Effect of Weed Control on Forage Production in the Nebraska Sandhills

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Highlight: Plots for the control of broadleaf weeds and for the determination of forage loss due to broadleaf weeds were established in the Nebraska sandhills. Herbicides were applied in the first year, the first and second years, the first, second and third years, and the first and third years in a four-year study. Forty lb/acre of N (40-N) were applied the fourth year. Herbicide treatments included 2,4-D amine, 2,4-D ester, 2,4,5-T, and silvex at 1 and 3 lb/acre; dicamba at 1/8 or 1/4 lb/acre in combination with 2 or 1 lb/acre 2,4-D amine, respectively; and picloram at 1/16 or 1/8 lb/acre in combination with 2 or 1 lb/acre 2,4-D amine, respectively. Control of broadleaf weeds with herbicide increased forage production up to 330 lb/acre when used without N. N applied following applications of dicamba at 1/4 lb/acre combined with 1 lb/acre 2,4-D amine increased forage production up to 660 lb/acre. Total herbage production increased when N was applied, but broadleaf weed production increased when weeds were not controlled. Herbicides and fertilizer can be effectively utilized to increase forage production, but they will not correct the mismanagement that results in weedy grazing lands.

Weed infestations in grazing lands inhibit forage production and alter livestock grazing patterns (Barrons, 1969; Morrison, 1972). The production of 1 lb of weeds will reduce production of more desirable plants by

an equal amount (Klingman, 1956). Weeds are also influenced markedly by the weather and their production fluctuates widely (McCarty et al., 1974).

Many grazing lands have a great potential for increased production by using intensive management practices (Rogler and Lorenz, 1956). Agricultural chemicals can be important in increasing the production on these lands (Barrons, 1969). Elwell and McMurphy (1963) found in Oklahoma that a single application of 2,4-D at rates of 0.5 and 1.0 lb/acre increased grass yields. Corns and Schraa (1965) found that although there was no definite improvement in forage yield associated with silverberry (*Elaeagnus commutata* Bernh.) control, the availability of forage was improved.

Weeds in grazing lands are considered to be a symptom of mismanagement (Dalrymple et al., 1964; Klingman, 1953). Although herbicides can help return weedy grazing lands to a more productive state, if benefits are to be realized over a long period of time, the use of herbicides must be accompanied by good grazing management. To be beneficial, herbicides must reflect an increase in the amount of forage available to the grazing animal.

The objective of this study was to determine the influence of green sage-wort (*Artemisia campestris* L.) and other broadleaf weeds on forage production in the grazing lands of the Nebraska sandhills. Weed control treatments and 40-N were evaluated for their effect on forage production.

Methods and Materials

The sandhills of Nebraska receive about 20 inches annual precipitation, 70% of which occurs during the growing season. The soil type is Valentine fine sand.

The major warm-season forage grasses are sand bluestem (*Andropogon hallii* Hack.), prairie sandreed (*Calamovilfa longifolia* (Hook.) Scribn.), and blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex. Steud.), which are found on the upland sites, and switchgrass (*Panicum virgatum* L.), which is found on the finer-textured

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The study is a contribution of the Agricultural Research Service, U.S. Dep. Agr., in cooperation with the Nebraska Agricultural Experiment Station (Paper No. 3898).

The authors express appreciation to Mr. Sid E. Salzman, Ainsworth, Nebraska, for the use of the study area and his help in conducting the study.

Manuscript received February 8, 1975.

Table 1. Comparison between broadleaf weed control and forage production from plots receiving two consecutive annual herbicide applications.¹

Herbicide	Treatment		Weed control (%)	Forage production	
	Rate (lb/acre)			Amount (lb/acre)	Increase (%)
Check	0		0 d	740 a	0
2,4-D amine	1		19 cd	710 a	0
2,4-D amine	3		85 ab	900 a	20
2,4-D ester	1		42 bcd	980 a	32
2,4-D ester	3		97 a	1,060 a	42
2,4,5-T	1		76 ab	990 a	32
2,4,5-T	3		62 ab	750 a	0
Silvex	1		51 bc	1,040 a	39
Silvex	3		90 ab	810 a	9
Dicamba + 2,4-D	1/8				
	2		84 ab	1,020 a	37
Dicamba + 2,4-D amine	1/4				
	1		37 bcd	990 a	32
Picloram + 2,4-D amine	1/16				
	2		69 ab	1,040 a	39
Picloram + 2,4-D amine	1/8				
	1		89 ab	970 a	29

¹ Means in the same column followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

soils. Prairie Junegrass (*Koeleria cristata* (L.) Pers.) and needleandthread (*Stipa comata* Trin. and Rupr.) are the main cool-season forage grasses. Broadleaf weeds that are present include green sagewort, western ragweed (*Ambrosia psilostachya* D.C.), and annuals such as sunflower (*Helianthus annuus* L.) and spurge (*Euphorbia* L.). Green sagewort comprises about 80% of the broadleaf weedy vegetation.

