RESEARCH UPDATE

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Spring 2021 Distribution

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Cultural Practices

Site	Plant	Harvest	Soil	Herbicide	Chem/Rate	Site Average Yield
	5/11/2020	10/6/2020	Silty Clay Loam	Date	Chem/Rate	bu/ac
Arlington	Cover crop seeded			11/9/2019	60 lbs/Ac	65
	Termination 4/23/2020*, 5/11/2020, 5/15/2020*				Roundup Powermaxx 32oz AMS 12 lb/100 gal.	
	Pre**			5/11/2020	Valor 3oz	
	Post***			6/24/2020	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	
	5/19/2020	10/9/2020	Silty Clay Loam	Date	Chem/Rate	bu/ac
Elgin	Cover crop seeded			11/6/2019	60 lbs/Ac	80
	Termination			5/19/2020	Roundup Powermaxx 32oz AMS 12 lb/100 gal.	
	Pre**			5/19/2020	Valor 3oz	
	Post***			6/25/2020	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	
	5/12/2020	10/8/2020	Silty Clay Loam	Date	Chem/Rate	bu/ac
Hildreth	Cover crop seeded			11/9/2019	60 lbs/Ac	77
	Termination			5/12/2020	Roundup Powermaxx 32oz AMS 12 lb/100 gal.	
	Pre**			5/12/2020	Valor 3oz	
	Post***			6/18/2020	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	
	5/18/2020	10/5/2020	Silt Loam	Date	Chem/Rate	bu/ac
Shelby	Cover crop seeded			11/19/2019	60 lbs/Ac	76
	Termination 4/30/2020*, 5/18/2020, 5/23/2020*				Roundup Powermaxx 32oz AMS 12 lb/100 gal.	
	Pre**			5/18/2020	Valor 3oz	
	Post***			6/24/2020	Roundup Powermaxx 32oz AMS 12 lb/100 Flexstar 1pt NIS @ 0.5% v/v	

*** Pre & Post plant terminations for Entomology study only**
**** Pre-emergence herbicide - Weed Science study excluded**
***** Post herbicide for Weed Science study - Roundup/AMS only**

Soybean Management Field Days On-Farm Research
Introduction

Keith Glewen, Nebraska Extension Educator

As I put my fingers to the keyboard to write the introduction, I am not sure where to start! The pandemic has impacted all of us, to some degree, on a daily basis. These are certainly wild times and conducting soybean research and trying to pull off a series of field days is no exception. A word uncommon to many of us prior to the pandemic was the word “virtual”. Today almost every conversation, meeting, and consultation to participate in is virtual.

The 2020 Soybean Management Field Day effort was virtual as well. We erected one tent at one location instead of four, brought in the camera crew and taped 29 short and informative presentations by University of Nebraska faculty and members of the Nebraska Soybean Board. If you have not yet viewed these video segments or listened to the podcasts, I encourage you to go the CropWatch newsletter at the following link https://cropwatch.unl.edu/ and click on Soybean Management Field Days located under virtual field tours section. To date, over 1,000 soybean growers have accessed this site.

We were able to capture replicated data from each on-farm location -Hildreth, Elgin, Shelby and Arlington. We are confident you will find the results to be of interest and value to your soybean enterprise.

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 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.

On a final note, this writing will be my last for this effort as I will be retiring after 45 years of employment with the University of Nebraska – Lincoln. Soybean Management Field Days has been an ongoing effort since 1999. During that timeframe, I have learned much about soybean production and just as important, an understanding of the dynamics associated with the soybean industry in Nebraska. You are to be commended for being the cornerstone of this industry and for your commitment to continuing education. We, at Nebraska Extension and the Nebraska Soybean Board, thank you.

May you and your family stay safe and well in 2021 and in the years to come...Thank You Nebraska Soybean Growers!

Cover Crop Termination Timing Impact 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)

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 negatively impacted when measured at V2 by delayed cover crop termination
- 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

Cover crop experiments were conducted at two of the four Soybean Management Field Day sites. These two sites were located near Arlington and Shelby, NE. The remaining two sites near Elgin and Hildreth were abandoned in the spring due to labor limitations from Covid-19. At the Arlington and Shelby sites there four termination dates relative to soybean planting. 'Elbon' 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.

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. 2019)	Termination 1 (early)	Termination 2 (at-plant)*	Termination 3 (post-plant)*			
Arlington	Nov. 9th	April 23rd	May 11th	May 15th	May 15th	June 11th-15th	June 11th
Shelby	Nov. 19th	April 31st	May 18th	May 22nd	May 18th	June 24th-29th	June 18th

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 days. All insects were identified to family with exception of spiders, millipedes and centipedes.

Pest damage assessment: Insect damage to soybeans was assessed through visual evaluation for frequency and severity at the V2-V3 stage.

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, no differences occurred between the two sites for biomass or extended leaf height (Table 2). Termination treatment timing (Table 3) had a significant effect on biomass and extended leaf height with biomass increasing by four times from early to at plant termination. Rapid biomass accumulation was observed in the 5-7 days after planting with an average of 445 lbs of additional cover crop biomass accumulated from at plant to post termination treatment across the two sites. Rye cover crop height gained an average of 9.8 inches of growth between early and at plant termination whereas an additional 3.8 inches of growth was observed between at plant and post plant terminations.

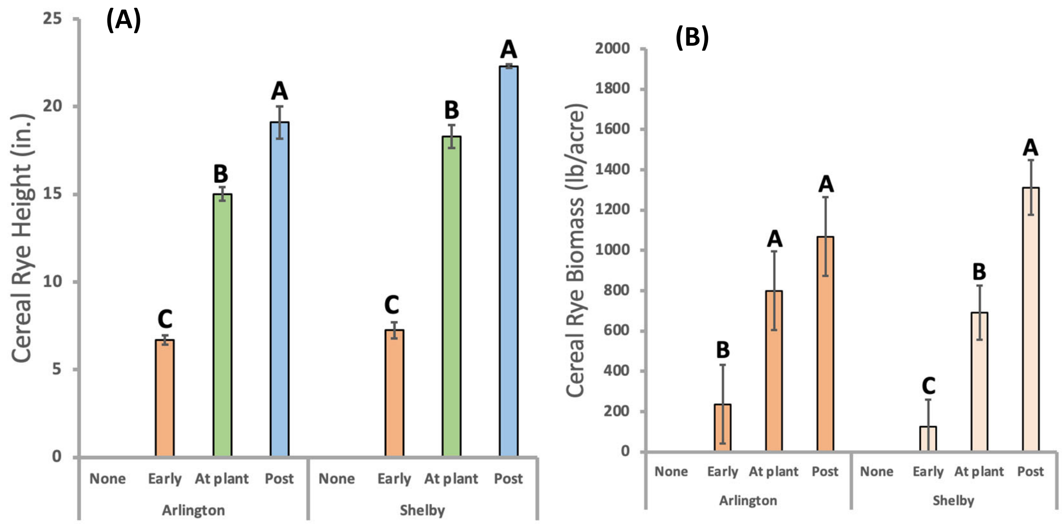
Table 2. **Mean biomass and extended leaf height for both cover crop species at each site. Letters indicate significant differences at P<0.05.**

Site	Cover Crop	
	Biomass (lbs/acre)	Extended Leaf Height (inches)
Arlington	701.7 A	13.5 A
Shelby	709.1 A	15.9 A

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 (lbs/acre)	Extended Leaf Height (inches)
Termination 1: Early	180.5 C	6.9 C
Termination 2: At plant	745.2 B	16.7 B
Termination 3: Post-planting	1190.4 A	20.5 A

Figure 1. **Cover crop biomass (lbs/acre) (A) and extended leaf height (in.) (B) 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 was significantly different between locations (Figure 3a) ($P<0.0001$) as well as cover crop termination date (Figure 3b) ($P<0.0001$) but there was no interaction between location and cover crop ($P=0.2384$). For location, the greatest number of arthropods were collected at Arlington (107.9) followed by Shelby (73.1). In the case of termination, all cover crop terminations (cover crop present) had a greater number of arthropods when compared to no cover crop (Figure 3b) with a steady increase in arthropod number with delayed termination of the cover crop. Of the four arthropod groups evaluated, rove beetles, sap beetles and spiders varied significantly between cover crop terminations (Figure 4). No differences between terminations were observed for ground beetles. For rove beetles, a significant increase in activity was observed with a cover crop at Arlington, however, no differences were observed at Shelby. Sap beetles showed a significant increase in number with all cover crop treatments compared to no cover at Arlington whereas only the late termination at Shelby had a greater number of sap beetles compared to no cover. Spiders were also more abundant in the cover crop plots compared to no cover but varied between at plant and early terminations for Arlington and Shelby, respectively.

Figure 3. **Average number of arthropods recovered from pitfall traps between sites (A) and for no cover crop, early, at plant and post plant terminations average across the two sites (B) over a 5-7 day period being at the V2-V3 stage in soybean.**

