

2021 SOYBEAN MANAGEMENT FIELD DAYS

RESEARCH UPDATE

N EXTENSION

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University of Nebraska–Lincoln

UNIVERSITY OF NEBRASKA–LINCOLN INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES

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Cultural Practices

	Plant	Harvest	Soil	Herbicide	
	5/25/2021	10/7/2021	Silty Clay Loam	Date	Chem/Rate
Arlington	Cover crop seeded			11/3/2020	62 lbs/Ac
	Termination*			5/25/2021	Roundup PowerMax 32oz AMS 12 lb/100 gal
	Pre**			5/25/2021	Fierce XLT 5 oz
	Post			6/23/2021	Liberty 43oz AMS 17 lb/100
	5/12/2021	10/6/2021	Silty Clay Loam	Date	Chem/Rate
Elgin	Cover crop seeded			11/4/2020	62 lbs/Ac
	Termination*			5/12/2021	Roundup PowerMax 32oz AMS 12 lb/100 gal
	Pre**			5/12/2021	Fierce XLT 5 oz
	Post			6/21/2021	Liberty 43oz AMS 17 lb/100
	6/4/2021	10/14/2021	Silt Loam	Date	Chem/Rate
Wilcox	Cover crop seeded			11/5/2020	62 lbs/Ac
	Termination*			6/4/2021	Roundup PowerMax 32oz AMS 12 lb/100 gal
	Pre**			6/4/2021	Fierce XLT 5 oz
	Post			7/2/2021	Liberty 43oz AMS 17 lb/100
	5/26/2021	10/8/2021	Silt Loam	Date	Chem/Rate
Rising City	Cover crop seeded			11/6/2020	62 lbs/Ac
	Termination*			5/26/2021	Roundup PowerMax 32oz AMS 12 lb/100 gal
	Pre**			5/26/2021	Fierce XLT 5 oz
	Post			6/21/2021	Liberty 43oz AMS 17 lb/100

*** Terminations for Entomology study excluded**
**** Pre-emergence herbicide - Weed Science study excluded**

Soybean Management Field Days On-Farm Research

Introduction

Aaron Nygren,
Nebraska Extension Educator

First off, thanks to all who helped make my first year coordinating Soybean Management Field Days a success, which includes faculty and staff from the University of Nebraska-Lincoln, the Nebraska Soybean Board, cooperating farmers, and many more. The highlight of this last year was getting to return to in-person field days in August at four locations across Nebraska and having great conversations with you, Nebraska's soybean farmers. For those that couldn't attend in person, I encourage you to watch the virtual presentations from those field days to gain more insight about the research and production topics which were covered this year. Those videos are available at the following link: https://go.unl.edu/2021virtualsmfd.

The following pages will highlight research results from not only this year's studies but results from those same studies conducted over multiple years.

Studies for 2021 started with the planting of a rye cover crop in the fall of 2020. Over the course of the year, we were able to capture a variety of replicated data from each of the four on-farm locations located near Wilcox, Elgin, Rising City 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 part in support and management of this effort. Their input into the selection of research topics and, in some cases, treatments was useful.

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.

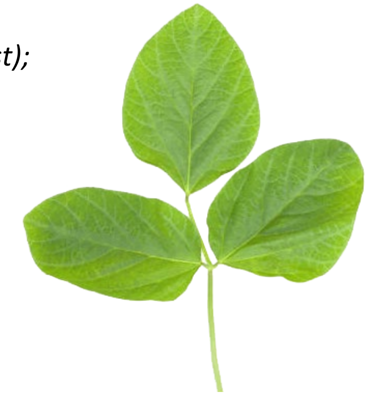
After reviewing the report, if you have additional questions, we encourage you to contact researchers associated with the study. Their names appear in the write up of each study and their contact information is listed on the back cover. We are committed to working for you, the soybean growers of Nebraska.

