Enhancing Botanical Composition and Wildlife Habitat of Pastures in South Central Iowa through Soil Disturbance by Mob-grazing of Beef Cattle

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Summary and Implications

South central Iowa grasslands are dominated by cool season grass species with low productivity and little plant diversity which limits the forage yield and quality for grazing animals and habitat for native grassland wildlife. Strategic spring mob-grazing may reduce competition from cool-season grass species allowing early successional species, legumes, and native plants to establish while improving soil characteristics. Two blocks of three replicated pastures were divided into 5 equal-sized paddocks to determine the effects of early spring mob-grazing on pasture forage and soil characteristics. In each pasture, one paddock was not grazed (NG) and 4 were strip- (S; moved once per day with a back fence) or mob- (M; moved 4 times per day with a back fence) grazed beginning in May of 2011 (BL1) and 2012 (BL2) by 10 cows at a live forage DM allowance of 2% BW/d. Subsequently, one mob (MR) and strip (SR) paddock in each pasture was rotationally stocked to remove 50% of the live forage with 35-d rest periods beginning 60 d after spring grazing in yr 1 of each block. Measurements included pasture botanical composition determined by the line transect method, soil penetration resistance determined with a penetrometer, water infiltration determined with double ring infiltrometers, soil bulk density, and ground nesting bird habitat measured as visual obstruction to a 3.3x 3.3 ft board by image analysis of digital photos. In BL1 and BL2 after mob- or strip- grazing, the proportion of bare ground was greater ($P < 0.05$) in rotationally grazed paddocks than NG paddocks in most months. The proportion of annual grasses was greater ($P < 0.05$) in grazed than NG paddocks in July 2011 in BL1. In 2012, the proportion of legumes was greater ($P < 0.05$) than NG paddocks in M, MR, and SR paddocks in May, M and SR paddocks in July, and all grazed paddocks in BL 1 in October. But in 2013, the proportion of legumes was greater in MR and S paddocks in May and MR paddocks in October than NG paddocks. The proportion of warm season grasses in BL2 was less ($P < 0.05$) in MR and SR paddocks than NG and M paddocks in August 2013. In BL1, penetration resistance was greater ($P < 0.05$) in rotationally stocked paddocks compared to NG paddocks in May and October of 2012 and 2013, however reductions ($P < 0.05$) in water infiltration rates occurred in rotationally stocked paddocks only in October 2012 and 2013. In BL1, visual obstruction was less ($P < 0.05$) in M paddocks than S and NG paddocks to 15.7 inches high in October 2011. However in BL2, no differences in visual obstruction occurred in October 2012. A single mob- or strip-grazing event of a grassland in the spring may improve the nutritional value of the forage for grazing livestock and habitat for wildlife. However, the extent and longevity of these responses are related to soil moisture at the time of grazing and subsequent management and climatic conditions.

Introduction

Overgrazing from continuous stocking of southern Iowa pastures allows cool season grasses like tall fescue to dominate other forage species and decrease persistence of legumes. Even with nitrogen inputs, production of these pastures are limited, resulting in reduced vegetative cover and increased soil erosion in precipitation runoff. Furthermore, the low productivity and nutritional value of overgrazed pastures provides little incentive to deter producers from converting pastureland into cropland or selling it for recreational uses like hunting. Typically after pastureland is sold for recreational uses such as hunting, cattle are removed. However, without the disturbance and defoliation provided by grazing of perennial grasslands, tree cover increases and cool season grasses become dominant resulting in poor habitat for some wildlife species including bobwhite quail.

Reducing competition from cool season grasses through disturbance by grazing allow legumes and other plant species to establish which increase seasonal productivity, resilience to weather disruptions, and wildlife habitat. The nitrogen-fixing capabilities and high protein concentrations of legumes improves productivity and nutritional quality of forages for grazing livestock. Increased plant diversity increases root mass and this along with forage incorporated into the soil through disturbance increases soil organic matter which may increase soil carbon sequestration, and water infiltration rates. These factors will, in turn, increase resilience to environmental stress and decrease soil erosion in grasslands. In addition, increased plant species diversity in grassland ecosystems will increase feed sources and habitat structure for wildlife. The improvement of wildlife habitat from grazing may create alliances between cow/calf producers needing more grazing land and landowners wanting to establish or improve wildlife habitat.

