

2019 SOYBEAN MANAGEMENT FIELD DAYS

RESEARCH UPDATE

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Soybean Management Field Days On-Farm Research

Introduction

Keith Glewen, Nebraska Extension Educator

“Wet and Wild” best describes the 2019 growing season. Above normal rainfall at all four locations made for an interesting experience. As you know, when it comes to production management, being in the right place at the right time is critical to maximizing yields. We found 2019 to be challenging from that aspect as I’m sure you did as well. This year also represented the ninth year replicated on-farm research was conducted at Soybean Management Field Day locations. The foundation of our research effort this year focused on cover crops and their impact on soybean yield. Our effort started with planting replicated strips of cereal rye and winter wheat, in the fall of 2018. As a grower you may have questions concerning the impact cover crop residue has on weed pressure, insects – good and bad, soil water use, fertility and how all of this eventually impacts soybean yield. We think you will find the results on the following pages relevant.

Cultural Practices

	Plant	Harvest	Soil	Herbicide	Chem/Rate	Site Average Yield
	5/16/2019	10/17/2019	Sandy Loam	Date	Chem/Rate	bu/ac
Pilger	Cover crop seeded			11/19/2018	60 lbs/Ac	73.2
	Termination 1			5/1/2019	Roundup Powermaxx 32oz	
	Termination 2			5/16/2019	AMS 12 lb/100 gal.	
	Termination 3*			5/23/2019		
	Pre			5/16/2019	Valor 3oz	
	Post			6/19/2019	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	
	5/15/2019	10/24/2019	Silty Clay Loam	Date	Chem/Rate	bu/ac
Plymouth	Cover crop seeded			11/21/2018	60 lbs/Ac	62.8
	Termination 1			4/26/2019	Roundup Powermaxx 32oz	
	Termination 2			5/15/2019	AMS 12 lb/100 gal.	
	Termination 3*			5/20/2019		
	Pre			5/15/2019	Valor 3oz	
	Post			6/17/2019	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	
	6/7/2019	10/23/2019	Loam	Date	Chem/Rate	bu/ac
Sargent	Cover crop seeded			11/20/2018	60 lbs/Ac	62
	Termination 1			5/16/2019	Roundup Powermaxx 32oz	
	Termination 2			6/7/2019	AMS 12 lb/100 gal.	
	Termination 3*			6/12/2019		
	Pre			6/7/2019	Valor 3oz	
	Post			7/11/2019	Roundup Powermaxx 32oz AMS 12 lb/100 Warrant 2qt NIS @ 1% v/v	
	5/14/2019	10/22/2019	Sandy Clay	Date	Chem/Rate	bu/ac
Waverly	Cover crop seeded			11/16/2018	60 lbs/Ac	73.2
	Termination 1			4/26/2019	Roundup Powermaxx 32oz	
	Termination 2			5/14/2019	AMS 12 lb/100 gal.	
	Termination 3*			5/22/2019		
	Pre			5/14/2019	Valor 3oz	
	Post			6/17/2019	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	

* Post plant terminations for Entomology Study only

As growers, you are increasingly challenged to grow soybeans more responsibly and to document sustainability. We are confident the results reported in this research update and the information provided at the Soybean Management Field Days this past August will be useful.

Faculty and staff representing the University of Nebraska-Lincoln greatly appreciate the financial investment you, the soybean growers of Nebraska, have made through your Checkoff contribution in supporting the research undertaken in this project. We would also like to thank the Nebraska Soybean Board for their part in support and management of this effort. Their input into the selection of research topics and, in some cases, treatments was most helpful.

We would also like to thank each of the four collaborating soybean growers who provided their farm as a research location. The names and locations of these operators are noted on the following pages.

After reviewing the report, if you have additional questions, we encourage you to contact researchers associated with the study. Their names appear in the write up of each study and their contact information is listed on the back cover. **We are committed to work for you, the soybean growers of Nebraska.**

Impact of Cover Crop Termination Timing on Arthropod Abundance, Defoliation, and Soybean Yield

Authors: Justin McMechan (Crop Protection and Cropping Systems Specialist), Thomas Hunt (Nebraska Research and Extension Entomologist), and Robert Wright (Nebraska Research and Extension Entomologist)

Research Support: Elliot Knoell (Research Project Coordinator), Steven Spicka (Agronomy Research Tech III), and Keith Glewen (Nebraska Extension Educator), Juan Betancurt Cardona (Research Scholar), Tauana Ferreira De Almedia (Research Scholar), and Dania Ozario (Research Scholar)

This project was funded in part by the Nebraska Soybean Board and the North Central Soybean Research program.

TAKE HOME POINTS:

- Large differences in cover crop biomass and extended leaf height were observed between termination dates and sites
- Termination date had a significant impact on arthropod activity with many representing beneficial arthropods such as predators or fungal feeders
- Defoliation thresholds were not reached at any of the cover crop termination dates or sites
- Soybean biomass was lower for the at-plant and post-planting cover crop termination dates.
- No differences in soybean yield were observed between termination treatments at any of the field study sites

INTRODUCTION

Cover crop adoption has been increasing as a means of reducing soil erosion, increasing soil organic matter, soil tilth, water infiltration, nutrient capture, and weed control. Despite these benefits, producers still face a number of production challenges. Of these challenges, spring termination of cover crops is a primary concern, second only to fall establishment (Butts and Werle 2016). A national survey of growers found 39% “planted green” into a cover crop with 69% of those producers planting soybeans as the subsequent cash crop (CTIC 2017). While some producers are motivated to plant green, others are forced to as a result of poor spring weather conditions or a lack of herbicide control. Currently, limited information is available on the risk of increased pests or disease for timing of termination of a cover crop relative to the cash crop planting.

Cover crops can attract both pest and beneficial arthropods. Damage from insect pests is based on a number of different factors such as, timing of cover crop establishment or termination method, number of years with a cover crop, weather conditions, and the interval between termination and planting as well as the subsequent cash crop species. Studies and field observations have shown significant risks from pests such as black cutworm, wireworm, Japanese beetle, green cloverworm, southern corn rootworm, seed corn maggot, stinkbugs, and bean leaf beetle and slugs with rye cover crops (Smith et al. 1988). In contrast, Koch et al. 2012 reported reduced aphid and bean leaf beetle population with a rye cover crop. Methods of termination varied considerably between studies (plowing, paraquat, or mowing). In addition, termination dates were not utilized in a way to evaluate their impact on insect populations. Such studies have demonstrated the risk with each of these pests, but no studies have been conducted to determine how management practices such as the timing of termination might influence this relationship.

METHODS

Experiments were conducted at each of the Soybean Management Field Day sites. These sites were located near Pilger, Plymouth, Sargent and Waverly. At each site there four termination dates relative to soybean planting. VNS (Variety Not Stated) rye was planted at 59 lb/acre, respectively. Cover crops were planted in mid- November (Table 1). These cover crops were terminated at three separate times during the spring with glyphosate (32 oz/acre) and 12lb/100 gallons of AMS at 15 gallons per acre (Table 1). Early termination treatments were made after extended leaf height of the cover crops reached 6-8 inches, which is defined as the minimum growth required for erosion control (NRCS Code 340). At plant terminations were made within a day of planting soybean, with late (post-planting) termination occurring 5-7 days after soybean was planted. This study was conducted as a randomized complete block design with four replications at each site. Each experimental unit was 30 ft wide (12 rows X 30 in. per row) and 30 ft long.

Section 1 - Table 1. Planting, application and data collection dates at each of the Soybean Management Field Day sites in 2018 and 2019. *at-plant and post-planting refer to times relative to the soybean planting date.

Site	Cover Crop				Soybean Planted	Pitfall Trap	Soybean Damage Assessment
	Planted (Yr. 2018)	Termination 1 (early)	Termination 2 (at-plant)*	Termination 3 (post-plant)*			
Pilger	Nov. 19 th	May 1 st	May 17 th	May 23 rd	May 16 th	June 13 th -18 th	June 18 th
Plymouth	Nov. 21 st	April 23 rd	May 14 th	May 20 th	May 14 th	June 13 th -18 th	June 18 th
Sargent	Nov. 20 th	May 16 th	June 7 th	June 12 th	June 7 th	July 9 th -16 th	July 16 th
Waverly	Nov. 16 th	April 23 rd	May 14 th	May 22 nd	May 14 th	June 13 th -18 th	June 18 th

DATA COLLECTION

Cover crop biomass and extended leaf height: Samples and measurements were taken on each plot prior to each termination date. Biomass samples were collected by cutting rye plants at ground level from 1ftx2ft area at 2 locations within in each plot. Plant samples were dried in an oven prior to being weighed. Extended leaf heights were determined by pulling a handful of rye plants to an upright position and measured from the soil surface to the tip of a leaf.

Soybean biomass: Soybean plant biomass was collected at the V2-V3 stage on 2 ft of row at 2 locations in each plot. Plant biomass was processed in the same manner as cover crop biomass.



Arthropod activity: Pitfall traps were placed in each plot (photo to the right) to capture arthropods moving across the soil surface. Traps were set up approximately two weeks after planting for a period of 5-7 days. All arthropods were identified to family.

Pest damage assessment: Insect damage to soybeans was assessed through visual evaluation for frequency and severity at the V2-V3 stage with the exception of Sargent that was evaluated at R1.

Yield: Soybean yields were taken using a small plot combine by harvesting the center two rows of each plot. Alleys were cut just prior to harvest and recorded to determine total plot length. All yields were adjusted to 13% moisture prior to the statistical analysis.

RESULTS

Cover Crop biomass and extended leaf height: Overall, biomass and extended leaf height varied between sites (Figure 1, Table 2) with the greatest at Waverly, followed by Sargent, Pilger and Plymouth. In contrast, the greatest heights occurred at Sargent, followed by Waverly, Pilger and Plymouth.

Termination treatments (Table 3) also had a significant effect on biomass and extended leaf height with biomass increasing by four times from early to at planting termination. Rapid biomass accumulation was observed in the 5-7 after planting with an average of nearly 500 lbs of additional cover crop biomass accumulated across all sites. Rye cover crop height gained an average of 9 inches of growth between early and at-plant termination whereas an additional 3 inches of growth was observed between at-plant and post planting terminations. At Pilger and Sargent there were no significant increases in plant height between the at-plant and post-plant termination where a significant increase in plant height was observed for Plymouth and Waverly over the same two treatments.