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 Aaron Nygren (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
- Yield differences did occur between treatments at some sites but there was no consistent trend across the 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. 'Elbon' rye was planted at 63 lb/acre, respectively. Cover crops were planted in early-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, applications, and data collection dates at each of the Soybean Management Field Day sites in 2020 and 2021. *at-plant and post-planting referring to times relative to the soybean planting date.**

Site	Cover Crop				Soybean Planted	Pitfall Trap	Soybean Damage Assessment
	Planted (Yr. 2020)	Termination 1 (early)	Termination 2 (at-plant)*	Termination 3 (post-plant)*			
Arlington	Nov. 3	April 21	May 25	May 29	May 25	June 28 – July 2	June 28
Wilcox	Nov. 5	April 31	May 18	May 22	May 18	July 1 -5	July 1
Rising City	Nov. 6	April 26	June 4	June 9	June 4	June 28 – July 2	June 28

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: Differences occurred between the three sites for biomass or extended leaf height (Table 2) as a result of greater biomass (Fig. 1A) and extended leaf height (Fig. 1B). Termination treatment timing (Table 3) had a significant effect on biomass and extended leaf height with biomass increasing by 8.3 and 4.5 times, respectively, 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 33.7 inches of growth between early and at plant termination whereas an additional 2.0 inches of growth was observed between at plant and post plant terminations.

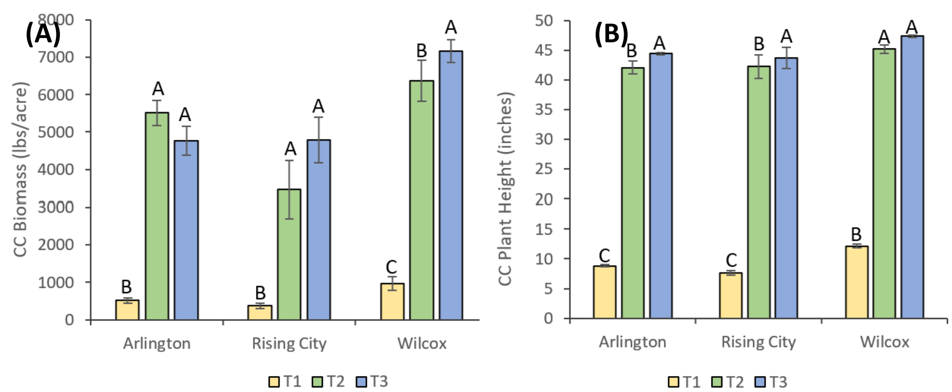
***Table 2.* Mean biomass and extended leaf height for both cover crop species at each site. Letters indicate significant differences at P<0.05.**

Site	Cover Crop	
	Biomass (lbs/acre)	Extended Leaf Height (inches)
Arlington	3592.8 B	31.8 B
Wilcox	4835.3 A	35.0 A
Rising City	2874.8 B	31.2 B

***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	617.3 C	9.5 B
Termination 2: At plant	5114.0 B	43.2 A
Termination 3: Post-planting	5571.7 A	45.2 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) and there was an interaction between location and cover crop (P<0.0001). For location, the greatest number of arthropods were collected at Wilcox (255.0) followed by Arlington (73.1) and Rising City (32.1). In the case of termination, at-plant (T2) and late (T3) crop terminations had a greater number of arthropods when compared to no cover crop and early termination (Figure 3b). Of the four arthropod groups evaluated (Fig. 4), ground beetles, rove beetles, sap beetles and spiders varied significantly between cover crop terminations. Ground beetles were steady or declined in activity with delayed termination. For rove beetles, a significant increase in activity was observed with a cover crop at Arlington and Wilcox with some cover crop terminations, however, no differences were observed at Rising City. Sap beetles showed a significant increase in number with all cover crop treatments compared to no cover at Wilcox whereas no differences were observed at Arlington and Rising City. Spider activity declined when a cover crop was present for Wilcox whereas no differences were observed at the other sites.

