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MODIFICATION TO CRESTED WHEATGRASS VEGETATION BY GRAZING AND MOWING MANAGEMENT TO AFFECT GRASSHOPPER POPULATIONS, 1993-1994

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Millions of acres in the northern Great Plains exist as mixtures or monocultures of crested wheatgrass (*Agropyron cristatum* (L.) Gaertn., *A. desertorum* (Fisch.) Schult., and related taxa) because it has been the principal grass selected for use during revegetation of previously plowed rangelands in the United States and Canada (Lorenz 1986). During the first 20 years of the 20th Century, millions of acres of rangeland were turned over with the use of the steel plow in order to fulfill the compliance requirements of the Homestead Acts and because of the high demand for wheat, flax, and a few other crops. The region was experiencing favorable climatic conditions during this period and cropland production was generally successful, which stimulated the plowing of additional acres of rangeland. During the 1930's and 1940's, both Canada and the United States suffered many years of severe drought conditions and economic depression. Much of the cropland areas were abandoned and exposed to wind and water erosion. Crested wheatgrass was successfully seeded into these areas primarily because of its seedling vigor, and it helped reduce erosion problems and stabilized the land. Crested wheatgrass plants have persisted on these revegetated cropland areas because of their ability to survive unfavorable conditions of low precipitation and cold winters. Some of these areas that have been revegetated with crested wheatgrass are large enough to be used and managed as separate units. These larger areas are currently being used primarily as hay fields and as spring and summer pastures. Much of the revegetated areas are small parcels located within management units that consist mainly of some other type of plant cover. These small parcels of crested wheatgrass usually can not be isolated and managed separately because the cost of fence material and separate livestock watering facilities can not be economically justified. Proper management of these small parcels of crested wheatgrass is a problem in the northern Great

Plains.

Crested wheatgrass is a very beneficial grass and is still the most often selected grass for reseeding cropland. Crested wheatgrass hay fields and pastures have made significant contributions to the production of livestock in the northern Great Plains and will continue to be an important forage grass long into the future (Lorenz 1986).

Some crested wheatgrass hay fields and pastures may provide suitable habitat for pest grasshopper population development. The natural growth form of crested wheatgrass is primarily widely spaced large bunches or widely spaced single tillers and small bunches. These growth characteristics of open canopy provide favorable habitat for several pest grasshopper species (Onsager 1995, and pers. comm.). Many of the grasshopper "hot spots" in the northern Great Plains are found on crested wheatgrass hay fields and pastures. If grazing and mowing management practices could be developed to manipulate the crested wheatgrass plants to grow, increase in tiller development, and decrease the size of the open canopy areas, then we may be able to negatively affect the pest grasshopper species' populations.

This research project was conducted to determine if cultural management practices can be used to manipulate beneficial changes in vegetation structure and density and negatively affect grasshopper nymphal development and adult egg laying. This was a cooperative project between the Range Research Laboratory at NDSU, Dickinson Research Center, Dickinson, North Dakota, and USDA-ARS, Rangeland Insect Laboratory, Bozeman, Montana. The range laboratory team was responsible for the grazing management and vegetation data and the insect laboratory team was responsible for the grasshopper and micro-climatic data.

The basic premise that we are working with is that most of the rangeland pest grasshopper species are favored by open canopy and bare areas which are used by the grasshoppers to provide access to solar radiation during nymphal development for thermoregulation and by some species for egg laying sites. The assumption that we have made from this premise and are testing with this project is that if defoliation management treatments using grazing and/or mowing can be developed that decrease open areas in the vegetation canopy then grasshopper development should be affected and should be shown as a change in the population density or species composition. The alternative to this first assumption is that if management can not be developed that causes a decrease in the canopy open areas for the entire year, then we should find management practices that annually change the time

when the open areas occur and are available for grasshopper use. This should, presumably, disrupt the natural patterns of the grasshoppers' phenological development enough to affect the populations, and assure that no single pest grasshopper species would be strongly favored for successive years.

The changes in the vegetation that are presently expected to negatively affect grasshopper populations are: increases in live plant basal cover, decreases in open areas in vegetation canopy cover, and increases in plant biomass. These vegetation parameters should yield lower temperatures, higher relative humidity, and reduced irradiation within the grasshopper microhabitat. These changes in the grasshopper microhabitat should affect nymphal growth and development and affect changes in the population. This report will include a summary of the crested wheatgrass vegetation data collected during the 1993 and 1994 field seasons (Manske 1993, Manske 1995).

