Effects of Corn Crop Residue Grazing on Soil Physical Properties and Subsequent Soybean Production in a Corn-Soybean Crop Rotation (A Progress Report)

A.S. Leaflet R1747

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Summary

Beginning in 1999, two locations in Iowa (Chariton, Atlantic) were used to study the effects of corn residue grazing by beef cows on soil characteristics and soybean yields the following growing season. Cows were allowed to graze inside selected paddocks at monthly periods throughout the fall and winter. For a grazed and ungrazed comparison, grazing exclosures were used inside the grazed paddocks while one paddock was left ungrazed for a control. The use of this design was to determine if grazing had any adverse effects on soil characteristics and at what date and weather conditions did they occur. Also equal portions of the fields went to no tillage and disked soil the following year before soybean planting to compare effects of corn residue grazing on tillage treatments. Soil was analyzed for soil bulk density, moisture, penetration resistance, roughness, texture, and type. Corn crop residues were also collected for yield, cover and composition. The following year, soybeans were harvested using a combine equipped with a yield monitor and global positioning system.

Crop residue grazed at the Atlantic site had a decrease in the organic matter yield in grazed paddocks, but no difference in the nutritional quality of residue between grazed and ungrazed paddocks. Soil bulk density data collected from the Atlantic site showed a significant difference between the 0-4 and 4-8 inches depths ($P<.01$) and tillage treatments ($P=.04$) apparently caused by soil types because no tillage treatment was given until the following spring. Bulk density and penetration resistance ratios inside and outside exclosures did not differ between periods grazed indicating there was no effect of grazing on soil compaction. However, there was an effect of grazing period on soil roughness.

Like the Atlantic site, crop residue organic matter yields at Chariton decreased over the winter. Unlike the Atlantic site, there was an increase in concentrations of NDF and ADF and a decrease in CP concentration in crop residue for the grazed paddocks over the ungrazed paddocks. Pre-grazing, post-grazing and post-planting corn crop residue cover did not differ between paddocks grazed and ungrazed, but was different between tilled and no tilled plots after soybeans were planted. Soil bulk density data at Chariton were not affected by grazing date. However, penetration resistance in the upper 6 inches in periods grazed at the beginning and end of the season were greater than paddocks ungrazed or grazed in January or February ($P=.077$). Soil roughness, however, was lower in these paddocks. Regardless of the effects of crop residue grazing on soil characteristics, soybean yields subsequent to grazing date did not differ between paddocks that were ungrazed or grazed at different periods of the winter.

Introduction

The highest cost to beef cow-calf producers is the feeding of stored feeds in winter months. To lower feed costs many producers will try to extend the grazing season on into the winter. The primary resource for winter grazing in the Midwest is corn crop residues. On the average corn crop residue grazing will reduce the amount of hay needed to maintain cows by approximately half a ton over the winter. Although crop residue grazing is quite effective in reducing feed costs, some producers are concerned that corn residue grazing will have an adverse effect on soybean yields the following year because of soil compaction. It has already been proven that the use of large machinery will cause soil compaction in wet conditions and will reduce corn grain yields from 6 to 10%. Furthermore, an increase in soil bulk density can occur in pastures overstocked in wet conditions. It is the purpose of this study to determine if corn residue grazing affects soil properties, and if so when, and will it reduce grain crop yields in subsequent years.

Materials and Methods

Two locations were selected for this experiment, 96 acres belonging to Bill Pellett at Atlantic, Iowa, and 72 acres belonging to Gerald Hansen at Chariton, Iowa. Each location was divided equally into two fields for a corn-soybean rotation. Corn was planted in 30-inch rows and soybeans were drilled in 7-inch rows. Prior to corn planting, fields were chisel-plowed to initiate the experiment on equal tillage treatments. Corn fields were then divided into four blocks (12-acre blocks at Atlantic and nine-acre blocks at Chariton) to determine the effects of cornstalk grazing on the yields of soybeans planted with no tillage or disking the year following grazing. Each block contained a lane leading to a common watering and supplementation site for the field. The blocks were divided equally into six paddocks for a 28-day rotation throughout the winter grazing period. One paddock in each block was randomly selected to be left ungrazed as a control. The remaining paddocks were associated with grazing in a specific grazing month (28 days) to evaluate the interactions of corn crop residue grazing and weather conditions on soil characteristics and soybean yields. Prior to grazing, 12 (9-ft^2) grazing exclosures were placed in each grazed paddock in two transects at approximately 80- and 90-ft intervals at the Atlantic and Chariton locations for comparison of grazed and ungrazed areas within a paddock.