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.**

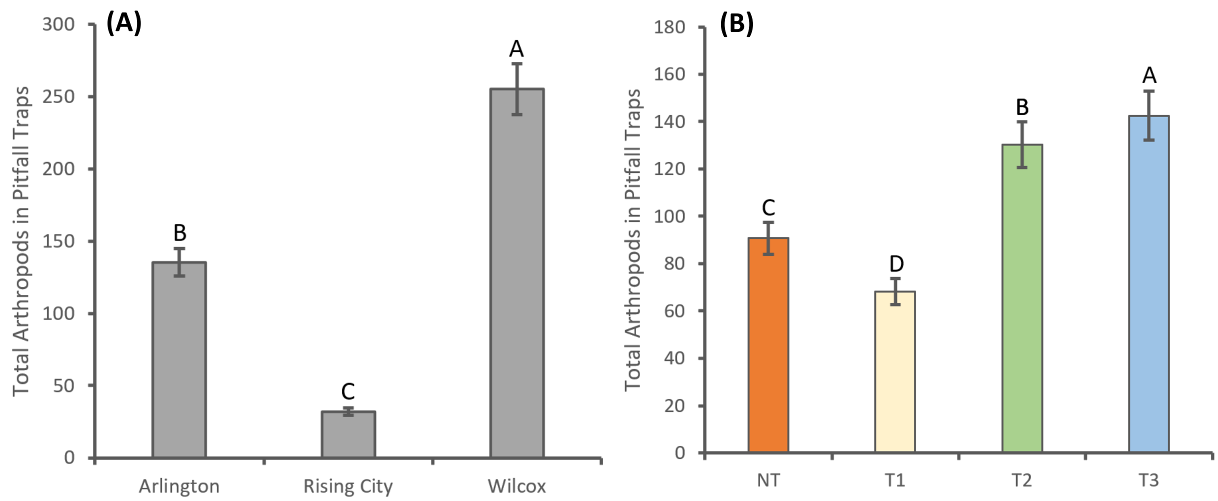
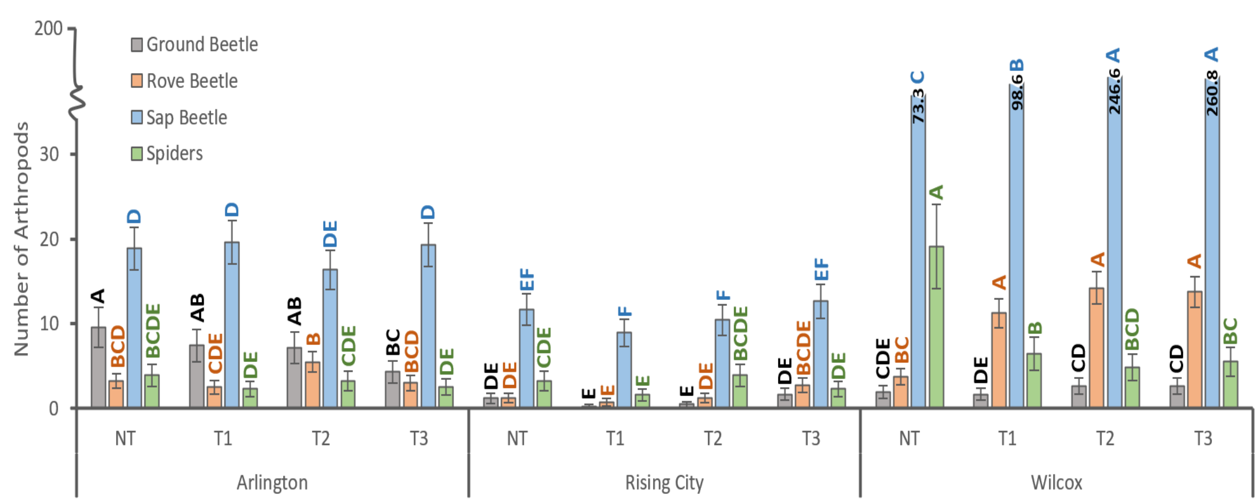


Figure 4. **Average number of ground beetle, rove beetle, sap beetle and spiders recovered from pitfall traps for no cover crop, early, at plant and post plant terminations average for each sites**



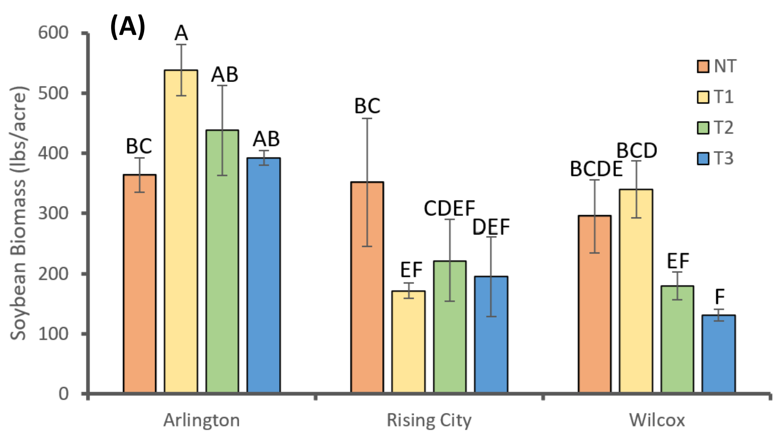
and Rising City (P=0.4363). A significant difference in defoliation with termination occurred at Wilcox (P=0.0401) as result of significantly lower defoliation for T3 (1.0) compared to NT (4.6), T1(3.8) and T2(3.8). The most common defoliators collected was bean leaf beetle.

