or in a single year. Effective management requires control of the current population and suppression of seed production, combined with establishment of competitive, desirable vegetation.

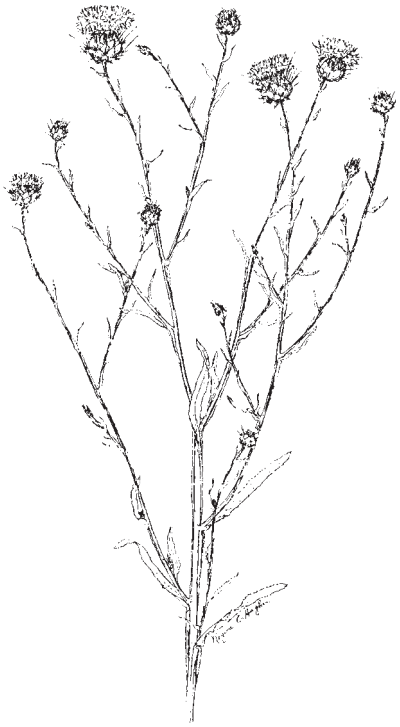


Figure 1. Yellow starthistle.

Prevention

Yellow starthistle proliferates along roadsides. Invasion by this weed may be increased with disturbances created by road building and maintenance. Seeds are often spread by vehicles or with the transportation of livestock or contaminated soil. Survey roadsides for the presence of this weed and immediately control new infestations to prevent seed production and its subsequent spread.

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Yellow starthistle also can be spread as a contaminant in grass seed. Only certified seed should be used for range or pasture seeding. Seed may also come as a contaminant in all classes of hay, particularly grass hay. Carefully check hay shipments for evidence of yellow starthistle. Hay used as mulch along roadsides or disturbed areas can be a source of yellow starthistle introduction. When feeding hay is suspected of containing yellow starthistle, place bales in one area and periodically check around feeding areas for signs of starthistle seedlings. Livestock that have fed in yellow starthistle-infested areas should not be pastured or shipped to uninfested areas. Control newly emerged seedlings to prevent establishment. It is important to control new infestations when they are small because spot eradication is least expensive and most effective at this time.

Biological Control

Four natural enemies of yellow starthistle have been imported from Europe and are well established in California as of 2003. These biological control agents include two weevils (*Bangasternus orientalis* and *Eustenopus villosus*) and two flies (*Urophora sirunaseva* and *Chaetorellia succinea*). They all attack the flower/seed head and directly or indirectly reduce seed production, the only means of reproduction and spread of the weed. The insects lay their eggs in, on, or near flower/seed heads and complete their development within them. *Eustenopus villosus* adults also directly reduce seed production by feeding on immature flower heads. All of these insects are highly host-specific to yellow starthistle and do not attack commercially valuable crops or native plants.

These insects already occur in most areas of California that are infested with yellow starthistle. If additional releases of these natural enemies are made, protect the release area from practices that may damage the insects. Such practices include insecticide applications, soil cultivation, summer-prescribed burning, or mowing when the plants are in the flowering stage. After establishment, the insects are capable of building up to high numbers and spreading on their own. These insects do best in areas with warm, dry summer climates.

The most recent releases, *Eustenopus villosus* and *Chaetorellia succinea,* have proven to be the most effective agents for yellow starthistle seed suppression. These insects are becoming more widespread throughout the state. However, they only suppress yellow starthistle seed production by about 50%, so they should not be considered as the sole method of control. It is possible that a combination of herbicides and biocontrol will provide more sustainable control than either technique used alone. Landowners and managers with yellow starthistle problems may contact their county agricultural commissioner's office about obtaining these biological control insects.

Most recently a rust, *Puccinea jaceae* var. *solstitialis*, was approved for release in California. Trials are under way to determine the potential effectiveness of this organism on yellow starthistle.

Cultural Control

Yellow starthistle begins emergence with fall rains and continues to germinate throughout the rainy season. A single cultivation after the rainy season when soils are dry effectively controls yellow starthistle seedlings and rosettes. This treatment must be made after the last rains but before seeds are produced. If cultivation is carried out too early (e.g., before the last rains) seed will continue to germinate and another cultivation will be needed to control each new flush of seedlings that results from a spring rain.