Strategic grazing at high stocking densities for short periods of time followed by long rest periods, known as mob-grazing, may reduce competition from cool season grass species and provide the soil disturbance necessary to establish more diverse plant communities while providing other ecosystem benefits in pasture and grasslands. The objective of this study was to evaluate the effectiveness of strategic spring mob-grazing to improve botanical composition of forage for grazing, wildlife habitat, and soil quality under the soil and climatic conditions prevalent in south central Iowa.

Materials and Methods

Two blocks of three replicated pastures containing mixtures of cool season grasses and legumes without (BL1) or with (BL2) warm season grasses were divided into 5 equal-sized paddocks (BL1, 1 acre; BL2, 0.5 acre) to determine the effects of a single early spring mob-grazing event on subsequent plant species diversity and soil characteristics in grasslands. In each pasture, one paddock was not grazed (NG) and 4 were strip (S; moved once per day with a back fence) or mob (M; moved 4 times per day with a back fence) grazed beginning in May of 2011 (BL1) and 2012 (BL2) by 10 August-calving cows (mean body weight; 1291[BL1] and 1416 [BL2] lb) at a live forage allowance of 2% BW/d. Subsequently, one mob (MR) and strip (SR) paddock in each pasture was rotationally stocked with 35-d rest periods beginning 60 d after spring mob-grazing in the first year of each block and in early May of each subsequent year. When grazing by rotational stocking, cattle were stocked to remove 50% of the live forage measured with a falling plate meter (8.8 lb/yd^2).

Dominant vegetative cover or plant species including bare soil, dead plant residue, perennial cool and warm season grasses, annual grasses, legumes, and broadleaf weeds were identified at 100 equally spaced sites on a 50 ft string at 10 sites per paddock in spring, summer, and fall of each year. The number of sites with perennial cool or warm season grasses, annual grasses, broadleaf weeds, sedge, and legumes were summed as the number of sites with live forage and the proportion of sites with each plant class was expressed as a percentage of sites with live forage. Water infiltration was determined at three randomly selected sites in each paddock in May and October by adding water to double ring infiltrometers to maintain a ponding depth between 2 and 1 inches over 90 minutes. Water infiltration was calculated as the average of the amount and time of the last three additions of water to the infiltrometers. Compaction was measured to a depth of 6 inches with a field scout SC 900 penetrometer with a 0.5 inch diameter cone tip at 10 sites in each paddock in May and October of each year. Soil bulk density and total carbon were determined with soil samples to a depth of 3 inches from 6 sites in each paddock. Ground nesting bird habitat was measured as visual obstruction in digital photos of a 3.3x3.3 foot board at a distance of 13.2 feet and height of 3.3 feet in July and October of each year. Digital photos were cropped and visual obstruction determined with Sigma Scan Pro 5 at 3.8 inch intervals marked on the visual obstruction board. Data were analyzed by month with the MIXED procedure of SAS within BL1 and BL2. Differences between means with significant treatment effects were determined by the PDIFF procedure of SAS.

Results and Discussion

Stocking densities for mob- and strip-grazed paddocks during early spring mob grazing were 530,000 and 147,000 lbs/acre in BL1 and 470,000 and 108,000 lbs/acre in BL2, respectively. In BL1, bare ground was greater ($P<0.05$) in S than MR and SR paddocks in July 2011. Following July 2011, the proportion of bare ground was ($P<0.05$) greater in MR paddocks than NG paddocks in all sampling months, but only greater in SR than NG paddocks through May 2012. Dead plant residue was greater ($P<0.08$) in October in paddocks grazed by either the M or S systems than NG paddocks after mob-grazing in 2011.The proportion of cool-season grasses (fig. 1A) was less ($P < 0.05$) in paddocks grazed by either the M, S, MR, or SR systems in July 2011 and May 2012 than NG paddocks. Following May 2012, lower ($P < 0.05$) proportions of cool season grasses were observed in MR and SR paddocks than NG paddocks. Annual grasses as a proportion of live forage were greater ($P<0.05$) in July 2011. The proportion of annual grasses in the live species did not differ between treatments in October 2011, 2012, and May 2013. However, in August and October 2013 the proportion of annual grasses was greater in MR and SR than NG, M, and S paddocks. Conversely, in 2012, legumes (fig. 1B) as a proportion of live forage were greater ($P<0.05$) in M, MR, and S in May, M and S in July, and all grazed paddocks in October than NG paddocks. Subsequently, in 2013, greater ($P<0.07$) proportions of legumes still occurred in MR and S in May, and MR paddocks in October than NG paddocks. This result implies that the increase in the proportion of legumes was better maintained in mob-grazed paddocks that were subsequently rotationally stocked.