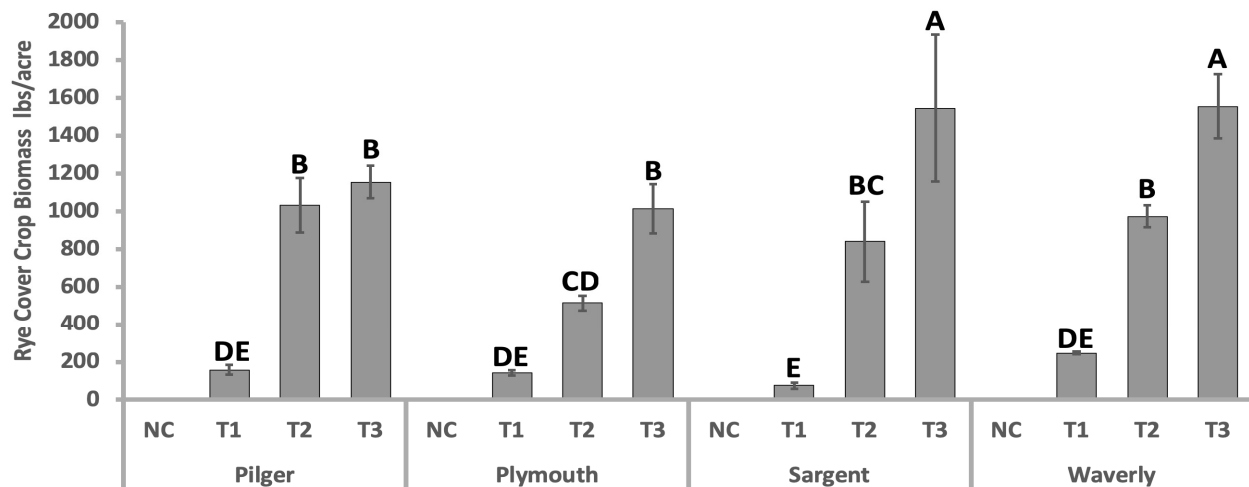
Section 1 - Table 2. Mean biomass and extended leaf height for both cover crop species at each site. Letters indicate significant differences at $P < 0.05$.

Site	Cover Crop	
	Biomass	Extended Leaf Height
Pilger	780.8 A	13.6 C
Plymouth	555.5 B	13.1 C
Sargent	819.5 A	18.3 A
Waverly	923.7 A	15.0 B

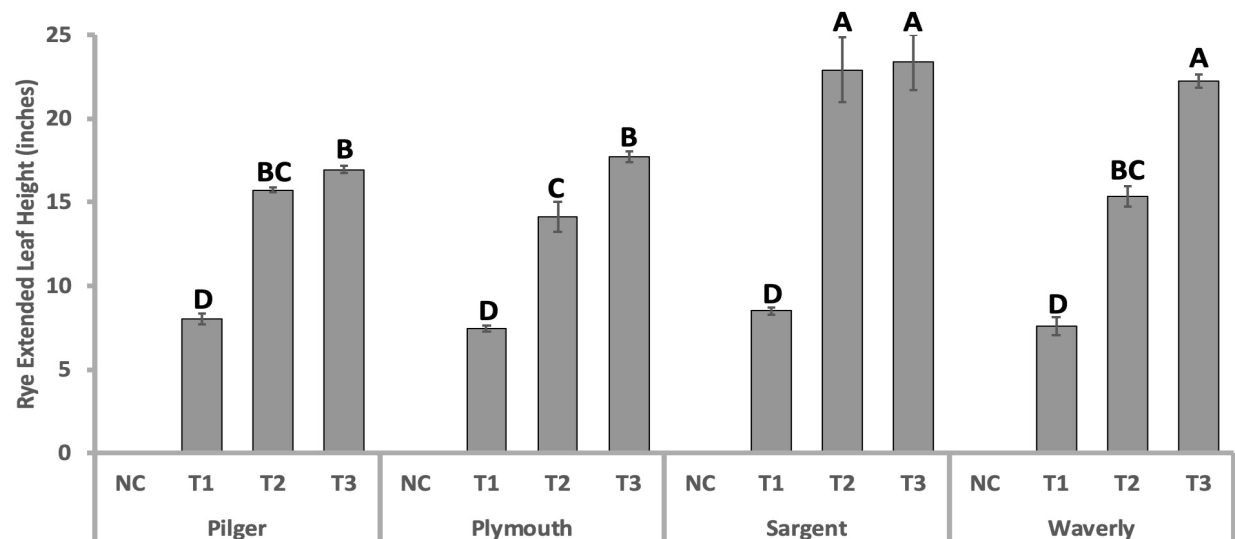
Section 1 - Table 3. Mean biomass and extended leaf height for cover crop species and termination date across all sites. Letters indicate significant differences at $P < 0.05$.

Cover Crop Termination	Cover Crop	
	Biomass	Extended Leaf Height (inches)
Termination 1: Early	155.2 C	7.9 C
Termination 2: At plant	838.2 B	17.0 B
Termination 3: Post-planting	1316.3 A	20.0 A

Section 1 - Figure 1. Cover crop biomass (lbs/acre) taken prior to each termination date for a cereal rye cover crop at each of the four SMFD sites. Letters indicate significant differences between treatments at $P < 0.05$.

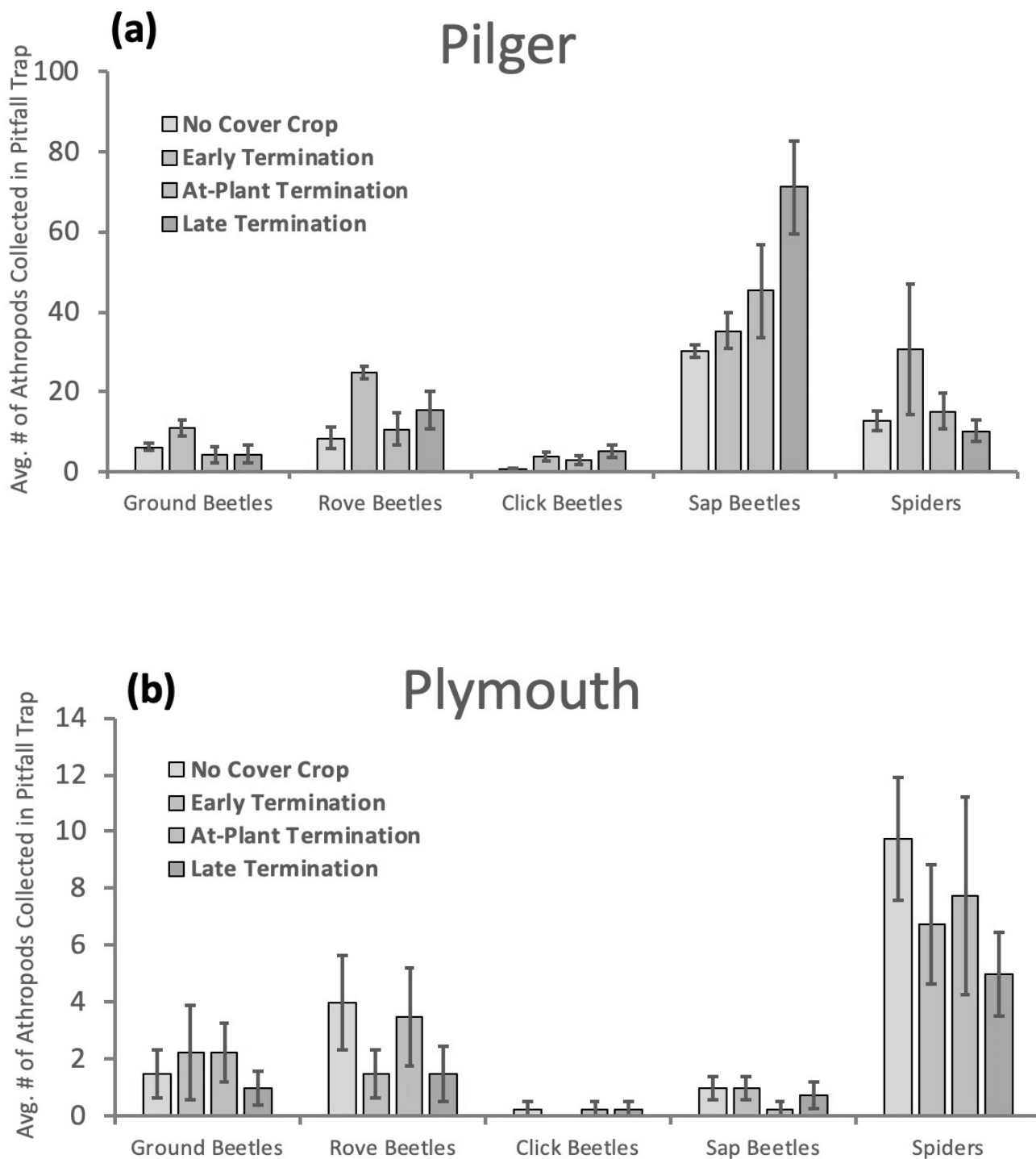


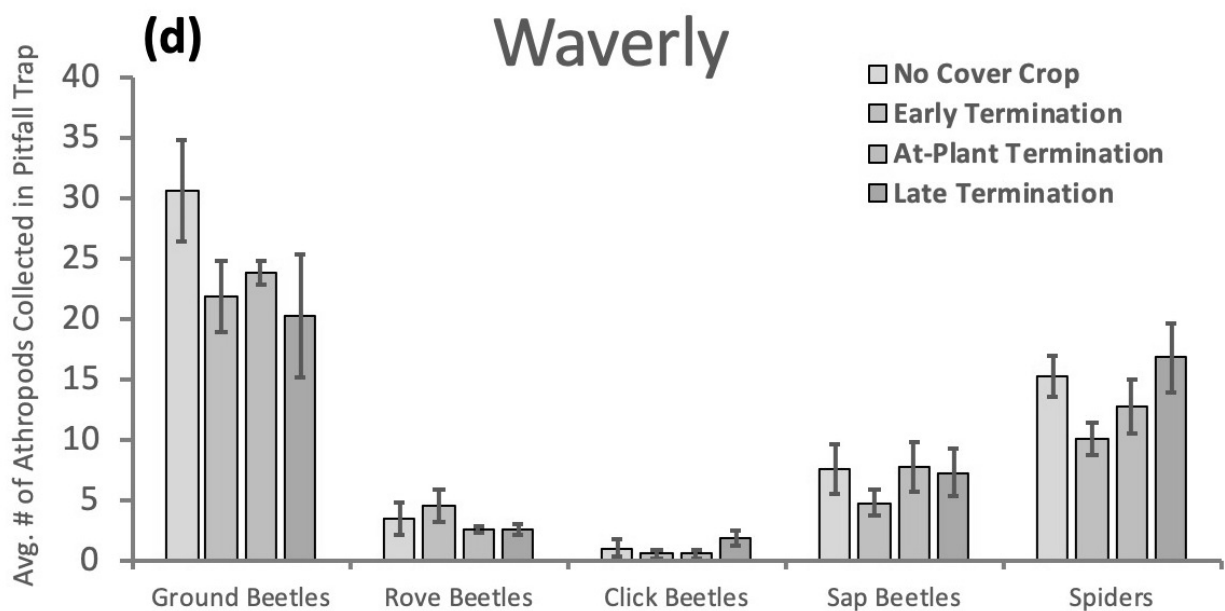
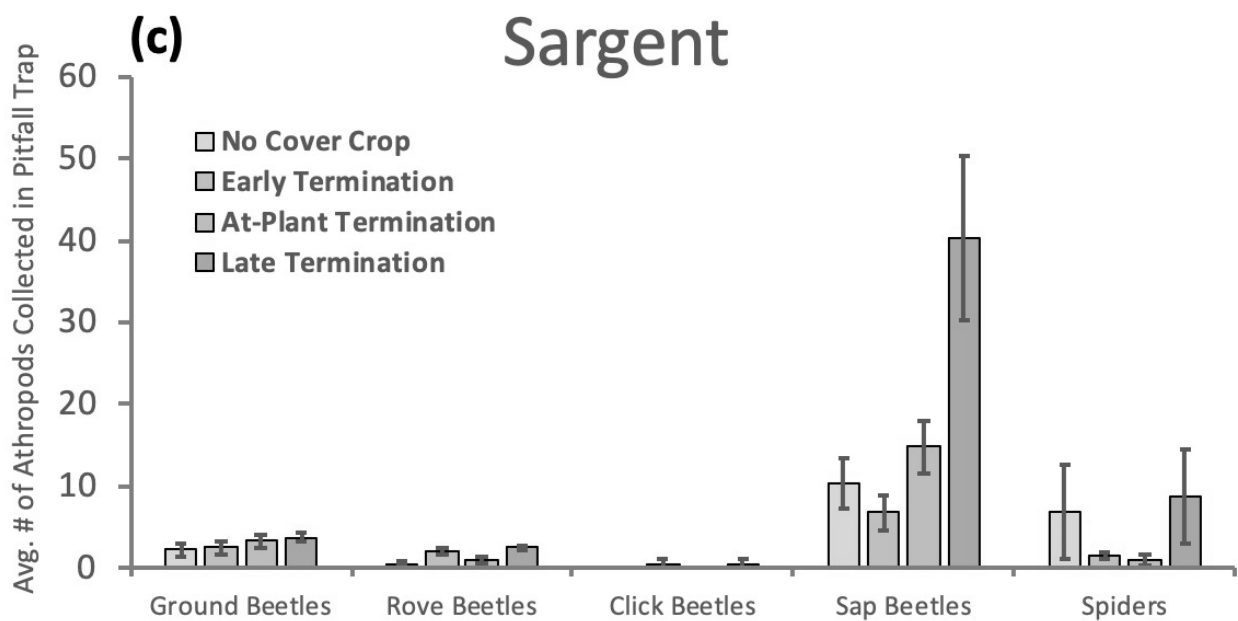
Section 1 - Figure 2. Extended leaf height (inches) taken prior to each termination date for a cereal rye cover crop at each of the four SMFD sites. Letters indicate significant differences between treatments at $P < 0.05$.