Mowing can be used to manage yellow starthistle, provided it is well timed and used on plants with a high branching pattern. Mowing early growth stages results in increased light penetration and rapid regrowth of the weed. If plants branch from near the base, regrowth will occur from recovering branches. Repeated mowing of plants too early in their life cycle (rosette or bolting stages) or when branches are below the mowing height will not prevent seed production, as flowers will develop below the mower cutting height. Plants with a high branching pattern are easier to control, as recovery will be greatly reduced. Even plants with this growth pattern must be mowed in the late spiny or early flowering stage to be successful. An additional mowing may be necessary in some cases.

To encourage growth of desirable vegetation, let these species set seed before mowing, but be sure to mow well before starthistle is in full flower. In general, mowing is most effective when soil moisture is low and no irrigation or rainfall follows mowing.

Grazing is effective in reducing yellow starthistle seed production. Sheep, goats, or cattle eat yellow starthistle before spines form on the plant. Goats will eat starthistle even in the spiny stage. The plant's crude protein concentration is variable, but ranges from 28% at the rosette stage down to 11% at the bud stage, and should be sufficient to meet the general maintenance requirements for most ruminants. When it is abundant, yellow starthistle appears to have the ability to sustain animals several weeks beyond annual grass "dry down." Intensive grazing in late May and June using large numbers of animals for short duration can reduce plant height, canopy size, and seed production. Avoid overgrazing, however; do not allow more than half the grass forage to be removed. Grazing more than this will reduce the grasses' recovery rate and ability to shade out yellow starthistle.

Burning is best performed at the end of the rainy season when flowers first appear. Yellow starthistle should be green at this time and will require desiccated vegetation to burn. Most annual vegetation other than yellow starthistle, particularly grasses, should have dried and shed their seeds by this time. The foliage of these plants serves as a fuel source to allow a more complete burn. Burning for 2 or more consecutive years helps suppress yellow starthistle and deplete the soil seedbank. Burning can also increase the recovery and density of perennial grasses. Burning can damage biological control agents, but insects from adjacent areas will readily move back into the site the following year.

Revegetation

Control practices are capable of reducing yellow starthistle populations, but in the absence of competition, starthistle will often reestablish. Effective management requires that desirable plant species be encouraged or planted and managed to prevent yellow starthistle germination or growth. Species choice for revegetation will depend on the intended use of that site. Resident vegetation such as perennial bunchgrasses or wildflowers may be desirable along roadsides, abandoned pastures, or in rangelands and wildlands. In these situations, cultural, biological, or chemical methods can be used to reduce yellow starthistle while encouraging other plant species, if possible, with practices such as fertilization. Research efforts to reestablish native perennial grasses are in progress. Perennial grasses are slow to establish and may require herbicide treatments to assist yellow starthistle or annual grass control during establishment, but once well established, alternative controls such as properly timed grazing, mowing, or burning can be used effectively.

In pastures, eliminate dense stands of yellow starthistle and reseed the area with a fast-growing, competitive forage species. Although annual legumes work well for this purpose, the lack of selective herbicides makes follow-up treatments difficult. Therefore, grasses are best because selective herbicides can then be used to control yellow starthistle plants not eliminated by grass competition. In areas with scattered yellow starthistle infestations, eliminate scattered plants and overseed with a desirable species to provide enough competition to prevent yellow starthistle from reestablishing.

In all instances, choose desirable species that are well adapted to the site and not likely to become invasive themselves. Species that grow well are the best competitors.

Chemical Control

Both postemergent and preemergent herbicides are available to control yellow starthistle along roadsides, rights-of-way, and noncrop areas. Most herbicides registered for use in rangeland and pastures are only active postemergence. Clopyralid, however, has both preemergence and postemergence activity on yellow starthistle.

Postemergent Herbicides. Postemergent herbicide treatments generally work best on seedlings. The long germination period of yellow starthistle makes control with a single application almost impossible. A treatment following the first flush of seedlings opens a site up for later flushes. Waiting until later in the rainy season to apply a postemergent herbicide allows a greater number of seedlings to be treated, but larger plants will require higher herbicide rates and may not be controlled.

