Yellow Starthistle: Chemical Control

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A number of herbicides are effective for control of yellow starthistle *(Centaurea solstitialis* L.). The use of these compounds, however, depends upon several factors, including the use of the area infested, overall objectives, and timing of application. For example, while many preemergence herbicides are registered for use along roadsides, only a few are registered in rangeland (Table 1). Furthermore, an herbicide which can control yellow starthistle may also kill desirable grasses (e.g., sulforneturon). Thus, if the objective of the management program is to enhance grasses in rangeland, this compound is unacceptable. The timing of application of both pre- or postemergence herbicides is critical to the successful control of yellow starthistle. When used alone, most preemergence herbicides should be applied prior to weed emergence. In contrast, most growth regulator herbicides (e.g., 2,4-D, dicamba, triclopyr) are effective at the seedling stage but will not provide sufficient control of yellow starthistle when applied after the bolting stage. At these mature growth stages, only glyphosate provides effective control (DiTomaso and Kyser 1996).

Several qualities of pre- and postemergence herbicides are presented in Table 2. It is important to note that the LD50 (lethal dose in mg herbicide/kg fresh animal weight which kills 50% of the tested animals) of nearly all these herbicides is fairly high. The higher the LD50 value, the lower the toxicity to animals. By comparison, aspirin has an LD50 of 750 mg/kg and table salt (NaCl) has an LD50 of 3,320 mg/kg.

Preemergence Herbicides

Preemergence herbicides are applied to the soil and require rainfall or irrigation to be activated. Herbicide activation occurs when the compound is solubilized and leaches into the target plant root zone. Only solubilized herbicide can be taken up by plants. Nearly all preemergence herbicide are taken up readily by roots. In most cases, the herbicide is translocated to shoots by the xylem in the bulk flow of water. Too much soil water will increase the likelihood that a herbicide will leach too deep into the soil profile. This not only decreases the effectiveness of the herbicide to control weeds but increases the chances of groundwater contamination. Movement of soil applied herbicides into water can also occur by surface runoff. This typically occurs when heavy rains follow herbicide application. When preemergence herbicides are applied to dry soil and little or no rainfall occurs for a prolonged period, some off-site movement may occur under windy conditions when soil particles are transported in the air.

Preemergence herbicides effective for the control of yellow starthistle in non-crop areas, not including roadsides, are discussed below.

Hexazinone (Velpar) and tebuthiuron (Spike)

Hexazinone and tebuthiuron are considered nonselective herbicides. For this reason, they are not typically used in areas where grasses or sensitive plants are desired (Ahrens et al. 1994). Hexazinone is used more often for control of herbaceous plants and brush in reforestation efforts. Its solubility in water is very high (33,000 ppm), consequently, it is not recommended for use in areas where runoff is common or where the water table is near the soil surface. Tebuthiuron is generally used for shrub control and is also highly soluble in water (2,300 ppm). In Idaho, tebuthiuron at 9.6 lb ai/A provided 100% control of yellow starthistle when applied in December or April (Callihan et al. 1991).

Table 1.
List of registered herbicides which effectively control yellow starthistle along roadsides, and in rangeland and non-crop areas of California

Herbicide		Registered Use			
Common Name	**Trade Name**	**Roadside**	**Rangeland**	**Non-crop**	**Comment**
Preemergence					
diuron	Karmex	X			Relatively non-selective
simazine	Princep	X			Relatively non-selective
atrazine	Atrazine	X			Relatively non-selective
hexazinone	Velpar		X		Non-selective
tebuthiuron	Spike		X		Non-selective
bromacil	Hyvar	X			Relatively non-selective
isoxaben	Gallery	X			Expensive
chlorsulfuron	Telar	X		X	Best if grasses are desired
sulfometuron	Oust	X		X	Non-selective
oxyfluorfen	Goal		X		Relatively non-selective
Postemergence					
2,4-D	Several names	X	X	X	Restricted use, effective on young plants
dicamba	Banvel, Vanquish	X	X	X	Effective on young plants
triclopyr	Garlon & others	X	X	X	Effective on young plants
glyphosate	Roundup	X	X	X	Non-selective, best on older plants

Oxyfluorfen (Goal)

Oxyfluorfen is typically applied preemergence, but has some postemergence activity on very young yellow starthistle seedlings (Elmore 1994). It is not registered for use in recreational areas, wastelands or pastures. Furthermore, it will control a wide range of broadleaf species and grasses, which may be undesirable in most areas infested with yellow starthistle. Unlike hexazinone and tebuthiuron, oxyfluorfen is very insoluble in water (0.1 ppm) and is, therefore, not often found contaminating groundwater (Ahrens et al. 1994).

