EFFECTS OF MULTI-SPECIES GRAZING ON LEAFY SPURGE INFESTED RANGELAND USING TWICE-OVER ROTATION AND SEASON-LONG GRAZING TREATMENTS (Eight-Year Summary)

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Impact Statement

Season-long grazing of cattle and sheep will reduce leafy spurge in fewer grazing seasons than twice-over rotation grazing of cattle and sheep; however, trends indicate that in time twice-over rotation grazing will provide similar control to season-long grazing.

Introduction

Herbicides continue to be the primary method to control and eradicate leafy spurge (*Euphorbia esula* L.; Lym et al. 1995). However, it is not economically feasible to control large infestations (Bangsund et al. 1996). Most herbicides which provide effective control of leafy spurge are not labeled for use in environmentally sensitive areas. This noxious weed, which is extremely persistent and competitive, has contributed significantly to economic losses to the livestock industry (Leitch et al. 1994). The economic losses associated with leafy spurge invasion require that the spread of leafy spurge is controlled and ultimately reversed.

Use of grazing as a biological control for leafy spurge has become more acceptable in recent years. Goats have been reported to be an excellent tool to control and reduce leafy spurge infestations (Sedivec and Maine 1993; Hanson 1994; Prosser 1995; Sedivec et al. 1995). The use of sheep as a control method was proven successful as early as the late 1930s and early 1940s by Helgeson and Thompson (1939) and Helgeson and Longwell (1942). However, there have been many disagreements in the literature concerning utilization of leafy spurge by sheep (Landgraf et al. 1984) due to the aversive chemicals found in the latex of leafy spurge. Research by Lym and Kirby (1987) reported that cattle totally or partially avoid leafy spurge infested sites and intensify use on non-infested sites.

Multi-species grazing, the concurrent use of rangeland by more than one kind of animal, has been advocated to maximize animal production/acre (Merrill and Miller 1961). The utilization of more than one livestock species on a rangeland which contains various vegetative communities provides the potential of increasing species diversity, vegetative production, and ultimately red meat production/acre. However, no published reports have documented the potential use of sheep and cattle in a multi-species grazing approach to improve graminoid species use, increase plant richness, and to control leafy spurge on leafy spurge infested rangeland.

The objectives of this study were to:

1) Determine effects of multi-species grazing using twice-over rotation grazing system (**TOR**), season-long grazing treatments (**SL**), and non-use treatment (**NU**) on leafy spurge control.

2) Evaluate species diversity, herbage production, degree of disappearance of herbage, and livestock performance on TOR and SL using a multi-species grazing program.

Study Area

The research was conducted on two separate tracts of land in Morton County. The first tract was Sections 31 and 32, T139N, R81W, in south central North Dakota, approximately two miles southwest of Mandan. This tract consisted of 603 acres of native rangeland owned by the North Dakota State Correctional Center. The second tract was on the north half of Section 9, T138N, R81W on 237 acres of native rangeland operated by the Northern Great Plains Research Laboratory, approximately three miles south of Mandan. Both tracts are found in the Missouri Slope Prairie Region and associated with the Heart River Watershed. Vegetation in this region is typical of northern mixed grass prairie (Barker and Whitman 1988) and classified as a wheatgrass-grama-needle grass (*Agropyron*, *Bouteloua*, *Stipa*) plant community (Shiflet 1994). Leafy spurge infestations were mapped before the study and estimated to cover 30 percent of each tract of rangeland.

The TOR consists of four pastures grazed by one herd of cow/calf pairs and mature dry ewes. A total of 96 animal units (AU) of cattle (eight five 1200 lb. cows with calves) and 33 AU of sheep (two hundred 135 lb. mature white-face ewes without lambs), or a total 532 animal unit months (AUM), grazed the TOR treatment in 1996 and 1997. Cattle AU were reduced to 85 AU of cattle (seventy six 1200 lb. cows with calves) in 1998; however, sheep AU remained the same and a total 491 AUM grazed the TOR in 1998. In 1999 - 2003, stocking rates were increased to 120 AU of cattle (85 – 1420 lb cows with calves) and 42 AU of sheep (250 – mature white-face ewes without lambs), or 810 AUM of grazing. The overall stocking rate was 0.88 AUM/acre in 1996 and 1997, 0.82 AUM/acre in 1998, and 1.3 AUM/acre in 1999 - 2003. Cattle and sheep are rotated through the four pastures twice each year.

The SL treatment was grazed moderately light in 1996 due to lack of range evaluation data and unknown carrying capacities. Twenty-seven AU of cattle (thirty five 700 lb. yearling steers) and 8 AU of sheep (forty eight 135 lb. mature white-face ewes without lambs), or a total 144 AUM, grazed the SL treatment in 1996. Stocking densities were increased in 1997 - 2003 to include 37 AU of cattle (forty nine 705 lb. yearling steers) and 13 AU of sheep (seventy eight 135 lb. mature white-face ewes without lambs), or a total 250 AUM. The overall stocking rate was 0.61 AUM/acre in 1996 and 1.05 AUM/acre in 1997 - 2003. Cattle and sheep graze one pasture the entire grazing season each year.