• *Clopyralid* is a growth regulator herbicide for use in noncrop areas, including rangeland and pastures. Unlike the other growth regulator herbicides, it is very effective on yellow starthistle both postemergence and preemergence. The most effective timing for application is from January to March, when yellow starthistle is in the early to mid-rosette stage. Applications earlier may not provide full-season control and later applications will require higher rates. A single application at the recommended time will provide season-long control. Clopyralid is effective at rates as low as 1.5 oz acid equivalent/acre. It is selective on many members of the sunflower family, particularly thistles, but can also injure legumes, including clovers. Most other broadleaf species and all grasses are not injured by clopyralid. There are no grazing restrictions after clopyralid use in rangelands. Clopyralid is also effective on plants in the bolting and early spiny stage, but higher rates (4 oz a.e./acre) are required. While not registered for use around the home, clopyralid does have registration for use in pastures, rangelands, rights-of-way, roadsides, and other noncrop areas. Clippings of clopyralid-treated areas should not be used as compost. The herbicide degrades slowly in compost and can be a problem when used as a mulch or fertilizer source in sensitive crops or landscapes.

• *2,4-D* can provide acceptable control of yellow starthistle if it is applied at the proper rate and time. Treatment in the rosette growth stage provides better control than later applications. Amine formulations are as effective as ester formulations at the small rosette growth stage, and amine formulations reduce the chance of off-target movement.

Application rates of 0.5 to 0.75 lb active ingredient/acre will control small rosettes. Applications made later in the season, when rosettes are larger or after bolting has been initiated, require a higher application rate (1 to 2 lb a.i./acre) to achieve equivalent control. 2,4-D is a growth regulator and a selective herbicide that controls many other broadleaf plants, but has minimal effect on clovers and generally does not harm grasses. It has little, if any, soil activity. Drift from 2,4-D applications is common, particularly from ester formulations. Use caution when applying near sensitive vegetation or during windy or high temperature conditions. Certain formulations of 2,4-D require a restricted materials permit; generally formulations that are sold in small quantities (i.e., liquid formulations that do not exceed 1 quart and dry formulations that do not exceed 1 pound) do not require a permit.

• *Dicamba* is very effective at controlling yellow starthistle at rates as low as 0.25 lb a.i./acre. When yellow starthistle rosettes are small, about 1 to 1.5 inches across, the 0.25 lb a.i./acre rate works well, but higher rates (0.5 to 0.75 lb a.i./acre) are needed if plants are larger. Applications made in late rosette to early bolting stages have provided excellent control, although earlier treatments are better.

Dicamba is also a growth regulator and selective herbicide that controls many broadleaf plants, including clovers, but does not harm grasses. Its soil activity is very short. Like 2,4-D, it is available as both an amine and as an ester formulation. Drift from dicamba applications is common, especially from the ester formulation. Some formulations have lower drift potential than others. Use caution when applying near sensitive vegetation. Certain formulations of dicamba require a restricted materials

permit; generally formulations that are sold in small quantities (i.e., liquid formulations that do not exceed 1 quart and dry formulations that do not exceed 1 pound) do not require a permit.

• *Triclopyr* at 0.5 lb a.i./acre provides complete control of yellow starthistle seedlings but is not as effective on larger plants. More mature plants require rates up to 1.5 lb a.i./acre. Like 2,4-D and dicamba, triclopyr is a growth regulator herbicide with little or no residual activity. It is foliar-absorbed and active on broadleaf species, including clovers, but typically does not harm grasses. Triclopyr is formulated as both an amine and ester. The ester formulation is more sensitive to drift than the amine form. Caution should be observed when using the ester formulation. This material is registered for use around the home as well as for pastures, rangelands, rights-of-way, roadsides, and other noncrop areas.

