Cost Effectiveness of Leafy Spurge Control During a Five-Year Management Program

Rodney G. Lym and Calvin G. Messersmith

Leafy spurge was first observed in North Dakota in 1909 and has spread rapidly since (2). Leafy spurge is found in all 53 counties of North Dakota and is present on nearly 7 percent of the untilled land in the state (5). Loss of hay and beef cattle production is estimated at 7 million dollars annually due both to reduced forage production from leafy spurge competition and to cattle avoiding grazing in leafy spurge infested areas. Leafy spurge contains a toxic substance that causes scours and weakness in cattle and may result in death (6).

The North Dakota Legislature emphasized leafy spurge control in the 1981-1983 biennium by appropriating $500,000 for a cost-share program. Also, each county was allowed to increase taxes by 1 mill to be used exclusively for leafy spurge control. The funding was divided 33:47:20 between the state, county and landowner, respectively. The 1983 and 1985 legislatures provided additional biennial appropriations of $500,000 and $600,000, respectively, to continue the cost-share program through the 1986-1987 fiscal year.

The importance of leafy spurge control on long-term land values is difficult to assess, but short-term returns can be estimated by measuring changes in forage production and grazing capacity following leafy spurge control. The purpose of this study was to evaluate several herbicides for leafy spurge control, influence on forage production, and cost effectiveness.

MATERIALS AND METHODS

An experiment to evaluate long-term leafy spurge management including forage production was established at four sites (Sheyenne National Grassland located near McLeod and Sheldon and two near Valley City) in North Dakota in 1980. The predominant grasses were Kentucky bluegrass (*Poa pratensis* L.) with occasional crested wheatgrass [(*Agropyron desertorum* (Fesch. ex Link) Schult], smooth brome (*Bromus inermis* Leyss.), big bluestem (*Andropogon gerardii* Vitman) or other native grasses. All sites were established in early June, except one site which was established in September 1980. The herbicides applied in June 1980 included 2,4-D [(2,4-dichlorophenoxy) acetic acid] at 2.0 pounds per acre and picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid; tradename Tordon) at 1.0 and 2.0 pounds per acre. The whole plots were 15 by 150 feet and treatments were replicated twice at each site in a split plot design with a factorial arrangement of treatments. In June 1981, each whole plot was divided into five 7.5 by 50 feet subplots for retreatments of 2,4-D at 1.0 pound per acre, picloram at 0.25 pound per acre, picloram plus 2,4-D at 0.25 + 1.0 pound per acre, and dicamba (3,6,dichloro-2-methoxybenzoic acid; tradename Banvel) at 2.0 pounds per acre or no retreatment, except the fall Valley City site which was retreated in August 1981.

The whole plots were retreated in 1982 with the original treatment, except picloram at 2.0 pounds per acre was reapplied to the control subplot only since the original treatment to plots with picloram at 2.0 pounds per acre in 1980 gave satisfactory leafy spurge control. The experimental site at the Sheyenne National Grassland was treated in the fall of 1982 to establish an equal number of spring and fall treatment sites. Subplot retreatments were reapplied in 1983 and 1984.

Forage yields were obtained from each plot by harvesting a 3 by 25 foot section with a flail mower in July 1981 and a 4 by 15 foot section with a rotary mower in July 1982, 1983 and 1984. Sub-samples were taken by hand clipping along each harvested strip and separating into leafy spurge and forage so the weight of each component in the mowed sample could be estimated. The samples were oven dried at 140 F and are reported at 12 percent moisture. The entire plot was mowed after harvest each year to remove dead leafy spurge stems and other plant material for improved forage measurement and maintenance of plot uniformity. The data for leafy spurge control and forage production were analyzed using the general linear models procedure (7). Economic return was estimated by converting forage production to hay sold for $48.00 per ton (average five-year price) minus the cost of the herbicide and estimated application cost, i.e., 2,4-D = $2.17/lb ai, picloram 2S = $40/lb ai, dicamba = $10.30/lb ai, and application = $2.04/A.

