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Economical control of leafy spurge

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The North Dakota Legislature emphasized leafy spurge control in the 1981-1983 biennium when it appropriated 500,000 dollars for a cost share program. Also, each county was allowed to increase its tax 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 dollars, respectively, to continue the cost-share program through the 1986-87 fiscal year.

There were approximately 750,000 acres in North Dakota infested with leafy spurge in 1980. The common herbicide treatment was either 2,4-D at 1.0 to 2.0 lb/A which cost $2 to 4/A and did little to control the weed or picloram at 2.0 lb/A which gave control for 2 to 3 years but cost $80/A. Thus a more cost effective, long-range program was needed to control leafy spurge on as many acres as the cost share money would allow.

It is difficult to assess the importance of leafy spurge control on long-term land values, but it is possible to estimate short-term returns by measuring changes in forage production and grazing capacity following leafy spurge control. The purpose of these studies was to evaluate several leafy spurge management alternatives with herbicides for leafy spurge control, forage production, and economic return.

Materials and methods

Forage production. An experiment to evaluate long-term leafy spurge management including forage production was established at two sites (Sheldon and Valley City) in North Dakota in 1980. The predominate grasses were bluegrass (*Poa* spp.) with occasional crested wheatgrass (*Agropyron desertorum*), smooth brome (*Bromus inermis*), big bluestem (*Andropogon gerardii*) or other native grasses. The sites were established in early June and herbicides applied included 2,4-D [(2,4-dichlorophenoxy)acetic acid) at 2.0 lb/A and picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid; tradename Tordon) at 1.0 and 2.0 lb/A. 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 six 7.5 by 50 feet subplots for retreatments of 2,4-D at 1.0 lb/A, picloram at 0.25 lb/A alone or with 2,4-D at 1.0 lb/A, and dicamba (3,6,dichloro-2-methoxybenzoic acid; tradename Banvel) at 2.0 lb/A 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 lb/A was reapplied to the control subplot only since subplots receiving annual retreatments maintained satisfactory leafy spurge control. Subplot retreatments were applied again in 1983 and 1984.

Forage yields were obtained from each plot by harvesting a 3 by 25 feet section with a flail mower in July 1981 and a 4 by 15 feet section with a rotary mower in July 1982, 1983 and 1984. Sub-samples were taken by hand along each harvested strip and separated into leafy spurge and forage so the weight of each component in the mowed sample could be calculated. The samples were oven dried at 140º F and are reported with 12% moisture content. 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. Economic return was estimated by converting forage production to hay sold for $48.00/T 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.

Forage utilization. An experiment to evaluate forage utilization by cattle in various densities of leafy spurge was established on 1 May 1984 near Leonard, ND. The 300 A pasture carried 80 cow-calf pairs from May until mid-October. Caged plots were established in four leafy spurge densities, 80% or above (high), 40-80% (moderate), 20-40% (low) and no infestation (zero). Four caged and uncaged 0.25 m^2 paired plots were established per density and there were three replications. Picloram at 1.0 lb/A was applied on 15 June to establish the zero density areas. Production was harvested on 25-26 July and 18 October for caged and uncaged plots, respectively, and separated into cool- or warm-season grasses, leafy spurge and forbs. Caged plots estimated production while the difference between caged and uncaged plots estimated utilization. Natural disappearance of forage was estimated from similar experiments to be 30%.

Herbicide synergism. An experiment to determine the number of annual applications of picloram needed to provide 90 to 100% control of leafy spurge and to investigate possible synergism between picloram and 2,4-D was established at three locations in North Dakota. The experiment was begun on 25 August 1981 at Dickinson, 1 September 1981 at Sheldon and on 11 June 1982 at Valley City. The soil at Dickinson was a loamy fine sand with pH 7.2 and 0.6% organic matter, at Sheldon was a silty clay loam with pH 5.8 and 3.4% organic matter, and at Valley City was loam with pH 6.0 and 3.3% organic matter. Dickinson, located in western North Dakota, generally receives much less precipitation than the other two sites located in eastern North Dakota. All treatments were applied annually except 2,4-D alone which was applied biannually (both spring and fall). Picloram treatments were applied in late August 1981 and in June of 1982 through 1984. Thus, the Dickinson and Sheldon sites have received four picloram and picloram plus 2,4-D treatments and seven 2,4-D treatments, while the Valley City site has received three and six treatments, respectively. The plots were 10 by 30 feet and each treatment was replicated four times in a randomized complete block design at all sites. Evaluations were based on percent stand reduction as compared to the control.

