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GRAZING MANAGEMENT FOR RANGELAND

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Grass plants have developed adaptive tolerance mechanisms in response to defoliation during the long period of coevolution with herbivores. Plants that have developed these adaptive processes, or resistance mechanisms, have the ability to persist in a grazing plant community. Defoliation by grazing, appropriately applied, can have beneficial effects on grass plants and the grassland ecosystem.

A study to evaluate the effects of defoliation on native range by comparison of a twice-over rotation grazing system, a 4.5-month seasonlong treatment, a 4-month deferred seasonlong treatment, a 6-month seasonlong treatment, and a long-term nongrazed treatment was conducted from 1984 to 1994 at the Dickinson Research Extension Center in western North Dakota (Manske et al. 1988, Manske 1994a, Manske 1996a, Manske 1996b). In 1990 the study was expanded to include sites in McKenzie County, North Dakota (Manske 1994b, Manske and Onsager 1997).

The treatments were organized as a paired-plot design with two replications. The twice-over rotation grazing treatments at the Dickinson Research Extension Center had three pastures, with each grazed for 15 days between 1 June and 15 July and for 30 days after mid July and prior to mid October for a total of 4.5 months. Three seasonlong treatments were used: a 4.5-month seasonlong grazing between mid June and early November, a 4-month deferred seasonlong grazing between mid July and mid November, and a 6-month seasonlong grazing between mid May and mid November. The long-term nongrazed treatment had not been grazed, mowed, or burned for more than 30 years prior to the start of data collection. Two grazing treatments were studied on the McKenzie sites. The rotation grazing treatment had four pastures, each grazed for two periods. The other treatment had a traditional 5-month seasonlong grazing method. A long-term nongrazed exclosure was available for nondestructive sampling of control sites. Commercial crossbred cattle were used on all grazed treatments in this trial.

Effects of defoliation on the vegetation were measured by basal cover and herbage biomass. Increase in basal cover of grasses was 25 percent greater on the rotation-grazing treatments than on the seasonlong treatments. Basal cover of sedges decreased by 14 percent and of forbs by 36 percent on the rotation system compared to the seasonlong treatments. Plant community relative percent composition changed: on the rotation treatments compared to seasonlong treatments, grasses increased by 14 percent; sedges decreased by 14 percent; and forbs plus shrubs decreased by 40 percent. On seasonlong treatments herbage biomass standing after grazing averaged 8 percent less than on nongrazed treatments and 29 percent less than on rotation treatments. During the entire grazing season, an average of 15 percent more herbage biomass was standing after each grazing period on rotation treatments than on long-term nongrazed treatments.

Defoliation stimulates tillering by reducing the influence of apical dominance, the physiological process by which the apical meristem from a lead tiller exerts hormonal regulation over axillary bud growth and inhibits axillary buds from developing into tillers (Briske 1991, Murphy and Briske 1992, Briske and Richards 1994, Briske and Richards 1995). Defoliation applied to grass plants at the appropriate phenological growth stages can beneficially affect the symbiotic activity of soil organisms within the rhizosphere, the narrow zone of soil surrounding the living roots of perennial grassland plants (Elliot 1978, Anderson et al.1981, Coleman et al. 1983, Ingham et al. 1985a, Ingham et al. 1985b, Clarholm 1985, Curl and Truelove 1986, Allen and Allen 1990, Whipps 1990, Campbell and Greaves 1990). Tiller development of grass plants and the resulting increase in plant growth and aboveground herbage biomass were greater on the rotation treatments than on the nongrazed and seasonlong treatments. This increase in growth suggests that removal of some young leaf material by defoliation at early growth stages has an effect on the stimulation of tiller growth from axillary buds and has an effect on increasing exuded material, which in turn presumably stimulates activity of the bacteria. Activity levels were presumably subsequently increased in protozoa, nematodes, and mites. Elevation of the activity levels of organisms in the rhizosphere increases the amount of nitrogen available for plant growth.

The increase in grass tiller development and symbiotic rhizosphere activity on the twice-over rotation treatments allowed greater stocking rates and enhanced individual animal performance. The rotation treatments supported a mean increase in stocking rate of 40 percent greater than that of the 4.5-month seasonlong treatments, 96 percent greater than that of the 6-month seasonlong treatments, and 9 percent greater than that of the 4-month deferred seasonlong treatments. Accumulated weight performance of individual cows and calves and their average daily gain were greater on the rotation treatments than on the seasonlong and deferred seasonlong treatments. Weight performance of cows and calves on the grazing treatments was generally not significantly different during the first grazing period of June and July. However, during the second grazing period, after early August, the animal weight performance on the rotation treatments was significantly greater than on the seasonlong and deferred seasonlong treatments. Individual animal performance improved on the twice-over rotation grazing system, with a calf average daily gain 6 percent greater than that on the 4.5-month seasonlong treatment and 23 percent greater than that on deferred seasonlong grazing treatments. Average daily weight gain of cows on the twice-over rotation system was 82 percent greater than that on the 4.5-month seasonlong treatment and 94 percent greater than that on the deferred seasonlong treatment.