Arthropod activity: Total arthropod activity had a significant interaction between location and cover crop termination date ($P = 0.0261$). The greatest differences were observed between sites with Pilger (138.8) having significant more arthropods per pitfall trap compared to Waverly (105.6) followed by Plymouth (54.3) and Sargent (52.2). No significant differences occurred between termination dates with an average of 98.9 arthropods per pitfall trap in post-planting followed by pre-planting (90.4), no cover crop (82.5) and at-plant (79.0) termination. Figure 3 shows of the major groups of arthropods and their average numbers per pitfall trap for Pilger (A), Plymouth (B), Sargent (C), and Waverly (D).

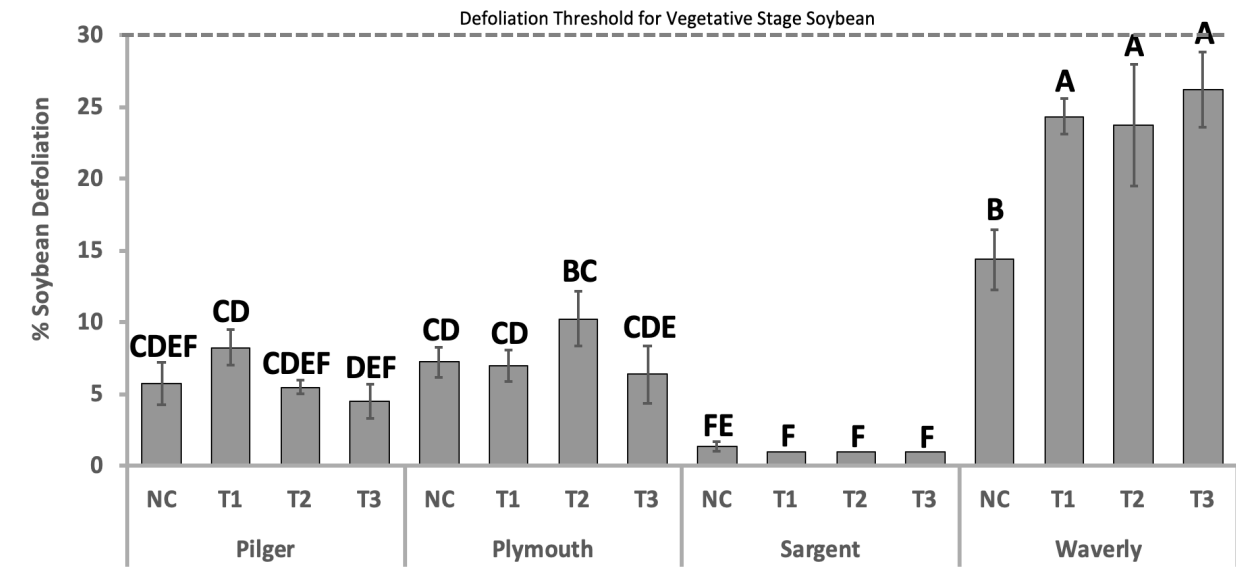
Section 1 - Figure 3. Average number of arthropods recovered from pitfall traps for no cover crop, early, at-plant and post-plant terminations at each site Pilger (A), Plymouth (B), Sargent (C), and Waverly (D) over a 5-7 day period being at the V2-V3 stage in soybean with the exception of Sargent at R1 stage.





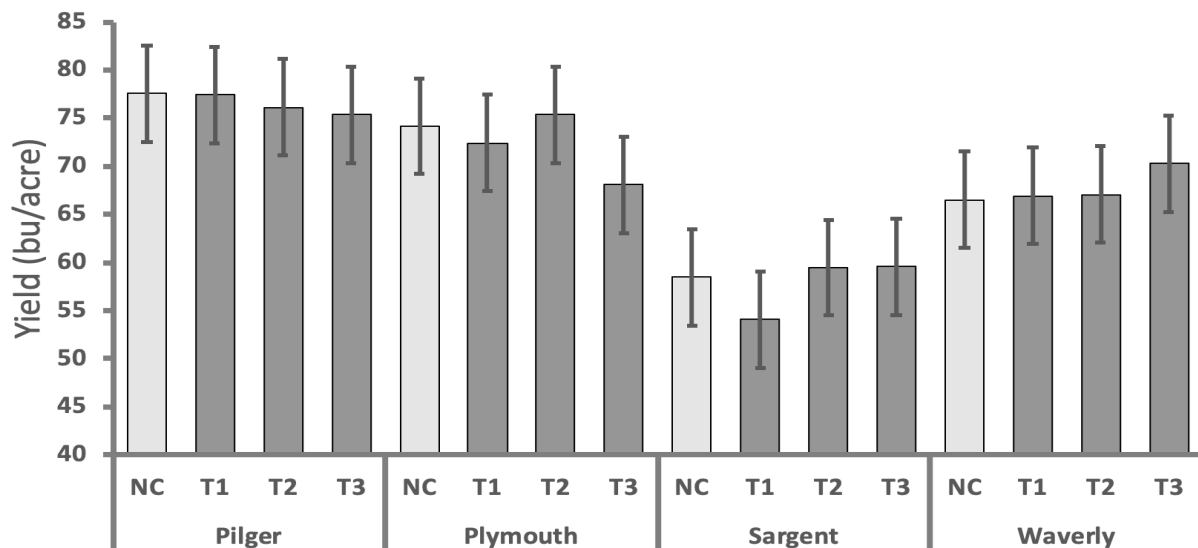
Pest damage assessment: Defoliation of plants was less than the economic threshold of 30% for vegetative stage soybean across all treatments and sites (Fig. 4). Waverly had the greatest defoliation of levels of any site and the highest levels of defoliation occurred for treatments where the cover crop was grown and did not differ based on the termination timing of the cover crop. The most common defoliators collected were thistle caterpillar, alfalfa caterpillar, loopers, yellowstriped armyworm, and green cloverworm.

Section 1 - Figure 4. Percent defoliation across all sites compared to the economic threshold of 30% for vegetative stage soybeans.



Soybean Biomass: Differences in soybean biomass ($P < 0.0001$) occurred between sites with the greatest biomass at Sargent (3151 lbs/acre) due to a late sampling date. Soybean biomass at Pilger (1069 lbs/acre) was similar to Plymouth (949.8 lbs/acre). The lowest soybean biomass was observed at Waverly with 546 lbs/acre). Site differences could be due to slight variations in soybean stage of development at the time of the sample. Differences in soybean biomass was approaching significance for termination times ($P = 0.0669$) with the greatest soybean biomass occurred for the early termination (1525 lbs/acre) followed by no cover crop (1511 lbs/acre) and post-planting termination (1348 lbs/acre). The at-plant termination (1334 lbs/acre) was significantly lower than the early termination. No interactions were observed between sites and termination meaning that the differences were similar for termination timings at each site.

Yield: No significant differences occurred between the different termination times at any of the sites.



DISCUSSION

Termination date had a significant impact on the total number of arthropods collected from pitfall traps, however, these differences varied between sites. Other factors such as previous crop, cover crop history, residue management, and environmental conditions can influence these results. Additional data are needed to confirm this result. Of the arthropods collected from pitfall traps, ground beetles, rove beetles, and spiders are considered to be generalist predators feeding on other insects. Sap beetles are typically found feeding on decaying fruit and fungi and are not considered to be a threat to vegetative stage soybeans. Click beetles were found in significant numbers at Pilger. The immature form of this insect is the wireworm which can cause significant damage to seedlings early in the growing season under cool conditions that slow plant growth.

Plant injury from defoliation was generally low on all treatments across all sites with the exception of Waverly. Of the defoliators observed, green cloverworm is the only insect pest that has been potentially associated with cover crop plantings in the past. Regardless of the increased defoliation levels observed at Waverly there were no differences in yield at that site or any of the other Soybean Management Field Day sites.

Cover Crops Influence Abundance of Soil Microbial Communities

Authors: Katja Koehler-Cole, Research Assistant Professor

Researchers: Katja Koehler-Cole, Research Assistant Professor

Research support: George Biliarski, Elliot Knoell, Steven Spicka, and Keith Glewen

TAKE HOME POINTS:

- Rye cover crops terminated at soybean planting increased total microbial biomass in mid-May
- This increase consisted mainly of bacteria
- Arbuscular mycorrhizal fungi, saprophytic fungi and actinomycetes populations stayed the same
- The effect did not persist into summer (July)
- Greater microbial abundance could improve residue breakdown, nutrient cycling and soil aggregation

INTRODUCTION

The formation of soil organic matter, the breaking down of plant residue and the release of plant available nutrients are all carried out by soil organisms. The space adjacent to living plant roots, called the rhizosphere, is where most soil microbes live. Planting a cover crop between main crops increases habitat by increasing the amount of living roots. Cover crops provide nutrients to soil microorganisms in the form of residue. Further, their living roots leak simple sugars and amino acids, preferred food sources for a multitude of soil organisms.

Bacteria are the most prevalent microbes in agricultural soils. They break down simple organic compounds such as the ones found in fresh cover crop residue. Bacteria can reproduce fast, and increase their populations quickly when a new food source becomes available. **Actinomycetes** are bacteria that can break down more complex organic compounds. **Fungi** are more delicate than bacteria and are disturbed by tillage. *Saprophytic fungi* can break down complex organic compounds, such as the ones found in corn stalks. *Arbuscular mycorrhizal fungi (AMF)* colonize plant roots, and transfer nutrients to the plant in exchange for sugars from the plant. Fungi are essential in forming soil aggregates by excreting glomalin, a glue-like substance that binds soil particles.