• *Glyphosate* controls yellow starthistle at 1 lb a.i./acre. Good coverage, clean water, and actively growing yellow starthistle plants are all essential for adequate control. Unlike growth regulator herbicides, glyphosate is nonselective and controls most plants, including grasses. It has no soil activity. A 1% solution of glyphosate also provides effective control and is used at this concentration for spot treatment of small patches. An application of glyphosate is a very effective method of controlling starthistle plants in the bolting, spiny, and early flowering stages at 1 to 2 lb a.i./acre. However, glyphosate will severely damage desirable perennial grasses if they are sprayed as well. Glyphosate is registered for use around the home as well as for pastures, rangelands, rights-of-way, roadsides, and other noncrop areas.

Preemergent Herbicides. Preemergent herbicides must be applied before seeds germinate to be effective. The long germination period of yellow starthistle requires that a preemergent material have a lengthy residual activity. Make applications before a rainfall, which will move the material into the soil. Because these materials adhere to soil particles, off-site movement and possible injury of susceptible plants could occur if the soil is dry and wind occurs before rain. When yellow starthistle plants have already emerged, it is possible to combine a postemergent herbicide (to control emerged plants) with a preemergent herbicide (to provide residual control of any subsequent germination) for an effective control strategy.

Chlorsulfuron and sulfometuron are preemergent herbicides registered for roadside and other noncrop uses. Chlorsulfuron was recently registered for use in rangelands. Both are very effective at controlling yellow starthistle when applied at 1 to 2 oz a.i./acre. Little postemergence activity occurs on yellow starthistle with these two compounds. Best control is achieved when applications are made before weeds emerge. They may not be used around the home.

Integrated Approaches

Combinations of prescribed burning and clopyralid can be very effective for yellow starthistle control. However, when using this integrated approach it is important that a prescribed burn be conducted the first year (or possibly for 2 years) and that clopyralid be applied in the last year of the program. Treating in the first year and burning in the second year may increase the starthistle problem because burning has been shown to increase seed germination during the following rainy season. Continued control of yellow starthistle after the last year of treatment can be accomplished by either mowing, spot spraying, or hand-pulling.

For more information contact the University of California Cooperative Extension or agricultural commissioner's office in your county. See your phone book for addresses and phone numbers.

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To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

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YELLOW STARTHISTLE CONTROL AT SFREC

Mike Connor

Methods used

Field scale trials were initiated in spring, 1999. Eight fields, ranging in size from 15 to 140 acres, were selected for the study because of their relatively uniform, moderately dense (20 to 31% composition) stands of yellow starthistle (YST). Four treatments were randomly assigned as follows: prescribed early summer burning in 1999 followed by late winter applications of clopyralid (trade name Transline) in 2000 and 2001 (BTT); Transline application in 1999, prescribed burn in 2000, and Transline again in 2001 (TBT); Transline application in each of the three years, 1999 through 2001 (TTT); and control or no treatment (C).

Prescribed burns occurred on June 12 and 17, 1999 and July 2, 2000. Fire breaks and other preparation were by Center staff. Firing and fire control was conducted by California Department of Forestry and Fire Protection (CDF) units with the assistance of Research Center staff. Timing of burns was targeted for 2% to 5% bloom of YST. Transline was applied by a commercial helicopter operator at the lowest registered rate for California, 1/4 pt/acre of Transline in 10 gallons/acre of water. Applications were made on March 12, 1999, March 11, 2000 and February 23, 2001.

Study fields were grazed by cattle twice a year, once in late summer or fall and again during the late winter or early spring. Stocking rate ranged from 0.5 to 1.2 animal unit months per acre per year.

Ten 200-foot-long transects were established in open grasslands in each of the eight treatment fields. Composition of important species or classes of species was determined at six foot intervals along each transect.

Yellow starthistle control

Prescribed fire successfully replaced chemical treatment in one year of a three-year treatment program for yellow starthistle control. As seen in table 1, all three treatment regimes reduced yellow starthistle composition, after three years of treatment, to 1% or less, significantly less than in the untreated control fields.