Plots 20 ft by 300 ft were arranged in a randomized complete block design with four replications to evaluate forage production in relation to broadleaf weed control. In the first year of a 4-year study, the entire plot was

sprayed for broadleaf weed control. In the second year, the plots were divided into four equal size sections, of which two were sprayed. In the third year, two sections were also sprayed. This sequence resulted in herbicide treatments that had been applied the first year; the first and second years; the first, second, and third years; and the first and third years of the study. In the fourth year, 40 lb N/acre (40-N) was applied to a 20-ft strip of all subplots perpendicularly to the direction of herbicide applications.

Herbicides were applied in late May of each year when green sagewort plants were 2 to 4 inches tall. Fertil-

izer was also applied in late May, to compliment the warm-season grasses that constitute the bulk of the forage in the sandhills.

Herbicides included 2,4-D amine [(2,4-dichlorophenoxy) acetic acid], 2,4-D ester, 2,4,5-T [(2,4,5-trichlorophenoxy) acetic acid] and silvex [2-(2,4,5-trichlorophenoxy) propionic acid] at 1 and 3 lb/acre; dicamba [3,6-dichloro-*o*-anisic acid] at 1/8 or 1/4 lb/acre with 2 or 1 lb/acre 2,4-D amine, respectively; and picloram (4-amino-3,5,6-trichloropicolinic acid) at 1/16 or 1/8 lb/acre with 2 or 1 lb/acre 2,4-D amine, respectively. All herbicides were applied in 20 gallons per acre solution with a tractor-mounted sprayer. The surfactant X-77¹ was added to all herbicides at the rate of 0.5%.

Forage and weed yields were determined in August of each year by clipping at ground level two 2 x 4 ft quadrats located at random in each subplot. Forage and broadleaf weed components were separated and dried at 77°C for 72 hours.

Results and Discussion

Forage yields were harvested the second year of the study. No harvests were made at this time if herbicides had been applied only once. Forage yields averaged 740 lb/acre when no herbicides were applied (Table 1). When herbicides were applied in 2 consecutive years, forage yields were not significantly increased. However, the trend was toward increased forage production when broadleaf weeds were controlled. Forage production was increased about 300 lb/acre when 3 lb/acre of 2,4-D ester, 1 lb/acre of silvex, 1/8 lb/acre dicamba combined with 2 lb/acre 2,4-D amine, or 1/16 lb/acre picloram combined with 2 lb/acre 2,4-D amine were applied in 2 consecutive years. Although these forage yields are not statistically significant, the trend indicates that forage production may be increased with broadleaf weed control. Although the increases in forage yields are large, they are not statistically significant because of the great amount of variability. Inadequate sampling may have contributed to the lack of statistical significance.

The third year, forage yields were harvested from all treatments (Table

Table 2. Forage production (lb/acre) from plots receiving herbicide applications in the first year (D); the first and second years (A); the first, second, and third years (C); and the first and third years (B).¹

Treatment		Oven dry forage weights				
Herbicide	Rate (lb/acre)	A	B	C	D	Average
Check	0	840 a	940 a	1,010 a	750 a	890 s
2,4-D amine	1	1,240 a	1,450 a	1,240 a	880 a	1,200 rs
2,4-D amine	3	1,140 a	1,370 a	1,140 a	1,070 a	1,180 rs
2,4-D ester	1	1,090 a	1,240 a	1,170 a	990 a	1,120 rs
2,4-D ester	3	1,470 a	1,310 a	1,240 a	990 a	1,250 r
2,4,5-T	1	1,390 a	1,190 a	1,090 a	860 a	1,130 rs
2,4,5-T	3	900 a	1,080 a	1,070 a	690 a	940 rs
Silvex	1	1,080 a	1,230 a	1,100 a	680 a	1,020 rs
Silvex	3	1,210 a	1,160 a	1,170 a	1,030 a	1,140 rs
Dicamba + 2,4-D amine	1/8					
	2	1,230 a	1,260 a	1,200 a	930 a	1,160 rs
Dicamba + 2,4-D amine	1/4					
	1	1,380 a	1,300 a	1,130 a	920 a	1,180 rs
Picloram + 2,4-D amine	1/16					
	2	1,220 a	1,330 a	1,250 a	1,030 a	1,210 rs
Picloram + 2,4-D amine	1/8					
	1	1,320 a	1,360 a	1,090 a	1,190 a	1,240 r
Average		1,190 y	1,250 y	1,150 y	920 z	

¹ Means in columns or rows followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

¹ Trade names are included for the benefit of the reader and do not imply endorsement or preferential treatment by the U.S. Department of Agriculture.