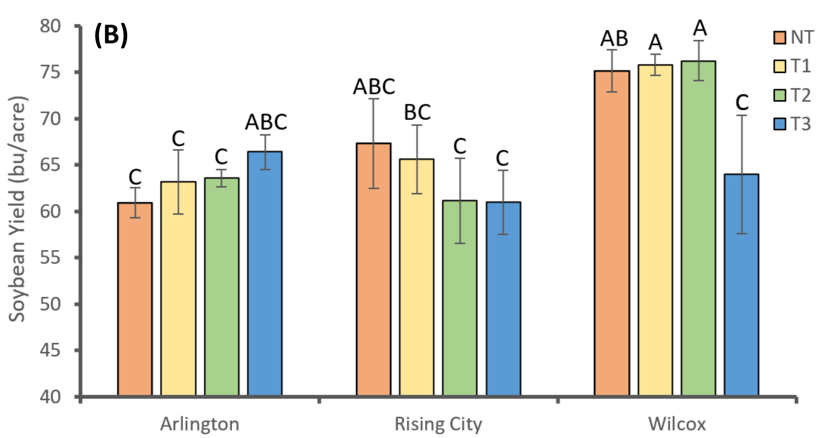
Soybean Biomass: Differences in soybean biomass (P<0001) (Fig.5A) occurred between sites with the greatest biomass at Arlington (432.7 lbs/acre) followed by Wilcox (236.3 lbs/acre) and Rising City (234.8 lbs/acre).

Cover crop termination differences were observed at all sites (Fig. 5A) (P=0.0531) 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).

Soybean Yield: Significant differences in yield occurred between the different termination times (Fig. 5B) with different numerical trends between sites. Arlington showed no differences between treatments with a gradual increase in yield whereas Rising City and Wilcox showed a reduction in yield with a delay in cover crop termination. Statistical differences between treatments within a site only occurred at Wilcox with reduced yield for the late termination date.

***Figure 5.* Soybean biomass (A) and yield (B) across cover crop termination treatments for Arlington, Rising City, and Wilcox.**





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 and analyses will be needed to better understand these results. 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, can be a very abundant species in cover crop treatments (Wilcox site) 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, bean leaf beetle was the most abundant. The low level of defoliation observed would not contribute to any differences in yield. Soybean biomass was negatively impacted by the presence of a cover crop at Rising City and Wilcox, regardless of this difference a significant yield reduction only occurred at Wilcox for the T3 treatment.

ALTERNATIVE STRATEGIES FOR WEED CONTROL IN SOYBEAN INTERSEEDING COVER CROPS IN SOYBEAN

Authors: Chris Proctor (UNL Weed Science Extension Educator);
Kayla Safarik (Graduate Student), Victor de Sousa Ferreira (Graduate Student);
Camila Chiaranda Rodrigues (Visiting Scholar); and
Aaron Nygren (UNL Cropping Systems Extension Educator)

Research Support: Steven Spicka (Agronomy Research Tech III)

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

TAKE HOME POINTS:

- The use of fall planted cover crops improve weed suppression where weeds were present.
- Spring interseeded cover crops did not survive until soybean harvest due to limited light availability under the soybean canopy
- Overall, the soybean yield was not affected by cover crop treatment when compared with the no-cover crop control treatments for all locations.
- Fall drilled cover crop and fall drilled cover crop with skip row produced between 4000 and 10,000 lb/A biomass when terminated mid-May to early-June.

INTRODUCTION

Cover crops have the potential to be a useful tool, in addition to herbicides, for managing weeds. It is generally well agreed upon that cover crop benefits are closely tied to biomass production. One challenge that comes with cover crop use in soybean/corn cropping systems includes limited time for successful establishment after harvest to accumulate cover crop biomass. To extend the cover crop growing season termination timing may be delayed in spring resulting in greater cover crop biomass. Another opportunity to overcome the short window for cover crop growth following harvest has been drill interseeding when planted at V3-V4 stage of corn. To better understand if this would work for soybean, a drill interseeding study and a delayed termination study using banded herbicides was conducted at each of the 2021 Soybean Management Field Day Sites.