At the initiation of grazing, 12 soil samples per paddock were collected (at 0 to 4 and 4 to 8-inch depths) to determine soil moisture, bulk density, and soil classification through soil type, topsoil depth, and slope. Residue cover was measured at six locations within a paddock using the point method. Crop residue samples were collected from one 4-m^2 site in each paddock and composited by block to determine residue yield and composition. Crop residue samples were also taken midway, and post-grazing was conducted in one 4-m^2 location within each grazed and ungrazed paddock to determine residue utilization and nutrient loss. Crop residue samples were analyzed for organic matter, crude protein, neutral detergent fiber, acid detergent fiber, acid detergent insoluble nitrogen and in vitro digestible matter.

At the Atlantic site corn was harvested as earlage on September 16, 1999. Although it was anticipated that the grazing allowance for each site would be 2.5 acres per cow, harvest of corn as earlage left less corn crop residue and the residue was of a reduced nutritional quality. As a result, each block was stocked with three mature pregnant cows (3.33 cows/acre) on October 18. After five paddocks were grazed, cows were removed on March 1. At the Chariton site, corn was harvested as grain on November 8, 1999. Each block was stocked with three mature cows (2.5 acres/cow) on November 29. Grazing was terminated on April 13. Throughout the grazing period, soil temperatures were measured with data loggers at 4 inches of depth every 30 minutes at two locations per block. Precipitation measurements were also recorded.

Upon completion of the grazing season in spring, soil compaction was evaluated through measurement of soil bulk density, and penetration resistance. In the grazed paddocks measurements were taken inside and in the same row 15-feet outside each grazing exclosure. Also, 24 measurements were taken within each ungrazed paddock. Soil bulk density and moisture content was determined by weighing and drying core samples from depths of 0 to 4 and 4 to 8 inches. In the same locations, penetration resistance was measured using a penetrometer at 3.5 cm (1.4 inches) intervals to a depth of 28 cm. Soil surface roughness was determined by measuring the length of a 2-m long chain forced to take the contour of the soil in 12 locations in each paddock, and also by digital analysis of a 2-m long pin meter with 40 pins in six locations in each paddock. Crop residue cover was measured by the point method in six locations per paddock.

In the spring of 2000, corn and soybean fields were rotated with the newly drilled soybean fields planted as 2 blocks with no tillage or disking. Crop residue covers were measured by the point method in six locations in each previously grazed paddock. The soybeans were harvested in the fall using a combine equipped with a global positioning system (GPS) and yield monitor for yield measurements within each paddock. The soybean yields are correlated with date of grazing and tillage treatment to establish if there were any effects of winter cornstalk grazing on soybean production.

Cow body weight was measured at the initiation and termination of grazing and cow body condition score was measured biweekly. Supplementation of hay is given based on forage availability and on maintenance of a BCS of 5. Hay supplementation was recorded for an economic evaluation of hay saved from cornstalk grazing to compare any effects of grazing on soybean yields.

Results and Discussion

Atlantic, Iowa, location

As expected, initial residue yields and composition of corn crop residues did not differ between fields that were subsequently planted with soybeans by different tillage methods (Table 1). Over the winter, corn crop residues displayed a significant decrease in dry matter yield between the ungrazed control and grazed paddocks, which is a typical result of cornstalk grazing. However, corn crop residues in grazed and ungrazed paddocks did not differ in the rates of changes of CP, NDF, ADF, IVDOM, or ADIN percentages. This indicates the amount of nutrient loss from grazing is comparable to that lost from weathering effects.

Corn crop residue covers at the initiation of grazing did not differ between paddocks to be grazed at different periods (Table 2). Post-grazing ground cover surprisingly showed no difference in grazed at any date and ungrazed paddocks, which is the opposite of the results found in the OM yield. Similarly, post-planting ground covers did not differ between grazed and ungrazed paddocks (Table 2).

However, as expected, post-planting ground covers were greater in soybean fields planted with no tillage than those planted with disking.