METHODS AND MATERIALS

Study sites were located in the McKenzie County Grazing District of the Little Missouri National Grasslands, 21 miles west of Watford City between 47^{o}35' and 47^{o}50' N. lat. and 104^{o}00' and 103^{o}45' W. long., North Dakota. This study was conducted with the cooperation of the USDA Forest Service and the McKenzie County Grazing Association. The project was funded by USDA, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Cooperative Grasshopper Integrated Pest Management Project.

The four crested wheatgrass management treatments were designed with two replications each. The mowing treatments had been mowed for hay production with one annual cutting in late June or early July and had not been grazed. The mowing treatments were cut in late June 1993 and 1994. The mowing plus spring grazing treatments were used as spring pasture during 1 to 31 May 1993 and from 28 April to 1 June 1994. A large portion of this spring pasture was mowed for hay in late July and early August of 1992 but not mowed in 1993 or 1994. The spring grazing treatments were used as spring pastures during 1 to 31 May 1993 and from 28 April to 1 June 1994 and have not been mowed or burned. The seasonlong grazing treatments were part of a large pasture of native range interspersed with several areas of seeded crested wheatgrass grazed from 1 June to 31 October 1993 and 1994.

Vegetation data were collected on similar range sites for each replication. Aboveground plant biomass was

collected on five dates from May to October 1993 by clipping five .25m^2 quadrants and on four dates from May to August 1994 by clipping four .25m^2 quadrants to ground level (Cook and Stubbendieck 1986). The major components were separated into live material (by growth form), standing dead material, and litter. Plant biomass samples were oven dried at 60^{o}C. Values reported represent amount of aboveground herbage dry matter remaining on the site on each sample date after grazing or mowing. Plant species composition was determined by the ten pin point frame method (Cook and Stubbendieck 1986) between mid July and mid August 1993 and 1994 and reported as percent basal cover. Line intercept method (Canfield 1941, Cook and Stubbendieck 1986) was modified to measure linear length of intercepted open areas not covered by vegetation canopy. Each replication was sampled four times between June and August 1993 and three times between June and August 1994 with ten 2000 cm transects. Total percent open area not covered by canopy and a frequency distribution of the length of open areas placed in 5 cm categories ranging from 0 cm to 60 cm were determined from the line intercept data. Statistical methods used to analyze differences between means were a standard paired plot t-test (Mosteller and Rourke 1973). Each treatment had coordinated sample plots for micro climatic data and grasshopper population and phenology data which were collected, and will be reported by the Rangeland Insect Laboratory research team.

RESULTS AND DISCUSSION

Mowing crested wheatgrass for hay generally occurs after the plants have passed the flowering (anthesis) phenological stage of development in late June and July. The plants under this type of management develop into large widely-spaced bunches. The basal cover of the mowing treatment in this study was significantly ($P<0.05$) lower than on the other crested wheatgrass treatments in 1993 and 1994 (Table 1 and 2) except the mowed and grazed treatment was not different in 1993. The percentage of open ground not covered by vegetation canopy was significantly ($P<0.05$) greater on the mowing treatments than the other treatments during June and July in 1993 and 1994 (Table 3 and 4). The differences in treatments are not as clear for the early stages of growth in May and late stages of growth in August.

The mowed treatments and the grazed seasonlong treatments had the greatest amount of plant biomass remaining on 15 October 1993 (Table 5). The aboveground herbage biomass on the mowing treatments was not significantly ($P<0.05$) different than the mowing and grazing, and spring grazing treatments in mid July 1994 (Table 6). The aboveground herbage biomass on the grazing seasonlong treatments was significantly ($P<0.05$) greater than on the

other treatments in mid July 1994 (Table 6).

Mowing crested wheatgrass in late June or July would not be the management treatment selected as the tool to manipulate the vegetation to reduce the open areas and increase basal cover and negatively affect habitat for most pest grasshopper species on crested wheatgrass.

Many crested wheatgrass areas are used as hay fields and mowed in late June or July and also used as pastures and grazed in early spring or late summer and early fall. Very little quantitative information is available of the effects of this double use management on plant basal cover and percent open canopy. A large area in a spring crested wheatgrass pasture was mowed for hay in late June of 1992 and not mowed in 1993 or 1994 but grazed during the spring of 1993 and 1994. The mowing and grazing treatment had significantly ($P<0.05$) lower basal cover in 1993 than the spring grazing treatment (Table 1) and the mowing and grazing treatment had significantly ($P<0.05$) greater percent open ground not covered by vegetation canopy than the spring grazing treatment for June, July, and August in 1993 (Table 3). In 1994, basal cover (Table 2) and percent open ground not covered by vegetation canopy (Table 4) was not significantly different between the mowing and spring grazing treatments and the spring grazing treatments. The additional pressure of grazing and mowing crested wheatgrass during the same year caused a decrease in plant basal cover and an increase in percent open ground not covered by vegetation canopy. These negative effects were measurable during the entire growing season of the year following treatment.