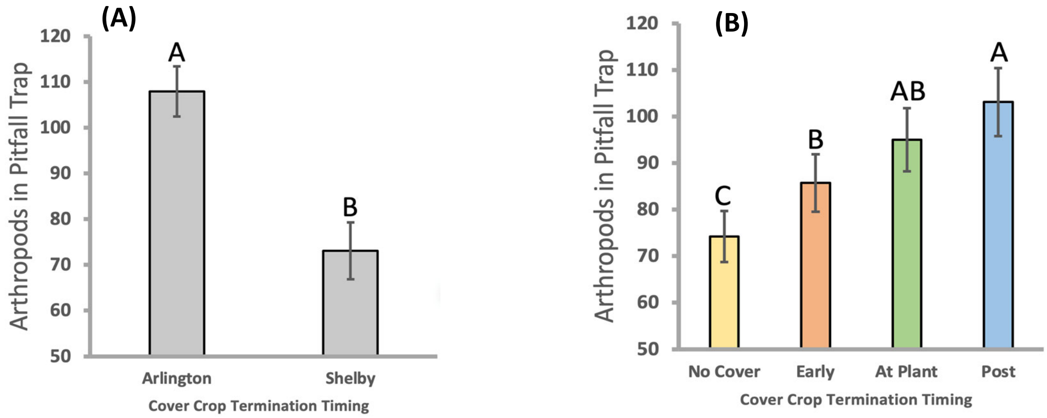
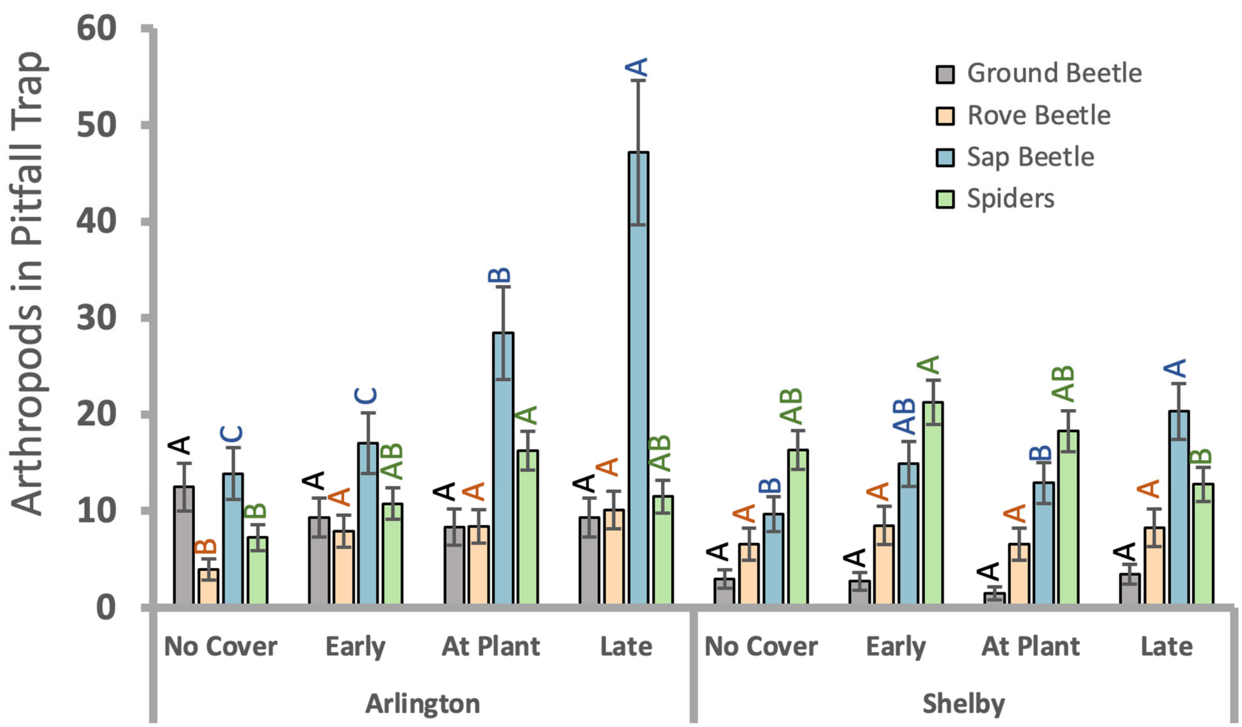


Figure 4. **Average number of ground beetle, rove beetle, sap beetle and spiders recovered from pitfall traps for no cover crop, early, at plant and post plant terminations average for each of the two sites over a 5-7 day period at the V2-V3 stage in soybean**



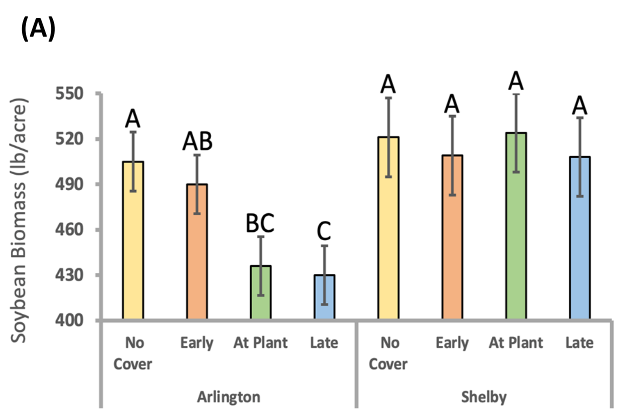
Pest damage assessment: Defoliation of plants was far less than the economic threshold with less than 4% defoliation for any of the treatments. This is well below the threshold of 30% for vegetative stage soybean. No differences occurred between terminations at Arlington (P=0.1462) or Shelby

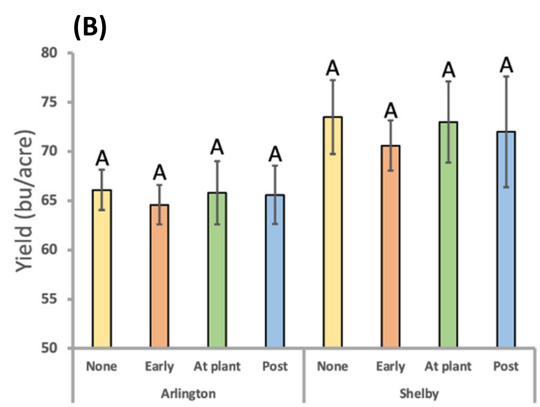
(P=0.8938). The most common defoliators collected were thistle caterpillar and silver spotted skipper.

Soybean Biomass: Differences in soybean biomass (P=0.0055) occurred between sites with the greatest biomass at Shelby (515 lbs/acre) followed by Arlington (465 lbs/acre). Site differences could be due to slight variations in soybean stage of development at the time of the sample with Shelby being samples 7 days later than Arlington. Cover crop termination differences were only observed at Arlington (Fig. 5A) (P=0.0364) location with the greatest soybean biomass occurring in no cover (505 lbs/acre) followed by early (490 lbs/acre), at plant (436 lbs/acre) and late (430 lbs/acre). No differences occurred between cover crop treatments at the Shelby location (P=0.8964).

Soybean Yield: No significant differences in yield occurred between the different termination times (Fig. 5B) at any of the sites.

***Figure 5.* Soybean biomass (A) and yield (B) across cover crop termination treatments for Arlington and Shelby.**





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, a very abundant species in cover crop treatments are typically found feeding on decaying fruit and fungi and are not considered to be a threat to vegetative stage soybeans.

Plant injury from defoliation was very low on all treatments across both sites. Of the defoliators observed, neither thistle caterpillar or silver spotted skipper have been associated with cover crop plantings in the past. Soybean biomass was negatively impacted by the presence of a cover crop at Arlington, however, these differences did not have any impact on yield.

Cereal Rye Influence on Soil Nutrients and Microbial Abundance

Authors: Katja Koehler-Cole, Research Assistant Professor

Research team: Katja Koehler-Cole, Justin McMechan (Crop Protection and Cropping Systems Specialist), Keith Glewen (Extension Educator), George Biliarski (Technician)

This project was funded in part by the Nebraska Soybean Board.

TAKE HOME POINTS:

- Rye cover crops take up between 25 and 40 lb N/acre
- May help reduce nitrate leaching to groundwater
- Soil N, P, K were not affected by rye cover crop in this year
- Rye cover crop did not improve soil microbial abundance in this year
- Increasing cover crop biomass may lead to greater benefits for soil microbes

BACKGROUND AND JUSTIFICATION

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. Planting a cover crop between main crops can improve the conditions in the soil for these microbes. Cover crop roots leak simple sugars and amino acids, and these root exudates are a preferred food sources for a multitude of soil organisms. The space adjacent to living plant roots, called the rhizosphere, is where most soil microbes live, illustrating the importance of plants roots as habitat.

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, are hardy and can quickly reproduce. **Fungi** are more delicate than bacteria and are disturbed by tillage. *Saprophytic fungi* can break down more 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 roots in the soil, for example by using winter annual cover crops such as cereal rye, may lead to greater microbial activity which in turn may improve 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 objectives for this study were to increase soil microbial abundance, especially that of fungi, by using a winter cover crop before soybean. In addition, we wanted to document the effect of the cover crop on soil nutrients.

Our research questions were:

1. Can rye cover crops growing before soybean reduce soil nitrate?
2. Can rye cover crops growing before soybean increase microbial abundance as a whole?
3. How do rye cover crops influence different groups of soil microbes?

RESEARCH METHODS

This report includes the results from the second year of trials. At the Soybean Management Field Day sites near Shelby and Arlington, cereal rye was planted at 60 lb/a in November of 2019. We compared plots with cereal rye to plots without cereal rye (control plots), a total of 8 plots per site. Soybean were no-till planted in mid-May and cereal rye terminated with glyphosate within 5 days after soybean planting.

Rye biomass was measured just before termination in May and is reported as dry matter. We took 10 soil samples (4" depth) in May and July from the plots without cover crops (NONE treatment) and from the plots with cereal rye cover crop (RYE treatment). The soil was analyzed for NPK and organic matter content. Soil microbial abundance was assessed using phospholipid fatty acid analysis (PLFA) which shows different microbial groups (bacteria, AMF, saprophytic fungi, and many others) present in the soil and their abundance. Total microbial biomass is the sum of the microbial biomass of each group. All soil tests were carried out by Ward Laboratories in Kearney, NE.

For statistical comparisons, an ANOVA was conducted in Proc Glimmix using a significance level of 0.1. Random variables were block and site and the fixed variable was treatment (rye or control).

RESULTS

<u>Cover crop biomass</u>

Rye had moderate amounts of biomass (see Table 1) and N uptake (see table 1). Greater biomass and N uptake could be achieved by planting rye earlier.

Table 1. Rye biomass production (in lb/ac), biomass N concentration (in %), biomass N uptake (in lb/ac), and biomass C:N ratio for rye grown at the two sites in 2020.

Site	Biomass in lb/ac	Biomass N in %	N uptake in lb/ac	Biomass C:N
Arlington	1,082	2.3	25	19
Shelby	1,310	3.2	40	14

<u>Soil chemical analysis</u>

Soil nitrate was slightly, but not significantly, lower following a cover crop than without cover crop (Figure 1). Soil phosphorus (P) was not different between the rye cover crop and the no cover crop treatment (Figure 2). Soil potassium (K) levels were also not influenced by a rye cover crop (Figure 3).

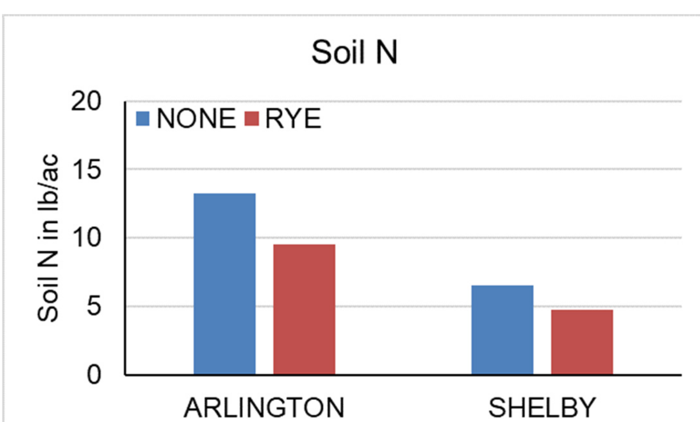


Fig. 1. Soil nitrate in lb/ac under cereal rye cover crop (RYE) and no cover crop (NONE) at Arlington and Shelby.