The combination of increases in stocking rate and individual animal performance gave the twice-over rotation system a considerable increase in animal weight gain per acre over the other grazing treatments. Calf weight gain per acre on the twice-over rotation system was 39 percent greater than that on the 4.5-month seasonlong and 40 percent greater than that on deferred seasonlong treatments. Cow weight gain per acre on the twice-over rotation system was 179 percent greater than that on the 4.5-month seasonlong and 212 percent greater than that on the deferred seasonlong grazing treatment.

The improved livestock weight performance during the later portion of the grazing season was attributed primarily to the increase in available nutrients from the secondary tillers. These tillers had developed from axillary buds and were at an early growth stage during the second rotation period. Generally, during the later portion of the grazing season the available herbage on the rotation treatments was 1.5 and 2.5 percentage points greater in crude protein content than the herbage on the seasonlong and deferred seasonlong treatments.

The amount of herbage that remained standing on 1 September after the rotation treatments was greater than the amount of total current-year's growth on the long-term nongrazed treatments and greater than the amount of standing herbage biomass on the seasonlong treatments. These data do not account for the amount of vegetation removed by livestock on the rotation and seasonlong treatments. The relatively greater amount of photosynthetic leaf area remaining on the rotation treatments at the end of grazing periods and the grazing season was beneficial as a deterrent to the proliferation of grasshopper populations. The greater amount of vegetation standing at the end of the grazing season causes a noticeable change in the vegetation canopy cover and a reduction in the amount of bare ground present in pastures. Most rangeland pest grasshopper species are favored by open vegetation canopy and bare areas; these open areas provide grasshopper nymphs with increased access to solar radiation necessary for body temperature regulation and furnish conditions favored by some species for egg-laying sites. Grazing management practices that promote early removal of plant canopy should increase temperature of grasshopper microhabitat and accelerate growth and development; this acceleration should produce more adults and earlier adults, with more time for reproduction (Onsager 1998). The changes produced in the vegetation structure by the twice-over rotation treatment should reduce air and soil temperatures, raise relative humidity, and reduce the level of solar radiation reaching the grasshopper microhabitat. These changes should lengthen the time required for nymphal development and expose the nymphs to numerous causes of death, thereby raising the average daily mortality rate and reducing the number of nymphs that survive to adulthood to lay eggs (Onsager 1998). In addition, because the sequence of grazing periods on the rotation system pastures is never the same in consecutive years, the vegetation growth patterns should be altered sufficiently that no single grasshopper species would consistently be favored. Preliminary interpretation of grasshopper population data indicates that there were between 69 and 79 percent fewer grasshopper nymphs and between 71 and 96 percent fewer adult grasshoppers on the twice-over rotation pastures than on the seasonlong pastures (Kemp and Onsager 1993, Kemp and Onsager 1994).

Defoliation with herbivores has the greatest beneficial effect if planned to stimulate two mechanisms: vegetative tillering from axillary buds and activity of symbiotic soil organisms. The phenological growth stages during which these two mechanisms can be manipulated are the same, between the third-leaf stage and flowering phenophase. The twice-over rotation system was developed for use in the Northern Great Plains and was designed to manipulate processes that result in beneficial changes to the rangeland ecosystem. The twice-over rotation grazing management system applies defoliation treatment to grass plants at the appropriate phenological growth stages to stimulate the adaptive tolerance mechanisms and the activity of the symbiotic rhizosphere micro-organisms. This stimulation increases both secondary tiller development of grasses and nutrient flow in the rhizosphere, resulting in increased plant basal cover and aboveground herbage biomass and improved nutritional quality of forage. The increase in quantity and quality of herbage permits increase in stocking rate levels, improves individual animal performance, increases total accumulated weight gain, reduces acreage required to carry a cow-calf pair for the season, improves net return per cow-calf pair, and improves net return per acre. The increase in basal cover and herbage biomass reduces the number and size of bare soil areas and increases the level of residual vegetation. These changes in vegetation produce conditions favorable to the limitation of grasshopper pest species populations. These beneficial effects of improved vegetation condition, livestock performance, and grasshopper control demonstrate the potential of the twice-over rotation grazing system for successful implementation in this region.

Acknowledgment
I am grateful to Amy M. Kraus for assistance in preparation of this manuscript.

Literature Cited

Allen, E.B., and M.F. Allen. 1990. The mediation of competition by mycorrhizae in successional and patchy environments. p. 307-389. *in* J.B. Grace and D. Tilman (eds.), Perspectives on plant competition. Academic Press Inc., San Diego, CA.

Anderson, R.V., D.C. Coleman, C.V. Cole, and E.T. Elliott. 1981. Effect of nematodes *Acrobeloides sp.* and *Mesodiploqaster lheritieri* on substrate utilization and nitrogen and phosphorus mineralization. Ecology 2:549-555.

