Reprinted with permission from: NCWCC Proceedings. 1983. 38:100-103.

Effect of leafy spurge control on pasture productivity

STEVEN R. GYLLING and W. EUGENE ARNOLD

The authors are Research Assistant and Professor, Department of Plant Science, South Dakota State University, Brookings, SD 57007.

Introduction

Leafy spurge infests approximately 51,000 acres of land in South Dakota, and can reduce crop yields from 10% to 100% (1). Leafy spurge is a pernicious perennial, which is competitive in both cropland and pastures due to its rapid spread by seed and rhizomes. While weed control in cropland is generally considered feasible, many producers question whether perennial weeds such as leafy spurge can be economically controlled in pastures. Control of mixed stands of Canada thistle and musk thistle in pasture resulted in increased forage production of 110 to 314% during a three-year period of treatment in one study (2).

The objective of this research was to evaluate the economics of leafy spurge control in pasture for several herbicide treatments.

Materials and methods

General

A field experiment was established in a pasture near Woonsocket, South Dakota in 1978. Leafy spurge density was approximately 100 plants per 1-m^2 when the study was established. Kentucky bluegrass (*Poa praetensis* L.) was the primary forage component of the pasture. The study area was fenced to prevent grazing.

The experiment was designed as a randomized complete block consisting of four replications and 18 treatments in plots 6.1 m by 12.2 m. Treatments consist of spring or spring and fall applications of 2,4-D butoxyethanol ester, dicamba, picloram, or glyphosate alone or in combination. Treatment dates for each year is listed in Table 1. Herbicides were applied in 187 L/ha water using a tractor-mounted sprayer. All data were subjected to analysis of variance, and means were separated using the Waller-Duncan K-ratio t-test at K ratio = 100 (P=0.05).

Table 1. Herbicide application times for spring and fall treatments.

	Application Date	
Year	Spring	Fall
1978	May 31	September 23
1979	June 12	October 2
1980	June 28	September 12
1981	June 23	September 17
1982	June 3	September 21
1983	June 9	October 27

Leafy spurge control

Leafy spurge control was visually evaluated in 1979 through 1983 when spring treatments were applied using a 0 to 100% scale in which 0 represents no control and 100 represents complete control of topgrowth. Results are presented for the 1979, 1981, and 1983 evaluations as representing short-, intermediate-, and long-term control.

Forage and leafy spurge production

The entire experimental area was mowed in late fall of 1981 and 1982 to remove existing topgrowth prior to yield measurements. Total production was estimated by harvesting and weighing a wet sample from a 0.61 by 12.2 m area in each plot on August 10, 1982 and August 17, 1983. A 150 gram wet herbage sub-sample was removed, oven dried, and re-weighed to measure moisture content at harvest. An area 1-m^2 was also harvested from each plot at the same time, which was later dried, separated into forage and leafy spurge, and the fractions weighed. Dry forage and leafy spurge yields were calculated for all plots from total production and relative forage and leafy spurge content in each sample.

Economics of leafy spurge control

Value of dry forage production from each plot was calculated using an estimated return of $45.00 per 1000 kg. Herbicide costs represent an average of 1979 and 1982 retail prices in South Dakota, and were: 2,4-D $5.70/kg, dicamba $22.55/kg, picloram $93.17/kg, and glyphosate $49.93/kg. Cost of one application was assumed to be $2.50/ha. Added return net over added cost (added return) was calculated for each plot using the formula: added return = forage increase over untreated * forage value average annual treatment cost. Average annual cost was calculated for each treatment at the 1982 and 1983 harvest by dividing total treatment cost by the number of years since the study was initiated. For example, an average annual treatment cost of $8.88 at the 1982 harvest for 2,4-D applied at 0.84 kg/ha spring and fall was calculated by dividing the total cost of herbicide and application for nine applications (spring 1978 to spring 1982) of $39.96 by 4.5 years. Thus, average annual treatment costs were assigned assuming that forage yields for a given year are a result of the cumulative influence of treatment applications since the beginning of the study.

Results and discussion

Leafy spurge control

Treatments, which consisted of herbicide applications in 1978 only, did not satisfactorily control leafy spurge in 1981 or 1983 (Table 2). Glyphosate applied in the fall of 1978 controlled leafy spurge only in 1979. Regrowth resulted in heavy re-infestation of leafy spurge after 1979, and consisted mainly of seedling growth which was relatively uninhibited by forage competition.