The proportion of bare ground was greater ($P < 0.05$) in MR and SR paddocks than NG paddocks in all sampling months after May 2012. While M or S grazing had little effect on the proportions of cool season grasses in the live forage immediately after grazing, the proportion of cool season grasses (fig. 2A) was less ($P<0.05$) in M and S than NG paddocks in October 2012. In comparison to NG paddocks, the proportion of warm season grasses was ($P<0.05$) lower in MR and SR paddocks in August 2013, but did not differ in other months. No differences in the proportion of annual grasses between treatments occurred in the year that paddocks in BL2 were mob- or strip-grazed (2012). However, while there continued to be no difference in the proportion of annual grasses in the NG, M, and S paddocks in May 2013, the proportion of annual grasses in MR and SR paddocks were greater ($P < 0.05$) than M, S, and NG paddocks in July and October 2013. Conversely, the proportions of legumes in the live forage were greater (P<0.05) in S and M paddocks than NG paddocks in October 2012 and May 2013, respectively (fig. 2B).

No differences in penetration resistance at any depth were observed between treatments after treatments were applied in BL1 in 2011. However, compared to NG paddocks in BL1, penetration resistance was greater (P<0.05) at a depth of 2 inches in paddocks grazed by any treatment in May 2012 and 2013 and in MR and SR paddocks in October 2012 and 2013 (fig. 3A). In addition, greater (P<0.05) penetration resistance in paddocks grazed by any treatment than NG paddocks occurred at a depth of 5 and 6 inches in October 2012 and May 2013. In BL2, penetration resistance at a depth of 2 inches was greater (P < 0.05) in MR and SR paddocks than NG, M, and S paddocks in October 2013 (fig. 3B). In 2012 and May 2013 there were few significant differences at other depths. However in October 2013, penetration resistance in rotationally stocked paddocks was greater than NG paddocks to a depth of 4 inches. Unlike BL1, in BL2 there were no significant differences in penetration resistance below 4 inches between treatments. Soil bulk density in BL1 was greater (P<0.05) in MR and S paddocks in October 2011 and all grazed paddocks in October 2012 than NG paddocks. However, unlike penetration resistance, there was no difference in soil bulk density between treatments in BL1 in October 2013. In BL2, soil bulk density was greater (P<0.05) in SR paddocks than NG paddocks in October 2013. As a result of the differences in soil compaction, water infiltration rate was greater (P<0.05) in NG, M, and S paddocks in October 2012 and NG paddocks in October 2013 than MR and SR paddocks in BL1. In BL2, infiltration rates in paddocks grazed by any of the systems were greater (P<0.05) than NG paddocks in October 2012. However, no differences in infiltration rates between treatments in BL2 occurred in any other month.

In BL1, M and S paddocks provided less (P<0.05) visual obstruction up to 39.4 inches than forage in NG paddocks in July 2011 which was immediately after the treatments were applied. In October 2011, visual obstruction to a height of 15.7 inches in M paddocks was less (P<0.05) than NG and S paddocks (fig. 4A). In addition, above 15.7 inches, visual obstruction was lower (P<0.05) in M and S paddocks than NG paddocks. In July 2012, no differences occurred in visual obstruction between treatments. But in October 2012, there was less (P<0.05) visual obstruction at 3.9 to 7.9 inches in S than M paddocks. In BL2, visual obstruction was less (P<0.05) up to 39.4 inches in M and S paddocks than NG paddocks in July 2012 immediately after the treatments were applied. In October 2012, there were no differences in visual obstruction in BL2 (fig. 4B).

