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

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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).

Use of grazing as a biological control for leafy spurge has become more acceptable in recent years. Goats have been shown 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 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) showed 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 (Merrill and Miller 1961). It is an important concept in rangeland management because of the presence of one or more classes of vegetation (Merrill et al. 1966). 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 and 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 consisted of four pastures grazed from 15 May to 1 October by one heard of cow/calf pairs and mature dry ewes. A total of 96 animal units (AU) of cattle (85 - 1200 lb. cows with calves) and 33 AU of sheep (200 - 135 lb. mature white-face ewes without lambs) or a total 532 animal unit month's (AUM's) grazed the TOR treatment in 1996 and 1997. Cattle AU were reduced to 85 AU of cattle (76 - 1200 lb. cows with calves) in 1998; however, sheep AU remained the same and a total 491 AUM's grazed the TOR in 1998. The overall stocking rate was 0.88 AUM's/acre in 1996 and 1997 and 0.82 AUM's/acre in 1998 on the TOR treatment. Stocking rates were decreased due to below average winter snow cover and rain fall in the spring 1998.

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 (35 - 700 lb. Yearling steers) and 8 AU of sheep (48 - 135 lb. mature white-face ewes without lambs) or a total 144 AUM's grazed the SL treatment in 1996. The overall stocking rate was 0.68 AUM's/acre in 1996 on the SL treatment. The SL treatment was grazed by yearling steers and mature ewes and stocked with 37 AU of cattle (49 - 705 lb. yearling steers) and 13 AU of sheep (78 - 135 lb. mature white-face ewes without lambs) or a total 207 AUM's grazed in 1997 and 1998. The overall stocking rate was 0.88 AUM's/acre in 1996, 1997, and 1998 on the SL treatment.

Sheep were placed on pasture approximately 15 May each year when leafy spurge was ready for grazing and cattle placed on pasture 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 1 October. During all three years livestock grazed until 1 October.

Methods

Objective 1

Leafy spurge density was counted in six 32 ft by 16 ft enclosures. Three enclosures were systematically placed in each of the TOR and SL treatments. Each 32 ft by 16 ft enclosure was subdivided in two 16 ft by 16 ft plots with one plot randomly assigned a grazed treatment (TOR

or SL) and 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 density counts. Leafy spurge 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 of the cages were systematically placed in leafy spurge infested sites and four in non-infested sites. Twelve cages were systematically placed in the SL, six cages placed on 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) frames.

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 each treatment.

Data Analysis

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). A mean separation was performed using Tukey's Honesty Significant Difference when significant ($P<0.05$) differences were found. The 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 significantly decreased ($P\leq0.05$) on the SL after three grazing seasons, and took four grazing seasons to see a significant change ($P\leq0.05$) within the TOR. After five grazing seasons the SL had a reduction of 100% and the TOR had 75% reduction of leafy spurge stem densities. These results followed similar trends found by Lym et al. (1997) comparing multi-species grazing with cattle and angora goats. They reported season-long grazing reduced leafy spurge stem density faster than rotational grazing. Results of this study support Lym et al. (1997) in that season-long grazing using a multi-species approach will reduce leafy spurge stem density faster than rotational grazing, however, with time the rotational grazing would provide similar control.

Plant species diversity on non-infested and leafy spurge infested range sites were different ($P\geq0.05$) in 1996 (Table 2 and 3). The SL native range sites did show an up and down trend with no significant changes. Plant species diversity on the TOR, however, showed a negative trend on non-infested range sites (Table 2). Leafy spurge sites on both treatments showed no significant changes. The trend, however, was positive on SL leafy spurge shallow range sites. No negative or positive trends were noticeable on the SL leafy spurge silty range sites, TOR leafy spurge shallow sites, and TOR leafy spurge silty sites (Table 3).

Cow average daily gain (ADG) decreased (P<0.05) from 1996 to 1998 and increased (P≤0.05) from 1998 to 2001. Cow ADG was significantly higher (P≤0.05) in 2000 than the other five grazing seasons. Calf ADG results showed a significant increase (P≤0.05) ADG from 1996 to 1999 and from 1999 to 2000, however, calf ADG significantly lower (P≤0.05) in 2001 and 2002 than 2000 (Table 4). Steer ADG results on the SL treatment also showed a significant decrease (P≤0.05) in 1998 and then an increase (P≤0.05) in 1999 (Table 4). Average daily gains decreased (P≤0.05) from 1999 to 2000 and from 2000 to 2001, and from 2001 to 2002 on the SL treatment. Ewe average daily gain results show no year effects were present through seven grazing seasons (Table 5). Treatment effects were present in years 1996, 1999, 2000, and 2001. Ewe performance on the TOR were significantly (P≤0.05) higher than the SL in years 1996, 1999, and 2000 (Table 5).

