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Horticulture Research

Brassica Yield Following Grazed and Un-Grazed Cover Crops

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In a Nutshell

- This project compares yields of fall brassica crops following a spring cover crop of oats and peas. In treatment plots spring cover was grazed by sheep; control plots were un-grazed.

Key Findings

- There were no statistical differences in brassica yield by treatment (grazed vs. un-grazed cover crop).
- Though Black had more than 3 tons DM/ac of aboveground biomass, the sheep trampled more than they foraged because the oats were too fibrous.
- Black is interested in grazing more spring-seeded cover crops based on trial results; Quee plans to stay with his current system of grazing in fallow years and in the early spring and late fall.

Project Timeline:

April 2017 – Nov. 2017

Sheep grazing cover crop plots at Black, May 31.

Background

Cover crops in annual crop ground can be grazed with economic benefit to the grazier and crop farmer, as shown in research from Practical Farmers' livestock program (Filbert et al., 2016; Filbert and Schmidt, 2015; Gailans and Schmidt, 2016). Vegetable farmers commonly raise livestock to diversify their income and the ecology of their farm, and to make better use of vegetable scraps as feed and manure as fertilizer.

Black and Quee both use cover crops in their rotations; fallow seasons with cover crops provide opportunities for grazing on vegetable fields. But vegetable farmers are interested in utilizing their vegetable production beds in non-fallow years for animal forage, too. Fall crops are seeded in July, which leaves time in the spring to establish, and graze, a cover crop. Both Carmen Black and Mark Quee raise sheep on their diversified vegetable farms. They were curious if grazing a cover crop prior to a fall crop, rather than simply terminating the cover crop by mowing and tillage, would have an impact on the yield of the next crop. For this trial each farmer measured the yield of a fall brassica crop following grazed and un-grazed cover crops.

Said Black, "I'm interested in finding ways to incorporate my sheep into my vegetable operation more holistically, but also in compliance with food safety regulations. This trial will allow me to see if there's any measurable difference right away."

Methods

This project was conducted at two Iowa farms: Carmen Black (Sundog Farm in Solon) and Mark Quee (Scattergood Friends School in West Branch).

Cover Crop and Grazing

Farmers set up plots in a randomized, replicated pattern, as shown in **Figure 1**. During the spring, a cover crop of oats and peas was seeded to all plots. Farmers used moveable electric fence to exclude the sheep from control (cover-only) plots, while the treatment plots were grazed. Quee grazed sheep in the plots on May 30; Black grazed sheep in her plots on June 5. Biomass samples were taken from all plots by clipping aboveground foliage at ground-level (four 1-ft^2 quadrats per plot), air-dried and weighed at the Practical Farmers of Iowa office. Biomass results are reported on a dry matter (DM) basis. Production practices, grazing, planting and harvest information for each farm is available in **Table 1**.

Figure 1

Rep 1		Rep 2		Rep 3	
brassica	brassica	brassica	brassica	brassica	brassica
cover	cover + graze	cover + graze	cover	cover	cover + graze

Figure 1: Plot design.

Fall Brassica Crop

When the oats and peas were terminated by grazing, mowing and tilling (in treatment plots), or by mowing and tilling (in control plots), fall brassica crops were seeded along the length of the plots. Quee collected yield data on fall broccoli; Black collected data on Brussels sprouts. Long season brassica crops were used to ensure livestock would have been off the fields 90 days prior to crop harvest, as required by the Food Safety Modernization Act.

After termination of the spring cover crop by grazing or mowing and tilling, Black and Quee seeded fall brassica crops. The rows ran the length of the plots, as shown in **Figure 1**. Quee measured broccoli (cv. Gypsy) yield; Black measured Brussels sprouts (cv. Diablo) yield. Planting, management and harvest practices were consistent across treated (grazed) and control (un-grazed) plots. For broccoli, Quee counted, weighed and measured the width of heads in each plot. For Brussels sprouts, Black harvested entire stalks, then counted and measured sprouts, and graded sprouts based on USDA criteria for color and firmness, by plot (Agricultural Marketing Service, 2016). Production practices and planting and harvest dates for both farms are available in **Table 1**.