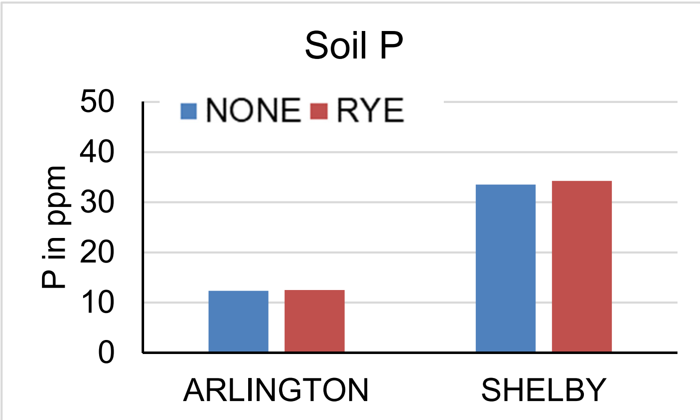


Fig. 2. Soil P in ppm under cereal rye cover crop (RYE) and no cover crop (NONE) at Arlington and Shelby.

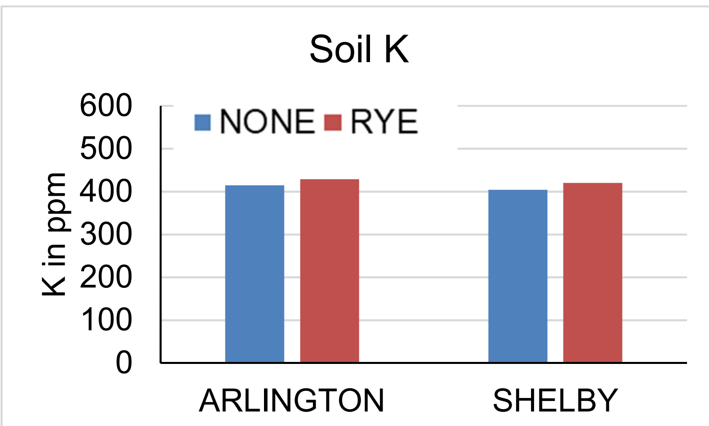


Fig. 3. Soil K in ppm under cereal rye cover crop (RYE) and no cover crop (NONE) at Arlington and Shelby.

<u>Soil microbial analysis</u>

We expected greater total microbial biomass, in particular more fungal biomass, in rye cover crop plots. However, rye cover crops did not significantly influence the total amount of microbial biomass (Fig. 4) at either site. When looking at specific microbial groups, such as bacteria, AM fungi or saprophytic fungi, there is also no clear response to the rye. The fungi:bacteria ratio did not change (Fig. 5). It should be noted that microbial biomass was average and fungi:bacteria ratio was above average in both cover crops and control plots. These findings contrast with 2019 results, where rye cover crops increased microbial biomass, especially that of bacteria (see 2019 SMFD booklet).

Soil microbial populations may not have responded to the rye cover crop, because of several reasons. Rye did not produce much biomass, so there was likely not a great amount of root exudates available that could have supported more microbes. Building up microbial populations may take several years of cover cropping, but this was only the first year at this site. Site-specific conditions, such as weather, soil nutrients, texture and organic matter concentrations also impact soil microbial populations.

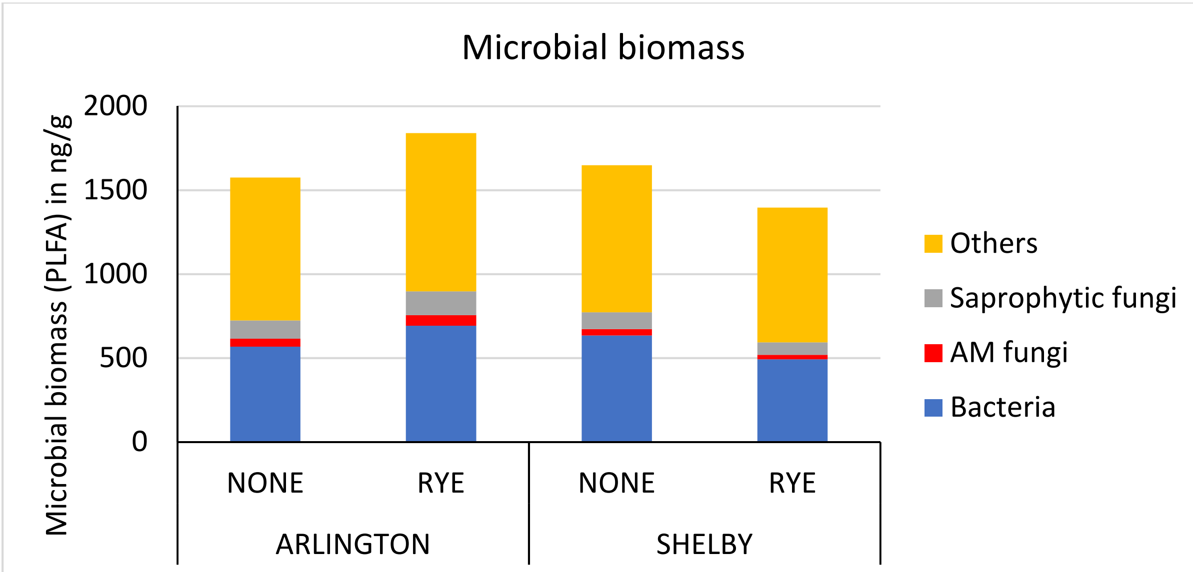


Fig. 4. Total soil microbial biomass (the sum of all microbial groups) and the proportions of certain microbial groups (bacteria, AM fungi, saprophytic fungi and others) at the Arlington and Shelby sites in cover crop plots (RYE) and control plots without a cover crop (NONE). Microbial biomass is measured in PLFA (phosphor-lipid fatty acids) in ng/g.

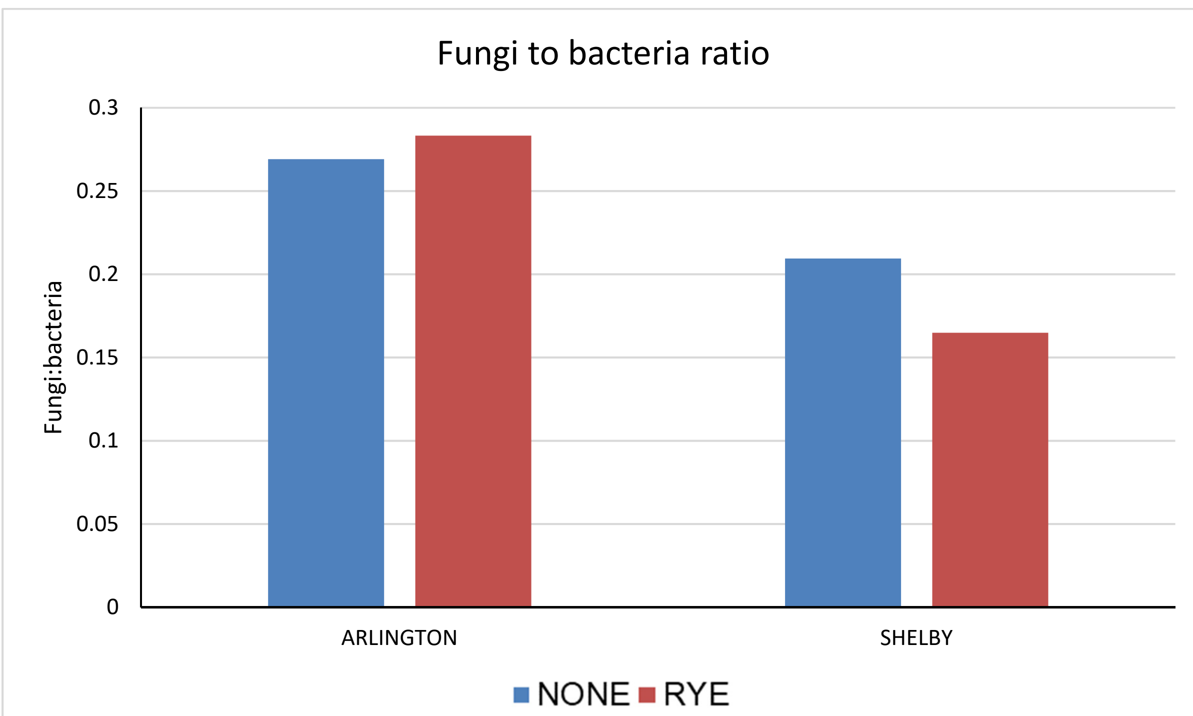


Fig. 5. The ratio of fungi to bacterial biomass at the Arlington and Shelby sites in cover crop plots (RYE) and control plots without a cover crop (NONE).

CONCLUSION

Rye cover crops take up nutrients which could reduce nutrient loss. Greater microbial abundance in the soil could improve soil structure, with larger and more stable aggregates which are less erodible by wind and water.

In this year of the study, we did not observe increases in soil microbial abundance that we documented last year. We will continue to investigate how cover crops can be used to increase the populations of beneficial soil microbes across a range of soil types in Nebraska.

Drill Interseeding Cover Crops in Soybean: Key Considerations for Success

Authors: Chris Proctor (UNL Weed Science Extension Educator),
Keith Glewen (UNL Cropping Systems Extension Educator)
Research Support: Elliot Knoell (Research Project Coordinator), Steven Spicka (Agronomy Research Tech III), and Keith Glewen (Nebraska Extension Educator)

This project was funded in part by the Nebraska Soybean Board.

TAKE HOME POINTS:

- Interseeded wheat and annual rye cover crops established in V3 soybean, but were unable to survive the season.
- Lack of cover crop survival was likely due to limited light availability under soybean canopy mid-season.
- Reducing soybean plant population and selecting shorter soybean varieties did not change light availability under soybean canopy enough to allow cover crop survival.
- Study treatment had very limited influence on soybean yield, where all but one site had no soybean yield differences between treatments.