Research Questions:

- How does fall planted cover crops compare with spring interseeded cover crops on biomass production and weed control?
- How does Preemergence herbicides placement (banded vs. broadcasted) affect subsequent weed control?
- How does fall planted cover crop and spring interseeded cover crops affect soybean yield?

METHODS

Studies were established at all 2021 Soybean Management Field Day locations (Arlington, Rising City, Elgin, and Wilcox). Cereal rye was fall drilled at 50 lbs/A using a 7.5 ft drill and 10 in row spacing. A skip-row treatment was included where the drill row falling on 30 in center was not used for seeding to provide a gap for the soybean planter (Fig. 1). An herbicide application of Fierce at 3.74 oz/A + Roundup 32 fl oz/A was applied at planting as either a 10" band over the soybean row or broadcast. A POST application was Liberty at 32 fl oz/A applied prior to cover crop interseeding. A cover crop mix of 10 lb/acre rye (40 lb rye) and red clover (10 lb) was drilled interseeded using a 10 ft Hiniker cover crop drill interseeder with 2 row-units between each 30 in soybean row at the V2-V3 soybean growth stage (Fig. 2). Soybeans were planted at 121,900 seeds/acre on 30 in rows. The spring interseeded and no-cover crop treatments were planted with a 1.8 Maturity Group (MG) soybean and the fall-drill, fall drill-skip-row, and no-cover crop treatments were planted with a 2.6 MG soybean. Soybean planting and cover crop drilling and interseeding dates are listed in Table 1. Data collected includes cover crop biomass, weed suppression following POST application, and soybean grain yield.

***Table 1. Soybean* and cover crop planting dates at each of the Soybean Management Field Day sites in 2021.**

Location	**Arlington**	**Rising City**	**Elgin**	**Wilcox**
Fall Drilled Cover Crop	Nov. 3	Nov. 6	Nov. 4	Nov. 5
Soybean Planting	May 25	May 26	May 12	June 4
Spring Interseeded Cover Crop	June 21	June 24	June 17	July 9

***Figure 1.* Soybean growth in fall drilled cover crop with skip-row on June 15th, 2021, at the Rising City location.**

***Figure 2.* Spring interseeded rye and clover into soybeans in Rising City on July 15th, 2021.**

Data Collection

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

Cover Crop Biomass: Cover crop biomass were collected within two randomly placed 1 ft^2 frames. Sub-samples from within each plot were combined dried and weighed.

Weed Biomass: Weed biomass was collected at the same time as the cover crop biomass but separated and weighed separately.

Statistical analysis. The experimental design was a randomized complete block with 4 replications. Analysis of variance was conducted using SAS statistical software and treatment means were separated using Fisher's LSD based on a probability of α = 0.05.

RESULTS

Yield

At all four sites (Arlington, Elgin, Rising City and Wilcox), there was no yield difference between treatments with and without cover crop (Fig. 3, 4, 5 and 6). At the Rising City location, the banded PRE herbicide application resulted in lower yield than the broadcast PRE for the 2.6 MG soybean with no-cover-crop (Fig. 5). There were no other yield differences when comparing between banded and broadcast herbicide applications for the other locations.

Figure 3. **Soybean grain yield (bu/acre) shown by cover crop treatment, soybean maturity group (MG), and herbicide application treatments (banded vs. broadcast) at the Arlington location.**