Table 1

Production practices and trial design by farm

Farm		Black	Quee
Plot area (ft^2)		29 ft x 36 ft (1,044 ft^2)	150
Number of Reps		3	3
Cover Crop and Grazing Info	Cover Crop Seeding Date	March 22	April 9
	Cover Crop Seeding Rate	486 lb/ac (1:1 oats and peas)	130 lb/ac (70 lb oats:60 lb peas)
	Grazing Date(s)	June 5	May 30
	Sheep and Lambs Grazed	30 ewes, 2 lambs	24 ewes, 33 lambs
	Cover Crop Termination Date	June 9	June 14
Fall Brassica Crop Info	Crop, Variety	Brussels Sprouts (Diablo)	Broccoli (Gypsy, Imperial 1 plot)
	Plants/Plot	27	30
	In-Row Spacing	16 in.	18 in.
	Btwn-Row Spacing	36 in.	30 in.
	Bed Configuration	single row	single row
	Mulch	N	N
	Irrigation	Drip to establish	Drip
	Harvest Date(s)	Nov. 7	Oct. 10; Oct. 27

Data were analyzed using JMP Pro 12 (SAS Institute Inc., Cary, NC) and comparisons among measured variables employ least squares means for accuracy. Mean separations for brassica crops between treatments at each farm were compared using Tukey's least significant difference (LSD). Statistical significance is reported at $P \leq 0.10$.

Results and Discussion

Monthly rainfall and growing degree days for the current year and historical averages are reported from the nearest weather station to each farm (**Table 2**).

May and August were cooler than normal; not a problem for cover crops or fall brassicas. July was very wet, with nearly double the average rainfall, and September was dry. Black only drip irrigates to establish her crops; the dry September slowed the progress of her broccoli, which she had planned to measure for the study. She found the Brussels sprouts plants to be less affected by the dry weather. She also found that the trial area maintained moisture well because of the additional organic matter left by the thick cover crop.

Cover Crops and Grazing

Black

Black grazed her sheep through the treatment plots on June 5, but quickly found she should have put them through earlier. "I think we waited until the cover crops were much too tall to graze the sheep on it, so they ended up knocking everything down and trampling it rather than eating it," she said. She noted that because of the crop's maturity, the stems were fibrous and unappetizing the sheep. "I think they would have stayed in each plot much longer if the cover crop had been shorter. It was also very hot; the sheep were not sheared, and had no shelter which contributed to their lack of enthusiasm for grazing in the plots."

Figure 2 shows aboveground dried biomass values from Black's grazed and un-grazed plots. Biomass in grazed plots was measured before the sheep grazed and again after – the slight difference in means confirms Carmen's observation that the sheep did more trampling than grazing. With a high seeding rate for the cover crop, Black had a dense stand of forage. Just before grazing there was 3.3 tons DM/ac in the plots (May 31). Following grazing, and just prior to cover crop termination (June 7), there was 3.0 tons DM/ac remaining. In the un-grazed plots, there was 4.3 tons DM/ac at the time of cover crop termination

Black also thought she may have had too many sheep in the plot, but considered the crop maturity and high temperatures in June the bigger issues. "If we did this again, I would put the sheep onto the plots much sooner, and potentially graze them, let the cover crop grow, and graze them again. Our first graze was simply too late this year, and by trampling the cover crop it was essentially terminated," she said.

Table 2

Monthly growing degree days and precipitation totals (in.) for the period March 2017 – Oct. 2017 and the long-term averages.

Month	Growing Degree Days (base 50˚F)		Monthly Precipitation Total, inches	
	2017	Avg.	2017	Avg.
March	69	69	3.04	2.25
April	217	210	4.76	3.42
May	**331**	**417**	3.99	4.19
June	613	616	3.52	4.73
July	734	741	**8.27**	**4.37**
Aug.	**563**	**690**	3.25	3.93
Sept.	513	489	**1.35**	**3.60**
Oct.	513	489	3.59	2.66

Climate data were accessed from the Iowa City (120 years) weather stations (Iowa Environmental Mesonet, 2017).

GDD (Base 50) values in bold indicate that the 2017 value was more than one standard deviation from the historical average. Where precipitation data is displayed in bold, 2017 values were more than 2 inches different from the historical average.

Figure 2

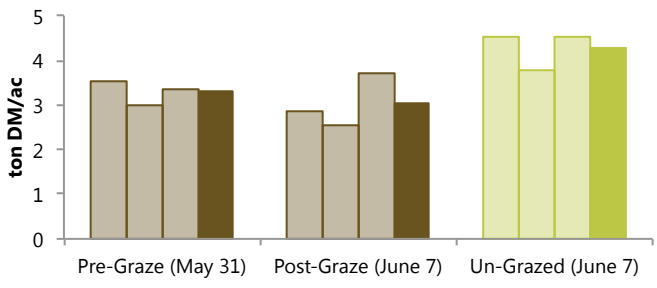

Figure 2: Cover crop biomass in ton DM/ac at Black. Black took biomass samples in grazed plots before and after grazing. Dark bars are the average value for the treatment on a particular sampling date; light bars are individual plot values.