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. To overcome the limited time for cover crop growth following harvest, drill interseeding has been used with some success planting at V3 of corn. To better understand if this would work for soybean a drill interseeding study is being conducted at each of the 2020 Soybean Management Field Day Sites.

Research Questions:

- What effect do soybean variety stature have on successful establishment of a drill interseeded cover crop?
- How do herbicide Preemergence herbicides effect establishment of a drill interseeded cover crop?
- How do drill interseeded cover crops affect soybean yield?

METHODS

Studies were established at all 2020 Soybean Management Field Day locations (Arlington, Shelby, Elgin, Hildreth). A cover crop mix of annual rygrass (2lb/a) and winter wheat (10 lb/a) was drilled interseeded using a Hiniker cover crop drill interseeder at soybean V3 growth stage (Fig 1). Standard height and short-stature soybean varieties planted at 100,000 seeds/acre were used. Two herbicide programs (Preemergence followed by Postemergence (PRE fb POST) and POST only) were tested. The PRE herbicide application was Valor at 3 oz/A applied at planting and the POST application was Roundup at 32 fl oz./A plus applied prior to cover crop interseeding. Soybean planting and cover crop interseeding dates are listed in Table 1. Data collected includes cover crop biomass, weed suppression following POST application, and soybean grain yield.

***Figure 1.* Hiniker interseeding into V3 soybean.**

***Table 1.* Planting and application collection dates at each of the Soybean Management Field Day sites in 2020.**

Site	Cover Crop Interseeded	Soybean Planted	Soybean Variety		Herbicide	
			Standard	Short	PRE	POST
Arlington	June 24th	May 11th	2.3	3.3	May 11th	June 24th
Shelby	June 24th	May 18th	2.7	3.7	May 18th	June 24th
Elgin	June 25th	May 19th	2.0	3.0	May 19th	June 25th
Hildreth	June 25th	May 12th	2.5	3.6	May 12th	June 25th

DATA COLLECTION

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.

Statistical analysis. The experimental data was analyzed to evaluate cover crop effects on yield. Significant differences are based on a probability of α = 0.05.

RESULTS

Cover Crop biomass: It was observed that wheat cover crop emergence following planting, but all cover crop treatments died under soybean canopy cover by the end of the season.

Figure 2. **Interseeded Cover crop under soybean canopy on August 4, 2020.**

Yield: There was a cover crop by herbicide interaction for the Elgin location where preemergence plus postemergence herbicide treatment resulted in higher yields with the wheat and annual rye cover crop mix compared to the postemergence only herbicide treatment (Fig. 5). There were no other yield differences for any of the other study locations (Fig. 3, 4, and 6).

Figure 3. **Soybean grain yield (bu/acre) by cover crop/no cover crop treatment, soybean variety, and herbicide treatments at the Arlington location.**

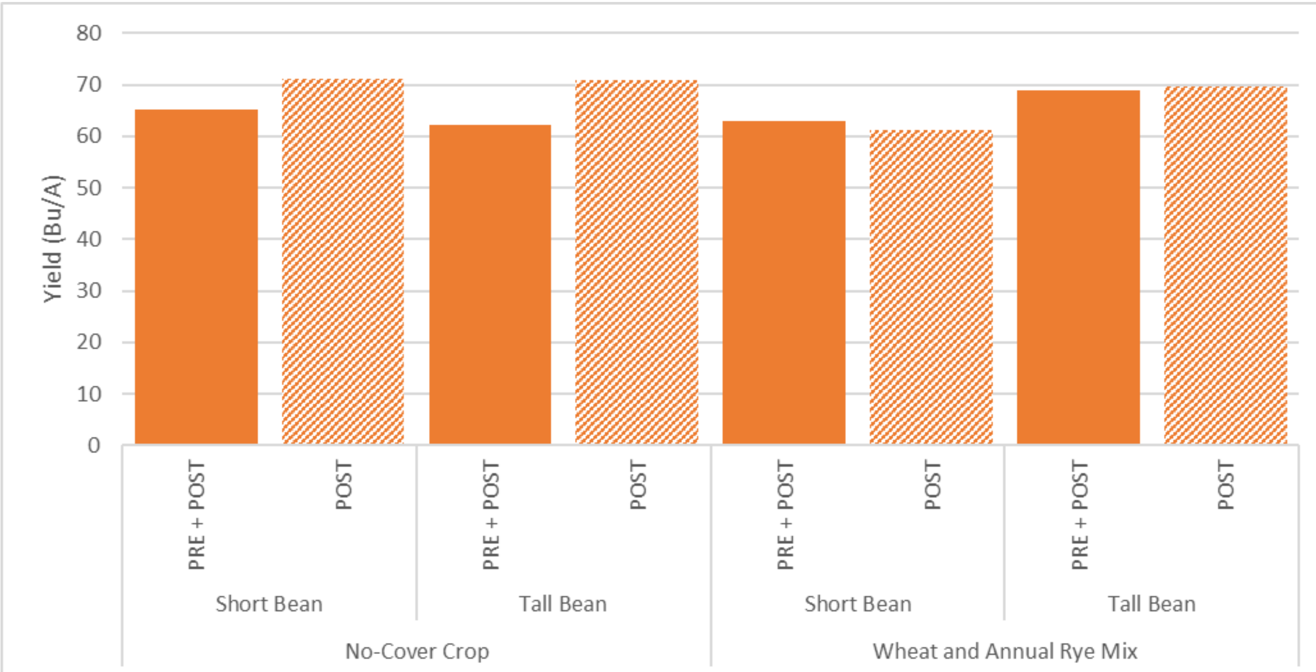


Figure 4. **Soybean grain yield (bu/acre) by cover crop/no cover crop treatment, soybean variety, and herbicide treatments at the Hildreth location.**

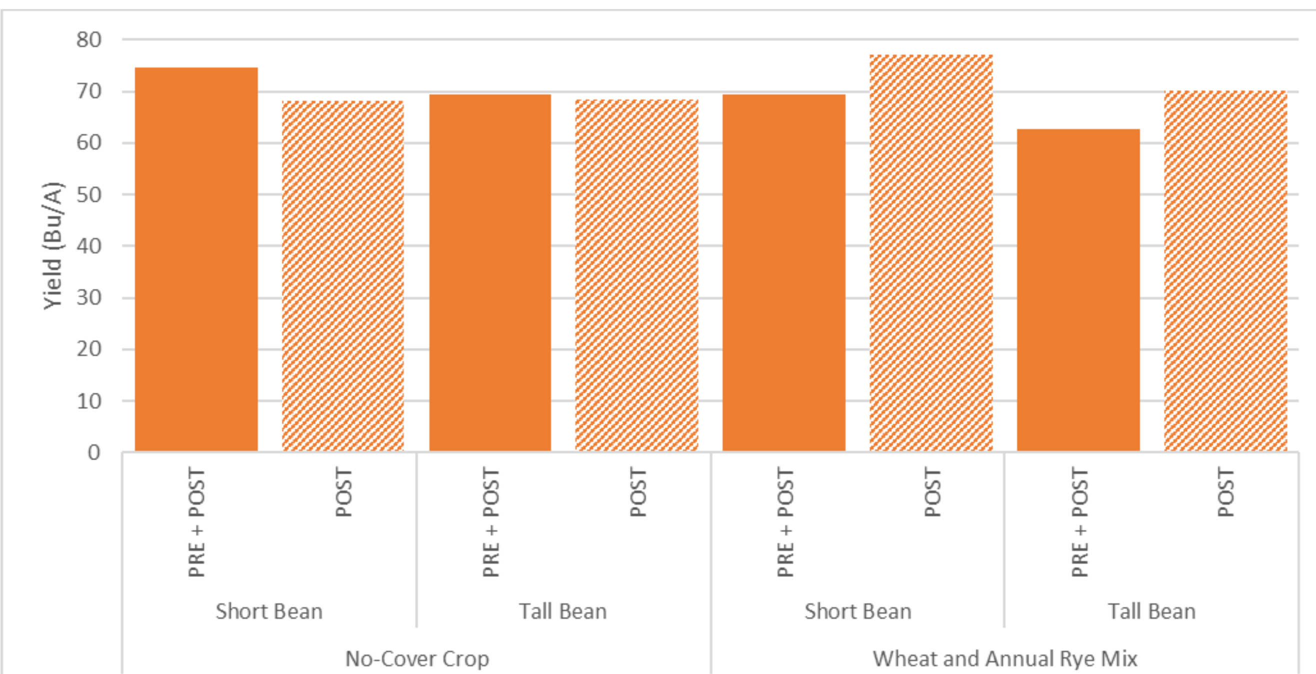


Figure 5. **Soybean grain yield (bu/acre) by cover crop/no cover crop treatment, soybean variety, and herbicide treatments at the Elgin location.**

