Integrated Management of Yellow Starthistle on California Rangelands

Stephen Enloe and Joe DiTomaso, U.C. Davis Weed Science
Steve Orloff and Dan Drake, U.C. Cooperative Extension

Introduction

Yellow starthistle (*Centaurea solstitialis* L.) is an aggressive Mediterranean invader that currently infests over 10 million acres in California. It reduces rangeland productivity and carrying capacity, decreases land value, and threatens biodiversity (Maddox and Mayfield 1985). Yellow starthistle is well adapted to California's annual grasslands, which are comprised primarily of introduced annual grasses and forbs. Yellow starthistle minimizes competition with annual grasses by utilizing deep soil moisture and entering its reproductive phase after annual grasses have senesced. There are currently few sustainable and economically viable management strategies available to rangeland managers in California for controlling yellow starthistle and increasing rangeland productivity. Burning, mowing, and certain herbicides, such as 2,4-D and dicamba, have been somewhat successful. However, long term management requires depleting the yellow starthistle soil seedbank and establishing competitive plant species in the niche yellow starthistle occupies.

Clopyralid is a selective broadleaf herbicide recently registered for use in California pastures, range, and wildlands. Initial studies in California have indicated clopyralid provides excellent pre- and postemergence yellow starthistle control (DiTomaso et al. 1999). There is, however, some concern that continuous use of a single management approach, such as clopyralid, may lead to selection for other noxious weeds, such as medusahead (*Taeniatherum caput-medusae*) or barb goatgrass (*Aegilops triuncialis*). Therefore, the objective of this study was to determine the effectiveness of utilizing clopyralid for yellow starthistle management in an integrated approach incorporating reseeding with a competitive perennial forage grass and an annual clover.

Materials and Methods

The experiment was conducted on yellow starthistle infested range near Yreka, California. Treatments consisted of three factors: clopyralid applied in the spring for 1, 2, or 3 years, range reseeding of 'Luna' pubescent wheatgrass (*Thinopyrum intermedium*) in the early spring the first year, and rose clover (*Trifolium hirtum*) seeding in the fall following the last clopyralid application. Range reseeding of wheatgrass consisted of a glyphosate application on February 29, 1997 followed by wheatgrass (12 lb/A) drill seeded the first week of March with a no-till range drill. Rose clover was broadcast seeded at 10 lb/A in September. Spring clopyralid applications were made on March 18, 1997 (1.0 oz ae/A) and March 17, 1998 (1.5 oz ae/A). Treatments were applied to 50 by 50 ft plots and arranged in a randomized complete block design with four replications.

Treatment evaluations consisted of the following: late spring vegetative cover evaluations of yellow starthistle, wheatgrass, annual grasses, and other forbs; and summer evaluations of yellow starthistle plant height, density, biomass, and seedhead production. Vegetative cover was determined by five random 1 m^2 quadrats per plot for a total of 20 quadrats per treatment. Yellow starthistle plant height, density, biomass, and seedhead production were determined by harvesting three 0.25 m^2 quadrats per plot, for a total of 12 quadrats per treatment.

A complete factorial analysis was performed on the data. Multiple comparisons (α=0.05) were done at the level of the highest order interaction. Data were pooled where main effects were not significant. All values are reported in original form.

Results and Discussion

In the 1997, yellow starthistle (YST) cover was significantly reduced in plots treated with clopyralid, with or without wheatgrass, to 14 and 4%, respectively (Table 1). Wheatgrass established only in plots treated with glyphosate and clopyralid. Additionally, there was a dramatic increase in other forb cover in plots treated with clopyralid compared to the control. The primary forbs were red-stem filaree (*Erodium cicutarium*) and tumble mustard (*Sisymbrium altissimum*). Annual grass cover significantly increased to 8% in plots treated with clopyralid alone. These findings suggest significant forb and annual grass suppression by yellow starthistle and the necessity of glyphosate for wheatgrass establishment.

