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Leafy spurge (*Euphorbia esula*) management by combining sheep grazing with fall-applied herbicides

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Introduction

Leafy spurge (*Euphorbia esula*) is an aggressive, perennial rangeland weed infesting millions of acres in the northern tier of the Great Plains states. It reduces cattle carrying capacity of rangeland and causes extreme economic losses to cattle producers and wildland areas (2).

Leafy spurge is very difficult to control and a combination of treatments, i.e., integrated weed management, may provide long-term leafy spurge population reductions. University of Wyoming research indicates that sequential applications of glyphosate followed by seeding perennial grasses controlled leafy spurge 83% on the average across all tilled plots three years after treatments were invoked (3).

Sheep will graze leafy spurge. Sheep readily consumed leafy spurge up to 50% of their diet free choice and showed no deleterious signs (1). While sheep grazing may not reduce leafy spurge populations, they may consume enough leafy spurge to release grasses from weed competition and thus, allow the area to be grazed by cattle. Additionally, sheep grazing in spring and summer may stress leafy spurge sufficiently to make it more susceptible to fall-applied herbicides.

The objectives of our research were to determine if sheep grazing of leafy spurge followed by fall applied herbicides would enhance control compared to herbicides applied alone in spring; and whether grazing would enhance the susceptibility to fall applied herbicides such that reduced herbicide rates would control leafy spurge similarly compared to higher rates.

Materials and methods

The experiment was initiated in 1991 at Cherry Creek State Park in Aurora, CO. The design was an eight (herbicides) by three (management approaches) factorial arranged in a strip-plot with four replications. The eight herbicide treatments (Table 1) comprised the horizontal factors (main plots) and the three management approaches (spring-applied herbicides at flowering, fall-applied herbicides to regrowth, or grazing followed by fall-applied herbicides to regrowth) were the vertical factors (sub-plots). Two sheep grazed their assigned plots (0.33 A) for 75 days per year. All herbicides were applied with a CO_2 backpack sprayer at 24 GPA. Spring applied herbicides, fall-applied herbicides, and graze plus fall-applied herbicides treatments were invoked for 4 consecutive years.

The impact from each management approach and herbicide treatment was assessed on the entire plant community. Leafy spurge, downy brome (*Bromus tectorum*), smooth brome (*Bromus inermis*), western wheatgrass (*Agropyron smithii*), Kentucky bluegrass (*Poa pratensis*), litter, and bareground cover (Daubenmire) and leafy spurge density were estimated twice per season; before sheep were introduced into the study area in spring (April) and in fall before herbicides were applied (October). Repeat cover and density determinations were taken from the same locations within plots. Percent control of leafy spurge was estimated visually each year in April, before sheep grazing began and in October before herbicides were applied. Cover, density, and control data from spring, 1995 are presented.

Results

Perennial grasses: Western wheatgrass and Kentucky bluegrass cover was not influenced by herbicide treatment or management approach. Smooth brome cover was affected by herbicide treatment (Table 1), but not by management approach. Smooth brome cover was 3 to 5 times less from picloram plus 2,4-D at 0.25 + 1.0 lb and 0.5 + 1.0 lb compared to picloram at 0.25 lb, picloram plus 2,4-D at 0.13 + 1.0, and dicamba plus 2,4-D. The highest rate of picloram alone and the two highest rates of picloram plus 2,4-D may have injured the smooth brome. Total perennial grass cover (sum of all perennial grasses) was influenced by herbicide treatment (Table 1). Total perennial grass cover was 1.5 to 2.5 times greater in plots treated with dicamba plus 2,4-D than in plots treated with picloram at 0.13 and 0.5 lb, and picloram plus 2,4-D at 0.25 + 1.0 lb. Total perennial grass cover was 1.6 to 1.9 times less in plots treated with picloram plus 2,4-D at 0.25 + 1.0 lb than in plots treated with picloram at 0.25 lb, picloram plus 2,4-D at 0.13 + 1.0 and 0.5 + 1.0, and the non-sprayed control.

Litter and bareground: Litter and bareground cover was influenced by management approach (Table 2), but not by herbicide treatments. Sheep grazing increased the amount of bareground and decreased the amount of litter. There was 8 to 16 times more bareground in plots where the graze plus fall herbicide management approach was used than in plots where herbicides were applied alone in spring or fall, respectively. There was 1.2 times more litter in plots where herbicides were applied alone in spring or fall than in plots where the graze plus fall-applied herbicides treatments were invoked.

Leafy spurge cover, density, and control: Leafy spurge cover and density were influenced by herbicide treatments and the different management approaches, but the herbicide by management interaction was insignificant. Leafy spurge cover (36%) and density

(19 shoots/0.1 m^2) were greater in the non-sprayed control plots than in all herbicide treated plots (Table 3). Leafy spurge cover was 4 to 8 times less and density was 2 to 5 times less in plots treated with picloram at 0.5 lb and picloram plus 2,4-D at 0.5 + 1.0 lb than in plots treated with picloram at 0.13, 0.25 lb, and picloram plus 2,4-D at 0.13 + 1. 0 lb. - Leafy spurge cover was 2 times less and density was 2.5 times less in plots where the graze plus fall-applied herbicide treatments were made than in plots that received only spring applied herbicides, whereas plots that received only fall applied herbicides were not different from the other management approaches (Table 4). It appears that the management system of grazing plus fall applied herbicides may have decreased leafy spurge more effectively than the traditional approach of only applying herbicides in spring, but these data were collected 6 and 11 MAT, respectively, and this artifact may have influenced our spring 1995 results.