The double use treatment of grazing crested wheatgrass in the spring and mowing the same area for hay later that same year would not be the management treatment selected as the tool to manipulate the vegetation to reduce the open areas and increase basal cover and negatively affect habitat for most pest grasshopper species on crested wheatgrass.

The spring grazing treatments had significantly ($P<0.05$) greater basal cover (Table 1) than the mowed, and mowed and grazed treatments and significantly ($P<0.05$) less open ground not covered by vegetation canopy in June and August than the other three treatments in 1993 (Table 3). In 1994, the spring grazing treatments had significantly ($P<0.05$) greater basal cover than the mowing treatments but not the other grazing treatments (Table 2). The spring grazing treatments had significantly ($P<0.05$) less open ground than the mowing treatments in June and July but not the other grazing treatments (Table 4).

Spring grazing of crested wheatgrass is the management treatment that reduces the size of the bunches and increases the number of tillers when the defoliation period occurs between the third leaf stage and flowering (anthesis) phenological growth stage. In western North Dakota, these phenological stages for crested wheatgrass generally occur during the month of May but can start during the last week in April and go until the second week in June.

The crested wheatgrass spring grazing treatments at the Dickinson Research Center have been grazed during the month of May for 12 years (1983-1994) and had very high basal cover of 44.8% in 1993 and very low percent open ground values of 6.5% and 6.4% in July of 1993 and 1994, respectively. The spring grazing treatment is a tested management treatment that is currently available that can be used to manipulate the vegetation on crested wheatgrass pastures to increase plant basal cover and reduce the percentage of open ground not covered by vegetation canopy. Spring grazing crested wheatgrass during the month of May between the third leaf stage and anthesis (flowering) phenological growth stage would be the management treatment selected as the tool to negatively affect habitat for most pest grasshopper species.

The grazing seasonlong treatment is not a desirable management strategy for use of crested wheatgrass pastures but it is a commonly used grazing practice in the northern Great Plains. The grazing seasonlong treatments had significantly ($P<0.05$) greater basal cover (Table 1) than the mowed treatment but not the other grazing treatments in 1993 and significantly ($P<0.05$) greater open ground than the spring grazing treatments in June and August 1993 (Table 3). In 1994, the basal cover was similar between the grazing seasonlong and spring grazing treatments (Table 2) and the percentage of open ground was significantly ($P<0.05$) lower on the grazing seasonlong treatments than the spring grazing treatments in May and July (Table 4). The vegetation on the grazing seasonlong treatment had similar basal cover but more open ground than the spring grazing treatments in 1993 and provided more suitable habitat for pest grasshoppers. The vegetation on the grazing seasonlong treatments moved in a desirable direction between 1993 and 1994 to be less suitable as grasshopper habitat. The vegetation on the spring grazing treatments moved in a less than desirable direction between 1993 and 1994 to be more suitable as grasshopper habitat. In 1994, there was no difference in basal cover between grazing seasonlong and spring grazing treatments, and there was no difference in the percent open ground for one third of the sample periods. The changes in the vegetation on the seasonlong grazing treatment between 1993 and 1994 are believed to be not caused by effects of defoliation by grazing for a five month period but rather primarily due to timely precipitation patterns and relatively

low grazing pressure from late June through August. The seasonlong grazing treatment may be able to develop favorable basal cover and percent open ground values similar to the spring grazing treatments during some years but the seasonlong grazing treatment on crested wheatgrass is not a desirable management practice for livestock production.

CONCLUSIONS

The changes in the crested wheatgrass vegetation that are expected to negatively affect grasshopper populations can be accomplished by the spring grazing treatment. The spring grazing treatment stimulates plant tiller development, which increases basal cover, and this in turn reduces the percentage of open ground not covered by vegetation canopy. Defoliation of crested wheatgrass with grazing after the third leaf stage and before anthesis (flowering) phenological growth stages stimulates tiller development.

Mowing treatments in late June and July after the anthesis (flowering) phenophase do not stimulate tiller development and do not manipulate changes in the vegetation that were expected to negatively affect pest grasshoppers. These data do not eliminate all mowing treatments as beneficial management tools. Mowing before the flowering phenophase may stimulate beneficial tiller development similarly to grazing defoliation at that same growth stage. Mowing at the early boot stage, for example, may stimulate tiller development and increase basal cover. Mowing at an earlier date and growth stage may also increase the amounts of harvested crude protein per acre.

Mowing and grazing crested wheatgrass during the same year puts stress on the plants that causes reductions in basal cover and increases in percent open ground. Double-use treatments on crested wheatgrass are not management tools that beneficially manipulate the vegetation to have negative effects on the pest grasshopper populations.