Soil bulk density at the initiation of grazing did not differ between paddocks; however, it did show significant differences for sampling depth (P<.01) and tillage treatment (P=.04; Table 3). The differences in initial bulk density for depths resulted from the different soil types at the 0-4 inch and 4-8 inch sampling depths. Similarly, the discrepancy in initial bulk density between tillage treatments seems related to soil type because all four blocks were tilled at the onset of the experiment and were not exposed to tillage treatments until the planting of soybeans in the following spring. Final bulk density ratios for inside the grazing exclosures to 15 ft outside the enclosures taken on the completion of the grazing season did not differ between the grazed and ungrazed paddocks. Also, the ratio of penetration resistance measurements taken outside and inside grazing exclosures did not differ between grazed and ungrazed paddocks (Figure 1). Both the bulk density and penetration resistance measurements implied that there were no effects of livestock grazing on soil compaction. Also, soil textures for topsoil, midsoil, and subsoil were not different when compared between paddocks.

One characteristic of the soil that did show distinct differences resulting from grazing was soil surface roughness (Table 4 Figure 2). When measured either with a 40-pin meter or a chain, soil surface roughness in the last paddock grazed during the season was greater than the ungrazed control paddock. This roughness seems to have resulted from hoof traffic on the paddock during a period when the soil was not frozen (Table 6).

Although grazing did increase soil surface roughness, there was no main effect of grazing or grazing by tillage interaction on soybean yields in the year subsequent to grazing (Table 5). This result indicates that whatever effect grazing may have had on soil roughness did not affect soybean yields. Soybean yields were lower (P<.05) in no-tilled fields than in tilled fields.

At the Atlantic site the cattle were grazing corn residue for 136 days and used 1,194 lbs per cow. They began the grazing season with a average body condition score (BCS) of 5.36 and wieght of 1,366 per cow. When the cows were removed on March 1 they had an average BCS of 5.09 and weight of 1,455 lbs per cow.

Chariton, Iowa, location

Similar to the Atlantic location, initial crop residue yields and compositions did not differ between fields (Table 1). Also, at the Chariton location, crop residue dry matter yields decreased more (P=.07) rapidly in grazed than ungrazed paddocks. However, unlike the Atlantic location, corn crop residues in grazed paddocks at the Chariton location had greater increases in the concentrations of neutral detergent fiber and acid detergent insoluble nitrogen (an indicator of indigestible protein) and a decrease in the concentration of crude protein than ungrazed paddocks (Table 6). The difference between the two sites likely results from the different methods of grain harvest used at each location. At the Atlantic location, corn was harvested as earlage leaving little grain or husks for the cows to selectively graze. In contrast, at the Atlantic location, corn was harvested as shelled corn leaving dropped grain, ears and husks that the cows could selectively graze resulting in the differences in the rates of change in residue composition between grazed and ungrazed paddocks.

As with the Atlantic location, corn crop residue covers of paddocks grazed at different periods or ungrazed did not differ before or after grazing or after planting (Table 2). However, post-planting ground covers were greater in soybean fields planted with no tillage than those planted with disking.

Post grazing bulk density rations taken outside and in the grazing enclosures showed no significance for date grazed (Table 3). However, the ratios of penetration resistance measurements taken 15 ft outside and inside the grazing enclosures to a depth of 14 cm (5.6 inches) were greater in paddocks grazed in December or in March and April (Depth x Date, P=0.077) than in ungrazed paddocks (Figure 3). This is an indication that soil compaction had occurred during the beginning and end of the grazing season. Bulk density ratios did show a significance (P<.01, Table 3) for depths of soil as a result of different soil textures between the topsoil, midsoil, and subsoil. Although soil texture differed for depths it did not differ between paddocks grazed and ungrazed.

Similarly to the Atlantic site, soil roughness data collected for the Chariton location from both the contometer (Figure 4) and chain method indicated (P<.01 and P=.09, respectively) a date grazed interaction (Table 4). The reason for this is not as clear as for the Atlantic site. Soil temperature data show the periods grazed with the greatest amount of frozen days resulted in the roughest soil (Table 4 and Table 6).