Results and discussion

Forage production. The treatments in these experiments provided the intended wide range of leafy spurge control to evaluate the impact of various treatment programs on forage production (Table 1). Annual application of 2,4-D (Treatment A) provided only 21% leafy spurge control after 5 years of treatment. Annual application of 2,4-D stopped leafy spurge seed production and restricted 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 lb/A in 1980 and 1982 (Treatments B and F), and averaged 81%. Adding an annual herbicide retreatment to picloram at 1.0 and 2.0 lb/A (Treatments C, D, E, G, H, and I) improved leafy spurge control only 7% for spring applied treatments. Thus, when high rates of picloram were applied every other year, there was little advantage to using more than 1.0 lb/A of picloram or to applying annual retreatments. Dicamba at 2.0 lb/A (Treatment J) generally provided leafy spurge control between 2,4-D (Treatment A) and picloram at 1.0 lb/A (Treatment B).

All treatments were harvested for forage production from 1981 to 1984. Forage yield tended to increase while leafy spurge production was decreased by all herbicide treatments (Table 1). Total dry matter (forage plus leafy spurge) production tended to decrease following all herbicide treatments compared to the control, and the reduction was due mainly to leafy spurge control. However, some treatments also reduced grass production. For example, forage production averaged 1193, 1632, 1551 and 1334 lb/A for picloram at 0 (control), 0.25 (annual), and 1.0 and 2.0 (alternate years) lb/A (Treatments M, K, B, and F), respectively, while leafy spurge production was 1240, 34, 60 and 20 lb/A for the same treatments, respectively. Thus, leafy spurge control with picloram resulted in greater forage production than the untreated control. However, injury to grass, mostly non-visible, by picloram at 1.0 and 2.0 lb/A applied every other year prevented the maximum increase of forage production when compared to picloram at 0.25 lb/A applied annually.

The highest average forage production was from picloram at 2.0 lb/A followed by annual treatments of picloram at 0.25 lb/A (Treatment H) or picloram plus 2,4-D at 0.25 plus 1.0 lb/A annually applied (Treatment L) which averaged 1809 and 1793 lb/A, respectively (Table 1). 2,4-D at 1.0 lb/A provided only 21% leafy spurge control but 1787 lb/A forage production (Treatment A). 2,4-D applied annually in the spring kills leafy spurge top growth and allows for increased forage production but does little to reduce the infestation.

The only treatments that provided a positive net return were picloram at 0.25 lb/A, picloram plus 2,4-D at 0.25 Plus 1.0 lb/A, and 2,4-D alone (Treatments K, L, and A) (Table 1). A program with low picloram rates that gradually reduced the leafy spurge infestation with an annual application of a relatively inexpensive herbicide combination was more cost effective for forage production and weed control than a single high picloram rate treatment.

All treatments that included picloram at 1.0 and 2.0 lb/A or dicamba at 2.0 lb/A (Treatments B through J) either as original or retreatments provided both low leafy spurge and increased forage production compared to the control, but resulted in net losses of $32 to 147 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. Thus, treatments with high rates of picloram and dicamba cannot be justified directly on 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.

This study probably underestimates the true dollar value of a control program on land that is grazed by cattle. Cattle refuse to graze in high densities of leafy spurge and thus the annual forage production of 1193 lb/A in the untreated area of this study may not be utilized.

Cattle utilization. Forage production was similar in all densities of leafy spurge except the highest density (Table 2). Unlike many pasture and rangeland weeds, leafy spurge only reduced forage production slightly. However, the forage produced is lost if cattle refuse to graze an infested area. Cattle utilized 31 and 34% of the total forage produced in the zero and low leafy spurge density plots, respectively. Utilization declined to 21% when leafy spurge reached a moderate density of 11 stems/ft^2, and to zero utilization in the high density plots of 22 stem/ft^2. It was expected that cattle would not graze in the moderate density plots but there are several possible reasons this area was grazed. Cattle may naturally graze in moderate leafy spurge stands, but past observations indicate this is unlikely. Mid-May to October was very dry and the stocking rate (animals/area for a given time) was very high so that the cattle may have been forced to graze in more dense leafy spurge stands than normal. Also, cattle were observed grazing in leafy spurge stands after the plants were killed by frost but prior to the final harvest. Thus, utilization would have been overestimated. During the second year of the study uncaged plot areas will be harvested monthly so utilization can be estimated throughout the growing season.

Herbicide synergism. Picloram at 0.25, 0.375 and 0.5 lb/A provided 48, 52 and 81% leafy spurge control, respectively, in August 1984 after four treatments when averaged across the Dickinson and Sheldon locations (Table 3). Control had gradually increased for the picloram at 0.5-lb/A treatment, but not the 0.25 or 0.375 lb/A treatments when compared to the August 1982 and 1983 evaluations. 2,4-D alone provided between 26 and 38% control of leafy spurge after biannual applications for four years.

Leafy spurge control tended to increase when 2,4-D was applied with picloram at 0.25 or 0.375 lb/A (Table 3). Leafy spurge control in June 1985 increased an average of 27 and 8% with picloram at 0.25 or 0.375 lb/A plus 2,4-D at 1.0 to 2.0 lb/A, respectively, when compared to the same picloram rate applied alone. Picloram at 0.5 lb/A plus 2,4-D provided 80 to 82% leafy spurge control and was similar to picloram at 0.5 lb/A alone at 74%. The greatest enhancement with 2,4-D plus picloram seems to be with 2,4-D at 1.5 lb/A or less and picloram at 0.375 lb/A or less. In general, leafy spurge control was similar at all sites and did not seem to be influenced by soil types, pH, organic matter or annual precipitation. After four treatments only picloram at 0.5 lb/A, with or without 2,4-D, is within 10% of the target of 90 to 100% leafy spurge control.