Sheep were placed on pasture approximately 15 May each year when leafy spurge was ready for grazing and cattle on 1 June when native cool season grass species reach grazing readiness (3-4 leaf stage). Livestock species were removed from the treatments when 50 to 60 percent degree of graminoid disappearance was reached, or by 1 October.

Materials and Methods

Objective 1

Leafy spurge stem density was determined in three 32 ft by 16 ft exclosures/treatment. Each exclosure was subdivided in two 16 ft by 16 ft plots with one plot randomly assigned a grazed treatment (TOR or SL) and the second plot an ungrazed treatment (NU). A 2.5 ft buffer was placed along the inside border of each grazed and ungrazed plot to prevent an edge effect. Each plot was further stratified into 1.08 ft^2 (0.1 m^2) quadrats and each quadrat assigned a number. Ten 1.08 ft^2 quadrats were randomly selected in each treatment for leafy spurge stem density counts. Leafy spurge stem densities were collected in the first week of June throughout the duration of the study.

Objective 2

Forage production and degree of disappearance for leafy spurge, grass and grass-like, shrubs, and other forbs were determined using a pair-plot clipping technique (Milner and Hughes 1968). Eight cages were dispersed in each of the four pastures of the TOR; four cages in leafy spurge infested sites and four in non-infested sites. Twelve cages were systematically placed in the SL pastures; six cages in leafy spurge infested sites and six cages on non-infested sites. Two plots were clipped from each cage using a 2.7 ft^2 (0.25 m^2) frame.

Livestock performance and production were determined for both cattle and sheep and expressed as average daily gain. Weights were taken when animals were allocated to and removed from pastures each year.

Treatment and year effects for leafy spurge stem density, species richness, forb and shrub density, herbage production, degree of use, and livestock performance were analyzed using a general linear model (**GLM**; SPSS 1999). Mean separation was performed using Tukey's Honesty Significant Difference when significant ($P < 0.05$) differences were found. Shannon Wiener Index was used to calculate species diversity indices for both leafy spurge infested and non leafy spurge infested range sites. Treatment and year effect's of species diversity was analyzed using a non-parametric test (**Krushal-Wallis Test**; SPSS 1999).

Results and Discussion

Leafy spurge stem density decreased ($P \leq 0.05$) on the SL after four grazing seasons while taking seven grazing seasons to achieve a decrease ($P \leq 0.05$) on TOR. Following eight grazing seasons, leafy spurge stem density was reduced 100% for SL, and 75% for TOR. These results support trends observed by Lym et al. (1997), who evaluated multi-species grazing with cattle and angora goats. They reported season-long grazing reduced leafy spurge stem density faster than rotational grazing. Results of both studies suggest that season-long grazing using a multi-species approach will reduce leafy spurge stem density faster than rotational grazing.

Plant species diversity on non-infested and leafy spurge infested range sites was different ($P \geq 0.05$) in 1996 because of experimental design (Table 2 and 3). No significant changes have occurred for SL on native sites, however, yearly variation is evident (Table 2). Plant species diversity on the TOR native sites exhibited a decrease ($P \leq 0.05$) as grazing seasons progressed (Table 2). No change ($P \geq 0.05$) in plant species diversity has been observed for leafy spurge infested sites for either treatment (Table 3).

Cow average daily gain (**ADG**) was lower ($P < 0.05$) in 1998 (Table 4) than all other grazing seasons for TOR, which coincides with the year with the lowest graminoid production (data not shown). Calf ADG was highest in 2000 ($P < 0.05$), which corresponds with an above average year for graminoid production (data not shown). Steer ADG for SL was highest ($P < 0.05$) in 1999 and lowest ($P < 0.05$) in 1998 and 2002. Ewe ADG for TOR was highest ($P < 0.05$) in 1996 and 2000, and lowest ($P < 0.05$) in 2001. Season-long ewe ADG was highest ($P < 0.05$) in 1997 and 2001, and lowest in 2003 ($P < 0.05$). Results for ewe ADG are not readily explainable, as performance did not follow available standing forage. Numerically, ewe ADG has been higher on TOR for 6 out of 8 years. A possible explanation is that leafy spurge stem density has not declined on the TOR treatment as rapidly as on SL, resulting in more available forage for sheep on the TOR treatment.