Chlorsulfuron (Telar)

Chlorsulfuron is reasonably effective for the control of yellow starthistle. Although it also has postemergence activity on many other weedy broadleaf species, it has little if any postemergence activity on yellow starthistle. It is registered for use in uncultivated areas, roadsides and industrial sites, but not rangeland, recreational areas, pastures, or wasteland. In grassland ecosystems, chlorsulfuron is currently the best choice for preemergence control of starthistle. It can be applied alone in late fall prior to germination, but is more effective when applied in combination with a postemergence growth regulator herbicide in winter or early spring. Chlorsulfuron is a weak acid herbicide. Thus, its solubility in water is dependent upon the acidity of the soil. Under acid conditions (pH 5), it is moderately soluble (300 ppm), but at a neutral (pH 7, solubility of 28,000 ppm) or alkaline pH it is highly soluble and, thus, susceptible to leaching (Ahrens et al. 1994).

Sulfometuron (Oust)

Unlike chlorsulfuron, sulforneturon is a non-selective compound and will injure broadleaf as well as grass species. It is not registered for use in rangeland, pastures or wasteland, but is registered in uncultivated areas, roadsides, recreational areas, and industrial sites. It is very effective for preemergence control of yellow starthistle but does not effectively control the weed when applied postemergence.

Postemergence Herbicides

Postemergence herbicides are applied to the foliage of target species. They must be retained on the leaves, penetrate the cuticle, cell wall, and cell membrane, and subsequently move to the site of herbicide activity. Nearly all postemergence herbicides translocate in plants via the phloem. Therefore, they eventually accumulate in the growing points of the plant, which can include shoot and root meristems, reproductive structures, and underground rhizomes, tubers, bulbs, and corms. For this reason, postemergence herbicides are typically more effective for control of perennials than are most preemergence compounds.

Since phloem transport is driven by both growth rate and sugar production through photosynthesis, the efficacy of postemergence herbicides is usually dependent upon environmental conditions. As a general rule, the performance of postemergence herbicides is reduced when plants are stressed (i.e., moisture, nutrient, acidity, etc.).

Postemergence herbicides typically do not have the soil persistence of preemergence herbicides. Therefore, they are not often found in groundwater. However, improper application of postemergence compounds can lead to off-site spray or vapor drift. It is important not to apply these herbicides under windy conditions or when temperatures are above 80°F. The best time to apply postemergence herbicides is usually in the morning when temperatures are lower and winds are lighter.

The most effective postemergence herbicides for yellow starthistle control, including 2,4-D, dicamba, triclopyr, and glyphosate, are registered for use in nearly all non-crop areas. All but glyphosate are growth regulators selective against broadleaf species. These three compounds are the best control option in areas where annual grasses have not yet senesced or where perennial grasses are common. While the growth regulator herbicides are effective in controlling yellow starthistle seedlings, they do not control seedlings germinating a couple of weeks after application (Lass and Callihan 1994). Thus, in many cases, multiple applications are required to achieve season long control of yellow starthistle (Callihan and Lass 1996).

2,4-D (Weedar 64 and several other names)

This phenoxy herbicide is very effective on yellow starthistle seedlings and plants in the rosette stage (Whitson and Costa 1986; Northam and Callihan 1991; Lass et al. 1993). It is also a very economical option. However, 2,4-D is a restricted use compound requiring a permit for use. Thus, its use may not be allowed in some areas. The best timing for treatment is between mid-February and the end of March. Amine forms are as effective as ester formulation for seedling control, but ester formulations are more effective on older plants (Lanini et al. 1996). Esters, however, are more likely to drift off-target.

Dicamba (Banvel, Vanquish)

Dicamba is a benzoic acid herbicide with activity very similar to 2,4-D. However, it is somewhat more active and can be used on older plants and at lower rates. In an April application in Idaho, dicamba at 4 oz ai/A provided complete control of yellow starthistle (Lass et al. 1993). In addition, the soil residual activity of dicamba is slightly longer than 2,4-D. Drift can also be a problem with dicamba.

Triclopyr (Garlon 3A, Garlon 4, Remedy, Redeem)

Triclopyr is another growth regulator herbicide in the picolinic acid chemical class. Its effect on yellow starthistle is similar to dicamba. The ester formulation (Garlon 4, Remedy) is more active than the amine form (Garlon 3A, Redeem) but is also more susceptible to drift.