RESULTS AND DISCUSSION

Leafy spurge control generally was higher from spring than similar fall applied treatments (Table 1). Previous

Lym is assistant professor and Messersmith is professor, Department of Agronomy.

research at North Dakota State University has shown that spring or fall applied treatments gave similar leafy spurge control (4). However, the fall treatments in this study were applied to leafy spurge plants that had been mowed in July of each year, so the leafy spurge was shorter and in the vegetative stage of growth compared to the normal fall growth stage. Mowing reduced the leafy spurge leaf area treated and may have resulted in less herbicide uptake and translocation compared to previous research.

The initial treatments in these experiments provided the intended wide range of leafy spurge control needed to evaluate the impact of various retreatment programs on forage production (Table 1). Annual application of 2,4-D (Treatment A) provided only 19 and 14 percent leafy spurge control as spring and fall applied treatments, respectively. Annual spring application of 2,4-D stopped leafy spurge seed production and prevented the infestation from enlarging, but reduction of the original infestation was small. Leafy spurge control was similar with picloram applied at 1.0 or 2.0 pounds per acre in 1980 and 1982 without retreatment (Treatments B and F). Control averaged 82 and 37 percent when applied in the spring or fall, respectively. Adding an annual herbicide retreatment to picloram at 1.0 and 2.0 pounds per acre (Treatments C, D, E, G, H, and I) increased leafy spurge control by an average of 28 percent over fall applied treatments alone, but control was only increased by 7 percent over spring applied treatments alone. When high rates of picloram were applied every other year, there was little advantage to using more than 1.0 pound per acre of picloram or to applying annual retreatments to spring applied picloram. Dicamba at 2.0 pounds per acre (Treatment J) generally provided leafy spurge control between 2,4-D (Treatment A) and picloram at 1.0 pound per acre (Treatment B).

Table 1. Leafy spurge control, annual forage and leafy spurge production, and net return with several herbicide treatments for four years in North Dakota.

Treatment 1980 and 1982	Rate	Retreatment 1981, 1983-1984	Rate	1984 Control	Annual production[a] Forage	Leafy spurge	Total[b] cost	Net return
	(lb/A)		(lb/A)	(%)	(lb/A)		($/A)	
Spring applied								
A. 2,4-D	2.0	2,4-D	1.0	19	1787	46	25	+ 46
B. Picloram	1.0	...	...	81	1551	60	84	− 41
C. Picloram	1.0	Dicamba	2.0	93	1497	0	152	−115
D. Picloram	1.0	Picloram	0.25	85	1323	10	120	−104
E. Picloram	1.0	Picloram + 2,4-D	0.25 + 1.0	91	1780	1	127	− 57
F. Picloram	2.0	...	...	82	1334	20	164	−147
G. Picloram	2.0[c]	Dicamba	2.0	94	1515	0	175	−136
H. Picloram	2.0[c]	Picloram	0.25	86	1809	0	132	− 58
I. Picloram	2.0[c]	Picloram + 2,4-D	0.25 + 1.0	86	1626	0	141	− 89
J. ...	...	Dicamba[d]	2.0	62	1677	98	91	− 32
K. ...	...	Picloram[d]	0.25	37	1632	34	48	+ 5
L. ...	...	Picloram + 2,4-D[d]	0.25 + 1.0	60	1793	0	57	+ 15
M. Control	...	Control	...	0	1193	1240		0
LSD (0.05)				23	477	486		
Fall applied								
A. 2,4-D	2.0	2,4-D	1.0	14	1308	417	21	− 2
B. Picloram	1.0	...	...	32	1510	103	84	− 46
C. Picloram	1.0	Dicamba	2.0	55	1488	15	129	− 72
D. Picloram	1.0	Picloram	0.25	64	1407	17	109	− 81
E. Picloram	1.0	Picloram + 2,4-D	0.25 + 1.0	62	1751	5	113	− 52
F. Picloram	2.0	...	...	41	1270	72	164	−149
G. Picloram	2.0[c]	Dicamba	2.0	73	1284	2	129	−112
H. Picloram	2.0[c]	Picloram	0.25	65	1577	4	108	− 63
I. Picloram	2.0[c]	Picloram + 2,4-D	0.25 + 1.0	68	1335	3	112	− 90
J. ...	...	Dicamba[d]	2.0	25	1246	406	68	− 55
K. ...	...	Picloram[d]	0.25	46	1706	196	36	+ 21
L. ...	...	Picloram + 2,4-D[d]	0.25 + 1.0	43	1644	101	43	+ 8
M. Control	...	Control	...	0	1111	772	...	...
LSD (0.05)				18	132	132		