Table 3. Average control (%) of broadleaf weeds and forage production (lb/acre, oven dry) from plots receiving herbicide treatments in the first year; the first and second years; the first, second, and third years; and the first and third years.¹

Treatment		Weed control (%)	Forage production	
Herbicide	Rate (lb/acre)		Amount (lb/acre)	Increase (%)
Check	0	0 c	890 b	0
2,4-D amine	1	15 bc	1,200 ab	35
2,4-D amine	3	27 ab	1,180 ab	32
2,4-D ester	1	28 ab	1,120 ab	26
2,4-D ester	3	34 ab	1,250 a	40
2,4,5-T	1	30 ab	1,130 ab	27
2,4,5-T	3	33 ab	940 ab	6
Silvex	1	16 bc	1,120 ab	26
Silvex	3	32 ab	1,140 ab	28
Dicamba + 2,4-D amine	1/8			
	2	33 ab	1,160 ab	30
Dicamba + 2,4-D amine	1/4			
	1	27 ab	1,180 ab	32
Picloram + 2,4-D amine	1/16			
	2	36 ab	1,210 ab	36
Picloram + 2,4-D amine	1/8			
	1	45 a	1,240 a	39

¹ Means in the same column followed by the same letter do not differ significantly at the 5% level by Duncan's multiple-range test.

2). Three lb/acre of 2,4-D ester or 1/8 lb/acre picloram in combination with 1 lb/acre 2,4-D amine significantly increased forage production over that of untreated check when all treatment years are averaged. Forage production was also increased when herbicides were applied in more than one year. No difference existed between treatments (averaged over all herbicides) that had been applied in the first and second years (A); the first, second, and third years (B); and the first and third years (C) of the study; but all were greater than when herbicides were applied in 1 year only (D).

Control of broadleaf weeds had decreased by the third year of the study (Table 3 compared to Table 1); but in general, broadleaf weed control increased forage production. Picloram at 1/8 lb/acre combined with 1 lb/acre 2,4-D amine resulted in 45% control of broadleaf weeds and increased forage production by 350 lb/acre. The 3 lb/acre rate of 2,4-D ester resulted in 34% control of broadleaf weeds and increased forage production by 360 lb/acre or 40% over the untreated check. Although these two herbicide treatments are the only ones that have increased forage production statistically, the trend is toward increased forage production where some degree of broadleaf weed control has been attained.

The fourth year of the study (Table 4), 1 year after the final herbicide application, forage production was

greatest where 3 lb/acre 2,4-D amine, 1 lb/acre 2,4,5-T, the dicamba-2,4-D amine combinations, and the picloram-2,4-D amine combinations had been applied, (averaged over all treatment sequences). The untreated check averaged 820 lb/acre forage, whereas the most successful herbicide treatments produced more than 1,110 lb/acre forage. When herbicides were applied in more than 1 year, forage production, averaged over all herbicides was increased. Herbicides applied in 2 consecutive years increased forage pro-

duction by 140 lb/acre, compared to a single herbicide application. No difference existed between herbicides that were applied in 3 consecutive years (B) or in alternate years (C). These treatments increased forage production by about 270 lb/acre when compared to a single herbicide application (D).

The best production resulted from herbicide applications in the first and third years or in the first, second, and third years. Forage produced from these repeated applications was nearly 300 lb/acre more than that of the untreated check. About 170 lb/acre more forage was produced from areas that had been treated in the first and second years. However, it had been 2 years since these treatments had been applied. This indicates the reestablishment of the weedy vegetation in the treated areas.

During the fourth year, forage yields were increased 330 lb/acre when 3 lb/acre 2,4-D amine or 1 lb/acre 2,4,5-T had been applied (Table 5). When 40-N was applied, forage yields were increased 200 lb/acre when all herbicide treatments are averaged. Forage production was increased about 520 lb/acre over that of the unsprayed, fertilized check when the application of 1/4 lb/acre dicamba in combination with 1 lb/acre 2,4-D amine was followed by 40-N. The 3 lb/acre rate of 2,4-D amine, dicamba

Table 4. Forage production (lb/acre, oven dry) harvested the fourth year from plots receiving herbicide applications in the first year (D); the first and second years (A); the first, second, and third years (B); and the first and third years (C).¹