Glyphosate (Roundup Pro)

Unlike the growth regulator compounds, glyphosate is non-selective and will kill or injure grasses as well as broad-leaf plants. Thus, it is not recommended for broadcast application early in the season or when perennial grasses are present. The advantage of glyphosate is its ability to control mature yellow starthistle plants even at the early flowering stages. In addition, it has no soil activity and is rarely found in groundwater. Glyphosate can also be effective when preparing to reseed perennial grasses in an area infested with annual grasses and yellow starthistle (Callihan and Lass 1996).

Table 2.

Characteristics of pre- and postemergence herbicides for control of yellow starthistle

Herbicide						
Common Name	Trade Name	Lb or oz active/A	Half-life in soil (days)	Selectivity (eff. Against)	Metabolic process inhibited	LD50 in rats (mg/kg)
Premergence						
Diuron	Karmex	1-3 lbs.	90	Many grasses and broadleaf	Photosynthesis	3,400
Simazine	Princep	2-4 lbs.	60	Many grasses and broadleaf	Photosynthesis	>5,000
Atrazine	Atrazine	1-3 lbs.	60	Many grasses and broadleaf	Photosynthesis	3,090
Bromacil	Hyvar	1.5-5 lbs.	150	Many grasses and broadleaf	Photosynthesis	5,200
Isoxaben	Gallery	0.5-1 lb.	50-120	Broadleaf	Cell wall	4,300
Oxyfluorfen	Goal	0.25-2 lbs.	35	Many grasses and broadleaf	Pigment-Protox emzymes	>5,000
Chlorsulfuron	Telar	1-2 oz.	40	Mainly broadleaf	Branched-chain amino acids	5,445
Sulfometuron	Oust	0.75-3 oz.	20-25	Non-selective	Branched-chain amino acids	>5,000
Postemergence						
Dicamba	Banvel, Vanquish	0.25-1.5 lbs.	14	Broadleaf	Growth regulator	1,707
2,4-D	Several names	0.5-2 lbs.	10	Broadleaf	Growth regulator	764
Triclopyr	Garlon	0.5-2 lbs.	14	Broadleaf	Growth regulator	1,581-2,574
Clopyralid	Transline	1-2 oz.	40	Broadleaf	Growth regulator	4,300
Glyphosate	Roundup	0.5-2 lbs.	0	Non-selective	Aromatic amino acids	5,600

Prospective New Herbicide

Clopyralid (Transline)

Although registered in every other state, clopyralid is not yet available in California. However, it is expected to be registered sometime in late 1997 or early 1998. Like triclopyr, clopyralid is a picolinic acid growth regulator selective on broadleaf species, particularly thistles, legumes and smart weeds. It offers several advantages over other herbicides for control of yellow starthistle. For example, it is not only effective postemergence on plants in the seedling or rosette stage, but has preemergence activity for 4-6 months (Table 2). This provides a rather wide window of application timing, ranging between January and April. In addition, it is active at very low rates (1-4 oz ae/A). In Idaho, clopyralid applied at 4 oz ae/A on May 1 provided complete control of yellow starthistle (Northam and Callihan 1991). Similar results were been obtained at 1 oz ai/A in trials conducted in California (DiTomaso, unpublished results). As additional

advantages, clopyralid has low mammalian toxicity and the cost of treatment should range between $5 and $20 per acre. It is likely to be registered for use on rangelands, roadsides and other non-crop areas. The availability of this compound should provide the most effective and affordable chemical option for the control of yellow starthistle.

Conclusions

To achieve effective long-term control of yellow starthistle, whether it be by chemicals or other means, several factors must be considered. First, initial control efforts should focus on small patches. Like wildfires, small infestations quickly spread to form larger problems. Once these have been controlled, emphasis can shift to the larger infestations. Second, control efforts should include follow-up treatments when necessary. For example, many plants may escape control because of the cover provided by old yellow starthistle stems (Lass et al. 1993) or poor treatment coverage. These skips need to be controlled prior to flowering to prevent reseeding of the infested area. Alternatively, a postemergence treatment may control only those seedlings emerged at the time of application. Subsequent emergence will require addition control efforts. It is critical to prevent seed production if long-term control of yellow starthistle is to be achieved. Finally, any effective effort to manage yellow starthistle will require a multi-year control program. Three years of consistent control, without subsequent reseeding, should provide better than 90% control of yellow starthistle (DiTomaso, personal observation).

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