[a] Average of 4 and 5 years for fall and spring applied treatments, respectively.

[b] Costs do not include 1984 Fall treatment cost, since forage increase will be measured by the 1985 harvest.

[c] Retreatments were applied instead of picloram at 2.0 lb/A in 1982.

[d] Treatment applied annually 1981-1984; no treatment in 1980.

Forage was harvested from all treatments from 1981 to 1984. Forage yield tended to increase as leafy spurge production decreased and all herbicide treatments reduced leafy spurge production compared to the untreated plots (Table 1). Total dry matter (forage plus leafy spurge) production tended to decrease following all herbicide treatments compared to the control and reduction was due mainly to leafy spurge control. However, some treatments also reduced grass production. For example, forage production averaged across spring and fall applied treatments averaged 1152, 1669, 1530 and 1302 pounds per acre for picloram at 0 (control), 0.25 (annual), and 1.0 (alternate years) and 2.0 (alternate years) pounds per acre (Treatments M, K, B, and F), respectively, while leafy spurge production was 1006, 115, 82 and 46 pounds per acre for the same treatments, respectively. Leafy spurge control with picloram resulted in greater forage production than the untreated control, but the greatest reduction in leafy spurge production did not result in the greatest forage production. Injury to grass, mostly non-visible, by picloram at 1.0 and 2.0 pounds per acre applied every other year prevented the maximum increase of forage production when compared to picloram at 0.25 pound per acre applied annually. Total dry matter production of herbicide-treated plots was lowest for picloram at 1.0 and 2.0 pounds per acre (Treatments B and F) and highest for annual treatments of 2,4-D and picloram plus 2,4-D (Treatments A and L).

In general, spring applied treatments resulted in higher forage production than fall applied treatments, which probably was due to the increased leafy spurge control from spring compared to fall applied treatments. Application of 2,4-D at 2.0 pounds per acre followed by 2,4-D at 1.0 pound per acre (Treatment A) is a good example of this trend as forage production averaged 1787 pounds per acre with spring treatments compared to 1308 pounds per acre with fall treatments. However, leafy spurge production was decreased to 46 and 417 pounds per acre from 1240 and 772 pounds per acre for the untreated control (Treatment M) by the spring and fall applied treatments, respectively. The 2,4-D applied to leafy spurge controlled the topgrowth but had minimal effect on the root system, so leafy spurge reinfested within one year to densities equal to or higher than the original stand (1). However, 2,4-D applied in June reduced leafy spurge competition long enough to allow increased forage production.

The highest average forage production was from annual treatments of picloram at 0.25 pound per acre (Treatment K) or picloram plus 2,4-D at 0.25 plus 1.0 pound per acre (Treatment L) which averaged 1669 and 1719 pounds per acre, respectively, when averaged over spring and fall treatments (Table 1). Spring or fall applied picloram at 0.25 pound per acre provided similar control, 37 and 46 percent, respectively (Treatment K). Leafy spurge control from spring applied picloram plus 2,4-D was 23 percent greater than picloram alone but 2,4-D did not increase leafy spurge control from fall applied picloram (Treatment K vs L).

The only treatments that provided a positive net return with both spring or fall applications were picloram or picloram plus 2,4-D (Treatments K and L) with an average net return of $12 per acre after four years (Table 1). The only other treatment to result in economic gain was 2,4-D spring applied annually (Treatment A). Low rates of picloram applied annually were more cost effective for forage production and weed control than a single high rate treatment. The annual low rate applications gradually reduced leafy spurge infestations to 80 percent or better in four years and were relatively inexpensive (3).