Conclusion

Season-long grazing of cattle and sheep will reduce leafy spurge in fewer grazing seasons than twice-over rotation grazing. However, it appears that with additional time twice-over rotation grazing will provide similar control to season-long grazing. Results for plant species diversity are inconclusive at this time. Additional years of treatment application should begin to yield significant results. Livestock performance results indicate that yearly variation exists, regardless of grazing management. Ewe ADG was higher 6 out of 8 grazing seasons for TOR, possible due to an increased availability of leafy spurge.

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Table 1. Effect of season-long or twice-over rotation grazing on leafy spurge stem density (number/1.08 ft^2; SE in parentheses).

	Season-long	Twice-Over Rotation
1996	14.4 (1.7)[c]	13.2 (1.0)[bc]
1997	12.3 (1.3)[c]	15.9 (1.1)[c]
% change, 1996 to 1997	**-13.2**	**+20.5**
1998	11.6 (1.7)[c]	12.8 (0.8)[bc]
% change, 1996 to 1998	**-20.1**	**-3.0**
1999	5.7 (0.9)[b]	13.4 (1.0)[bc]
% change, 1996 to 1999	**-60.4**	**+1.0**
2000	1.1 (0.2)[a]	9.0 (0.9)[b]
% change, 1996 to 2000	**-92.3**	**-31.8**
2001	0.1 (0.1)[a]	9.5 (0.7)[b]
% change, 1996 to 2001	**-99.3**	**-28.0**
2002	0.0 (0.0)[a]	3.4 (0.4)[a]
% change, 1996 to 2002	**-100.0**	**-74.5**
2003	0.13 (0.1)[a]	3.4 (0.4)[a]
% change, 1996 to 2003	**-100.0**	**-74.5**

[a,b,c]Within a column, means without a common superscript differ ($P>0.05$).

Table 2. Effect of season-long or twice-over rotation grazing on Shannon Weiner diversity index on non leafy spurge infested sites.

	Season-long		Twice-over Rotation	
Year	Shallow	Silty	Shallow	Silty
1996	2.98	2.69	2.55	2.62
1997	NA	NA	NA	NA
1998	3.01	2.52	2.36	2.44
1999	2.65	2.69	2.36	2.34
2000	3.06	2.83	2.04	2.07
2001	2.84	2.78	2.23	2.08
2002	2.71	2.68	2.25	2.18

Table 3. Effect of season-long or twice-over rotation grazing on Shannon Weiner diversity index on leafy spurge infested sites.

	Season-long		Twice-over Rotation	
Year	Shallow	Silty	Shallow	Silty
1996	2.12	2.15	2.25	2.19
1997	1.99	2.04	2.09	2.09
1998	1.94	2.22	2.19	2.39
1999	2.14	2.15	2.39	2.31
2000	2.04	2.00	2.15	2.28
2001	2.38	2.07	2.26	2.35
2002	2.32	1.99	2.23	2.04

Table 4. Effect of season-long (SL) or twice-over rotation (TOR) grazing on cattle average daily gain (lb/d; SE in parentheses).

Year	TOR Cow	TOR Calf	SL Steer
1996	0.79 (0.05)^{b}	2.34 (0.03)^{a}	1.99 (0.04)^{de}
1997	1.00 (0.05)^{bc}	2.33 (0.03)^{a}	1.84 (0.03)^{cd}
1998	0.00 (0.05)^{a}	2.42 (0.03)^{ab}	1.54 (0.04)^{a}
1999	0.67 (0.05)^{b}	2.64 (0.03)^{c}	2.08 (0.04)^{e}
2000	1.39 (0.05)^{d}	2.86 (0.02)^{d}	1.91 (0.03)^{cd}
2001	0.85 (0.05)^{bc}	2.55 (0.03)^{bc}	1.79 (0.04)^{bc}
2002	0.82 (0.04)^{bc}	2.60 (0.03)^{c}	1.60 (0.04)^{a}
2003	1.18 (0.22)^{cd}	2.64 (0.05)^{c}	0.66 (0.04)^{ab}

^{a,b,c,d,e}Within a column, means without a common superscript differ (P>0.05).

Table 5. Effect of season-long (SL) or twice-over rotation (TOR) grazing on ewe average daily gain (lb/d; SE in parentheses).

Year	TOR Ewe	SL Ewe
1996	0.32 (0.01)^{d}	0.26 (0.02)^{de}
1997	0.25 (0.01)^{bc}	0.28 (0.01)^{e}
1998	0.26 (0.01)^{c}	0.23 (0.10)^{cd}
1999	0.24 (0.01)^{bc}	0.17 (0.10)^{ab}
2000	0.30 (0.00)^{d}	0.19 (0.01)^{abc}
2001	0.20 (0.01)^{a}	0.32 (0.01)^{e}
2002	0.22 (0.01)^{ab}	0.21 (0.01)^{bcd}
2003	0.24 (0.01)^{bc}	0.15 (0.01)^{a}

^{a,b,c,d,e}Within a column, means without a common superscript differ (P>0.05).