Effects of Grazing Cover Crops in a Three-year Non-irrigated Rotation
3 year summary report

Study ID: 0720129201901
County: Nuckolls
Soil Type: Hastings silt loam 0-1% slope
Reps: 4

Introduction

In rainfed systems, adding cover crops into the rotation can decrease crop yields if precipitation is limited; however, the use of cover crops for forage may offset costs while retaining soil benefits. This study evaluated three treatments: grazed cover crop (or stubble, depending on the year of crop rotation), non-grazed cover crop, and non-grazed wheat stubble. This is a three-year, no-till crop rotation of wheat, corn, and soybean, with cover crops planted in the cover crop treatments following the wheat crop only. WATERMARK™ soil moisture sensors were installed to determine treatment impacts for each growing season.

Year 1 (2017 crop)

In year one of the study, cover crop treatments were planted on August 14, 2016, following wheat harvest and consisted of a mix of winter peas, spring triticale, oats, collards, and purple top turnip. Cover crop biomass measured on October 19, 2016, was 3,401 lb/ac and consisted mainly of grass and turnip (Table 1).

Table 1. Cover crop composition (% of biomass on DM basis).

Grass	53.5%
Winter Pea	1.5%
Collards	8.7%
Turnip Tops	20.9%
Turnip Bottoms	14.5%
Other	0.9%

The grazed treatment was grazed in the fall of 2016. Starting in November 2016, 28 (1,100 lb) first-calf heifers grazed 9.6 acres for 22 days, resulting in the cover crop carrying 2.4 animal unit months (AUM)/ac. Post-grazing 2,177 lb/ac of biomass were still present. Baseline soil samples were collected in April 2017, prior to planting corn (Table 2).

Table 2. Soil analysis taken prior to corn planting in April 2017.

	0 to 8 inches			
	Soil pH	**OM %**	**Nitrate-N ppm**	**Nitrogen lb N/A**
Cover Crop – Non-grazed	5.52 A	3.1 A	5.4 B	9.3 B
Cover Crop/Stubble – Grazed	5.68 A	3.1 A	7.3 B	12.6 B
Stubble – Non-grazed	5.40 A	3.1 A	12.9 A	24.5 A
P-Value	0.38	0.90	0.01	<0.01

	0 to 4 inches				
	Solvita CO_2-C (ppm)	**Total Biomass (ng/g)**	**Total Bacteria Biomass (ng/g)**	**Total Fungi Biomass (ng/g)**	**Diversity Index**
Cover Crop – Non-grazed	133 A	4,225 A	2,187 A	351 A	1.44 A
Cover Crop/Stubble – Grazed	161 A	3,927 AB	2,142 A	333 A	1.44 A
Stubble – Non-grazed	128 A	3,046 B	1,605 A	306 A	1.5 A
P-Value	0.19	0.09	0.12	0.90	0.90

*Values with the same letter are not significantly different at a 90% confidence level.

During March through May 2017, prior to planting corn, the cover crop treatments were around 35% depletion (the typical trigger point for irrigation on these soil types), whereas the wheat stubble treatments remained near field capacity (full soil moisture profile). Corn was planted in 2017 across all treatments. In May 2017, 8" of rain recharged the soil profile and all treatments had a full 4' soil moisture profile at the beginning of June. Therefore, the cover crop treatments did not result in lower beginning moisture, which could limit yield potential. The grazed treatments began to show greater soil moisture depletion than the ungrazed treatments as time progressed. In June 2017, it was observed that the grazed treatments had concentrations of Palmer amaranth where the cattle created trails walking along the electric fence; palmer amaranth was controlled with dicamba herbicide. For the 2017 corn crop, no significant yield differences occurred (Table 3). Corn yield where the cover crop was planted and not grazed (213 bu/ac) did not differ from where it was grazed (211 bu/ac).

Table 3. 2017 corn yield results.

	Stand Count (plants/ac)	Moisture (%)	Test Weight	Corn Yield (bu/ac)†
Cover Crop—Non-grazed	22,500 A	15.0 A	61 A	213 A
Cover Crop/Stubble—Grazed	22,167 A	14.9 A	61 A	211 A
Stubble—Non-grazed	22,500 A	15.2 A	61 A	218 A
P-Value	0.952	0.129	0.267	0.141

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture for corn.

Year 2 (2018 crop)

In year two of the study, following corn harvest in the fall of 2017, no cover crops were planted. In the previously established grazed cover crop treatment, 11 bulls grazed on the corn stalks (9.6 acres) for 18 days. The two previously non-grazed treatments remained non-grazed. Soybeans were planted in 2018 across all treatments. In August, the grazed treatment showed greater moisture stress than the non-grazed treatments (Figure 1).