Treatment		Forage production				
Herbicide	Rate (lb/acre)	A	B	C	D	Average
Check	0	660 j	920 b-j	870 c-j	820 d-j	820 t
2,4-D amine	1	730 g-j	1,280 a-d	1,120 a-j	850 c-j	1,000 rst
2,4-D amine	3	1,000 a-j	1,190 a-g	1,310 abc	1,070 a-j	1,140 r
2,4-D ester	1	1,040 a-j	1,000 a-j	970 a-j	840 d-j	960 rst
2,4-D ester	3	1,130 a-i	920 b-j	1,150 a-i	850 c-j	1,010 rst
2,4,5-T	1	1,220 a-f	1,360 ab	1,110 a-j	750 f-j	1,110 r
2,4,5-T	3	730 hij	910 b-j	1,090 a-j	680 ij	850 st
Silvex	1	950 a-j	1,360 ab	920 b-j	730 g-j	990 rst
Silvex	3	1,070 a-j	1,010 a-j	1,030 a-j	990 a-j	1,020 rst
Dicamba + 2,4-D amine	1/8					
	2	960 a-j	1,150 a-h	1,140 a-i	860 c-j	1,030 rs
Dicamba + 2,4-D amine	1/4					
	1	1,110 a-j	1,400 a	1,250 a-e	780 e-j	1,130 r
Picloram + 2,4-D amine	1/16					
	2	1,160 a-h	1,030 a-j	1,280 a-d	780 e-j	1,060 rs
Picloram + 2,4-D amine	1/8					
	1	1,050 a-j	1,190 a-g	1,230 a-e	1,000 a-j	1,120 r
Average		990 y	1,130 x	1,110 x	850 z	

¹ Means in columns or rows followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

Table 5. Forage production (lb/acre, oven dry) the fourth year as affected by herbicide applications in the first year (D); the first and second years (A); the first, second, and third years (B); and the first and third years (C) and 40-N.¹

Treatments		Forage production									
Herbicide	Rate (lb/acre)	A		B		C		D		Average	
		NF ²	F	NF	F	NF	F	NF	F	NF	F
Check	0	680	650	810	1,030	940	800	560	1,080	750 p	890 p-s
2,4-D amine	1	760	700	1,110	1,460	1,060	1,180	790	900	930 p-t	1,060 q-u
2,4-D amine	3	1,070	930	1,000	1,390	1,420	1,200	830	1,300	1,080 r-u	1,210 tuv
2,4-D ester	1	870	1,220	830	1,160	930	1,010	710	970	830 pqr	1,090 r-u
2,4-D ester	3	1,070	1,200	790	1,050	1,100	1,190	690	1,010	910 p-t	1,120 r-u
2,4,5-T	1	1,190	1,250	1,310	1,410	1,100	1,130	710	800	1,080 r-u	1,150 r-v
2,4,5-T	3	610	840	770	1,050	1,050	1,150	610	750	760 p	940 p-t
Silvex	1	970	930	1,090	1,630	1,070	760	830	630	990 p-u	990 p-u
Silvex	3	1,210	940	970	1,040	920	1,130	790	1,180	970 p-u	1,010 q-u
Dicamba + 2,4-D amine 1/8 + 2		1,020	900	1,070	1,230	1,030	1,250	610	1,110	930 p-t	1,120 r-u
Dicamba + 2,4-D amine 1/4 + 1		800	1,430*	970	1,820*	930	1,560*	710	850	850 pqr	1,410 v
Picloram + 2,4-D amine 1/16 + 2		1,040	1,290*	1,040	1,020	1,070	1,500*	630	930	940 p-t	1,180 s-v
Picloram + 2,4-D amine 1/8 + 1		760	1,330*	1,150	1,240	1,010	1,440*	940	1,070	970 p-u	1,270 uv
Average		930 x	1,050 xy	990 x	1,270 z	1,050 xy	1,180 yz	720 w	970 x	920 j	1,120 k

¹ Means in columns or rows followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

² NF—No fertilizer was applied; F—40-N.

*Value differs significantly at the 5% level from the check in the same column.

at 1/4 lb/acre combined with 1 lb/acre 2,4-D amine and picloram at 1/8 lb/acre in combination with 1 lb/acre 2,4-D amine increased forage production when they were followed with 40-N. Forage production was increased by 300 lb/acre from herbicide applications in 3 years (B) followed by 40-N when compared to a single herbicide application (D). This combination of treatments increased forage production by 520 lb/acre when compared to the sprayed, unfertilized check. No difference existed between 3 consecutive years (B) of herbicide applications and alternate yearly herbicide applications (C) when all herbicides are averaged.

After applications of 1/4 lb/acre dicamba in combination with 1 lb/acre 2,4-D amine or the picloram-2,4-D amine combinations in the first and third years (C) followed by 40-N, forage production was slightly higher than for these treatments applied in the first and second years (A) but less

than the same treatments applied for 3 consecutive years (B).

The data indicate that the control of broadleaf weeds will increase forage production. Additional increases in forage production will result from effective weed control treatments followed by N fertilizer. Application of herbicides in alternate years, in conjunction with N fertilization, appears to have as many benefits as applications in consecutive years for the control of green sagewort and other broadleaf weeds in this study. Applications of weed control treatments in alternate years will control the reestablishing seedlings, while costs of application and material will be reduced by applying them in alternate years.

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CLYDE ROBIN NATIVE SEEDS

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