Increasing the amount of living plant may lead to greater microbial activity, and thus improved soil structure and nutrient cycling. Further, nutrient uptake by the plant itself may reduce contamination of groundwater and surface water, a reason why cover crops are now subsidized in several states.

OUR RESEARCH QUESTIONS WERE:

1. Can rye cover crops increase soil microbial abundance?
2. Which microbial groups are most likely to increase?

RESEARCH METHODS

At three Soybean Management Field Day sites (Pilger, Plymouth, and Waverly), cereal rye was planted at 59 lb/ac in mid-November of 2018 and terminated with glyphosate the following spring within 5 days of soybean planting. Soybean were no-till planted in 30" rows into the rye residue.

We took 10 soil samples (4" depth) from 4 rye plots and 4 plots without rye (controls) within a week of soybean planting and again in mid-July. Soil biology was analyzed at Ward Laboratories (Kearney, NE) using phospholipid fatty acid analysis (PLFA) which shows the abundance of different microbial groups (bacteria, actinomycetes, AMF, saprophytic fungi, and others) present in the soil. Total microbial biomass is the sum of the microbial biomass of each group.

	Chemical properties					Soil texture			
Site	pH	OM	N	P	K	Sand	Silt	Clay	Texture
		%	Ppm			%			
Pilger	6.2	1.3	8.7	176	145	78	9	13	Sandy Loam
Plymouth	6.5	3.1	5	49	305	18	45	37	Silty Clay Loam
Waverly	6.5	3.6	8.4	33	253	48	13	39	Sandy Clay

Section 2 - Table 1. Soil properties at each site in fall 2018 at rye cover crop planting. Chemical properties are given as concentrations. OM is organic matter, N is the concentration of nitrate.

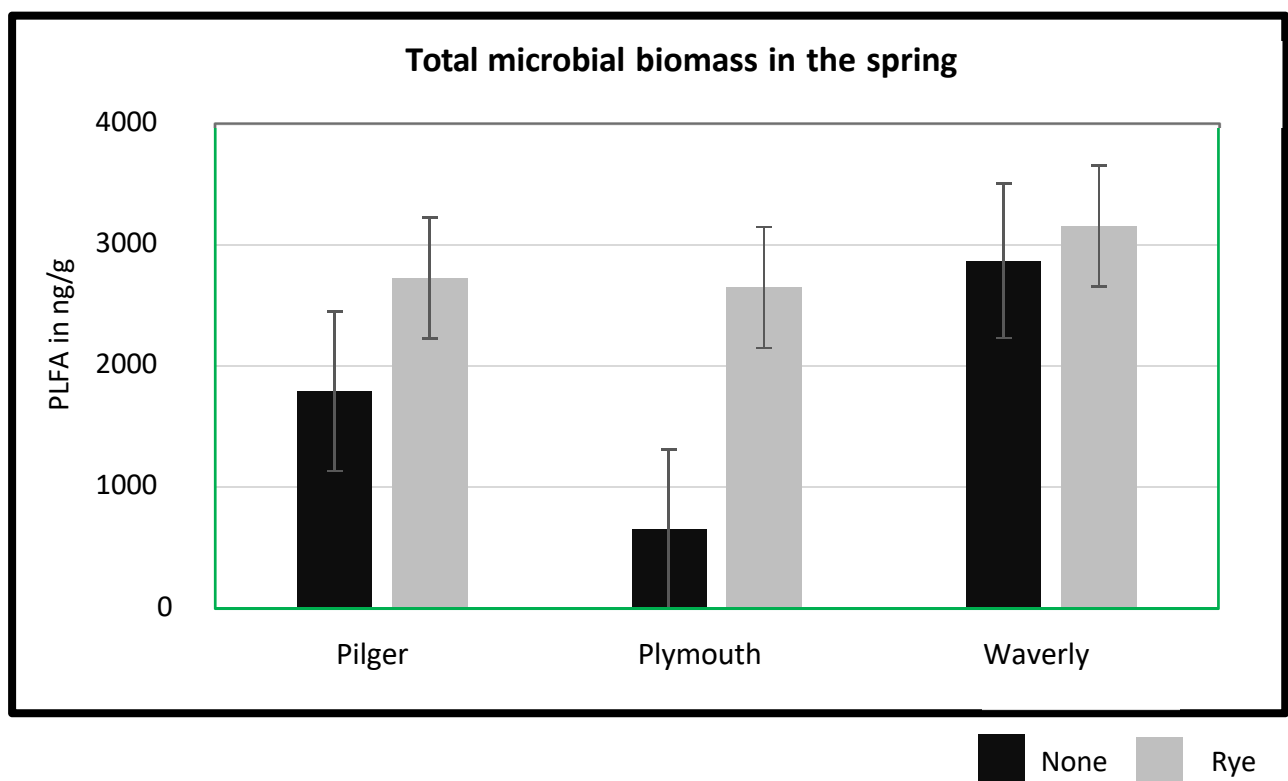
MICROBIAL ABUNDANCE UNDER RYE COVER CROPS

In May, soil under the rye cover crop had significantly greater total microbial biomass than soil under the control (no cover crop) (see Figure 1). Most of the increase in overall microbial abundance came from the bacterial population (Figure 2). Bacteria are the most numerous soil microbes, and often quickly respond to changes in management, such as cover crops. The rye cover crop did not significantly increase populations of actinomycetes, AMF and saprophytic fungi, although populations were often numerically greater (Figure 3, 4, 5). Microbial populations are highly variable even within small areas such as research plots which may explain these results. Note that the populations of actinomycetes and fungi are about one magnitude lower than the bacterial population.

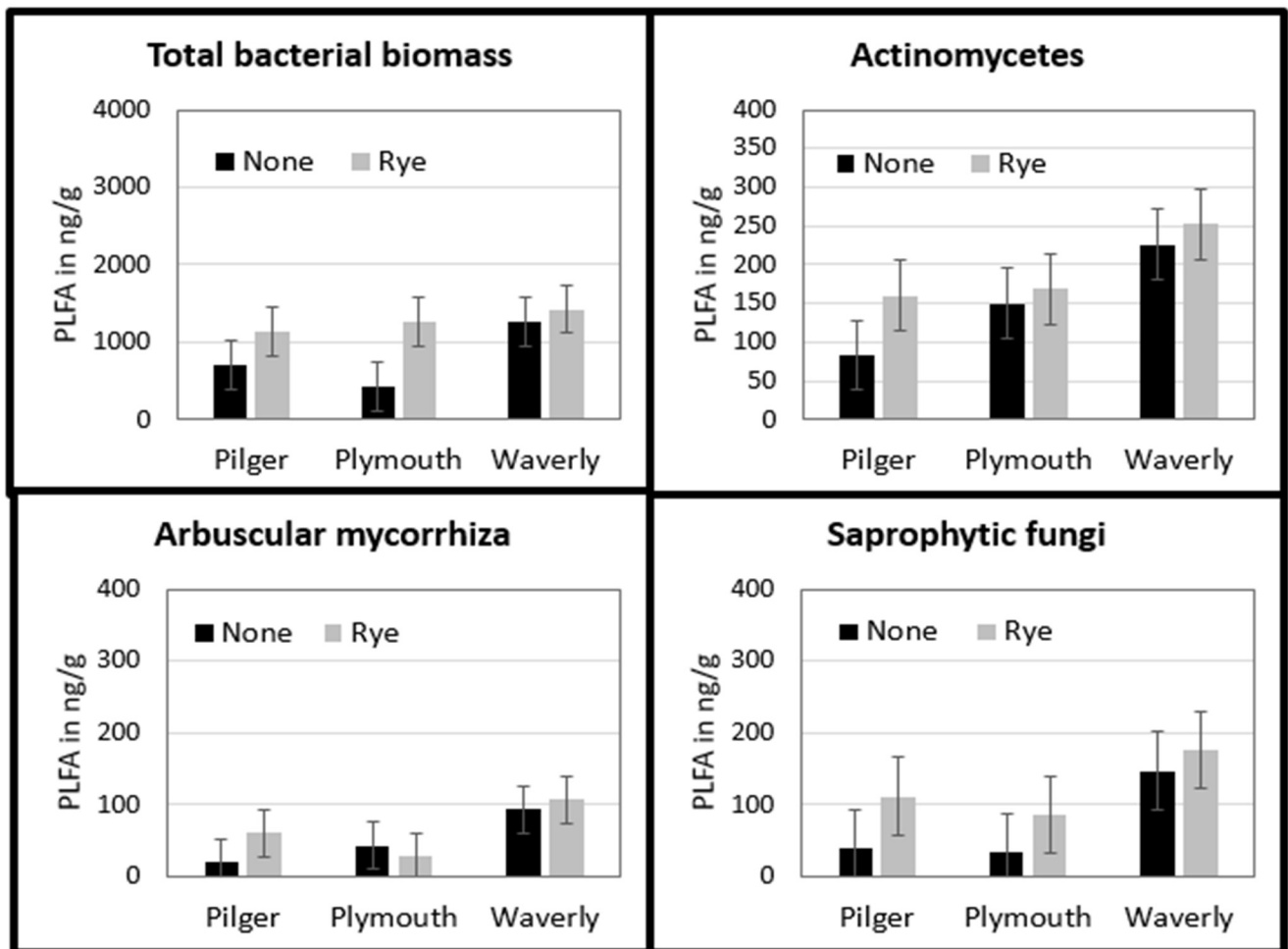
By July, the differences in total microbial biomass between plots where rye had been grown and plots without rye had disappeared. Bacteria, actinomycetes, AMF and saprophytic fungi tended to have greater abundance under the rye cover crops at some sites, although these increases were not statistically significant.

CONCLUSION

Greater microbial abundance in the soil could improve the breakdown of residue, increasing nutrient availability to soybean. More fungi could improve soil structure, with larger and more stable aggregates which are less erodible by wind and water. This could be particularly useful in soils with low organic matter or sandy soils that are prone to erosion. We will continue to investigate how cover crops can be used to increase the populations of beneficial soil microbes such as fungi across a range of soil types in Nebraska.



Section 2 - Figure 1. Total microbial biomass in mid-May at each site under rye (gray bar) or control (none, black bar). Lines above bars indicate standard errors.



Section 2 - Figure 2 (top left), 3 (top right), 4 (bottom left) and 5 (bottom right) shows biomass of selected groups in mid-May at each site. Lines above bars indicate standard errors.

Impact of Cover Crop Species, Termination Timing, Herbicide Program and Maturity Group on Weed Suppression and Soybean Yields

Authors: Chris Proctor (UNL Weed Science Extension Educator),
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Research Support: Elliot Knoell (Research Project Coordinator),
Steven Spicka (Agronomy Research Tech III), and Keith Glewen (Nebraska Extension Educator), Juan Betancurt Cardona (Research Scholar), Tauana Ferreira De Almedia (Research Scholar),
Dania Ozario (Research Scholar), and Kaity Wilmes (Graduate Student)

TAKE HOME POINTS:

- Cover crop species had no effect on biomass production, but termination date did effect biomass for some locations.
- Low weed pressure and high weed variability resulted in no treatment difference for weed suppression
- Soybean yield was not affected by treatment, though yield differences were observed at two locations as a result of high variability.