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 piclo-

ram at 0.25 lb/A or picloram plus 2,4-D at 0.25 plus 1.0 lb/A should be the most cost effective treatments when considering both leafy spurge control and forage production. The leafy spurge stand can be reduced gradually while the forage production and forage utilization by cattle is maximized. If leafy spurge is located in terrain where annual application is very expensive, then picloram at 1.0 and 2.0 lb/A could be used to provide long-term leafy spurge control. 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 due to reduced production and carrying capacity. It is much more economical to control small areas of leafy spurge when it first appears, rather than allow the infestation to expand.

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			Retreatment		1985	Annual production			
	1980 and 1982	Rate	1981, 1983-1984	Rate	Control	Forage	Leafy spurge	Total[a] cost	Net return
		(lb/A)		(lb/A)	(%)	(lb/A)		($/A)	
Spring applied									
A.	2,4-D	2.0	2,4-D	1.0	21	1787	46	25	+ 46
B.	Picloram	1.0	...	...	76	1551	60	84	- 41
C.	Picloram	1.0	Dicamba	2.0	92	1497	0	152	- 115
D.	Picloram	1.0	Picloram	0.25	78	1323	10	120	- 104
E.	Picloram	1.0	Picloram + 2,4-D	0.25 + 1.0	92	1780	1	127	- 57
F.	Picloram	2.0	...		86	1334	20	164	- 147
G.	Picloram	2.0[b]	Dicamba	2.0	96	1515	0	175	- 136
H.	Picloram	2.0[b]	Picloram	0.25	92	1809	0	132	- 58
I.	Picloram	2.0[b]	Picloram + 2,4-D	0.25 + 1.0	88	1626	0	141	- 89
J.	…	...	Dicamba[c]	2.0	72	1677	98	91	- 32
K.	…	...	Picloram[c]	0.25	62	1632	34	48	+ 5
L.	…	...	Picloram + 2,4-D[c]	0.25 + 1.0	70	1793	0	57	+ 15
M.	Control	...	Control	...	0	1193	1240		0
	LSD (0.05)				21	477	486		

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

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

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

Table 2. Forage utilization by cattle in four leafy spurge densities.

Leafy spurge density	Leafy spurge	Leafy spurge	Yield						Disappearance	
			Caged			Uncaged				
			Cool	Warm	Total	Cool	Warm	Total	Total	Utilization
	(stems/									
(% cover)	ft)		----------(lb/A) ----------						--------- (%) ---------	
0 (zero)	0	31	1259	159	1418	484	74	558	61	31
20-40 (low)	5	89	1517	265	1782	522	119	641	64	34
40-80 (moderate)	11	464	1061	486	1547	442	304	746	51	21
80-100 (high)	22	1362	925	245	1170	600	217	817	30	0
LSD (0.05)	3	221	396	209	440	396	209	440	4	

[a]Estimate of utilization by cattle based on: Total disappearance - natural disappearance (30%).

Table 3. Leafy spurge control from annual picloram or picloram plus 2,4-D treatments and biannual 2,4-D treatments at three locations in North Dakota.

Herbicide	Rate	Site and 1985 evaluation			Mean			
					August			June
		Sheldon	Dickinson	Valley City	1983	1983	1984[a]	1985
	(lb/A)	---------- (% control) ----------						
Picloram	0.25	12	61	34	39	48	48	36
Picloram	0.375	55	66	78	65	62	52	66
Picloram	0.5	87	74	58	65	71	81	74
2,4-D bian	1.0	31	44	23	22	30	38	33
2,4-D bian	1.5	35	31	38	22	24	26	35
2,4-D bian	2.0	51	29	41	19	30	26	40
Pic + 2,4-D	0.25+1.0	48	82	51	52	66	63	60
Pic + 2,4-D	0.25+1.5	72	71	48	58	66	70	63
Pic + 2,4-D	0.25+2.0	70	71	58	57	62	66	66
Pic + 2,4-D	0.375+1.0	77	82	65	69	72	70	75
Pic + 2,4-D	0.375+1.5	63	85	69	68	74	76	72
Pic + 2,4-D	0.375+2.0	90	75	64	68	59	76	76
Pic + 2,4-D	0.5+1.0	86	89	70	71	75	84	82
Pic + 2,4-D	0.5+1.5	78	85	81	64	73	80	81
Pic + 2,4-D	0.5+2.0	71	86	84	76	75	81	80
LSD (0.05)		33	23	24	18	14	19	15

[a]Experiment at Valley City began in June 1982 and is not included in August 1984 mean.