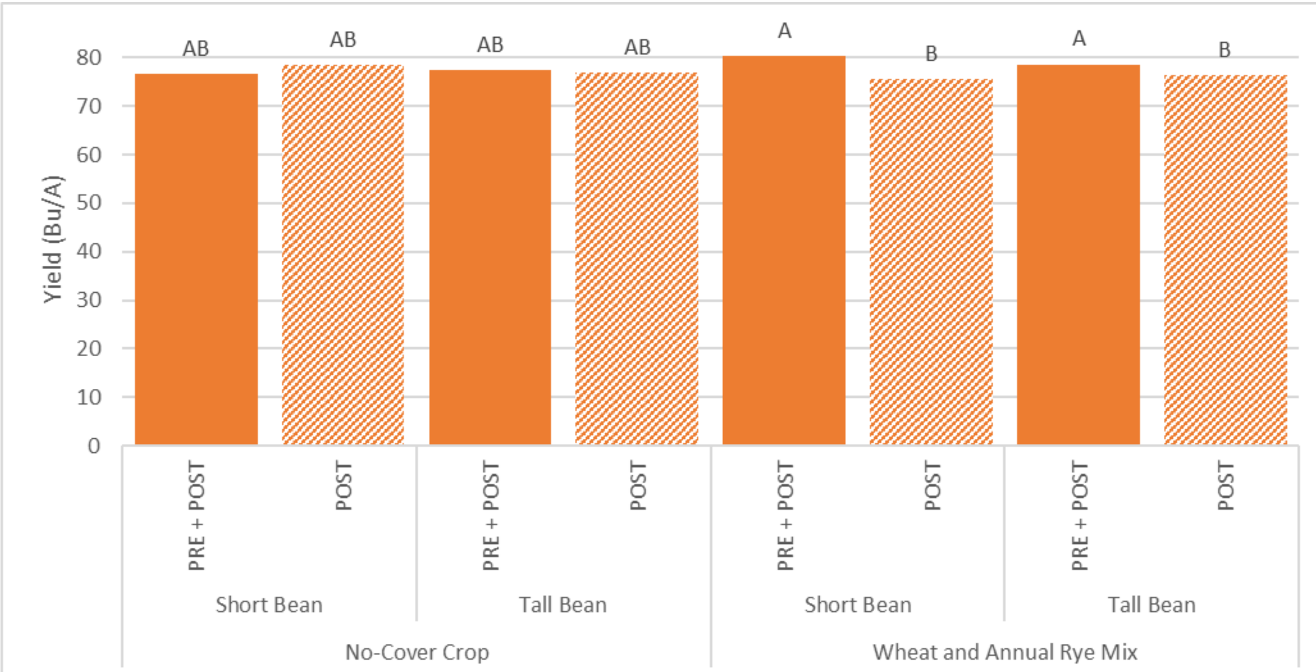
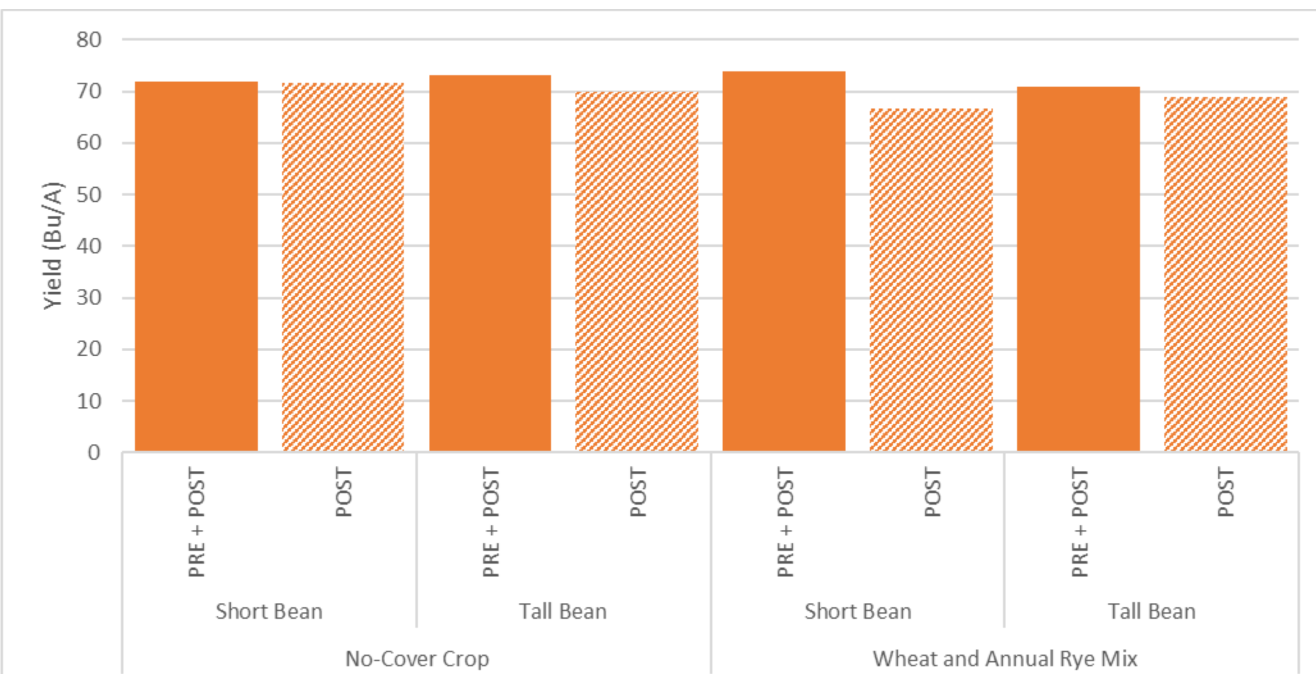


Figure 6. **Soybean grain yield (bu/acre) by cover crop/no cover crop treatment, soybean variety, and herbicide treatments at the Shelby location.**



DISCUSSION

For interseeded cover crops light availability mid-season is often the most limiting factor affecting growth and survival. The study selected grass cover crops that have some shade tolerance, reduced soybean population from 130,000 seed per acre to 100,000 seed per acre and tested a shorter soybean variety to determine if what effect this may have on cover crop survival. At the conclusion of this study it was determined that these did not have a significant enough effect on light penetrating through the soybean canopy mid-season to result in season-long cover crop growth. In addition, there were almost no treatment effects on soybean yield. A follow up to this study has been planned for future SMFDs to evaluate the timing of cover crop interseeding/planting (fall planted, at soybean planting, and V3 soybean growth stage), soybean variety, (determinate vs indeterminant), and soybean plant population. We will also test the use of banded compared to broadcast preemerge herbicide application in combination with cover crop treatments to evaluate the effects on weed suppression. We have concluded that additional investigation and testing is needed to determine if cover crop interseeding in soybean is a viable option for Nebraska soybean growers.

Effects of Cover Crops on Soil Water in Irrigated Soybean-Corn Systems

Authors: Aaron Nygren (Nebraska Extension Educator Crops and Water);
Steve Melvin (Nebraska Extension Educator Crops and Water)

This project was funded in part by the Nebraska Soybean Board.

TAKE HOME POINTS:

1) Significant differences in soil water content existed between a rye cover crop and no cover crop at planting time.
2) After planting, rainfall exceeded crop water use for a few weeks and refilled the soil profile, resulting in little to no differences in soil water content and no yield differences between a rye cover crop and no cover crop
3) Soils with no cover crop are likely to deep percolate more water than those with cover crops in the spring and early summer, likely resulting in the loss of nitrogen that the crop could have used.
4) 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.
5) 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 eleven site-years.

METHODS

Plots with a cereal rye cover crop established in the fall of 2017 (2018 SMFD), 2018 (2019 SMFD), and 2019 (2020 SMFD) were compared to no-till plots with no cover crop. This study was conducted as a randomized complete block design with four replications at each site. To measure soil water content differences, three Irrometer® Watermark granular matrix sensors attached to CPCV pipe were installed at depths of 6", 18" and 30" in each plot (Image 1). Watermark sensors measure soil matric potential through electrical resistance. Sensors were installed into the plots initially the last two weeks of April or early May depending on the site. Sensors were then pulled directly prior to 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 time of planting in all three years. At each site, the experiment was embedded in a larger center-pivot irrigated soybean field. Plots received irrigation amounts and timing as applied to the larger field. Irrigation events were scheduled at the discretion of the site's host producer with all plots receiving the same amount of irrigation water. Sensors were located in plots with 30" row spacing and a seeding rate of 120,000 plants per acre.

Image 1. **Watermark soil water sensors installed at SMFD plot.**

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 soil water content at planting time at seven of the eleven site years. At sites with differences, the no cover crop plots had higher soil moisture contents than the rye cover crop plots (Figure 1 (A)). Looking at the inches of soil water content of the entire three foot soil profile, the differences between plots ranged from +0.30 inches at Pilger in 2019 to -2.44 inches for Cedar Bluffs in 2018 (Table 1). In 2020, the Arlington and Elgin sites had significant differences of 2.07 and 2.03 inches less water at planting time for the cover crop plots, respectively.

While differences existed in total water content at planting, both the no cover crop and cover crop soils at nine of the eleven site years were above field capacity. The two exceptions were Kenesaw in 2018 and Elgin in 2020. At both sites, the soil water content for the rye cover crops were below field capacity, while the no cover crop plot was above field capacity.

Wettest Day of the Summer after Planting: Only one of the eleven site years had a significant difference in Watermark readings. The 2018 Cedar Bluffs site had a significant difference in water content (Figure 1 (B)), with the no-cover crops plot having 0.35 inches more water in the profile. However, both treatments were still above field capacity. Eight of the eleven sites have had water contents of more than 1.5 inches above field capacity after planting (Figure 1 (B)). In 2020, the four sites ranged from 2.58 to 3.93 inches above field capacity.

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

DISCUSSION

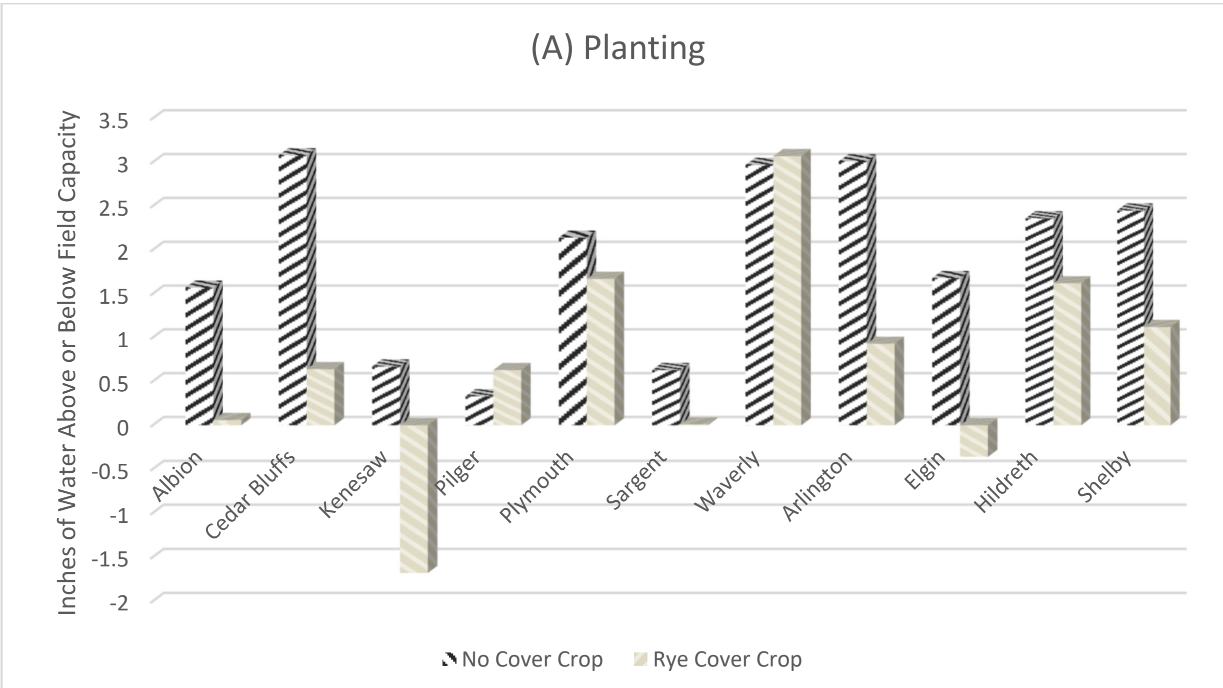
Cover crops had a significant impact on soil water content at the time of planting but differences diminished or disappeared over the course of the growing season as rainfall replenished the soil profile after cover crop termination. The range of these differences varied between sites.
The largest differences 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. Only two sites experienced soil water contents below field capacity at planting, which has the potential to negatively affect emergence and growth. At these sites, 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.