Annual applications of 2,4-D provided 75% or better leafy spurge control by 1983. Applying 2,4-D at 0.8 kg/ha spring and fall provided improved control over a single spring application of 1.7 kg/ha in 1979 and 1981, although the same total amount of herbicide was applied during the year. Orthogonal contrasts were made for each year comparing average control for spring applications of 2,4-D at 1.7 and 3.4 kg/ha vs. average control for spring and fall applications of 2,4-D at 0.8 and 1.7 kg/ha. Significantly higher control was obtained in 1981 and 1982 from split applications than from single annual applications of 2,4-D. However, differences in 1979, 1980, and 1983 evaluations were not significant, indicating there is no benefit to split 2,4-D applications over single annual applications if treatments continue for more than five years. Maximum leafy spurge control in 1983 was from 2,4-D applied spring and fall at 3.4 kg/ha. Control was not significantly different from spring and fall applications of 2,4-D at 1.7 kg/ha.

Dicamba at 0.6 kg/ha applied biannually did not satisfactorily control leafy spurge. When dicamba was applied with 1.1 kg/ha of 2,4-D in the spring, control was equivalent to that of any spring and fall 2,4-D treatment. However, when a dicamba spring application of 0.6 kg/ha was followed with 1.7 kg/ha of 2,4-D in the fall, control was significantly less than all biannual 2,4-D treatments, 2,4-D applied in the spring at 3.4 kg/ha, and dicamba + 2,4-D applied in the spring. Control was comparable to that of the biannual application of dicamba alone; indicating there was no benefit from the fall 2,4-D application.

Picloram applied at 2.2 kg/ha in 1978 and 1979 controlled leafy spurge as well as any other treatment throughout the term of the study. Control from the treatment was less in 1983 than in 1981 due to weed regrowth. This is a recommended treatment for patch control of leafy spurge, but is not generally economical for large areas. Picloram at 0.3 kg/ha applied annually did not control leafy spurge as effectively during 1979 and 1981 as 2.2 kg/ha of picloram applied in 1978 and 1979. By 1983, control was comparable to all treatments containing picloram, and to all annual 2,4-D applications except for spring and fall 2,4-D at 3.4 kg/ha. Picloram at 0.3 kg/ha applied with either spring or fall 2,4-D provided leafy spurge control in 1981 and 1983 equivalent to any other treatment tested.

Glyphosate applied in the spring of 1978 at either 1.1 or 3.4 kg/ha followed annually by 2,4-D at 1.7 kg/ha provided leafy spurge control in 1979 and 1983 equivalent to any other treatment.

Table 2. Leafy spurge control in 1979, 1981, and 1983, average herbage yield for leafy spurge and forage, and average added return over treatment cost.[a]

Treatment	Rate	Treatment Application			Leafy Spurge Control			Average Herbage Yield[b]		Average Added Return
		1978	1979	1980-1983	1979	1981	1983	Leafy Spurge	Forage	
	(kg/ha)				%			(kg/ha)		($/ha)
2,4-D[c]	1.7	S		...	36 f-h	1 f	11 fg	860 b-d	1600 g-i	8 e-g
2,4-D	0.8	S&F	S&F	S&F	60 c-g	74 a-c	83 bc	66 g	2620 b-d	34 b-d
2,4-D	1.7	S	S	S	39 f-h	42 de	75 cd	160 fg	2550 b-d	41 b-d
2,4-D	1.7	S&F	S&F	S&F	62 b-f	75 a-c	93 ab	28 g	2630 b-d	47 a-d
2,4-D	3.4	S	S	S	50 d-g	67 bc	82 bc	24 g	2400 c-e	38 b-d
2,4-D	3.4	S&F	S&F	S&F	67 b-e	90 ab	98 a	13 g	2900 ab	55 ab
dicamba	0.6	S	...	...	14 hi	4 f	23 f	1300 b	1260 ij	-8 g
dicamba	0.6	S&F	S&F	S&F	37 f-h	30 e	59 e	770 c-e	1930 e-g	9 e-g
dicamba + 2,4-D	0.6 + 1.1	S	S	S	64 b-f	71 a-c	87 a-c	1 g	2720 a-d	48 a-d
dicamba +	0.6	S	S	S	33 gh	35 e	63 de	560 d-f	1820 f-h	5 fg
2,4-D	1.7	F	F	F						
picloram	0.3	S	S	S	49 d-g	62 cd	83 bc	69 g	2310 d-f	26 d-f
picloram	2.2	S	S		86 a-c	94 a	88 a-c	360 e-g	2520 b-d	30 c-e
picloram + 2,4-D	0.3 + 1.1	S	S	S	55 d-g	78 a-c	94 ab	12 g	2880 a-c	31 cd
picloram +	0.3	S	S	S	62 b-f	84 a-c	95 ab	73 fg	2630 b-d	38 b-d
2,4-D	1.7	F	F	F						
glyphosate	3.4	F	...	...	98 a	0 f	0 g	2350 a	790 j	-44 h
glyphosate +	1.1	S	...	...	89 ab	68 bc	91 ab	32 g	2990 ab	52 a-c
2,4-D	1.7	F	S&F	S&F						
glyphosate +	3.4	S	...	...	76 a-d	79 a-c	88 a-c	45 g	3150 a	65 a
2,4-D	1.7	...	S	S						
untreated					0 i	0 f	0 g	1140 bc	1400 hi	0 g