TABLE 1. Control of yellow starthistle by Transline applications, burning or combinations of Transline and burning

	- - - - - - - 1999 - - - - - -		**- - - - - - - 2000 - - - - - -**		**- - - - - - - 2001 - - - - - -**	
Treatment	**Treat.[1] Applied**	**Composition %**	**Treat.[1] Applied**	**Composition %**	**Treat.[1] Applied**	**Composition %**
C	C	16 b	C	21 c	C	7.8 b
BTT	C	24 c	BT	11 b	BTT	1.2 a
TBT	T	0.3 a	TO	3.8 a	TBT	0.0 a
TTT	T	0.0 a	TT	0.7 a	TTT	0.0 a

Treatment means in the same column followed by different letters are significantly different at $P < 0.05$
[1] Procedure that was applied prior to the date of observation

Medusahead control

Prescribed burning, integrated with Transline application, significantly reduced medusahead composition (table 2). Part of the reduction was reversed in the fields burned in 1999 as medusahead made a partial comeback in 2001, but over the length of the study medusahead reduction was substantial.

TABLE 2. Effect on medusahead of Transline applications, burning or combinations of Transline and burning

Treatment	1999 Composition %	2001 Composition %	1999 vs. 2001 Change Percentage Unit
C	6 a	8 a	2
BTT	25 b	10 a	-14*
TBT	25 b	6 a	-18*
TTT	23 b	28 b	5

*Treatment means in the same column followed by different letters are significantly different at P < 0.05. * Statistically significant at P < 0.05*

Effects on Legumes

The legume component in this study was predominantly rose clover. Transline application in 1999 reduced legume composition to zero, and a repeated application in 2000 also resulted in low legume populations (table 3). Burning in 1999 caused an increase in legumes the following year even following Transline treatment, but burning in 2000 did not stimulate a similar effect. Legumes in the TBT treatment appeared to recover in 2000 from Transline treatment the previous year. By 2001 we did not demonstrate a consistent change in legume composition due to treatment.

TABLE 3. Effect on legumes of Transline applications, burning or combinations of Transline and burning

		1999		2001	
Treatment	Start of Study	Treat.[1] Applied	Composition %	Treat.[1] Applied	Composition %
C	18 b	C	15 c	C	12 c
BTT	7 a	C	5 b	BTT	1.8 a
TBT	8 a	T	0 a	TBT	8 bc
TTT	11 ab	T	0 a	TTT	5.5 ab

Treatment means in the same column followed by different letters are significantly different at P < 0.05

[1] *Procedures that had been applied prior to date of observation*

Cost of treatment

The following table presents the actual costs for treating yellow starthistle that were incurred at Sierra Foothill Research and Extension Center. Costs provided are averaged over two years, 1999 and 2000. Transline application was by aerial spraying using a helicopter; approximately 300 acres were sprayed each year. Application costs will be much higher for small acreages, and they should be less if larger blocks are treated. Application costs may be reduced if the terrain allows use of a fixed wing aircraft and there is a landing strip nearby.

Prescribed burns were conducted with the assistance of the California Department of Forestry and Fire Protection (CDF) as personnel training burns. Labor costs presented below are meant to represent costs to the landowner and do not include any costs incurred by CDF. Burning occurred in approximately 200 acre blocks. As with chemical spraying, larger burns should be cheaper on a per acre basis. Equipment costs for prescribed burning include only out-of-pocket costs for fuel, oil and minor repairs resulting directly from work on the project.

Prescribed burning resulted in a reduction in forage growth in the season following the burn. We estimated a loss of 60% or about two thirds of an animal unit month (AUM) per acre. If winter dryland pasture is costing $15 per AUM, then this is a loss of $10. A UC bulletin (Agriculture and Natural Resources publication 21494) indicates a forage loss of 30% to 50% in the first year following a fire and 20% the year following that.

Spot spraying was accomplished using a small field sprayer on a four-wheel-drive ATV. Costs for spot spraying assume that about one-tenth of the area, for example 100 acres of a 1000 acre field, is actually sprayed. Labor cost is high because the entire area must be checked, although only one-tenth is treated. Costs given are for the entire area (1000 acres in the example above) not just the area treated.