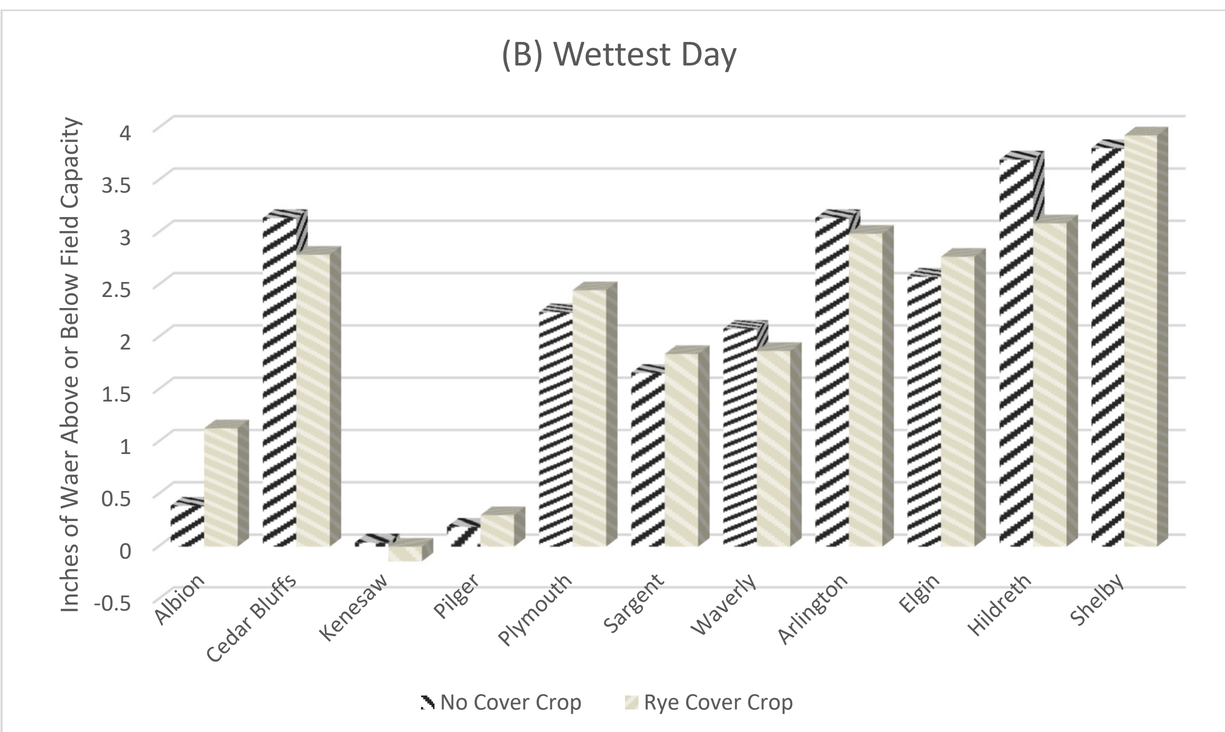
Looking at planting time, the majority of the sites had soil water contents for the rye plots that were closer to field capacity while the no cover plots were significantly wetter. In wet years, this may result in better planting conditions with the use of cover crops. Additionally, soils that are above field capacity can deep percolate a significant amount of soil water. This deep percolation may move mobile nutrients such as nitrates past the root zone, resulting in economic losses and contributing to water quality concerns.

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

In all three years, rainfall exceeded crop water use amounts for a few weeks after planting while the soybean 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. Notably, the 2020 seasonal water use by the cover crop did not impact soybean yields at the four SMFD sites as documented in the next report (see booklet pages 25-32).

Figure 1. Average soil water content in relationship to field capacity for eleven sites years at (A) planting time, (B) wettest day of the growing season, and (C) driest day of the growing season. Values greater than zero indicate water content is above field capacity resulting in water likely deep percolating below the root zone. Negative values indicate water content is below field capacity.





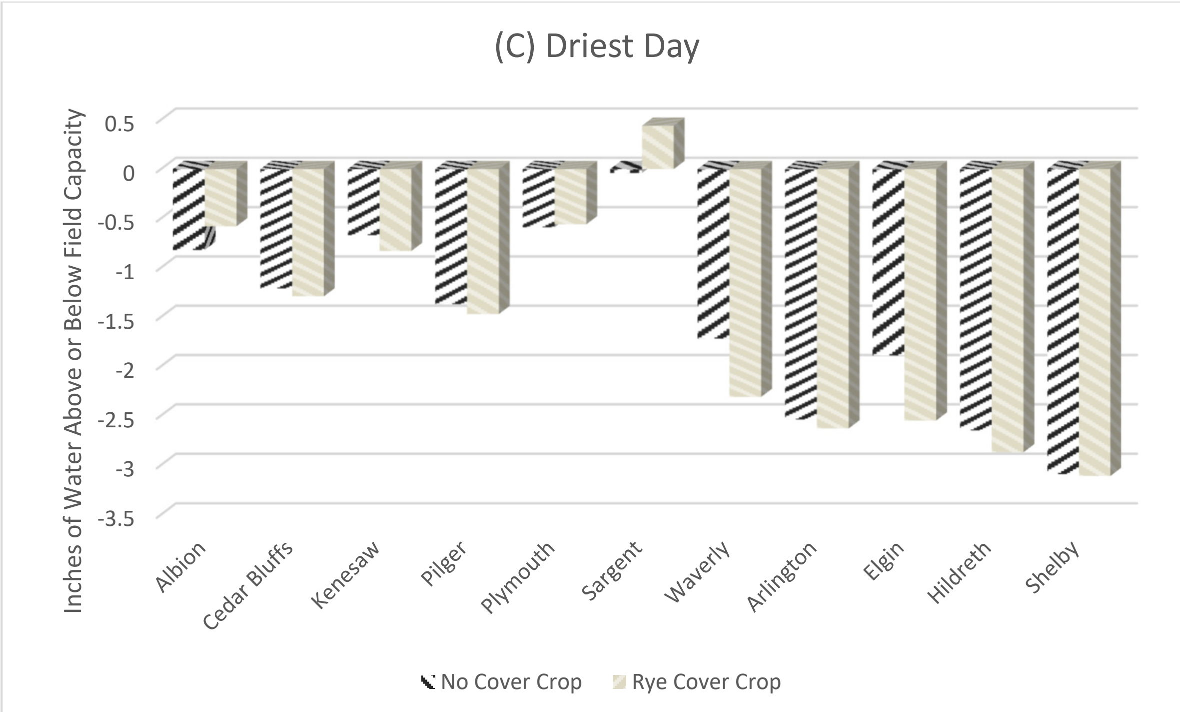


Table 1. **Soil water content at planting time above or below field capacity and differences between plots. Treatments sharing a common letter are not statistically different at P<.05. The "+" numbers for soil water content show soils that are above field capacity and a high level of deep percolation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

	Soil Water Content Above (+) or Below (-) Field Capacity in Inches at Planting		Difference in Soil Water Content of Rye Cover Crop plots versus No Cover Crop in Inches
Site	No Cover Crop	Rye Cover Crop	
Albion (2018)	+1.57 a	+0.06 b	-1.15
Cedar Bluffs (2018)	+3.08 a	+0.64 b	-2.44
Kenesaw (2018)	+0.67 a	-1.68 b	-2.35
Pilger (2019)	+0.33 a	+0.63 a	+0.30
Plymouth (2019)	+2.14 a	+1.67 b	-0.47
Sargent (2019)	+0.63 a	+0.01 b	-0.62
Waverly (2019)	+2.97 a	+3.07 a	+0.10
Arlington (2020)	+3.01 a	+0.93 b	-2.07
Elgin (2020)	+1.68 a	-0.36 b	-2.03
Hildreth (2020)	+2.36 a	+1.62 a	-0.74
Shelby (2020)	+2.45 a	+1.12 a	-1.33

Soybean Production & Cover Crops in Irrigated Soybean-Corn Systems: Planting Date, MG, Row Spacing, Seeding Rate & Irrigation Management

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This project was funded in part by the Nebraska Soybean Board.

TAKE HOME POINTS:

- A cereal rye cover crop (CC), when fall-planted in a no-tilled corn field, and then terminated the next spring, just after a mid-May planting of a soybean crop, did not depress or enhance soybean yield.
- This finding was not unexpected, given that the soil health benefits of a CC crop are assumed to not become measurably detectable in terms of greater cash crop yield until 3-5 years of successive CC use.
- Stepwise reductions in soybean planter row width from 30 to 15 and thence to 7.5 inches resulted in two stepwise 4 bu/acre yield increases –Does this warrant upgrading the row width of your planter?
- Stepwise 60,000 seeds/acre increases in seeding rate from *ca.* 70,000 up to *ca.* 190,000 seeds/acre resulted in just two 1 bu/acre stepwise yield increases – Does this warrant re-examination of your current soybean seeding rate?

Soybean Production with Cover Crops

The agronomic practices of most relevance in NE soybean production are planting date (PD), varietal maturity group (MG), their interaction (i.e., PD x MG), plus choice of seeding rate and row spacing. Irrigation is also key management practice that is available on about half of the NE soybean acreage.

The optimum practices for cover crop - cash crop production systems are assumed to not differ much from the optimum practices used for non-cover crop – cash crop production systems, except for choice of planting date and variety maturity group (MG). This exception arises because optimization of cover crop (CC) biomass accumulation before a CC is terminated requires delaying the planting of the soybean cash crop to mid-May, and of course, choosing a varietal MG suitable for that later planting date. Also, to enhance the establishment of a fall-planted cover crop after soybean harvest, producers may elect to use a variety of an earlier MG to hasten soybean harvest, thus enabling an earlier fall planting of the CC to allow it to accumulate more fall biomass before it goes into dormancy upon the arrival of winter air temperatures. Establishment of a fall-planted CC can be delayed in the absence of coincident rainfall, but in center-pivot irrigation production systems, this can be remedied with a timely fall irrigation.