In 1998, wheatgrass cover increased to 16-18% in plots treated with either one or two years of clopyralid. Yellow starthistle cover was less than 1% in plots treated with clopyralid for two years, but increased to 40-43% in plots treated with clopyralid only in 1997 (Table 2). Forb cover was significantly higher in plots treated with clopyralid for two years compared to plots treated for only one year. Annual grass cover was significantly higher in plots receiving clopyralid alone compared to the control and the clopyralid (1 year) + wheatgrass treatment. There was also a notable trend in decreased annual grass cover where both YST was controlled and wheatgrass was established. Annual grass cover was 16% in plots treated with clopyralid (2 yr) + wheatgrass compared to 32% where clopyralid was used for two years alone. However, this trend was not significant.

There was also a very apparent trend in yellow starthistle's response to clopyralid applied only in year one. Yellow starthistle biomass, plant height and seedhead production all tended to be greater in plots treated with only one year of clopyralid compared to all other treatments, including the control (Table 3). This "thinned out" population appeared more vigorous than the highly dense controls.

The data may also suggest some suppression of yellow starthistle by pubescent wheatgrass. YST biomass and seedhead production was significantly lower in plots where wheatgrass was established compared to the control. Additionally, YST biomass and seedhead production was significantly lower in plots treated with clopyralid (1 yr) + wheatgrass compared to clopyralid (1 yr) alone. However, YST late spring cover was not significantly different between these two treatments. This may suggest that the wheatgrass is providing late season competitive suppression when yellow starthistle is in the reproductive phase.

These findings indicate that clopyralid may be used as an effective management tool for yellow starthistle. However, long term management may require a minimum of two years clopyralid use. When clopyralid was used for only one year, YST seedhead production was comparable to the control in the second year. There was also a significant release of annual grasses and forbs when YST was controlled with clopyralid alone. There is concern that this strategy may result in a long-term shift to other undesirables, such as medusahead. However, this did not occur in the second year. Pubescent wheatgrass provided significant suppression of YST seedhead production and tended to suppress other annual grasses, such as downy brome (*Bromus tectorum*). Pubescent wheatgrass has been successfully used to suppress downy brome in other areas (Whitson and Koch 1998). This study will continue for the next two years to determine the long-term effectiveness of this integrated management strategy for yellow starthistle control. Additional monitoring not discussed here includes water infiltration and erosion potential, soil moisture depletion and profile recharge, and yellow starthistle seedbank dynamics.

References

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Table 1. Spring cover (1997) of yellow starthistle, other forbs and annual grasses.

Treatment[a]	YST	Other forbs	Annual grasses
	% cover[b]		
Control	58 A	2 B	2 B
Clopyralid	4 B	26 A	8 A
Clopyralid + glyphosate + wheatgrass	14 B	29 A	3 AB

[a]Evaluations taken approximately 110 days after clopyralid treatment.
[b]Means within columns followed by the same letter are not significantly different (α=0.05).

Table 2. Spring cover (1998) of yellow starthistle, other forbs and annual grasses.

Treatment[a]	YST	Other forbs	Annual grasses
	% cover[b]		
Control	83 A	3 B	4 C
Clopyralid (1 yr)	43 B	20 B	28 AB
Clopyralid (1 yr + wheatgrass)	40 B	17 B	11 C
Clopyralid (2 yr)	0 C	56 A	32 AB
Clopyralid (2 yr + wheatgrass)	0.1 C	40 A	16 BC

[a]Evaluations taken approximately 100 days after 2nd year clopyralid treatment.
[b]Means within columns followed by the same letter are not significantly different (α=0.05).

Table 3. Yellow starthistle response (1998) to clopyralid and wheatgrass.

Treatment[a]	Yellow starthistle parameter[b]		
	Biomass (g / 0.25 m^2)	Seedheads (# / 0.25 m^2)	Plant height (cm)
Control	66 B	173 AB	29 B
Clopyralid (1 yr)	95 A	215 A	51 A
Clopyralid (1 yr + wheatgrass)	25 C	78 C	23 B
Clopyralid (2 yr)	0.2 C	0.4 D	0.8 C
Clopyralid (2 yr + wheatgrass)	0 C	0 D	0 C

[a]Evaluations taken approximately 130 days after 2nd year clopyralid treatment.
[b]Means within columns followed by the same letter are not significantly different (α=0.05).