Because of the differences in the responses of plant communities and soil quality to grazing treatments in BL1 and BL2, this study indicates the effects of mob- and strip-grazing on plant species and soil properties are likely influenced by more factors than stocking density. The species succession which occurred in BL1 with increased levels of annual grasses, did not occur in BL2. Furthermore increases in penetration resistance which occurred in all grazed paddocks in BL1 only occurred in paddocks that were rotationally grazed in BL2. Differences between blocks may have been related to rainfall during mob- and strip-grazing which were 0.55 and 0.05 inches in BL1 in 2011 and BL2 in 2012, respectively. Results from BL1 indicate mob- or strip-grazing can be used to reduce competition from cool season grasses and allow annual grasses and eventually legumes to establish if rainfall amounts are enough to allow significant soil disturbance. These effects may also be altered by greater stocking densities or lengths of the grazing period. The increase in annual grasses and legumes resulting from mob- and strip-grazing in BL1 may be beneficial to ground nesting birds and other wildlife. However within 2 years, the plant community began to resemble paddocks with no grazing which lacked quality wildlife habitat. In both blocks bare ground increased with rotational grazing and was most persistent in MR paddocks. This effect could increase the risks of soil erosion in pastures, but bare ground is needed in grasslands managed for bobwhite quail habitat. Furthermore, the increased legume populations in rotationally stocked paddocks in BL1 lasted longer in mob-grazed than strip-grazed paddocks possibly resulting from more soil disturbance. Although soil penetration resistance and bulk density are sometimes related to water infiltration rates, in this project correlation coefficients were not greater than 0.25. Further analysis on the impact of soil moisture on the change in plant species and soil characteristics following mob- and strip-grazing is needed to determine environmental conditions most likely to produce the desired change in plant species while improving soil quality characteristics.

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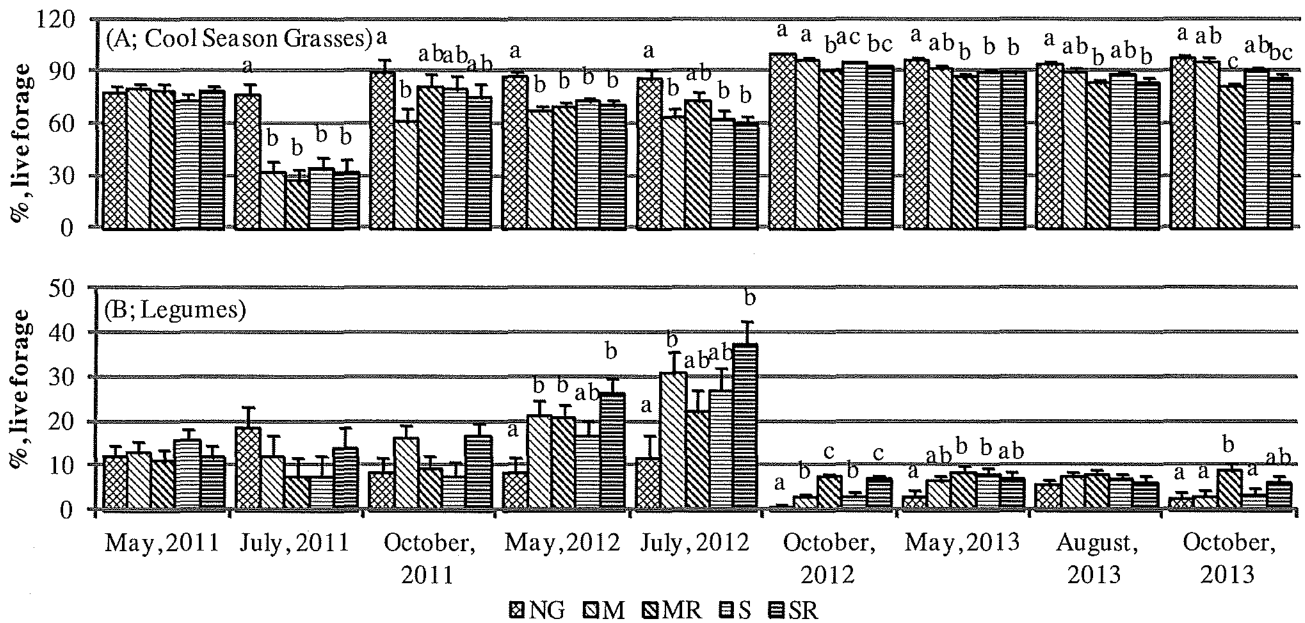
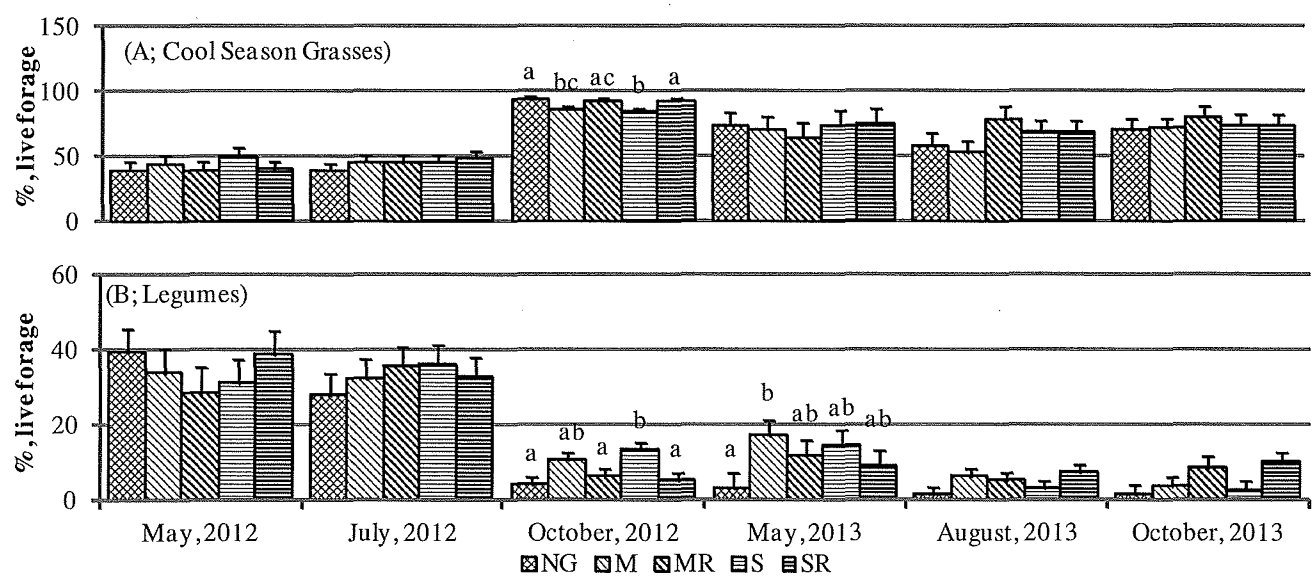
Figure 1. The Effects of Strip or Mob-grazing with or without Subsequent Rotational Grazing on the Proportion of Cool Season Grasses (A) and Legumes (B) as a Percentage of Total Pasture Area in BL1 paddocks not grazed (NG), Mob-grazed (M), Mob-grazed with 60 Days Rest Followed by Rotational Grazing (MR), Strip-grazed (S), Strip-grazed with 60 Days Rest Followed by Rotational Grazing (SR).