Production practice research in non-CC production systems has demonstrated that when the soybean planting date is delayed in NE and other north central USA regions, yields predictably decline from the high yields attainable with late April & early May planting dates. The rate of decline is 0.25 bu/acre per day of delayed planting in non-ideal soybean production years (or in fields of low productivity), but this yield penalty can be as much as 0.6 to 0.7 bu/acre per day in ideal soybean production years (or in highly productive fields, especially irrigated ones). In addition, planting date choice and varietal MG choice are intricately linked. Full-season (later MG) varieties are typically greater yielding than short-season (earlier MG) varieties in early planting date scenarios, though that advantage lessens when the planting date is delayed. Readers interested in more information on the interaction of planting date choice and MG choice are encouraged to view the 2020 SMFD presentation videos (https://go.unl.edu/2020soydays).

The impact of row spacing and seeding rate on soybean yield in conventional non-CC systems is also well-documented (Andrade et al., 2018 https://go.unl.edu/rneu). Narrowing the row spacing consistently leads to greater yields, but the yield response to increasing seeding rates, beyond a basal threshold rate, is frequently small. In many NE studies, the yield response often plateaus when the seeding rate is sufficient to generate plant densities of about 120,000 mature plants per acre (Mueller et al., 2020 https://go.unl.edu/8kbj). However, not much research data has been generated to date with respect to the impact of changes in row spacings and seeding rates on the yield of a soybean crop when it is preceded by a cover crop. To remedy this lack of data, the focus of the 2020 SMFD was an experiment conducted at each of **four NE field sites** that was designed to evaluate soybean yield response to **three row spacing (RS) widths of 30-, 15-, & 7.5-inch** in combination with **three low, medium, & high seeding rates (SR)** that were chosen with the expectation of being able to generate an emerged plant density of about **60, 120, & 180 thousand (K) plants per acre**. This factorial set of 3 RS x 3 SR = 9 treatments was no-till planted in the spring of 2020 into prior year corn fields that had been sub-divided into four replicates of two main plots, with one main plot consisting of a mid-November planted **cereal rye cover crop (CC)**, and the other main plot serving as a **non-CC control**. The cereal rye CC was herbicide-killed immediately after the soybean crop was planted and a pre-emergence herbicide was applied to all plots to ensure subsequent weed control in the soybean cash crop. A soybean variety of MG 3.0 was planted in fields located near **Arlington (A), Hildreth (H), Shelby (S) , & Elgin, NE**, on May 11, 12, 18, & 19, respectively. Agronomic data collected from each of the 72 total plots at each site included emerged plant counts (plants/acre), mature plant height (inches ground to stem tip), seed mass (number of seed/pound), seed yield (bushels/acre @13% moisture content), plus seed protein (%) and oil (%). Due to covid-19 constraints on in-state personnel travel, yield component data (e.g., pods and seeds per plant) could not be collected except at one site (that data is not reported here). Data loggers were used to collect daily soil water sensor data in the CC and in the non-CC blocks at each site from early April to mid-September. This data, along with seasonal rainfall data, are summarized and interpreted in the prior report (see booklet pages 20-24).

Experimental Results & Discussion

The soil moisture conditions during the mid-May 2020 planting of soybean seed (placed two inches deep – see next page left photo) were ideal at all four sites, due to timely rainfall events the week before planting. A 15-inch planter was used to plant both the 30-inch and the 15-inch plots (center-left photo), whereas a drill was used to plant the 7.5-inch plots (center-right photo). Note the degree to which the soil surface with its overlying CC plant tissue and prior corn crop residue was "tillage-disrupted" (center photos) by each planter unit, with the "disruption" being greater, on a per area basis, in the narrower row plots. Also note that the tractor wheel tracks compressed the soil surface ahead of planter row units 2 and 6 in the 7-row 15-inch planter and planter row units 2 &3 and 10 & 11 of the 12-row 7.5-inch drill.

Photos: *2-inch seed depth; 30-in & 15-inch planter; 7.5-inch drill planter; plots viewed after emergence*

A low, medium, and high span of 75K, 150K, and 225K seeds per acre was desired for this experiment. However, the limited range of gear/sprocket settings available on the planter and drill did not allow us to prescribe exactly these three choices, and instead resulted in calibrated settings of **75,200**, **141,000**, & **213,400 seeds per acre**. Readers will recognize that the number of seeds planted per acre does not ordinarily translate into an equivalent number of seedlings per acre, because (1) not all planted seed germinates (MG 3.0 variety seed tag indicated 90% germination), and because (2) not every germinated seed successfully results in an emerged seedling (a nominal assumption is 95%). Adjusting seeding rates for possible unexpected seedling loss (in addition to adjusting for seed germination) is considered to be a sound risk-mitigation decision, given that **seed-to-seedling translation factors of less than 85%** have been documented in many seeding rate studies (e.g., page 62 - 2019 NE On-Farm Research Network https://go.unl.edu/6am8).

Seedling emergence counts were collected in mid-June (above center-right photo) in all site plots. Due to a covid-19 restriction on labor resources and travel at that time, these counts were taken by one person in one randomly chosen 3-foot section of each plot row, instead of a more meticulous (but far more laborious) method of counting plants in 30-foot sections of each plot row. The shorter 3-ft row section sampling resulted in more variable plant counts that were not precise enough to be used as a covariate for a mathematical modeling of plot yield on actual plot plant density. However, the data were sufficiently reliable for estimation of seedling densities achieved in each of the three SR treatments, which averaged **68K**, **128K**, & **193K/acre**, thereby reflecting **a seed-to-seedling translation factor of about 91%** of the calibrated actual seeding rates of **75K**, **141K**, & **213K/acre**. This percentage was clearly closer to the varietal germ of 90% than to our 85% translation expectation. The three seedling count averages did not significantly differ among the four sites, or between the CC or RS factor levels. Seedling counts were not taken in the plant rows located in the tractor tire track soil-compression zones, where seedling emergence/vigor was notably sub-optimal. In that regard, only the two middle rows of 4-row 30-inch plots, the three middle rows of the 7-row 15-inch plots, and the six middle rows of the 12-row 7.5-inch plots were harvested with the plot combine (photos). The plots in each replicate were 37.5 feet long but were end-trimmed to a central 25-ft harvested section.

The analysis of the experimental yield data generated the factor treatment means displayed as solid circle symbols in **Figure 1** (see next page). Overall, yields in the 75-80 bu/acre range were attained at three of the four sites (**Panel A**). The use of a fall-planted cereal rye cover crop prior to a soybean crop did not significantly enhance (nor depress) the yield of the cash crop (**Panel B**), irrespective of site, row spacing and/or seeding rate. The fact that a first-time use of a fall-planted CC did not improve yield of the subsequent soybean cash crop should not be treated as an indication that CC use is a non-economic practice. The soil health benefits of a CC crop are alleged to become measurably detectable in terms of greater cash crop yield only after 3-5 years of successive CC use (Myers et al. 2019 https://go.unl.edu/25o3). Presumably, those beneficial greater yields will eventually become large enough over time to offset the yield penalty incurred by having to delay soybean planting in CC production scenarios from early May to mid-May.

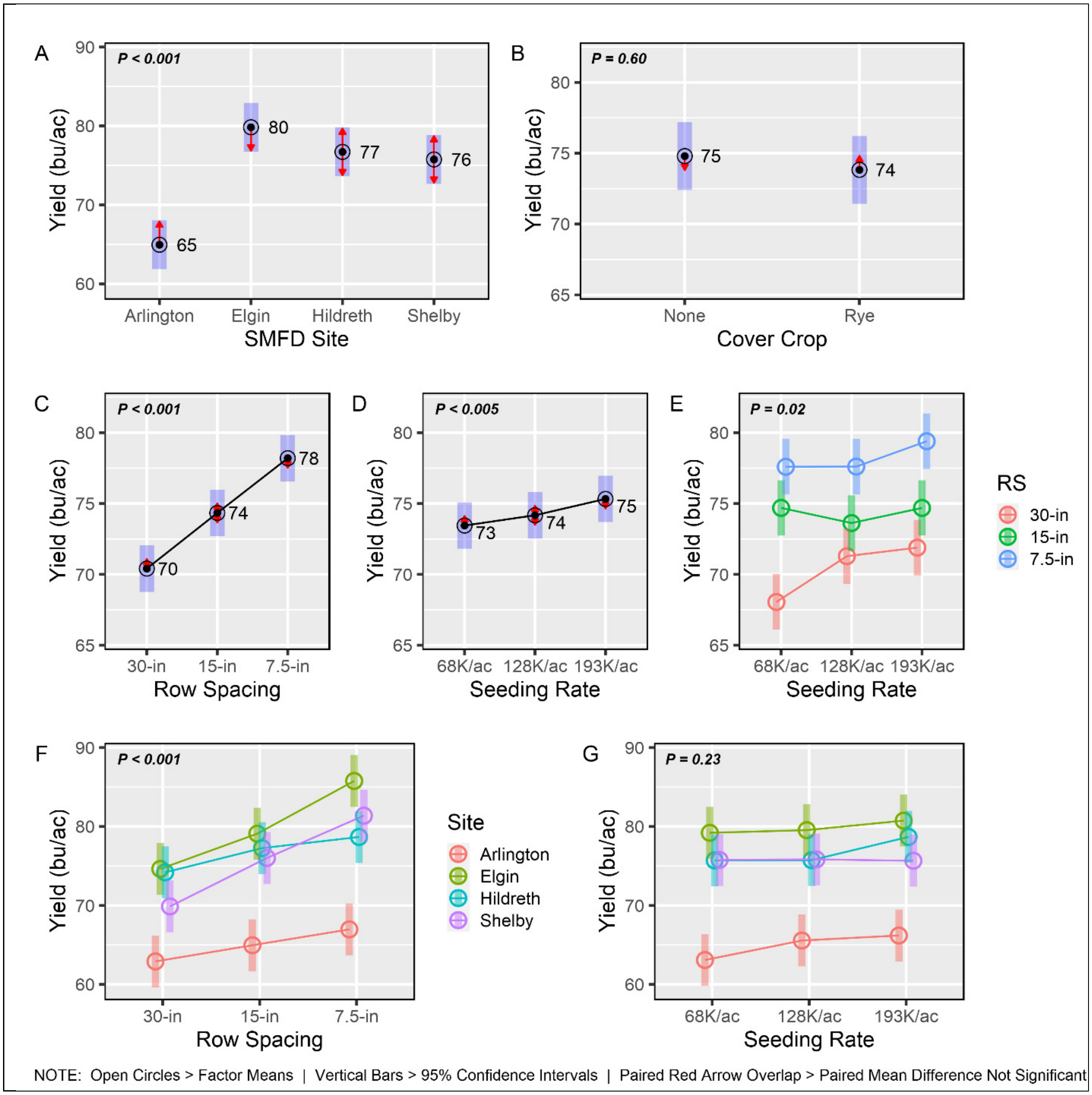

Figure 1. Plots of mean yields for the factors of Site (**Panel A**), Cover Crop (**B**), Row Spacing (**C**), and Seeding Rate (**D**), and for the interactions of RS x SR (**E**), Site x RS (**F**), and Site x SR (**G**). The probability values reflect significance of the analysis of variance F-test of the given factor or interaction.