Table 1. Leafy spurge stem densities on the season-long (SL), twice-over rotation (TOR) grazing treatment's for 1996 through 2002. (SE in parentheses.)

	Season-long	**Twice-Over Rotation**
	# / 1.08 ft^2	
1996	14.4 (1.9)[a]	13.2 (1.5)[a]
1997	12.5 (1.0)[a]	15.9 (1.4)[a]
% change 1996 to 1997	**-13.2**	**+20.5**
1998	11.5 (1.5)[a]	12.8 (1.1)[a]
% change 1996 to 1998	**-20.1**	**-3.0**
1999	5.7 (0.6)[b]	13.4 (1.4)[ac]
% change 1996 to 1999	**-60.4**	**+1.0**
2000	1.1 (0.3)[b]	9.0 (1.3)[c]
% change 1996 to 2000	**-92.3**	**-31.8**
2001	0.1 (0.1)[b]	9.5 (0.7)[c]
% change 1996 to 2001	**-99.3**	**-28.0**
2002	0.0 (0.0)[b]	3.4 (0.4)[d]
% change 1996 to 2002	**-100**	**-74.5**

[1] Years and treatments with the same letter within treatments are not significantly different (P>0.05).

Table 2. Shannon Weiner diversity index on shallow and silty non-infested sites on the twice-over rotation and season-long grazing treatment's for 1996 through 2002.

	Season-long		**Twice-over Rotation**	
	Species Diversity Index on Non-Infested Sites			
	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. Shannon Weiner diversity index on shallow and silty leafy spurge infested sites on the twice-over rotation and season-long grazing treatment's for 1996 through 2002.

	Season-long		**Twice-over Rotation**	
	Species Diversity Index on Leafy Spurge Infested Sites			
	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. Cattle average daily gains on treatments: twice-over rotation (TOR) and season-long (SL) for 1996 through 2002. (SE in parentheses.)

Year[1]	**TOR Cow**	**TOR Calf**	**SL Steer**
	kg/day		
1996	0.35 (0.02)[a]	1.06 (0.02)[a]	0.90 (0.02)[ad]
1997	0.45 (0.02)[b]	1.06 (0.02)[a]	0.83 (0.01)[ab]
1998	0.01 (0.02)[c]	1.10 (0.02)[a]	0.69 (0.02)[c]
1999	0.30 (0.02)[a]	1.20 (0.02)[b]	0.94 (0.02)[d]
2000	0.63 (0.02)[d]	1.30 (0.02)[c]	0.87 (0.01)[a]
2001	0.39 (0.02)[ab]	1.15 (0.02)[b]	0.81 (0.02)[b]
2002	0.37 (0.02)[ab]	1.17 (0.02)[b]	0.73 (0.02)[e]

[1]Years with the same letter within each treatment are not significantly different (P>0.05) (a, b, c, d, and e).

Table 5. Ewe average daily gains on treatments: twice-over rotation (TOR) and season-long (SL) for 1996 through 2002. (SE in parentheses.)

Year[1]	TOR Ewe[2]	SL Ewe[2]
	kg/day	
1996	0.15 (0.003)^{ax}	0.12 (0.001)^{ay}
1997	0.11 (0.002)^{ax}	0.13 (0.003)^{ax}
1998	0.12 (0.003)^{ax}	0.10 (0.003)^{ax}
1999	0.11 (0.003)^{ax}	0.08 (0.003)^{ay}
2000	0.14 (0.002)^{ax}	0.09 (0.002)^{ay}
2001	0.09 (0.003)^{ax}	0.15 (0.003)^{ay}
2002	0.10 (0.001)^{ax}	0.10 (0.003)^{ax}

[1]Years with the same letter within each treatment are not significantly different (P>0.05) (a, b, and c).
[2] Treatments with the same letter are not significantly different (P>0.05) (x, y, and z).

Conclusion

Multi-species grazing with cattle and sheep in a season-long (SL) grazing treatment will reduce leafy spurge quicker than a twice-over rotation (TOR) grazing treatment. The trend of this study, however, would show that in time the TOR would provide similar control than the SL in a long term management plan. The continuation of this project will allow use to detect which treatment will increase plant species diversity on leafy spurge infested sites. At this time it is too soon to make any conclusion on species diversity. Livestock performance results showed that the TOR has provided greater average daily gains than the TOR for the ewes, however, this may be related to the amount of leafy spurge remaining in the TOR. Leafy spurge stem counts on the TOR are still much higher than the SL, which would suggest that the ewes on the TOR are receiving a higher quality diet than the SL throughout the growing season with the presence of leafy spurge, however, this doesn't hold true for the 2001 and 2002 grazing season's where ewe ADG was higher and similar on the SL treatment. Livestock results have also shown that the TOR has increased calf average daily gains over five grazing seasons.

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