Figure 1. August 3, 2018 image with grazed treatment (cover crop in 2016 and stubble in 2017) showing greater moisture stress.

Table 4. 2018 soybean yield results.

	Stand Count (plants/ac)	Test Weight	Moisture (%)	Soybean Yield† (bu/ac)
Cover Crop—Non-grazed	120,750 A*	55 A	10.7 B	50 A
Cover Crop/Stubble—Grazed	120,500 A	55 A	11.0 A	40 B
Stubble—Non-grazed	117,750 A	55 A	10.6 C	52 A
P-Value	0.629	0.397	0.0002	0.0004

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture for soybeans.

For the 2018 soybean crop, there were no differences in test weight or stand counts between the three treatments (Table 4). Grain moisture was significantly higher for the grazed cover crop treatment, followed by the non-grazed cover crop treatment, then the non-grazed wheat stubble. Yield of the non-grazed treatments was 10-12 bu/ac higher than for the grazed cover crop treatment.

Year 3 (2019 crop)

Following soybean harvest in October of 2018, Overland wheat was planted on October 22, 2018 at a seeding rate of 120 lb/ac and row spacing of 7.5". The field received 10 gal/ac 10-34-0 at planting and 80 lb N/ac as a spring topdress application. Wheat was harvested on July 26, 2019 and yield and grain moisture was recorded. For the 2019 wheat crop, there was no difference in test weight or yield (Table 5). Grain moisture was slightly different with the grazed cover crop treatment being wetter than the ungrazed wheat stubble treatment. The wet 2019 season delayed wheat harvest to July 26, 2019. This study will continue another full three years with the cover crop planted on September 4, 2019 due to the rain and wet field. Three-year follow-up soil analysis for nutrient and soil health (Table 6) were taken August 5, 2019 (following wheat harvest and prior to planting cover crops).

Table 5. 2019 wheat yield results.

	Test Weight (lb/bu)	Moisture (%)	Wheat Yield (bu/ac)†
Cover Crop – Non-grazed	59 A*	10.3 AB	84 A
Cover Crop/Stubble – Grazed	59 A	10.4 A	84 A
Stubble – Non-grazed	59 A	10.2 B	83 A
P-Value	0.483	0.067	0.613

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre adjusted to 13% moisture.

Table 6. Three-year follow up soil analysis taken prior to cover crop planting August 5, 2019.

	0 to 8 inches			
	Soil pH	**OM %**	**Nitrate-N ppm**	**Nitrogen lb N/A**
Cover Crop – Non-grazed	5.7 A*	3.3 A	6.6 A	16.0 A
Cover Crop/Stubble – Grazed	5.5 AB	3.2 A	6.3 A	15.0 A
Stubble – Non-grazed	5.5 B	3.1 A	6.0 A	14.5 A
P-Value	0.090	0.105	0.395	0.390

*Values with the same letter are not significantly different at a 90% confidence level.

	Solvita CO2-C (ppm)	**Total Biomass (ng/g)**	**Total Bacteria Biomass (ng/g)**	**Total Fungi Biomass (ng/g)**	**Diversity Index**	**Soil Health Calculation**
	0 to 4 inches					
Cover Crop – Non-grazed	59	2860	1073	183	1.06	10.00
Cover Crop/Stubble – Grazed	44	3498	1524	298	1.44	7.87
Stubble – Non-grazed	63	2760	1287	198	1.30	9.69
	4 to 8 inches					
Cover Crop – Non-grazed	31	906	353	4	0.94	5.89
Cover Crop/Stubble – Grazed	29	1526	569	53	1.22	5.53
Stubble – Non-grazed	21	977	354	12	1.06	4.65

3 Year Soil Physical Properties Changes

Sampling for soil physical properties including bulk density was completed on August 5, 2019. Neither cover crops nor grazing had a significant effect on soil bulk density in the top 2 inches. The average bulk density for the grazed cover crops was 1.08 g/cm^3, for ungrazed cover crops was 1.09 g/cm^3, and the ungrazed wheat stubble was 1.06 g/cm^3. There was no effect of grazing or cover crop in the 2-4" depth of soil. The average bulk density for the soil in the 2-4" depth was 1.31 g/cm^3 for the grazed cover crop treatment, 1.28 g/cm^3 for the ungrazed cover crop treatment, and 1.28 g/cm^3 for the ungrazed wheat stubble treatment.

Soil cone index value is a measurement of how easy it is to penetrate the soil. Figure 2 shows no significant effect on soil cone index value at any of the soil depths. The ungrazed cover crop tended to have a lower soil cone index value, but it was not significantly different from the other two treatments.