INTRODUCTION

As resistant weed populations continue to increase, the challenge of successful weed management has also increased. These resistant populations limit effective herbicide options, which makes integrated weed management approaches even more important. Cover crops have the potential to be a useful tool, in addition to herbicides, for managing weeds. A recent survey from Nebraska Extension on cover crop use found that 97 percent of growers using cover crops believe cover crops improved their weed control. It is generally well agreed upon that cover crop benefits are closely tied to biomass production. In Nebraska soybean/corn cropping systems, the window for producing cover crop biomass is relatively short following harvest. There is opportunity however, to increase spring cover crop biomass by delaying termination, but the later termination occurs the higher the potential for detrimental effect or delayed planting of the next crop. Thus, finding a balance between cover crop biomass production without negative impacts on the subsequent crop are important.

The objective of this study was to evaluate the impact of cover crop species (wheat and cereal rye) and biomass (termination timing) on weed control and soybean yield when paired with different soybean maturity groups and herbicides application timings.

METHODS

Experiments were conducted at each of the Soybean Management Field Day sites. These sites were located near Pilger, Plymouth, Sargent, and Waverly. At each site there 24 treatments (three cover crop treatments x two cover crop termination dates x 2 herbicide applications x 2 soybean maturity groups). Cover crop treatments consisted of wheat, rye and no cover crop. 'VNS' rye and 'Ruth' wheat was planted at 59 and 63 lb/acre, respectively. Cover crops were planted in early- to mid- November (Table 1). These cover crops were terminated at two separate times during the spring with glyphosate (32 oz/acre) and 12lb/100 gallons of AMS at 15 gallons per acre (Table 1). Early termination treatments were made after extended leaf height of the cover crops reached 6-8 inches, which is defined as the minimum growth required for erosion control (NRCS Code 340). Late termination occurred approximately 2-3 weeks after the first termination application and coincided with soybean planting (Table 1). The full herbicide treatment was flumioxazin (Valor, 3 oz/A) applied at soybean planting followed by fomesafen (Flexstar, 1 pt/A) + glyphosate (32 fl oz/A) (Table 1). The postemergence only herbicide treatment was fomesafen (1 pt/A) + glyphosate (32 fl oz/A) when soybean was V3 growth stage (Table 1). This study was conducted as a randomized complete block design with four replications at each site. Each experimental unit was 10 ft wide (4 rows X 30 in. per row) and 30 ft long.

Section 3 - Table 1. Planting and application collection dates at each of the Soybean Management Field Day sites in 2018 and 2019.

Site	Cover Crop			Soybean Planted	Soybean Maturity		Herbicide		Weed Density	Weed Biomass
	Planted (Yr. 2017)	Termination 1	Termination 2		Early	Late	PRE	POST		
Pilger	Nov. 19	May 1	May 17	May 16	2.3	3.3	May 17	June 20	May 17	Sept
Plymouth	Nov. 21	April 23	May 14	May 14	2.7	3.7	May 14	June 15	May 14	-
Sargent	Nov. 20	May 16	June 7	June 7	2.0	3.0	June 7	July 6	June 7	-
Waverly	Nov. 16	April 23	May 14	May 14	2.5	3.6	May 14	June 14	May 14	Sept

DATA COLLECTION

Cover crop biomass: Samples and measurements were taken on each plot prior to each termination date. Biomass samples were collected by cutting rye or wheat plants at ground level from a 1ftx2ft area at 10 plot locations for each cover crop species and study location. Plant samples were dried in an oven prior to being weighed.

Weed density: Weed numbers were counted at two random sites within each plot using a 12" x 12" sampling square.

Weed biomass: Biomass samples were collected from two random sites within each plot using a 12" x 12" sampling square. Weeds were cut at ground level, bagged, and dried prior to being weighed.

Yield: Soybean yields were taken using a small plot combine by harvesting the center two rows of each plot. Alleys were cut just prior to harvest and recorded to determine total plot length. All yields were adjusted to 13% moisture prior to the statistical analysis.

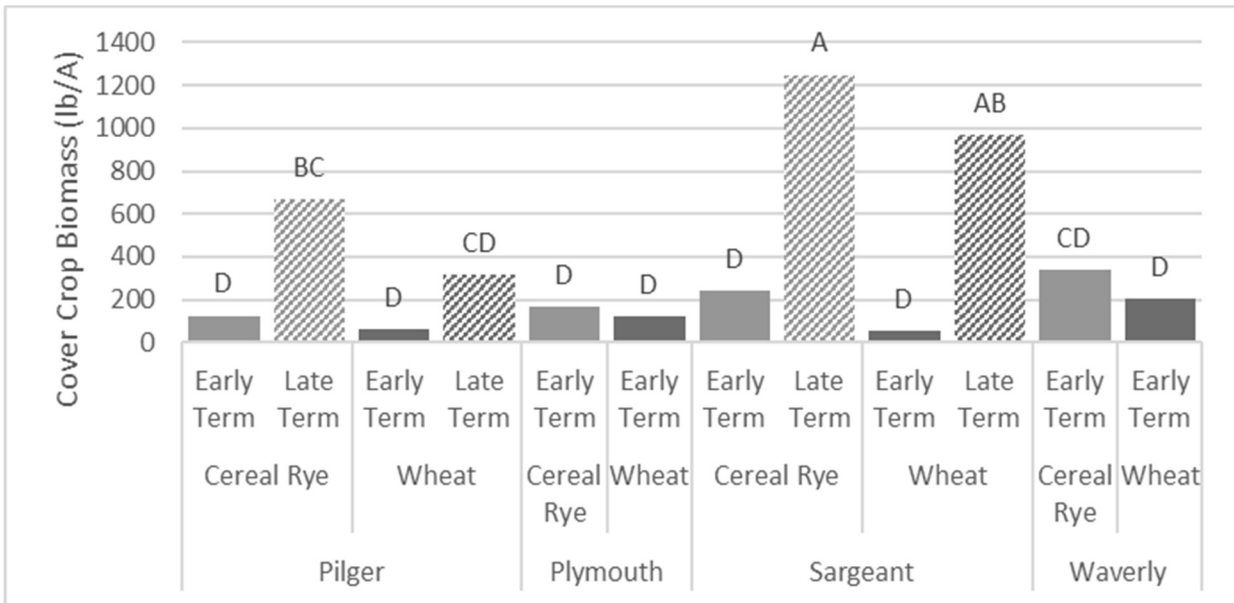
RESULTS

Cover Crop biomass: Overall, biomass varied between sites (Fig. 1). There were no biomass differences between Cereal Rye and Wheat although the late termination timing produced more biomass at Sargent and for Cereal Rye at Pilger.

Weed Density: There were no significant difference in weed density for all treatments and locations (Data not shown).

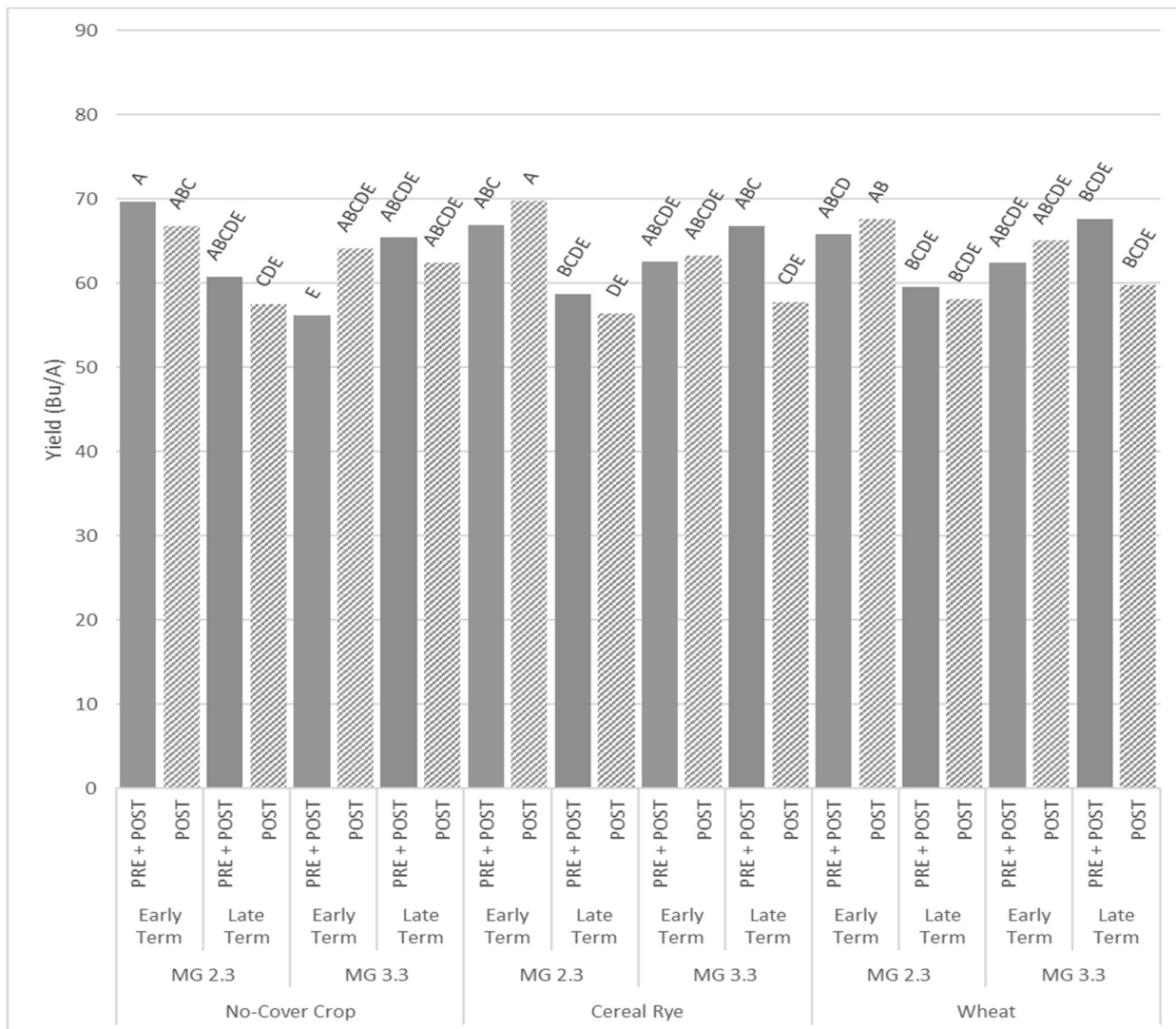
Weed Biomass: Given the high variability and relatively low population of weeds across plots and locations, statistical analysis was not possible as there were too many missing values to generate estimates or perform an analysis.

Section 3 - Figure 1. Cover crop biomass (lbs/acre) taken prior to early and late termination for cereal rye and wheat cover crops at each of the four SMFD sites. Letters indicate significant differences between treatments at $P < 0.05$.