The effects of seasonlong grazing on the crested wheatgrass vegetation are difficult to interpret from the data collected during this study. The percent open ground was different than the spring grazing treatments in 1993 but generally not different in 1994. The changes in the vegetation on the seasonlong grazing treatments are believed to be not due to a treatment effect from five months of grazing but rather primarily due to timely precipitation patterns

and relatively low grazing pressure from late June through August. The seasonlong grazing treatment on crested wheatgrass is not a desirable management practice for livestock production.

Spring grazing of crested wheatgrass can be used as a management tool to increase plant basal cover, decrease percent open areas not covered by vegetation canopy, and increase herbage biomass.

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Table 1. Percent basal cover and percent greater than mowed treatment on crested wheatgrass treatments, 1993.

Treatments	% Basal Cover	% Greater Than Mowed
Mowed	28.9*a* ± 1.4	0.0
Mowed/Grazed	28.8*ab* ± 7.5	-0.3
Grazed Spring	39.8*c* ± 0.3	37.6
Grazed Seasonlong	36.0*bc* ± 4.7	24.7

Means of same column followed by the same letter are not significantly different (P<0.05).

Table 2. Percent basal cover and percent greater than mowed treatment on crested wheatgrass treatments, 1994.

Treatments	% Basal Cover	% Greater Than Mowed
Mowed	17.6*a* ± 0.6	0.0
Mowed/Grazed	25.0*b* ± 3.4	42.1
Grazed Spring	24.1*b* ± 2.6	36.9
Grazed Seasonlong	26.1*b*	48.3

	±2.3	

Means of same column followed by the same letter are not significantly different (P<0.05).

Table 3. Percentage of ground not covered by vegetation canopy on the crested wheatgrass treatments, 1993.

Treatments	Early June	Late June	Mid July	Mid August
Mowed				
Pretreatment	26.4*a* ±5.2	-	-	-
Post treatment	-	50.9*a* ±12.4	20.1*a* ±4.7	23.1*a* ±7.4
Mowed/Grazed	9.6*b* ±1.4	8.3*b* ±1.2	7.7*b* ±1.1	13.5*a* ±2.5
Grazed Spring	3.3*c* ±0.9	4.6*c* ±0.7	10.7*c* ±1.4	7.8*b* ±1.2
Grazed Seasonlong	-	17.3*d* ±3.2	10.9*c* ±1.5	13.9*a* ±2.7

Means of same column followed by the same letter are not significantly different (P<0.05).

Table 4. Percentage of ground not covered by vegetation canopy on the crested wheatgrass treatments, 1994

Treatments	Mid May	Mid June	Mid July	Mid August
Mowed				
Pretreatment	10.2*a* ± 4.6	17.5*a* ± 5.5	-	-
Post treatment	-	-	21.9*a* ± 6.4	-
Mowed/Grazed	8.5*a* ± 3.8	8.3*b* ± 3.5	10.5*b* ± 2.6	-
Grazed Spring	6.0*a* ± 2.4	6.9*b* ± 5.0	10.5*b* ± 3.5	-
Grazed Seasonlong	2.6*b* ± 0.9	3.6*b* ± 1.2	3.9*c* ± 0.5	-
Means of same column followed by the same letter are not significantly different (P<0.05).				

Table 5. Total aboveground plant biosmass in pounds/acre on crested wheatgrass treatments, 1993.

Treatments	1 May	1 Jun	24 Jun	19 Jul	12 Aug	Sep	15 Oct
Mowed			I				
Pretreatment							
lbs/acre	-	1307	1441	-	-	-	-
Post treatment							
lbs/acre	-	-	1005	1663	1392	-	1652

Mowed/Grazed	|----------|[a]					
lbs/acre	-	828	727	1060	669	-	914
Grazed Spring	|----------|					
lbs/acre	-	1097	735	837	1560	-	888
Grazed Seasonlong		|----------|				
lbs/acre	-	-	1164	1364	1131	-	1331
[a]Dashed lines indicate period of grazing.							

Table 6. Total aboveground plant biomass in pounds/acre on crested wheatgrass treatments, 1994.

Treatments	1 May	23 May	21 Jun	18 Jul	11 Aug	Sep	Oct
Mowed							
Pretreatment							
lbs/acre	-	2029	2293	-	-	-	-
Post treatment							
lbs/acre	-	-	-	547	693	-	-
Mowed/Grazed	|----------|[a]					
lbs/acre	-	451	495	467	572	-	-
Grazed Spring	|----------|[a]					

lbs/acre	-	397	490	441	470	-	-
Grazed Seasonlong			I----------				----------I
lbs/acre	-	1217	1122	840	706	-	-
[a]Dashed lines indicate period of grazing.							

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