Bagged biomass samples, Black.

Tossing the quadrat to sample biomass at Quee.

Figure 3

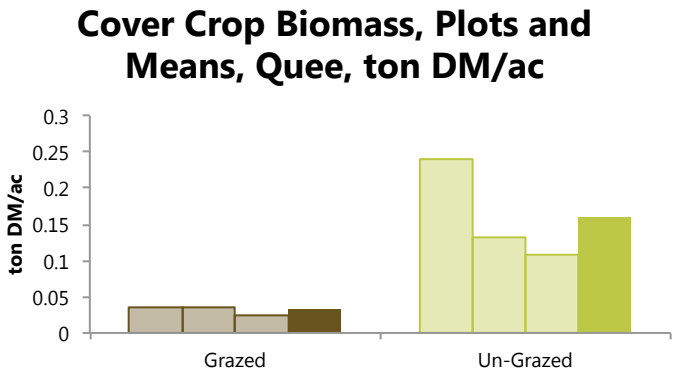

Figure 3: Cover crop biomass in ton DM/ac at Quee. Dark bars are the average value for the treatment on a particular sampling date; light bars are individual plot values. Biomass amples were taken June 14.

Quee

Quee seeded a few weeks later than Black, and grazed his sheep a week earlier (May 30). Though he had less standing biomass, the sheep grazed more heavily on the younger, more delicate forage, providing a thorough mow-down of the cover crop. Though Quee did not sample grazed plots prior to grazing, the difference in the amount of cover crop remaining after grazing is visible and telling in the data. Aboveground biomass in the un-grazed plots averaged 0.16 tons DM/ac, while grazed plots averaged 0.03 tons DM/ac on June 14 just prior to cover crop termination (**Figure 3**).

Brassica Yield

Brussels Sprouts at Black's

Brussels sprout yield at Black were not statistically different in grazed and un-grazed plots; only color ranking was statistically different, with the grazed plots tending lighter green than un-grazed plots (**Figure 4**, **Table 3**). Average number of sprouts per plant was 76.6 in the grazed plots, and 64.9 sprouts/plant in the un-grazed plots. Sprouts in grazed plots, on average were slightly larger and more firm than in un-grazed plots, but the means were not statistically different. Details of yield components are shown in **Table 3**.

Measuring the length of sprouts at Black.

"Sometimes you imagine you see a difference in the treatment plots," said Black. "Just looking at the plants I didn't think there was a difference. And even though the means are not statistically different, 12 sprouts per plant is a big difference. It shows the importance of actually counting," she said.

Black noted that she did a few things right with Brussels this year – planted at the right time and topped them at the right time. Overall it was a good season for Brussels; some customers bought a Thanksgiving Share box specifically for the Brussels sprouts. "Even with all the measurements for the trial, it's still good to know that people like them," she said. Black was pleased with the quality of the Brussels, noting that Diablo (the variety she measured for the trial) was a taller plant and less susceptible to flea beetles than Hesta, another variety they grew.

Table 3

Yield and Yield Components, Brussels Sprouts at Black's

	Sprouts/ Plant	Sprout Length (in.)	Color Ranking (1-4)[a]	Firmness Ranking (1-3)[b]
Grazed	76.6	1.69	1.96 a	2.39
Un-Grazed	64.9	1.56	2.83 b	2.28
LSD	*17.6*	*0.14*	*0.11*	*0.83*

[a] Sprout color was ranked according to the following scale: 1 - lighter than yellow-green; 2 - yellow green; 3 light green; 4 dark green.

[b] Firmness was ranked according to the following scale: 1 - puffy; 2 - fairly firm; 3- firm

Figure 4

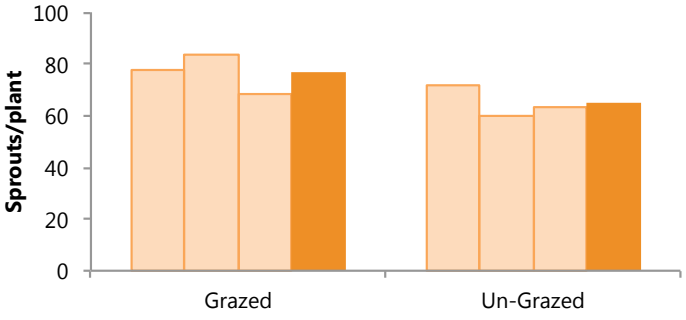

Figure 4: Brussels sprout yield in number of sprouts/plant at Black. Dark bars are the average value for the treatment; light bars are individual plot values. Bars with the same letter are not statistically different ($P < 0.10$). Where no letters are reported, there were no differences among values.