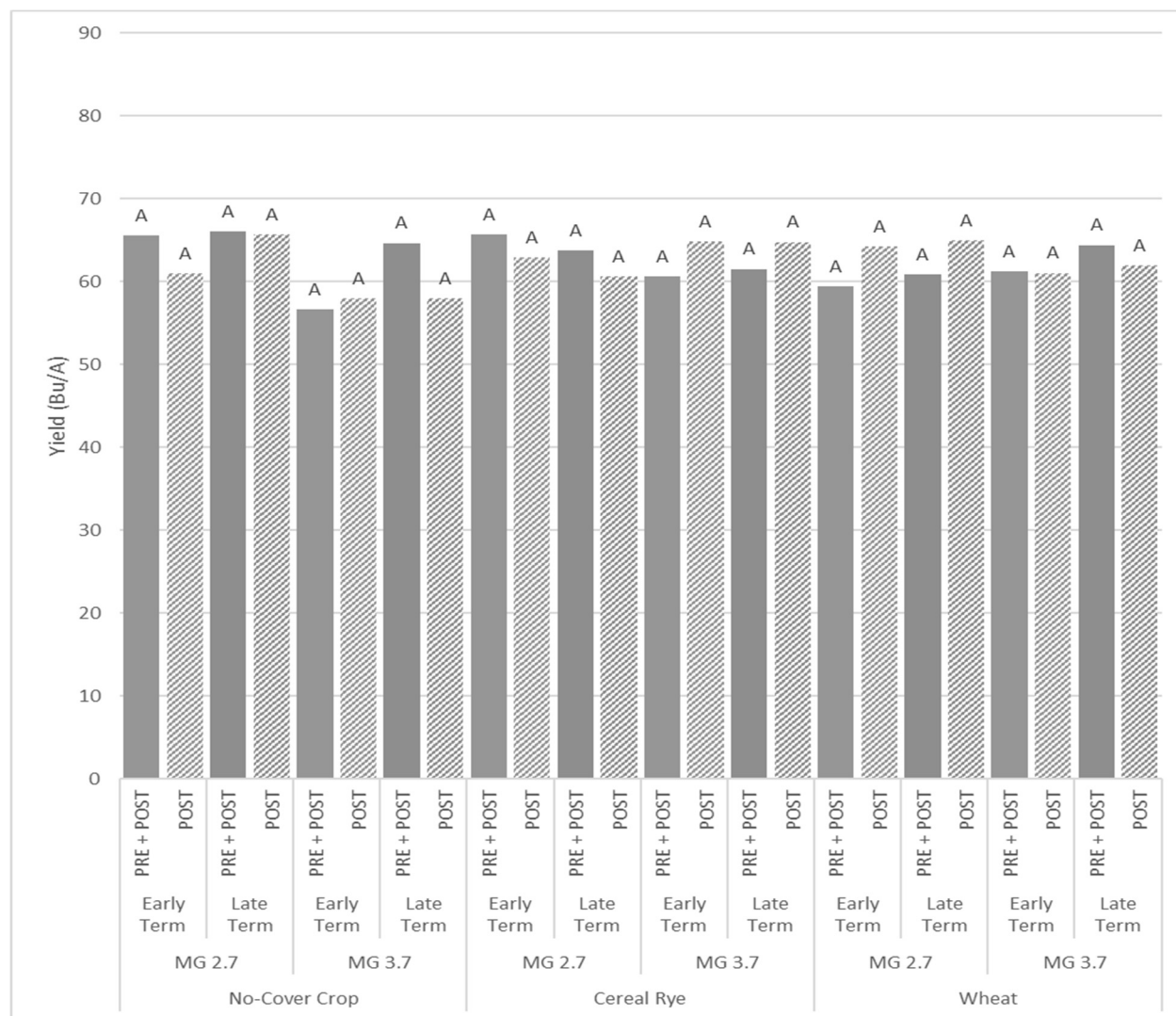


Yield: At the Plymouth and Waverly locations, there were no differences in yield between treatments (Figures 3 & 5). Yield differences did occur at the Pilger and Sargeant locations (Figures 2 & 4). The early termination treatment for the short maturity group were always among the highest yields for all cover crop treatments. There is some evidence that late termination reduced yield, though it was not consistent across all cover crop and maturity group treatments (Figure 2).

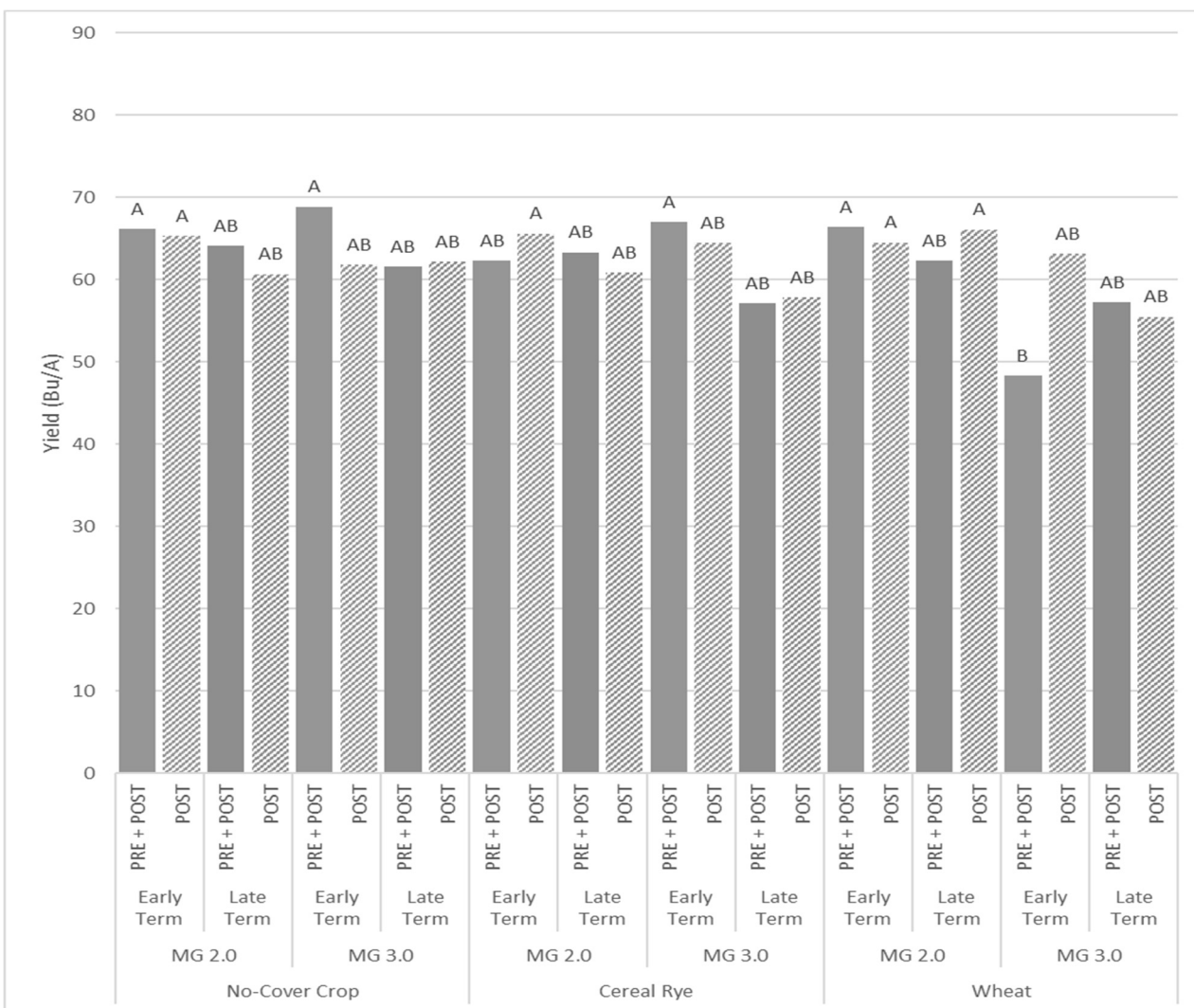
Section 3 - Figure 2. Soybean grain yield (bu/acre) by cover crop species, soybean maturity group, termination timing, and herbicide treatments at the Pilger location. Letters indicate significant differences between treatments at $P < 0.05$.



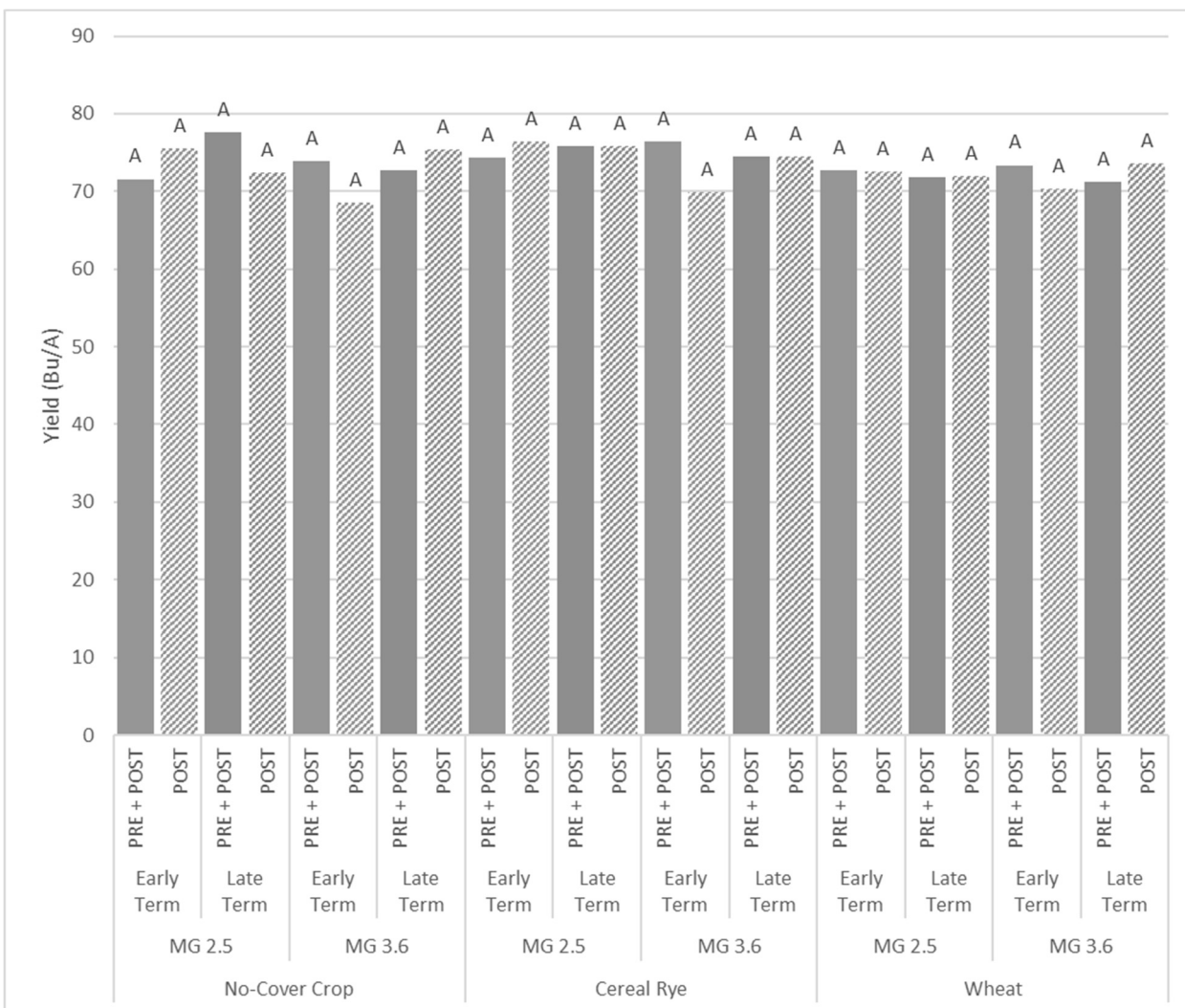
Section 3 - Figure 3. Soybean grain yield (bu/acre) by cover crop species, soybean maturity group, termination timing, and herbicide treatments at the Plymouth location. Letters indicate significant differences between treatments at P<0.05.