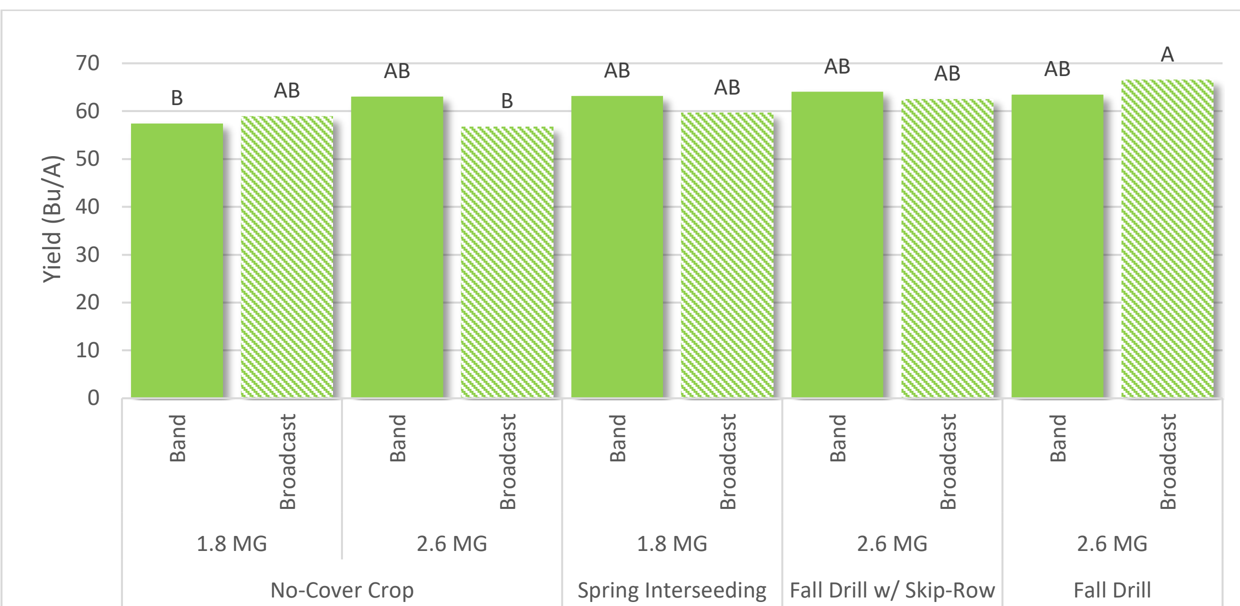


Figure 4. **Soybean grain yield (bu/acre) shown by cover crop treatment, soybean maturity group (MG), and herbicide application treatments (banded vs. broadcast) at the Elgin location.**

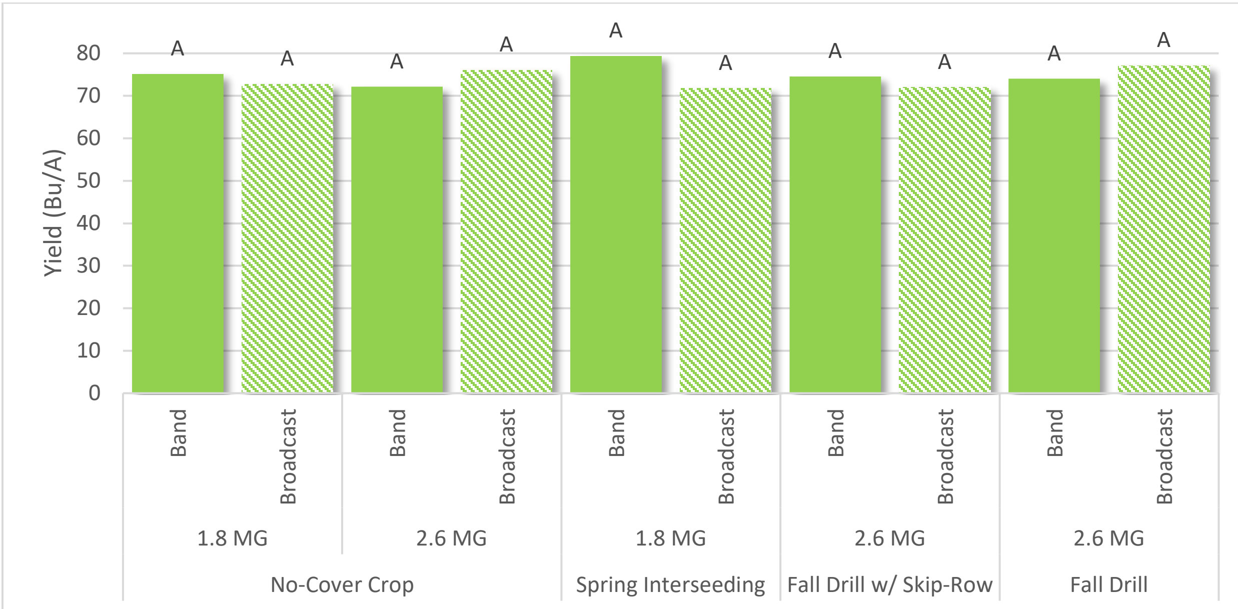


Figure 5. **Soybean grain yield (bu/acre) shown by cover crop treatment, soybean maturity group (MG), and herbicide application treatments (banded vs. broadcast) at the Rising City location.**