Broccoli at Quee's

Quee had nice sized broccoli crowns, though the average weights were not statistically different by treatment. Crowns averaged 1.44 lb/crown and 1.35 lb/crown for the grazed and un-grazed plots, respectively (**Figure 5**). This might be the most reliable measure of impact, as he noted there was some plant attrition due to rabbits, and one plot was accidentally planted to Imperial, a different variety of broccoli. Additionally, with harvest running up against the first frost, some smaller crowns were left in the field. These factors may have impacted the data for plant yield and crown yield by causing more variability among the plots on a per square-foot basis. There was not a statistically significant difference between plant yield (lb/ft^2) or crown yield (crown/ft^2). Complete information on yield and yield components is available in **Table 4**.

Table 4

Yield and Yield Components, Broccoli at Quee's

	Yield (lb/ft^2)	Crown Yield (crown/ft^2)	Crown Weight (lb/crown)
Grazed	0.10	0.07	1.44
Un-Grazed	0.16	0.11	1.35
LSD	*0.15*	*0.08*	*0.54*

Values with the same letter are not statistically different ($P<$ 0.10). Where no letters are reported after the numbers, there were no differences among values.

Figure 5

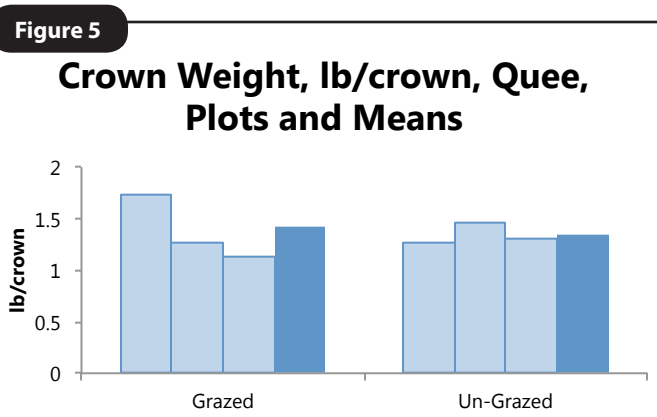

Figure 5: Broccoli crown weight at Quee. Dark bars are the average value for the treatment; light bars are individual plot values. Bars with the same letter are not statistically different ($P<$ 0.10). Where no letters are reported, there were no differences among values.

Broccoli harvest at Quee.

Sheep grazing the treatment plots at Quee on May 30.

Grazed vs. ungrazed plots, foreground and background on the left at Quee.

Conclusions and Next Steps

Both farmers are committed to integrating grazing into their vegetable fields, but the timing of grazing spring-planted cover crop before a fall crop is tricky. Black found several benefits of the trial: "This trial motivated me to put in an early season cover crop, which I've never done before. The cover crop looked really good, and I plan to continue seeding cover crops in March. This project helped me think through how I want to use the sheep on my vegetable fields, and what will be most feasible."

To begin, she plans to graze sheep earlier in the spring-seeded plots, when the forage is still tender and before the June heat sets in (there is no shade near the vegetable beds), and she plans to have the sheep sheared earlier in the season. In addition to better grazing by the sheep, an earlier and longer grazing period will alleviate cover crop termination struggles. She said, "Tilling the plots was very difficult because of how dense and how long the stems were. Even though I mowed very close to the ground to try to grind up the stems into smaller pieces they were still so long that they got wrapped around the tiller shaft and I had to cut them out at the end of each section I tilled. If I owned a disc I think that could have helped."

Even though Black was not satisfied with the grazing this year, she noted that moving the sheep through such a small plot really concentrated their manure and urine, and she thinks provided additional nutrients. In future trials she is interested in taking in-season soil samples or plant tissue samples to measure nutrients.

Quee executed this trial as an additional way to integrate sheep to his vegetable plots. He said, "We graze our sheep, cows, turkeys and pigs as frequently as possible on the vegetable land, most often during the fallow time in the annual crop rotation. We also plant hairy vetch in the vegetable beds in the fall, which allows us to flash graze in March, when no other food crops are producing, and we allow animals to forage in the beds at the end of the season when the crops come out. Doing this, I feel we gain many of the benefits of livestock on the land." Because they already have an animal integrated system, Quee was not convinced the additional risk – grazing while other food crops are producing nearby – was worth the benefit. "I think, ultimately, I am less likely to implement a June/July cover crop grazing in the vegetable fields into my management because of the risks involved. Waiting so long in the season to graze can complicate the organic set-aside period for manure application, and there is the possibility that the sheep get out and run freely through established cash crops," he said.

Quee terminating and incorporating cover crops on June 14.

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