[a]Means within a column followed by the same letter are not significantly different at the 5% level using Waller-Duncan test.
[b]Leafy spurge yield, forage yield, and added return are the averages of 1982 and 1983 harvests.
[c]Butoxyethanol ester.

Forage and leafy spurge production

Forage and leafy spurge weights presented are the average of 1982 and 1983 harvests (Table 2). Leafy spurge production showed a strong inverse relationship to leafy spurge control (r = -0.75). Thus, visual control observations were effective predictors of leafy spurge dry weight. All repeated herbicide treatments significantly decreased the dry weight of leafy spurge compared to untreated plots. The leafiest spurge was present in plots treated with glyphosate at 3.4 kg/ha in the fall of 1978. Forage was essentially removed by the treatment, so leafy spurge growth was uninhibited by forage competition. Forage dry weight was highest when glyphosate was applied at 3.4 kg/ha in spring of 1978 followed with annual 2,4-D treatments. However, considerable grass injury was observed from the glyphosate + 2,4-D treatments for two years following application. Grass regrowth in glyphosate + 2,4-D treated plots was mainly switchgrass (*Panicum vergatum* L.), a warm-season grass, while predominant forages in untreated plots were the cool-season plants Kentucky bluegrass and sedge (*Carex* spp.).

Apparently, glyphosate applied in the spring killed the cool-season forage present, and warm-season grasses were favored by the reduced competition. A spring glyphosate application may then be useful for promoting growth of warm season grasses in pastures. No difference was measured between forage production from treatments of dicamba + 2,4-D applied in the spring, 2,4-D applied spring and fall at 3.4 kg/ha, picloram + 2,4-D, or glyphosate + 2,4-D. A strong positive correlation was measured between leafy spurge control and forage yield, and a strong negative correlation between leafy spurge yield and forage yield (r = 0.74 and -0.82 respectively). It is thus apparent that leafy spurge is a strong competitor with pasture forages, and leafy spurge control will increase forage yields.

Economics of leafy spurge control

All treatments which included picloram or 2,4-D applied in the spring increased added return over untreated plots. Spring glyphosate treatment of 3.4 kg/ha followed by 2,4-D at 1.7 kg/ha increased pasture returns by an average of $65.00/ha in 1982 and 1983 after treatment costs. Added returns were similar to those obtained with annual spring and fall applications of 2,4-D at 1.7 or 3.4 kg/ha, dicabma + spring 2,4-D, and glyphosate at 1.1 kg/ha followed with biannual treatments of 2,4-D.

Conclusions

Treatments which provided the most economically beneficial control of leafy spurge were: 2,4-D at rates of 1.7 to 3.4 kg/ha applied as spring or spring and fall treatments, dicamba + 2,4-D at 0.6 + 1.1 kg/ha applied in the spring, spring applied picloram at 0.3 kg/ha, or glyphosate at 1.1 kg/ha or more followed by annual or biannual 2,4-D applications of 1.7 kg/ha. In general, herbicidal control of leafy spurge was feasible in the pasture tested, and repeated applications of herbicide were necessary to achieve long-term control.

Literature cited

1. Derscheid, L. A. and L. J. Wrage. 1976. Leafy spurge. South Dakota Cooperative Extension Service FS 449.
2. Reece, P. E. and R. G. Wilson. 1983. Effect of Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*) control on grass herbage. Weed Science 31:488-492.