Soybean yield was significantly impacted by row spacing (RS) and seeding rate (SR), but more so for RS, wherein halving the width from 30 to 15 inches and thence to 7.5 inches resulted in linear enhancement in soybean yield by about 4 bu/acre in each step (**Panel C**). An obvious question of producer interest is whether the magnitude of these yield increases would, given the current soybean price, warrant upgrading a 30-inch row planter to a 15-inch row planter or the purchase of a drill. Keep in mind that widening an existing planter must also be considered an upgrade option, given that being able to plant more farm acres more quickly can theoretically improve on-farm soybean yield via a completion of all soybean planting at an earlier May date! Comparatively, increasing the seeding rate by 60K/acre from low to medium to high resulted in stepwise increases of just 1 bu/acre (**Panel D**), which are simply too small, relative to the current soybean price, to warrant the purchase cost of the extra seed planted per acre. The current NE Extension recommendation is to use a seeding rate that will ensure generation of about 120,000 mature plants per acre (Meuller et al., 2019 https://go.unl.edu/8kbj). On occasion, adverse soil conditions at planting can result in plant densities that fall short of this 120K plants per acre benchmark, but data we present here demonstrate that yield does not decline much (1 bu/acre), at least up to point of a density drop from 120K to 70K /acre, a finding to keep in mind relative to plant-loss-based replant decisions. A significant interaction between row spacing and seeding rate was detected (**Panel E**) but was primarily due to an inexplicable yield difference between the 30-inch *vs.* 15-inch row spacing at the lowest seeding rate. The linear yield response to the narrowing of row width differed amongst sites (**Panel F**); the response was steeper at Elgin and Shelby but less so at Hildreth and Arlington, leading to Site x RS interaction. No significant Site x SR interaction was evident in the nearly flat response of yield to increasing seeding rates observed at these sites (**Panel G**).

One key yield component, seed mass, which is measured as number of seeds per pound, was not impacted by any experimental factor (i.e., CC, RS, nor SR), though it did differ among sites, ranging from 2572 seeds/pound (larger seed) at Elgin to 2752 seeds/pound smaller seed) at Shelby, likely reflecting the timing of major rainfall (or irrigation) events prior to *vs.* after the seed-filling period. Plant height differed among sites, with taller plants (42 inches) at Elgin, but shorter plants (32 inches) at Arlington, likely due to the same water timing reason (main stem growth ceases when seed-fill starts). Of interest was the observation that narrowing the row spacing resulted in shorter plants, presumably because of lessened within-row plant-to-plant competition, whereas increasing the seeding rate resulted in taller plants, presumably due to the same reason. However, the changes induced in plant height by RS or SR were small (just a few inches) and not consequential, given the absence of any significant plant lodging.

The 2020 SMFD experiment did result in one novel finding of interest. The seed produced at the four sites differed with respect to seed composition, with seed produced at Hildreth and Arlington exhibiting the highest and lowest respective seed protein contents (see next page - **Figure 2 - Panel A**), but with those same two sites exhibiting a *vice-versa* lowest-highest seed oil pattern (**Panel B**). Soybean seed protein and oil contents are known to be negatively correlated, so this *vice-versa* protein-oil response pattern is commonly observed. What was surprising, however, was that the narrowing of row spacing resulted in a reduction in seed protein (**Panel C**) along with an expected (i.e., correlated) enhancement of seed oil (**Panel D**). In contrast, increasing the seeding rate led to an enhancement in seed protein (**Panel D**), in conjunction with a correlated reduction in seed oil (**Panel F**). Note that these changes in seed protein and seed oil were relatively small (i.e., decimal point percentage range), and thus may not be of much interest to soybean processors (or to producers in the absence of any price premium for either constituent). However, this finding is worthy of more research, not only to identify the causal mechanisms, but also, and more importantly, to determine if these RS and SR impacts in this 2020 SMFD experiment can be confirmed as repeatable in the 2021 SMFD experiment.

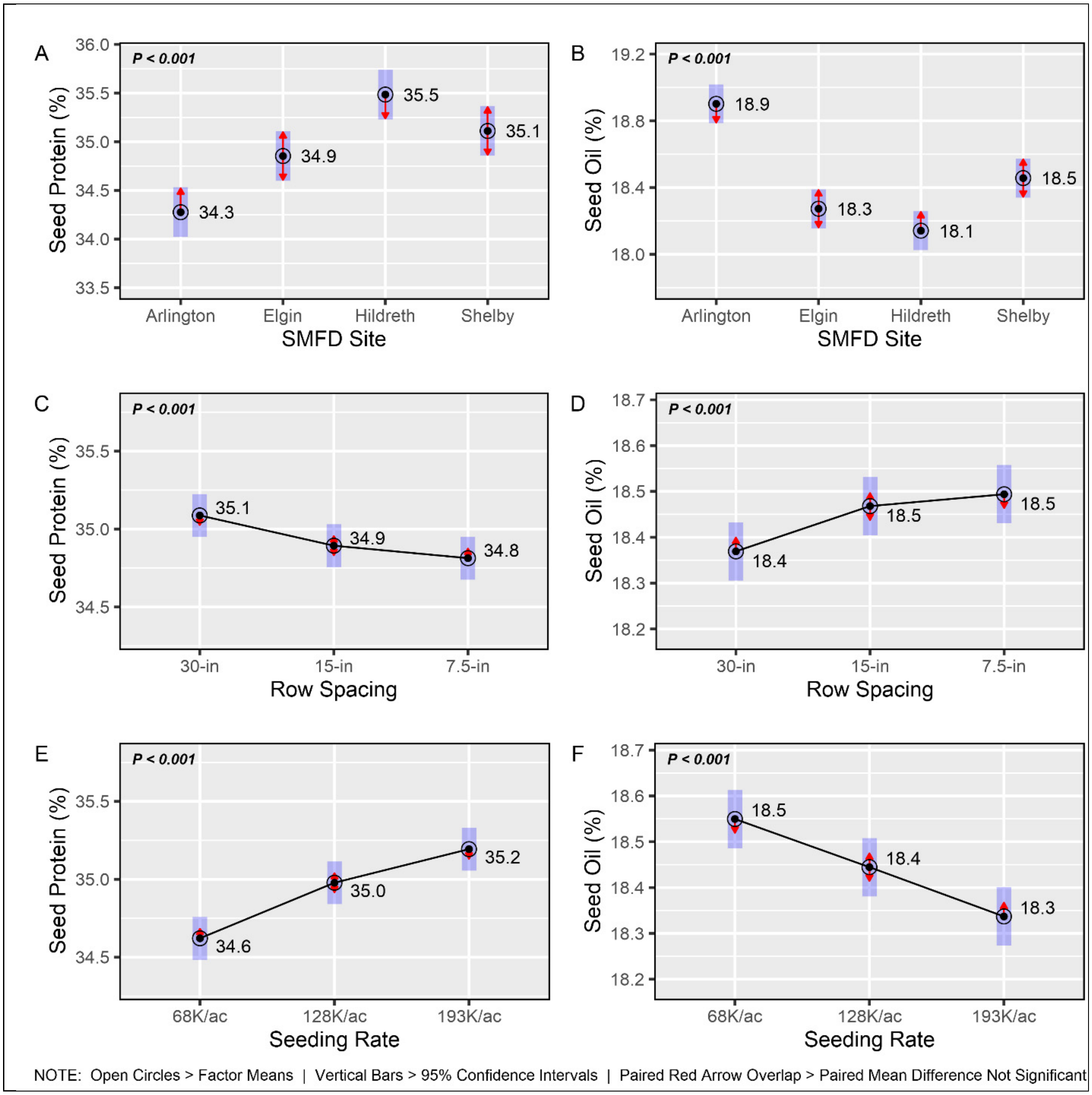

Figure 2. Plots the factor mean percentages of seed protein (left) or seed oil (right) for Site (**Panels A & B**), Row Spacing (**C & D**), and Seeding Rate **(E & F**). Probability values reflect factor F-test significance.

Readers are reminded that the results reported here for these NE sites might not be exactly repeatable at other NE sites that may differ in climate, soil, and background farm management. Producers at other locations are advised to conduct on-farm trials (for help, contact Nebraska On-Farm Research Network https://cropwatch.unl.edu/farmresearch/contact) to determine if one or more of the factors/levels tested here might improve soybean yield on their own farm. As is customary in field research, the 2020 SMFD experiment will be repeated at the same four NE sites in the 2021 SMFD, which will allow us to determine if the 2020 results are repeatable in a different growing season.

Acknowledgements

Justin McMechan, Chris Proctor, and Steve Spicka assisted in the planning, planting, plot trimming, and combine harvest of this experiment. Kent Eskridge (UNL) and Russ Lenth (Univ of Iowa) provided useful advice relative to the statistical analysis of the experimental data using the on-line R software package.

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2020 SOYBEAN MANAGEMENT FIELD DAYS RESEARCH UPDATE

2020 Soybean Management Field Days Research Locations:

- **Jerome Fritz Farm - Hildreth, NE**
- **Kevin Dinslage Farm - Elgin, NE**
- **Bart and Geoff Ruth Farm - Shelby, NE**
- **Mike Fuchs Farm - Arlington, NE**

For more information, contact the Nebraska Soybean Board at (402)441-3240 or Nebraska Extension at (800)529-8030.

Cumulative Rainfall Totals