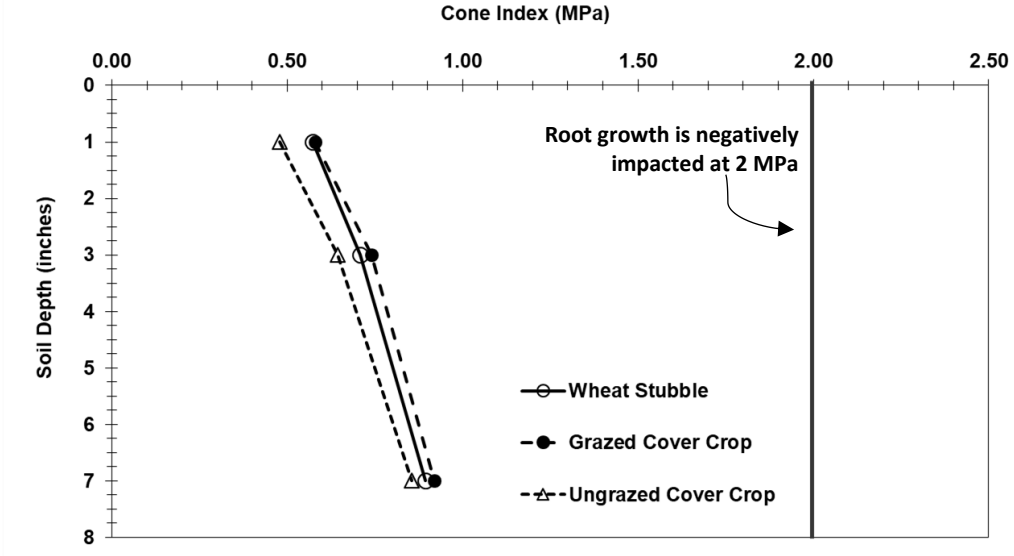

Figure 2. Three-year follow up soil cone index values by treatment taken August 5, 2019. The line on the far right represents where root growth is negatively impacted because roots are no longer able to easily penetrate through the soil.

Multi-Year Economic Analysis (2016 cover crop to 2019 wheat crop)

2016: Cost for spraying wheat stubble was $18/ac. Costs for the non-grazed cover crop treatments were $46.64/ac ($28.64/ac for seed and $18/ac for drilling). Costs for grazed cover crop treatments were $61.94/ac ($46.64/ac for the cover crop seed and planting, $5/ac for fencing, and $10.30/ac for water). Water cost was calculated assuming hauling water (1,000 gal) 15 miles every two days at $2 per loaded mile and $6 per $1,000 gal. Costs for the grazed cover crop treatments equaled $30.97/AUM (animal unit months). Value of the forage is estimated to be $84.80/ac (based on rental rates of $53/pair/month [1.25 AUMs] or $42.40 AUM).

2017: The economic analysis had no input differences for any of the treatments for corn production. UNL Corn Budget 21 (EC872, 2017 Nebraska Crop Budgets, revised Nov. 2016) was the closest that fit this operation, so a total cost/ac of $459.60/ac and a market year average price of $3.15/bu was used. In the previously established grazed cover crop treatment, cattle grazed on the corn stalks. A $5/ac cornstalk rental rate value was assessed to this 9.6 acre area. This rate assumes water, fencing, and the care of the animals.

2018: The inputs were the same for the soybeans planted into all the previous treatments. UNL Budget 56 (EC872, 2018 Nebraska Crop Budgets, revised Nov. 2017) was used, which stated a $315.82/ac total cost. A market year average price of $7.40/bu was used.

2019: The inputs were the same for the wheat planted into all the previous treatments. UNL Budget 70 (EC872, 2019 Nebraska Crop Budgets, revised Nov. 2018) was used which stated a $247.04/ac total cost. A market year average price of $3.65/bu was used. The summary of all years is presented in Table 7.

Table 7. Three crop year economic analysis summary of this study.

	2016 Cover	2017 Corn	2018 Soy	2019 Wheat	3-Year Total
Cover Crop—Non-grazed	-$46.64	$211.35	$54.18	$59.56	**$278.45**
Cover Crop/Stubble—Grazed	$22.86	$210.05	-$19.82	$59.56	**$272.65**
Stubble—Non-grazed	-$18.00	$227.10	$68.98	$55.91	**$333.99**

Sponsored by: University of Nebraska Lincoln
In Partnership with: Nebraska Corn Board, Nebraska Soybean Checkoff, Nebraska Corn Growers Association, Nebraska Dry Bean Commission