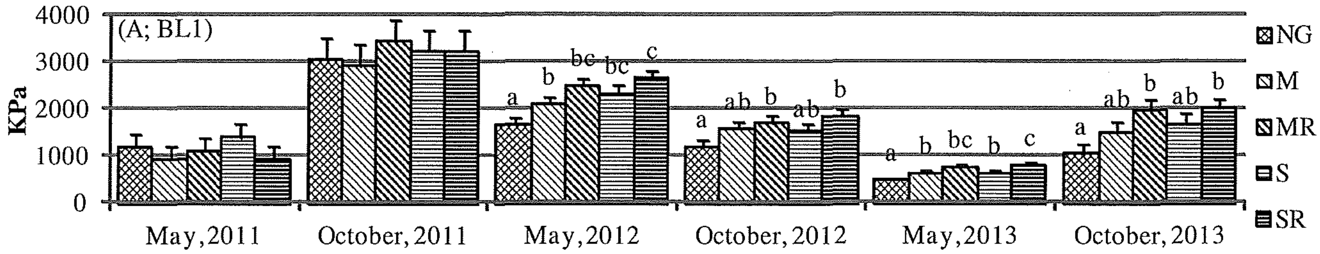
[a-c] Differences between treatment (NG, M, MR, S, SR) means within month with different superscripts are significant ($P<0.05$)