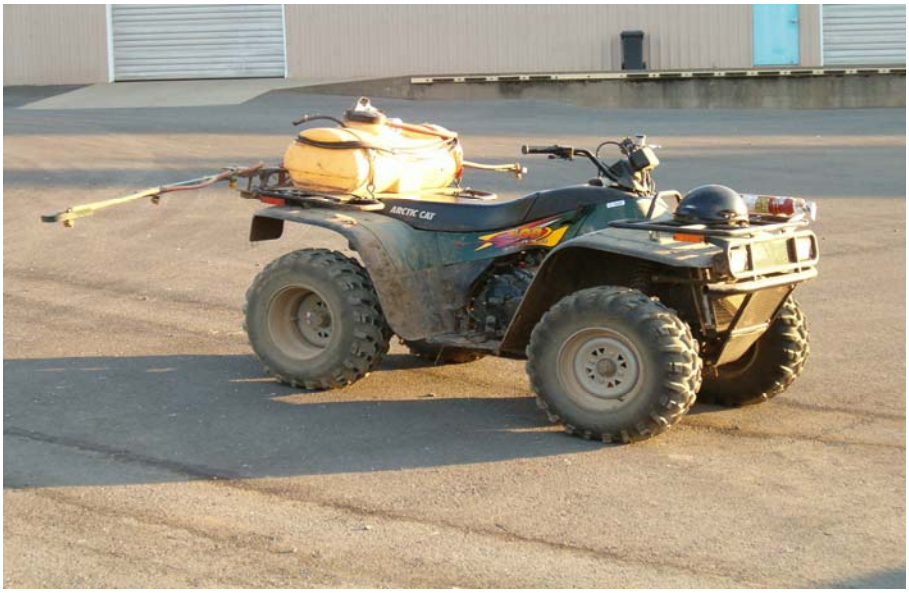
Labor was figured at $12.00 per hour.

Costs for Yellow Starthistle Treatment, per acre

Aerial spraying	
Transline (1/4 pt/ac)	$12.00
Helicopter application	14.50
Total	$26.50
Prescribed burning	
Fuel, oil, repairs	$ 2.50
Labor	17.50
Permits	.50
Seed, fertilizer to reseed fire breaks	2.50
Loss of feed	10.00
Total	$33.00
Spot spraying	
Roundup	$ 5.80
Labor	1.20
Equipment maintenance	0.10
Total	$ 7.10

TRANSLINE SUSCEPTIBILITY CHART
(N = no control, P = partial control, C = control)

Species or Plant Group	Susceptibility	Species or Plant Group (continued)	Susceptibility
Grasses (annual and perennial)	N	Alfalfa (Medicago sativa)	P to N during dormancy
Chickweed (Stellaria media)	P to C	Vetch (Vicia spp.)	C
Fiddleneck (Amsinckia menziesii)	N	Thistles	C
Mustards and other crucifers	N	Knapweed (spotted, diffuse, Russian)	P to C
Common lambsquarters (Chenopodium album)	N	Tarweeds (except Hemizonia pungens)	C
Russian thistle or tumbleweed (Salsola tragus)	N	Ragweed (Ambrosia spp.)	C
Filarees (Erodium spp.)	N	Mayweed (Anthemis cotula)	C
Teasel (Dipsacus spp.)	C	Sagebrush (Artemisia spp.)	C
Puncturevine (Tribulus terrestris)	N	Pineappleweed (Chamomilla suaveolens)	C
Prostrate knotweed (Polygonum arenastrum)	N	Oxeye daisy (Chrysanthemum leucanthemum)	C
Smartweed or ladysthumb (Polygonum spp.)	P	Chicory (Cichorium intybus)	C
Red sorrel (Rumex acetosella)	C	Horseweed and marestail (Conyza spp.)	C
Curly dock (Rumex crispus)	P to C	Sunflower (Helianthus spp.)	C
Jimsonweed (Datura spp.)	C	Prickly lettuce (Lactuca serriola)	P to C
Nightshades (Solanum spp.)	C	Common groundsel (Senecio vulgaris)	C
Annual clovers and other annual legumes	C	Dandelion (Taraxacum officinale)	P to C
Perennial legumes	P or N during dormancy	Salsify (Tragopogon spp.)	C
Lupines (Lupinus spp.)	C	Cocklebur (Xanthium strumarium)	C
Burclovers and medics (Medicago spp.)	C		



ATV with ground-rig setup