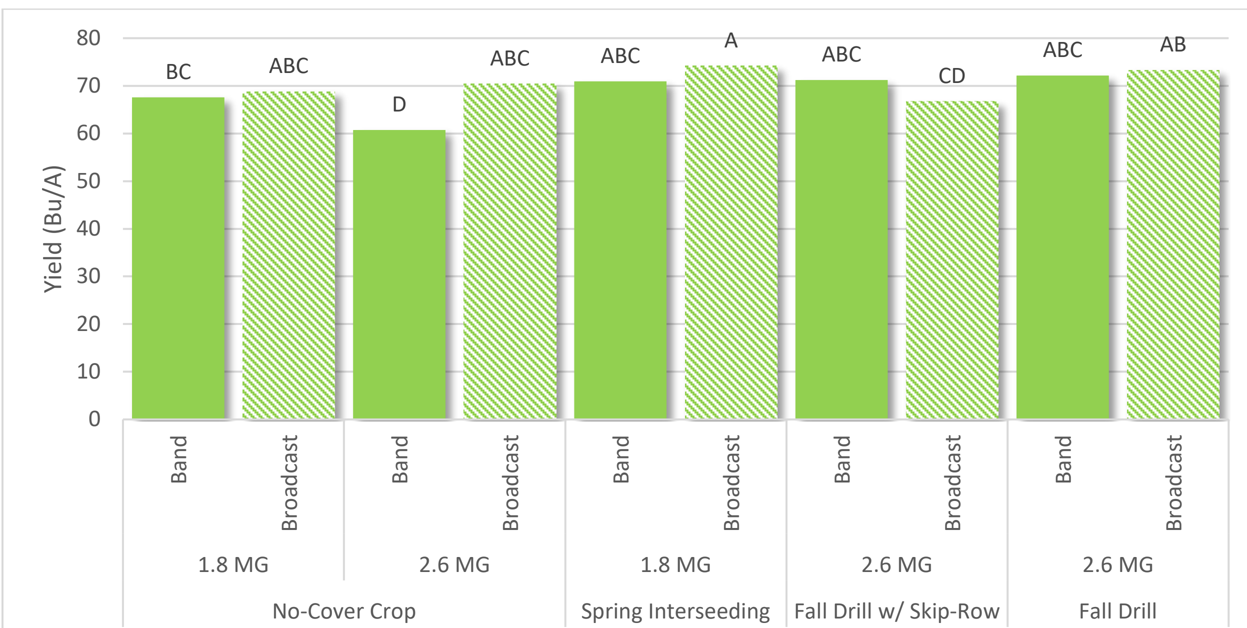
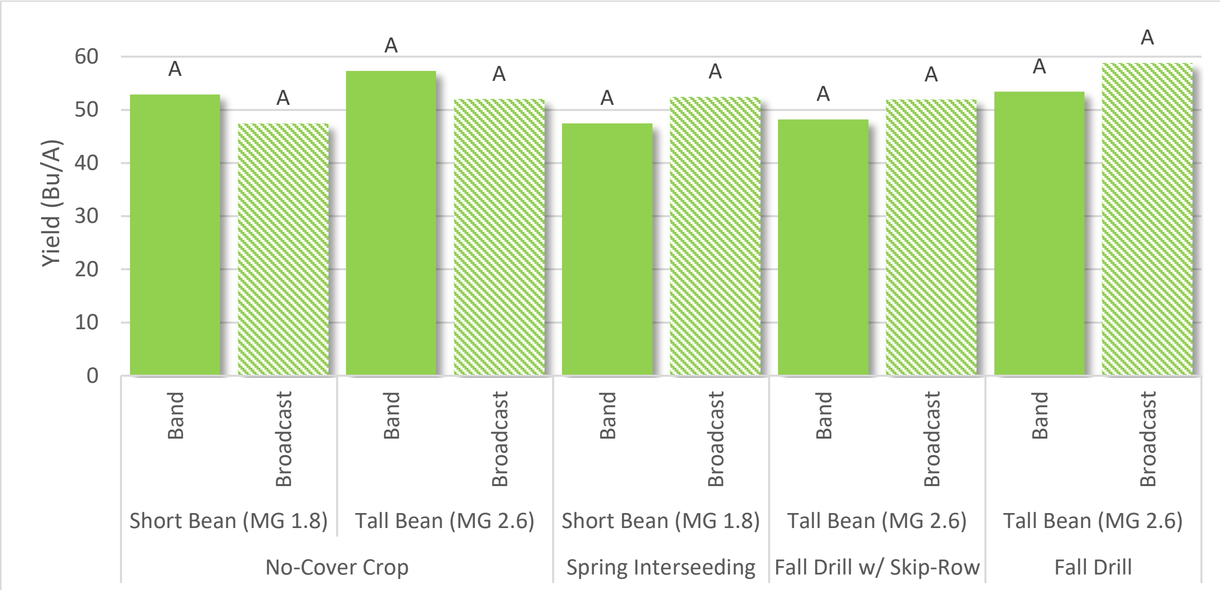