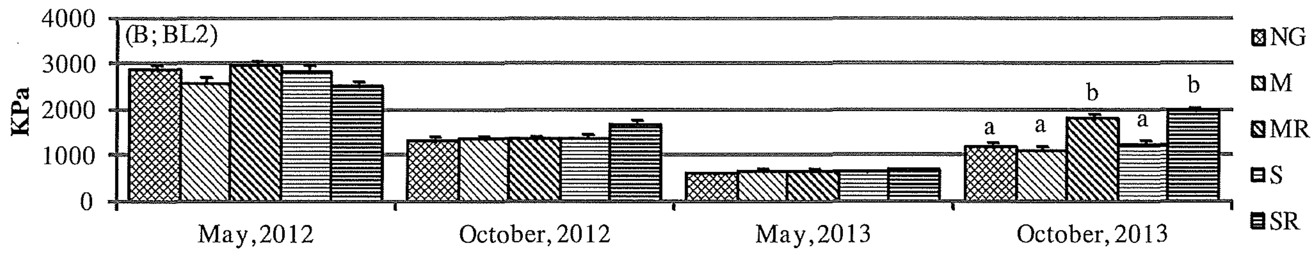
Figure 2. The Effects of Strip or Mob-grazing with or without Subsequent Rotational Grazing on the Proportion of Cool Season Grasses (A) and Legumes (B) as a Percentage of Total Live Forage in BL2 paddocks not grazed (NG), Mob-grazed (M), Mob-grazed with 60 Days Rest Followed by Rotational Grazing (MR), Strip-grazed (S), Strip-grazed with 60 Days Rest Followed by Rotational Grazing (SR).



[a-c] Differences between treatment (NG, M, MR, S, SR) means within month with different superscripts are significant ($P<0.05$)

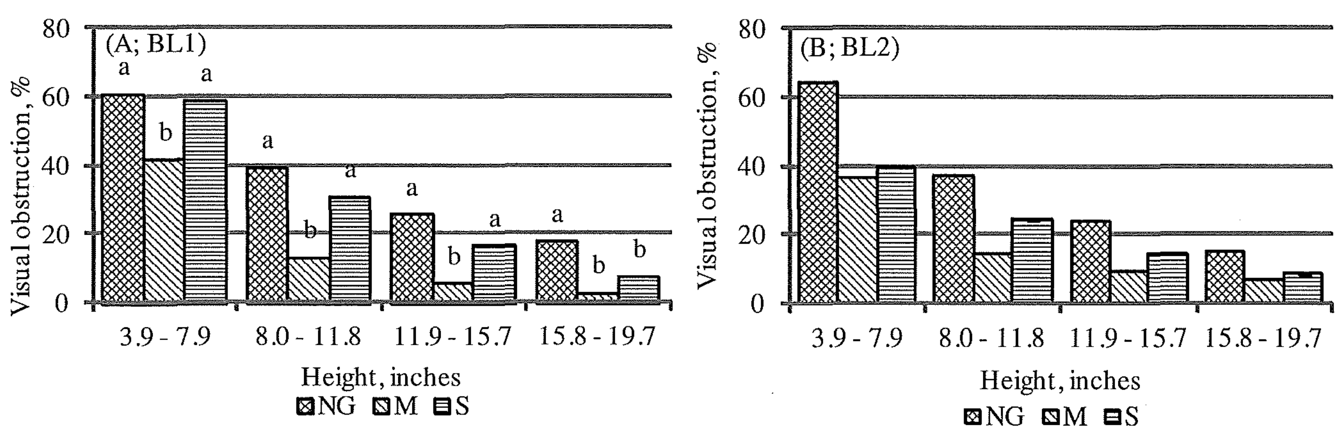
Figure 3. The Effects of Strip or Mob-grazing with or without Subsequent Rotational Grazing on penetration resistance at a depth of 2 inches in BL1 (A) and BL2 (B) paddocks not grazed (NG), Mob-grazed (M), Mob-grazed with 60 Days Rest Followed by Rotational Grazing (MR), Strip-grazed (S), Strip-grazed with 60 Days Rest Followed by Rotational Grazing (SR).





[a-c] Differences between treatment (NG, M, MR, S, SR) means within month with different superscripts are significant (P<0.05)

Figure 4. The Effects of Strip or Mob-grazing with or without Subsequent Rotational Grazing on Visual Obstruction in October 2011 in BL1(A) and October 2012 in BL2 (B) at Height Increments of 3.9-7.9, 8.0-11.8, 11.9-15.7, and 15.8-19.7 inches at a Distance of 13.2 feet in paddocks not grazed (NG), Mob-grazed (M), and Strip-grazed (S).



[a-b] Differences between treatment (NG, M, MR, S, SR) means within month with different superscripts are significant (P<0.05)