A significant herbicide by management approach interaction was observed for leafy spurge control. Leafy spurge control did not vary within a herbicide treatment when compared among management approaches (Table 5). However, 38% of leafy spurge was controlled in plots that were grazed and where no herbicides were applied compared to no control in the non-grazed, non-sprayed plots. When comparing leafy spurge control from herbicide treatments within a management approach, picloram plus 2,4-D at 0.5 + 1.0 lb applied in spring controlled 34 and 28% more leafy spurge than the lowest rates of picloram and picloram plus 2,4-D, respectively. Picloram at 0.5 lb applied in fall controlled 45% more leafy spurge than picloram at 0.13 lb and 39 % more than picloram at 0.25 lb. After 4 consecutive years of applying the integrated management approach, leafy spurge control from grazing plus fall applied picloram at 0.13 lb was not different from grazing plus fall applied picloram at 0.5 lb.

It is apparent that grazing of leafy spurge by sheep did not enhance the susceptibility of leafy spurge to herbicide treatments when comparing a rate of a herbicide among the three management approaches. However, grazing enhanced the susceptibility of leafy spurge to fall applied herbicides sufficiently enough that the weed was controlled equivalently from picloram at 0.13 and 0.5 lb as long as these treatments were preceded by grazing.

Literature cited

1. Landgraf, B.K., P.K. Fay, and K.M. Havstad. 1984. Utilization of leafy spurge (*Euphorbia esula*) by sheep. Weed Sci. 32:348-352.
2. Leistritz, F.L., D.A. Bangsund, N.M. Wallace, and J.A. Leitch. 1992. Economic impact of leafy spurge on grazingland and wildland in North Dakota. North Dakota gric. Exp. Stn. Staff Paper Series AE92005, North Dakota State University, Fargo,ND 58105.
3. Whitson, T.D., D.W. Koch, A.E. Gade, and M.E. Ferrell. 1990. The control of leafy spurge (*Euphorbia esula* L.) by the integration of herbicides and perennial grasses. Proc. Leafy Spurge Symp., July 10-12, Gillette, WY. p.26-27.

Table 1. Smooth brome and total perennial grasses cover in spring 1995, as influenced by 4 consecutive years of herbicide treatments to control leafy spurge, when treatments were averaged over management approaches.

Herbicides	Rate	Cover[1]	
		Smooth brome	Total perennial grasses
(lb ai/A)	%		
Picloram	0.13	12 bcd	36 bc
	0.25	23 abc	41 ab
	0.5	10 cd	27 bc
Picloram + 2,4-D	0.13 + 1.0	21 ab	36 ab
	0.25 + 1.0	7 d	22 c
	0.5 + 1.0	5 d	39 ab
Dicamba + 2,4-D	1.0 + 2.0	29 a	56 a
Control	0	10 bcd	39 ab

[1]Data were analyzed as square root transformations, but are presented as their original values. Means within a column followed by the same letter do not differ, LSD (0.05).

Table 2. Litter and bareground cover in spring 1995, as influenced by management approach invoked for 4 consecutive years, when management approaches were averaged over all herbicide treatments.

Management approach	Cover[1]	
	Litter	Bareground
Spring-applied herbicides	93 a	1 b
Fall-applied herbicides	95 a	2 b
Graze + fall-applied	78 b	16 a

[1]Data were analyzed as square root transformations, but are presented as their original values. Means within a column followed by the same letter do not differ, LSD (0.05).

Table 3. Leafy spurge cover and density in spring 1995, as influenced by 4 consecutive years of herbicide treatments when treatments were averaged over all management approaches.

Herbicides	Rate	Leafy spurge[1] Cover	Density
	(lb ai/A)	%	(shoots/0.1 m^2)
Picloram	0.13	8 b	5 b
	0.25	4 b	2 bc
	0.5	<1 c	< 1 d
Picloram + 2,4-D	0.13 + 1.0	7 b	3 bc
	0.25 + 1.0	2 bc	<1 cd
	0.5 + 1.0	<1 c	<1 d
Dicamba + 2,4-D	1.0 +2.0	2 bc	<1 cd
Control	0	36 a	19 a

[1]Data were analyzed as square root transformations, but means are presented as their original values. Means within a column followed by the same letter do not differ, LSD (0.05).

Table 4. Leafy spurge cover and density in spring 1995, as influenced by management approach invoked for 4 consecutive years, when management approaches were averaged over herbicide treatments.

Management approach	Leafy spurge[1] Cover	Density
	%	(shoots/0. 1m^2)
Spring-applied herbicides	10 a	5 a
Fall-applied herbicides	8 ab	4 ab
Graze + fall-applied	5 b	2 b

[1]Data were analyzed as square root transformations, but are presented as their original values. Means within a column followed by the same letter do not differ, LSD (0.05).

Table 5. Leafy spurge control in spring 1995, as influenced by herbicide treatments and management approaches invoked for 4 consecutive years.

		Management approaches[1]		
Herbicides	Rate	Spring-applied herbicides	Fall-applied herbicides	Graze + fall herbicides
	(lb ai/A)		% Control	
Picloram	0.13	65 a	55 a C	89 a AB
	0.25	79 a B	61 a C	83 a B
	0.5	83 a AB	100 a A	100 a A
Picloram + 2,4-D	0.13 + 1.0	71 a	78 a BC	84 a AB
	0.25 + 1.0	81 a AB	81 a ABC	100 a A
	0.5 + 1.0	99 a A	95 a AB	100 a A
Dicamba + 2,4-D	1.0 + 2.0	78 a AB	93 a AB	89 a AB
Control	0	0 b C	0 b D	38 a C

[1]Data were analyzed as arc sine square root transformations, but are presented as their original values. Use lower case letters to compare means within a row and upper case letters to compare means within a column. Means within a row or a column followed by the same letter do not differ, LSD (0.05).