Section 3 - Figure 4. Soybean grain yield (bu/acre) by cover crop species, soybean maturity group, termination timing, and herbicide treatments at the Sargent location. Letters indicate significant differences between treatments at $P < 0.05$.



Section 3 - Figure 5. Soybean grain yield (bu/acre) by cover crop species, soybean maturity group, termination timing, and herbicide treatments at the Waverly location. Letters indicate significant differences between treatments at $P < 0.05$.



DISCUSSION

Cover crop species did not result in different cover crop biomass production, however late termination significantly increased cover crop biomass compared to early termination at two of the sites. It was thought that the additional biomass at the late termination might have a negative effect on soybean yield, but this was not seen in 2019 yields likely due in part to sufficient soil moisture available. For some sites there were differences in soybean yield, but the treatment effects were not obvious. There was relatively low weed pressure across locations and high variability in weeds at each location. The low weed population combined with effective herbicide programs resulted in no treatment difference being detected for both weed density and weed biomass. In the future, larger sample sizes or more uniform weed populations may help better understand the effects of cover crops on weed suppression. Even though the benefits of cover crops were not obvious it is important to note that cover crops did not have an obvious detrimental effect on the soybean crop which suggests the integration of cover crops into a soybean-corn rotation has potential for success in Nebraska.

Soil Water Differences Between Rye Cover Crop and No Cover Crop on Irrigated Fields

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Steve Melvin (Nebraska Extension Educator Crops and Water);
Troy Ingram (Nebraska Extension Educator Crops and Water)

TAKE HOME POINTS:

- Significant differences in soil water content existed between a rye cover crop and no cover crop at planting time.
- After planting, rainfall exceeded crop water use for a few weeks while the plants were small and refilled the soil profile, resulting in little to no differences in soil water content between a rye cover crop and no cover crop. The no cover crop area likely deep percolated more water than the cover crop area, likely resulting in the loss of nitrogen that the crop could have used.
- When growing cover crops that will be terminated just before planting soybeans, it is always important to make sure the pivot is ready to apply water before the crop is planted in case the soils are dry, even though most years it will not be needed.
- Cover crop termination timing may be more critical on rainfed acres to ensure sufficient soil water for crop establishment.
- Other than the possibility of irrigation to ensure the establishment of the cover crop in the fall or the soybean crop in the spring, proper irrigation scheduling for soybeans does not differ between cover crop or non-cover crop fields.

INTRODUCTION

Interest in establishing cover crops has grown across Nebraska in recent years. Cover crops offer many potential benefits for farmers, such as reduced soil erosion, increased soil organic matter, soil health, soil structure, nutrient cycling, and weed control. While the potential benefits are numerous, one cost often associated with cover crops is the use of stored soil water. If cover crops reduce the amount of stored soil water in the profile, this could potentially decrease the yields of the subsequent cash crop. The actual amount of water stored in the soil profile for the subsequent crop is actually dependent on many different factors in addition to cover crops, including the water use of the previous crop, off-season precipitation, early-season precipitation, soil texture, tillage practice, and irrigation management. With 2.8 million acres (USDA-NASS) of Nebraska's soybean crop grown with irrigation, which represents 48% of the total soybean acres, it is worth exploring differences in cover crops and irrigation management on soil water content. The objective of this study

was to quantify any differences in soil water in a soybean crop with cover crops versus no cover crops across seven site-years.

METHODS

Plots with a cereal rye cover crop established in the fall of 2017 (2018 SMFD) and 2018 (2019 SMFD) were compared to plots with no cover crop. While cover crop plots with wheat were also available, the rye plots were focused on given the expectation of greater biomass growth (and thus higher expected soil water use) compared to wheat, and to simplify the experimental design. This study was conducted as a randomized complete block design with four replications at each site. To measure soil water content differences, three Irrrometer® Watermark granular matrix sensors attached to CPCV pipe were installed at depths of 6", 18" and 30" in each plot. Sensors were installed into the plots initially the last two weeks of April. Sensors were then pulled right before planting and reinstalled in the soybean row in the days following planting. Sensor readings were taken with a data logger every two hours during the growing season. Cereal rye was terminated at the same dates as the late termination treatments both years. All plots received the same amount of irrigation water.

RESULTS

Soil water contents at three main points during the growing season were looked at: planting time, wettest day (highest soil water content) of the summer after planting, and driest day (lowest soil water content) of the year after planting.

Planting Time: There were significant differences in Watermark sensor readings at planting time at five of the seven site years. At these sites, the no cover crop plots had higher soil moisture contents (Figure 1 (A)). When these values are converted to soil water content in inches, the differences in soil water content for the entire three foot soil profile between plots ranged from +0.30 inches at Pilger to -2.44 inches for Cedar Bluffs (Table 1). While differences existed in total water content at planting, both the no cover crop and cover crop soils at six of the seven site years were above field capacity. The Kenesaw site in 2018 is the lone exception, with the soil water content for the cover crop below field capacity, while the no cover crop plot was above field capacity.

Wettest Day of the Summer after Planting: The 2018 Cedar Bluffs site had a significant difference in Watermark sensor readings (Figure 1 (B)), with the no-cover crops plot having slightly lower readings. When converted to soil water content, this represents 0.35 inches more water in the profile for the no cover crop plots. However, both treatments were still above field capacity. There were no significant differences in Watermark sensor readings with the other six site years (Figure 1 (B)).

Driest Day of the Summer after Planting: There were no significant differences in Watermark sensor readings at any of the seven site years (Figure 1 (C)).

DISCUSSION

Cover crops had a significant impact on soil water content at the time of planting but differences diminished or disappeared over the course of the growing season. The range of these differences varied between sites.

The largest differences in soil water content at planting were seen in the top six inches of soil. Reductions in soil water content have the potential to affect soybean germination and growth after planting. One site experienced soil water contents below field capacity at planting, which has the potential to negatively affect emergence and growth. At this site, rye cover crop plots were being managed with a pre-determined later termination date, resulting in additional biomass growth even with dry weather conditions. Farmers in a similar situation could manage this by using either earlier termination of the cover crop or by the use of irrigation, if available. This is why it is recommended that pre-season maintenance be performed on irrigation systems before planting time to ensure that they are ready to apply water if needed.

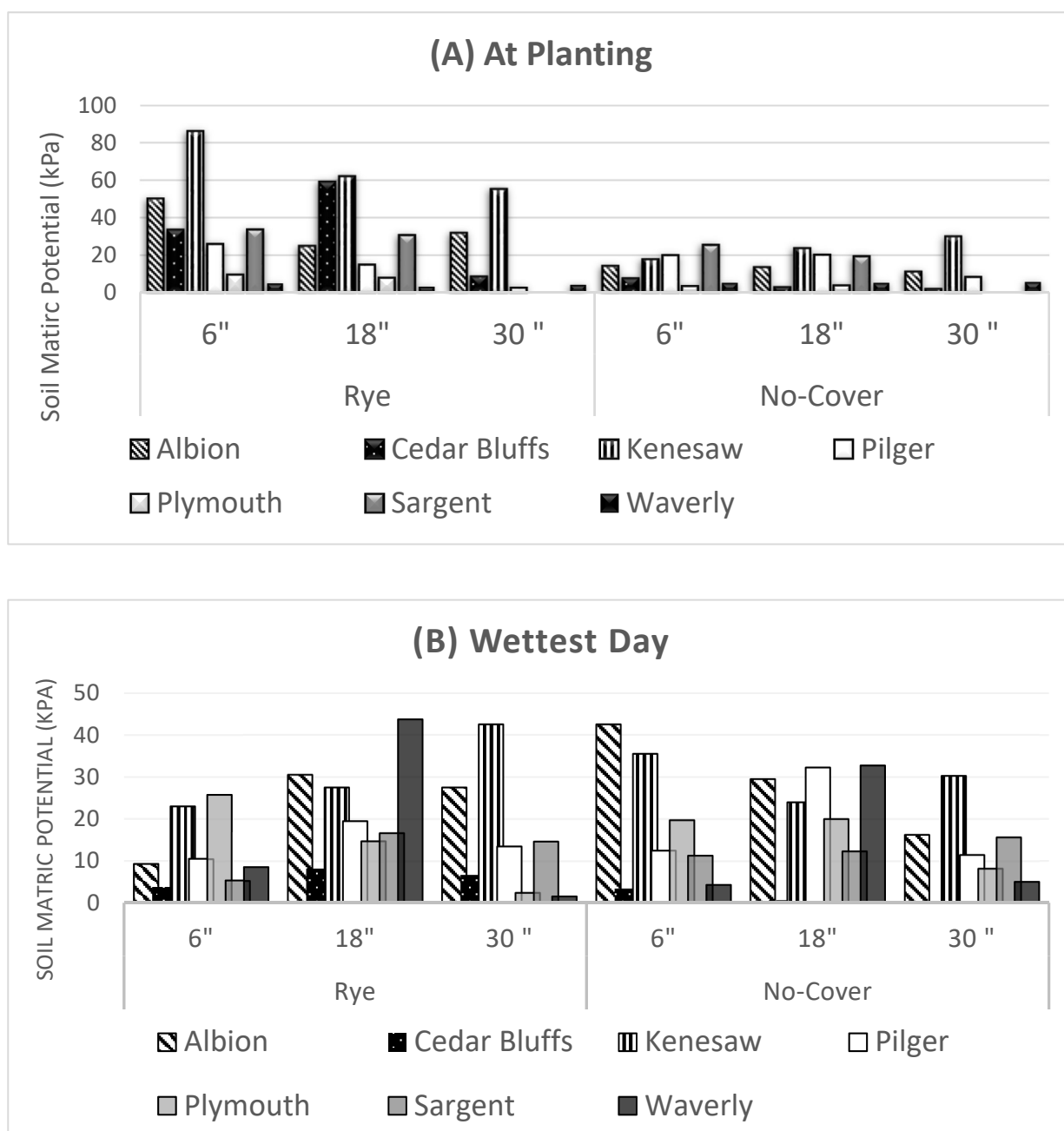
Three sites had soil water contents for the rye plots that were closer to field capacity while the no cover plots had excess water in the profile. In wet conditions, this may result in better planting conditions with the use of cover crops. Additionally, soils that are above field capacity are deep percolating a significant amount of soil water which will take nitrates with it and will be lost if not used by the cover crop.

