INFLUENCE OF TIMING AND CHEMICAL CONTROL ON YELLOW STARTHISTLE

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Yellow starthistle (*Centaurea solstitialis*) is one of the most aggressive and invasive weeds encountered in non-irrigated range and non-crop areas. For any yellow starthistle control program to be effective, it should be designed to ultimately deplete the starthistle soil seedbank. This will require at least three years of persistent management with no or minimal new seed production. An integrated approach using mechanical, cultural and chemical control measures is typically the best way of managing this noxious weed. However, in many situations, control options are limited by physical, political, or economics constraints. Important considerations for the proper use of herbicides in a yellow starthistle management program are discussed in this pamphlet.

A limited number of herbicides are registered for use in California rangelands and pastures. Of these, the majority are applied to the foliage of target plants, including yellow starthistle. Most of these compounds, including 2,4-D, triclopyr, dicamba, and glyphosate have little or no soil activity, and thus will not control seedlings emerging after herbicide application. In contrast, the newly registered herbicide clopyralid (Transline), has excellent soil (preemergence) and foliar (postemergence) activity. This paper provides information on the use of these herbicides for control of yellow starthistle seedlings and mature plants in California rangelands and pastures, as well as important precautions and considerations for the development of long-term control strategies.

POSTEMERGENCE HERBICIDES

Yellow starthistle is difficult to control with *postemergence herbicides.* This is primarily due to the ability of starthistle seeds to germinate throughout much of the year when sufficient soil moisture is present. The majority of seeds, however, germinate in fall and early winter. While a single application of a growth regulator herbicide (2,4-D, dicamba, or triclopyr) will provide excellent control of seedlings, it typically will not control yellow starthistle for the duration of the season. These herbicides lack residual soil activity and will not provide control of plants germinating after the herbicide treatment.

Growth regulator herbicides only control broadleaf species and can be used in late winter or early spring to control yellow starthistle seedlings without harming grasses. Excellent postemergence control of seedlings can also be achieved at 2 pt of Roundup (glyphosate) per acre or spot application with 1% solution. However, glyphosate is a broad spectrum herbicide and will injury germinated grasses and other broadleaf species. The addition of a surfactant to amine formulations of 2,4-D and triclopyr can enhance yellow starthistle control. Yellow starthistle that has emerged by the time of herbicide application is controlled, but more starthistle emerges with subsequent rains.

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

A single 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 ineffective should late-season rains occur. Clopyralid is also a very effective postemergence herbicide. However, it also has excellent preemergence activity. Thus, it is discussed separately below under the section PREEMERGENCE AND POSTEMERGENCE ACTIVITY.

PREEMERGENCE HERBICIDES

A number of selective or broad spectrum *preemergence herbicides* control yellow starthistle, including 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, and cannot be used on rangelands and pastures, or by homeowners. These compounds are not as effective for the control of yellow starthistle as clopyralid and will injure a number of desirable species, including natives and important forage species.

PREEMERGENCE AND POSTEMERGENCE ACTIVITY

Clopyralid is a growth regulator herbicide. It is very effective for the control of yellow starthistle, as well as other invasive composites (Sunflower family), but does not injure grasses. The effectiveness of clopyralid on yellow starthistle can be partially attributed to its postemergence and preemergence activity. Hence, a single application at the appropriate rate will control emerged yellow starthistle and prevent more seedlings from emerging for a season. It is important to note, however, that clopyralid is a slow-acting herbicide and may require two months to kill susceptible species. A few composites, such as spikeweed (*Hemizonia pungens*) are not injured by clopyralid. In addition to composites, clopyralid injures most legumes, particularly annuals such as clovers and vetches. Injury to perennial legumes can be avoided when clopyralid is applied when legumes are dormant. Other plant groups which may be susceptible to clopyralid include some members of the nightshade family (Solanaceae) and the knotweed or smartweed family (Polygonaceae). In contrast, many other broadleaf species, including mustards and filarees, appear to be relatively tolerant to the herbicide (see table).

Since clopyralid is a relatively narrow spectrum herbicide, it is important to be aware of the species which may replace yellow starthistle following application. In some cases, these species may be equally undesirable and additional management strategies should be employed to prevent their establishment.

Clopyralid can be applied aerially (helicopter or plane) or by ground equipment. Under optimal conditions, 1/6 pt/acre (1 oz ae/A) of Transline can provide excellent control of yellow starthistle when applied from December through April. However, under drought conditions, higher rates are necessary. Thus, for consistent control of yellow starthistle, rates between 1/4 and 2/3 pt/acre are preferable. The higher rates are needed for aerial applications. When dead erect stems are present from previous years infestation, control can still be achieved with labeled use rates. Higher rates may provide measurable control for a second season. When the objective is to enhance rangeland forage while reducing yellow starthistle, early application dates (January to February) are preferred. Although clopyralid kills starthistle up 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.

The addition of a surfactant to the treatment solution may enhance the activity of clopyralid on plants in the late rosette, bolting or spiny stage, but is not necessary for the control of seedlings or for preemergence activity.

CONTROL OF MATURE PLANTS

In the rosette and bolting stage, higher rates of dicamba, 2,4-D, triclopyr, clopyralid, and glyphosate will control yellow starthistle. However, once bolted plants have produced spines and begin to flower, 3 to 4 pt/acre Roundup is the most effective herbicide. Unlike seedlings, 2 pt Roundup Pro per acre may not effectively control large rosettes or more mature plants. The best time to treat with glyphosate is after annual grasses or forbs have died but prior to yellow starthistle seed production. Applications after more than 5% of the spiny heads are in flower will not completely prevent seed production. Control is less effective when mature plants show physical signs of drought stress. When clopyralid has been previously applied, glyphosate can be used in a broadcast or spot treatment follow-up program to kill uncontrolled plants before they produce seed, or to prevent the proliferation of potential clopyralid-resistant plants (see below). Glyphosate is not recommended when desirable perennial grasses or broadleaf species are present, except when used as a spot application.

LONG-TERM CONTROL

Any control program should be continued for at least three years to reduce the yellow starthistle seedbank. Whenever possible, make every effort to expose an infested site to high light during the germination period of yellow starthistle germination. This will deplete the seedbank more rapidly by increasing the rate of germination. Fall or winter grazing, burning, or mowing will provide increased soil surface light during the germination period. By comparison, tillage will bury seeds and prolong the dormancy period.

The presence of high populations of biological control agents (weevils and flies) does not appear to significantly impact yellow starthistle populations when used as the sole means of control. Although no evidence is available, the presence of these organisms in combination with clopyralid applications may provide more long-term or sustainable control. Thus, landowners are encouraged to sustain high levels of the biocontrol organisms.

Reseeding infested areas with competitive perennial grasses and legumes may provide long-term sustainable control of yellow starthistle and higher forage quality. Another possible long-term approach is to alter grazing management strategies to maintain increased grass vegetative cover during the critical period when yellow starthistle rosettes are prepared to bolt.

PRECAUTIONS

Continuous clopyralid use will likely have a long-term detrimental effect on the legume population in the treated area. Consequently, other control options should be rotated in the overall yellow starthistle management program. In addition, the development of clopyralid-resistant yellow starthistle is possible. A Washington population of yellow starthistle developed resistance to repeated use of picloram (Tordon). This population was also resistant to clopyralid, which has a similar mode of action. The potential exists for the development of resistance to clopyralid if the herbicide is used year after year, with no other method employed. Resistance can be minimized by incorporating other control strategies or by utilizing late season applications of glyphosate to control escapes due to application skips or resistant plants.

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

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