Although there may have been an interaction between date grazed and soil compaction or soil roughness, there was no evidence of effect of grazing on soybean yield (P=0.9, Table 5). However, as with the Atlantic site, there was a slight difference between soybean yields on no-till and tillage blocks (P=0.08). In this instance disking yielded less than no-till with 33.98 and 35.09 bu/acre, respectively.

For the 137 days of grazing, the Chariton site used 120 lbs of hay per cow. The amount of hay fed at the Chariton site is considerably less than at Atlantic due to the method of corn grain harvest. The cows began the study with an average body condition score of 5 and a weight of 1,259 lbs. Upon completion of the study the cows had an average BCS of 4.6 and an average weight of 1,195 lbs.

Implications

With only one year partially completed it is difficult to determine the effects of corn residue grazing on soil characteristics and soybean yields. Currently the Atlantic location shows no effect on soybean yields and a grazing effect on soil roughness. The Chariton location demonstrated an effect on date of grazing on soil compaction and roughness without any adverse effects on soybean yield. Hopefully as more data are collected the results will become apparent.

Acknowledgments

This project was funded, in part, by grants from the Leopold Center for Sustainable Agriculture and the USDA-Foreign Agricultural Service. The authors thank Bill Pellett, Atlantic, IA, and Gerald Hansen, Chariton, IA, for their cooperation in this project and gratefully acknowledge the assistance of Bernie Havlovic, Dallas Maxwell, and Dennis Maxwell in conducting this project.

Figure 1: Penetration resistance ratio taken inside and 15ft outside grazing exclosures ploted by depth for each grazing period and ungrazed control at Atlantic location.

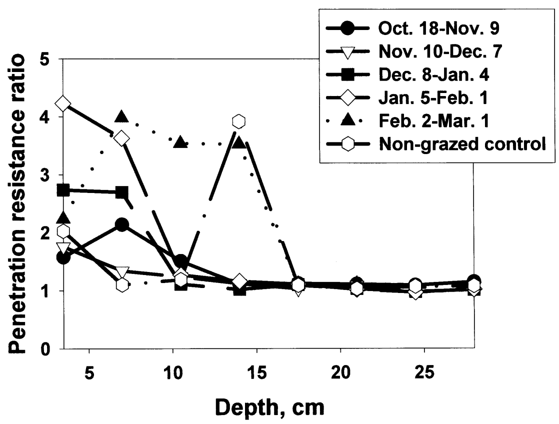

Figure 3: Penetration resistance ratio of soil taken inside and 15ft outside grazing exclosures plotted by depth for each grazing period and ungrazed control at Chariton location.

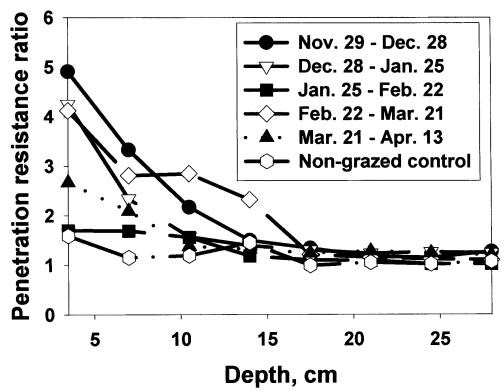

Figure 2: Soil surface roughness measured as standard deviation of contometer pins for grazing periods and ungrazed control at Atlantic location.

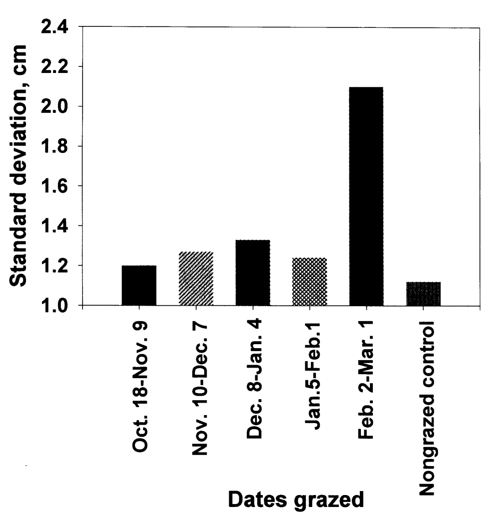

Figure 4: Soil surface roughness measured as standard deviation of contometer pins for grazing periods and ungrazed control at Chariton location.