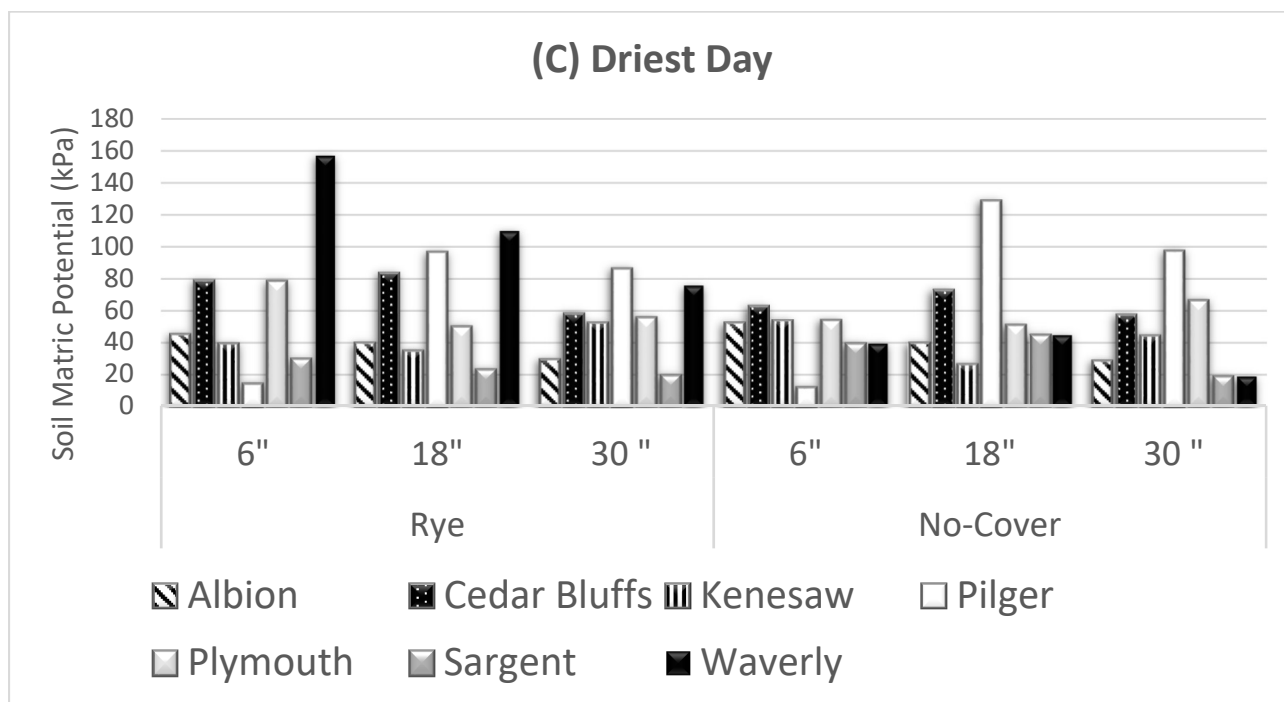
Two sites in 2019 had soil water contents for both cover crop and no cover crop plots that were well above field capacity at planting. It is likely that rainfall at both these sites was excessive enough that any water used by the cover crop was replenished, eliminating differences.

It is important to note the experiment was conducted on irrigated fields that are usually wetter after harvest and only require a few inches of precipitation to refill the soil profile. Non-irrigated fields or land in the pivot corners may be drier resulting in different results.

In both 2018 and 2019, rainfall exceeded crop water use amounts for a few weeks after planting while the plants were small, which resulted in the soil water profile being refilled to either near or above field capacity. This is expected to happen most years in the eastern half of Nebraska given our normal rainfall pattern. This is important as the most critical water period for soybeans is much later in the season beginning at R3.

Section 4 - Figure 1. Average Watermark sensor readings for seven sites years at (A) planting time, (B) wettest day of the growing season, and (C) driest day of the growing season. Higher soil matrix potential readings indicate the soil is dryer.





Section 4 - Table 1. Soil water content at planting time above or below field capacity and differences between plots. Treatments sharing a common letter are not statistically different at $P < .05$. The "+" numbers for soil water content show soils that are above field capacity and a high level of deep percolation of soil water is occurring.

Site		Albion (2018)	Cedar Bluffs (2018)	Kenesaw (2018)	Pilger (2019)	Plymouth (2019)	Sargent (2019)	Waverly (2019)
Soil Water Content Above (+) or Below (-) Field Capacity in Inches	No Cover	+1.57 a	+3.08 a	+0.67 a	+0.33 a	+2.14 a	+0.63 a	+2.97 a
	Rye	+0.06 b	+0.64 b	-1.68 b	+0.63 a	+1.67 b	+0.01 b	+3.07 a
Difference in Soil Water Content of Rye versus No Cover		-1.15	-2.44	-2.35	+0.30	-0.47	-0.62	+0.10

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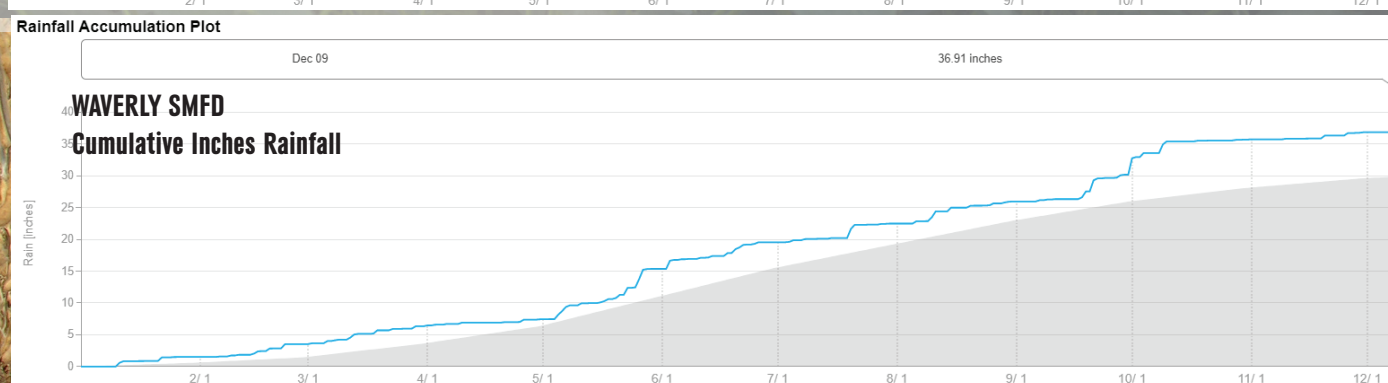
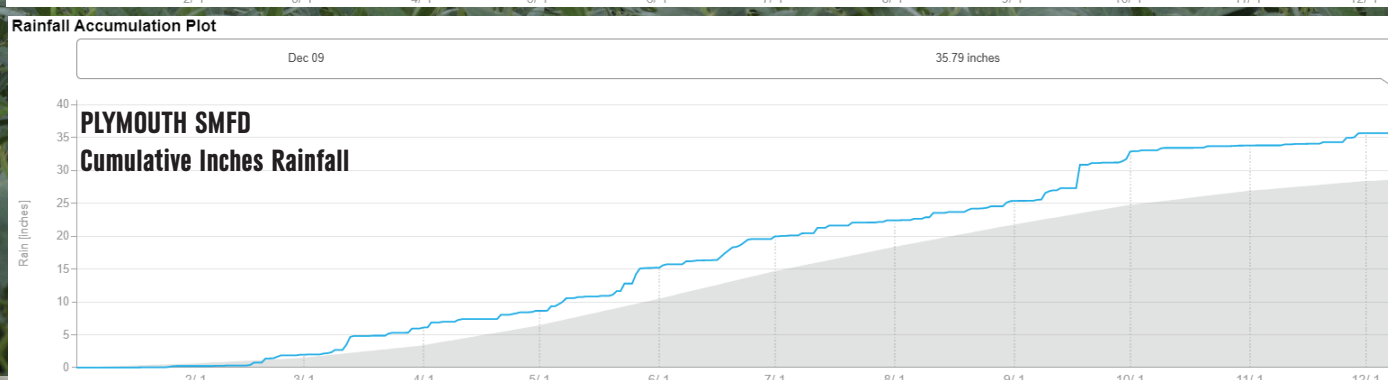
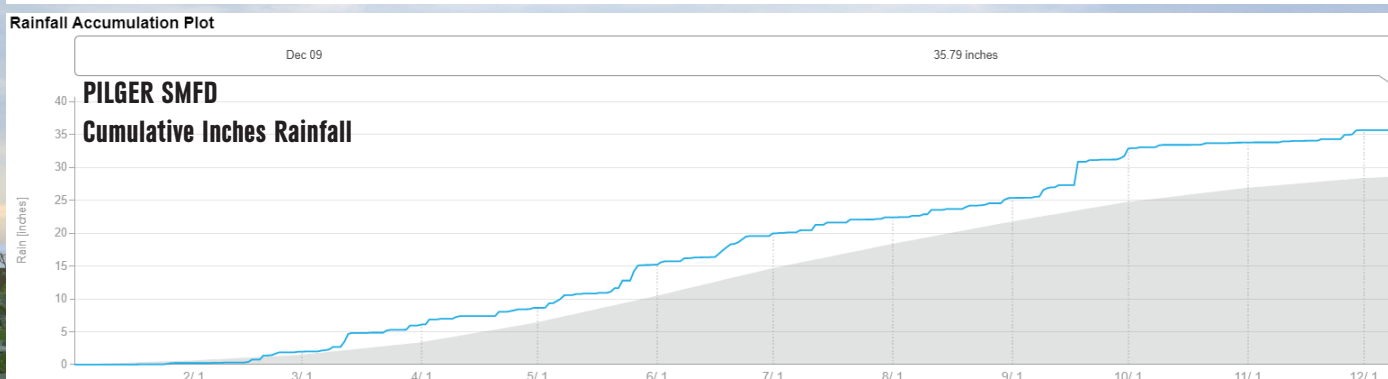
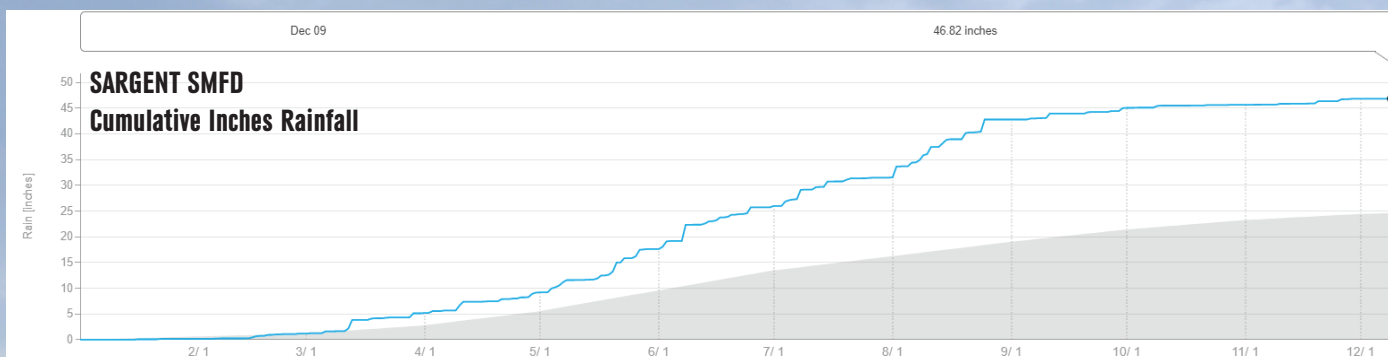
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RESEARCH UPDATE

Cumulative Rainfall Totals



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