All treatments that included picloram at 1.0 and 2.0 pounds per acre or dicamba at 2.0 pounds per acre (Treatments B through J) either as original or retreatments reduced leafy spurge production and increased forage production compared to the control, but also resulted in net losses of $32 to $149 per acre (Table 1). These losses were due to the high cost of the herbicides and/or the less than maximum forage production due to grass injury. Treatments with high rates of picloram and dicamba cannot be justified directly by improved net income. However, these treatments had a comparatively long soil residual that provided the highest leafy spurge control. They can be cost effective in a prevention program to eradicate small infestations of leafy spurge, so annual treatment of large areas will not be required in the future.

Several long-term management alternatives provide a choice of herbicides, duration of acceptable control, and forage production in leafy spurge infested areas. If leafy spurge is in an area that can be treated annually with relatively low application costs, then picloram at 0.25 pound per acre or picloram plus 2,4-D at 0.25 plus 1.0 pound per acre should be the most cost effective treatments when considering both leafy spurge control and forage production. The leafy spurge stand can be reduced gradually (3) while the forage production is maximized. If leafy spurge is located in terrain where annual application is very expensive, then picloram at 1.0 or 2.0 pounds per acre could be used to provide long-term leafy spurge control. Although the 2,4-D treatment provided greater net return than picloram, annual 2,4-D applications will cause minimal reduction of the original infestation but should minimize spreading. The effectiveness of leafy spurge control on future land value cannot be assessed. However, leafy spurge infested land will always have a lower value than uninfested land. It is much more economical to control small areas of leafy spurge when it first appears rather than allow the infestation to expand.

LITERATURE CITED

1. Bybee, T.A. 1979. Factors affecting leafy spurge control including leafy spurge reestablishment, herbicide application dates, herbicide translocation, and root carbohydrates. Ph.D. Thesis. North Dakota State Univ. 80 p. Univ. Microfilms, Ann Arbor, Mich. (Diss. Abstr. 7922217).

2. Hansen, H.C., and V.E. Rudd. 1933. Leafy spurge life history and habits. North Dakota Agric. Exp. Stn. Bull. 266.

3. Lym, R.G., and C.G. Messersmith. 1984. Picloram and 2,4-D combination treatments for long-term leafy spurge management. Res. Rept. North Cent. Weed Control Conf. 41:79-80.

Continued on page 14

Fornstrom, J.K. 1980. Scientific Report No. 1043. Agricultural Engineering Division, University of Wyoming, Laramie, Wyoming.

Gaver, E., C.F. Shaykewich, and E.H. Stobbe, 1981. Departments of Soil Science and Plant Science, University of Manitoba. In Proc. of Tillage Symposium North Dakota. pp. 130-134.

Kapusta, G. 1979. Seedbed tillage and herbicide influence on soybean weed control and yield. Weed Sci. 27:520-526.

Robertson, W.K., H.W. Lundy, G.M. Prine, and W.L. Currey. 1976. Planting corn in sod and small grain residues with minimum tillage. Agron. J. 68:271-274.

Triplett, G.B., Jr. and G.D. Lytle. 1972. Control and ecology of weeds in continuous corn grown without tillage. Weed Sci. 20:453-457.

Continued from page 9

4. Lym, R.G. and C.G. Messersmith. 1985. Leafy spurge control with herbicides in North Dakota: 20-year summary. J. Range Manage. 38:149-154.

5. Messersmith, C.G., and R.G. Lym. 1983. Distribution and economic impacts of leafy spurge in North Dakota. North Dakota Farm Res. 40(5):8-13.

6. Selleck, G.W., R.T. Coupland, and C. Frankton. 1962. Leafy spurge in Saskatchewan. Ecol. Monograph 32:1-29.

7. Statistical Analysis System Institute. 1982. SAS User's Guide: Statistics, Cary, NC. 586 pp.