Briske, D.D. 1991. Developmental morphology and physiology of grasses. p. 85-108. *in* R.K. Heitschmidt and J. W. Stuth (eds.), Grazing management : an ecological perspective. Timber Press, Portland, OR.

Briske, D.D., and J.H. Richards. 1994. Physiological responses of individual plants to grazing: current status and ecological significance. p. 147-176. *in* M. Vavra, W.A. Laycock, and R.D. Pieper (eds.), Ecological implications of livestock herbivory in the west. Soc. for Range Manage., Denver, CO.

Briske, D.D., and J.H. Richards. 1995. Plant responses to defoliation: a physiological, morphological and demographic evaluation. p.635-710. *in* D.J. Bedunah and R.E. Sosebee (eds.), Wildland plants: physiological ecology and developmental morphology. Soc. for Range Manage., Denver, CO.

Campbell, R., and M.P. Greaves. 1990. Anatomy and community structure of the rhizosphere. p. 11-34. *in* J.M. Lynch (ed.), The rhizosphere. John Wiley and Sons, New York, NY.

Clarholm, M. 1985. Interactions of bacteria, protozoa and plants leading to mineralization of soil nitrogen. Soil Biol.

Biochem. 17:181-187.

Coleman, C.D., C.P.P. Reid, and C.V. Cole. 1983. Biological strategies of nutrient cycling in soil ecosystems. Adv. Ecol. Res. 13:1-55.

Curl, E.A. and B. Truelove. 1986. The rhizosphere. Springer-Verlag, New York, NY.

Elliot, E.T. 1978. Carbon, nitrogen and phosphorus transformations in gnotobiotic soil microcosms. M.S. Thesis, Department of Agronomy, Colorado State Univ., Ft. Collins, CO.

Ingham, R.E., D.A. Klein, and M.J. Trlica. 1985a. Response of microbial components of the rhizosphere to plant management strategies in semiarid rangelands. Plant and Soils 85:65-76.

Ingham, R.E., J.A. Trofymow, E.R. Ingham, and D.C. Coleman. 1985b. Interactions of bacteria, fungi and their nemotode grazers: effects on nutrient cycling and plant growth. Ecol. Monogr. 55:119-140.

Kemp, W.P., and J.A. Onsager. 1993. Grasshopper population responses to modification of vegetation by grazing. USDA/APHIS/PPQ Cooperative Grasshopper Integrated Pest Management Project Annual Report, FY 1993. USDA/APHIS. Boise, ID. p.77-79.

Kemp, W.P., and J.A. Onsager. 1994. Grasshopper population responses to modification of vegetation by grazing. USDA/APHIS/PPQ Cooperative Grasshopper Integrated Pest Management Project Annual Report, FY 1994. USDA/APHIS. Boise, ID. p.93-97.

Manske, L.L. 1994a. Ecological management of grasslands defoliation. p.130-136. *in* Taha, F.K., Z. Abouguendia, and P.R. Horton, (eds.), Managing Canadian rangelands for sustainability and profitability. Grazing and Pasture Technology Program, Regina, Saskatchewan, Canada.

Manske, L.L. 1994b. Modification of native range vegetation by grazing management to affect grasshopper populations. USDA/APHIS/PPQ Cooperative Grasshopper Integrated Pest Management Project Annual Report, FY 1994. USDA/APHIS. Boise, ID. p. 99-108.

Manske, L.L. 1996a. Economic returns as affected by grazing strategies. p.43-55. *in* Z. Abouguendia, (ed.), Total Ranch Management in the northern Great Plains. Grazing and Pasture Technology Program, Saskatchewan Agriculture and Food. Regina, Saskatchewan, Canada.

Manske, L.L. 1996b. Adaptive tolerance mechanisms in grass plants. p.97-99. *in* Z. Abouguendia, (ed.), Total Ranch Management in the northern Great Plains. Grazing and Pasture Technology Program, Saskatchewan Agriculture and Food. Regina, Saskatchewan, Canada.

Manske, L.L., M.E. Biondini, D.R. Kirby, J.L. Nelson, D.G. Landblom, and P.J. Sjursen. 1988. Cow and calf performance on seasonlong and twice over rotation grazing treatments in western North Dakota. Proceedings of the North Dakota Cow-Calf Conference. Bismarck, ND. p. 5-17.

Manske, L.L., and J.A. Onsager. 1997. Cultural management practices as tools to help reduce grasshopper populations. Proceedings of the National Grasshopper Management Board 1997 Annual Meeting. Rapid City, SD. p. 10-11.

Murphy, J.S., and D.D. Briske. 1992. Regulation of tillering by apical dominance: chronology, interpretive value, and current perspectives. J. Range Manage. 45:419-429.

Onsager, J.A. 1998. Theoretical benefits of modifying grasshopper life history parameters. Proceedings of the 1998 Annual Meeting of the National Grasshopper Management Board. Denver, CO. p. 3-4.

Whipps, J.M. 1990. Carbon economy. p. 59-97. *in* J.M. Lynch (ed.), The rhizosphere. John Wiley and Sons, New York, NY.

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