Figure 6. **Soybean grain yield (bu/acre) shown by cover crop treatment, soybean maturity group (MG), and herbicide application treatments (banded vs. broadcast) at the Wilcox location.**



Cover Crop Biomass

Fall drilled cover crop biomass was over 4000 lbs./A at all locations and reached as high as 10,000 lbs./A (Figs. 7-10). Within each location there was no difference in cover crop biomass between the fall drill and the skip-row fall drill treatments. Interseed cover crop biomass was not collected in the fall as the interseeded treatments emerged, but there was no biomass remaining at time of soybean harvest.

Figure 7. **Cover crop biomass (lb/acre) by cover crop treatment, soybean maturity group, and herbicide application treatments at the Arlington location.**

Figure 8. **Cover crop biomass (lb/acre) by cover crop treatment, soybean maturity group, and herbicide application treatments at the Elgin location.**

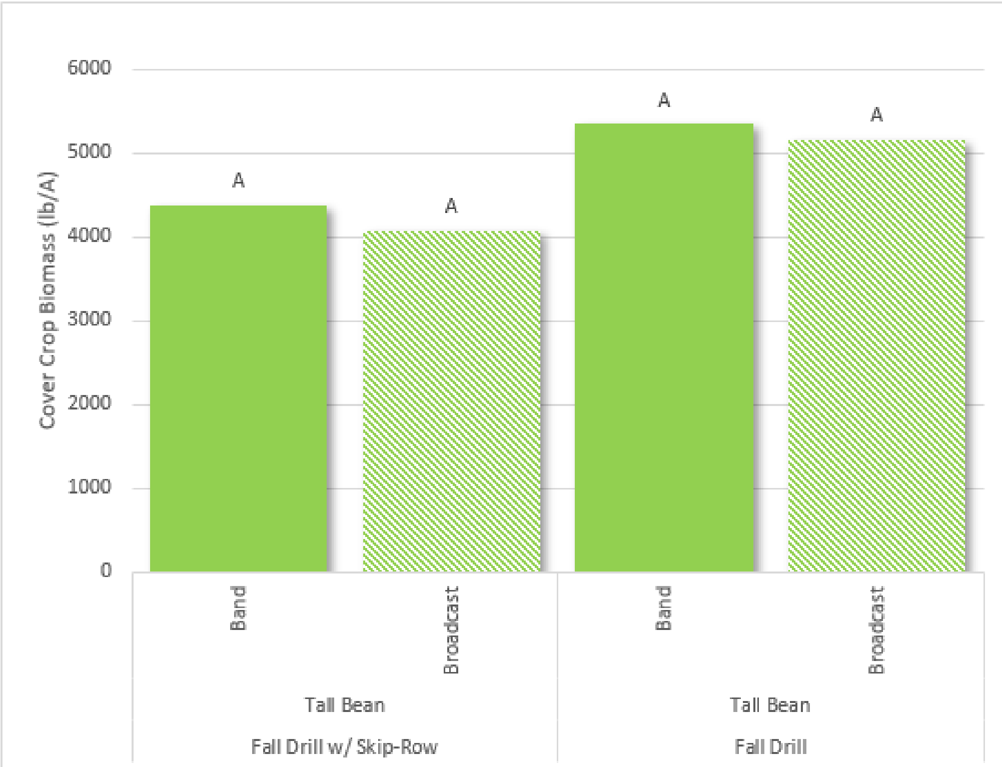


Figure 9. **Cover crop biomass (lb/acre) by cover crop treatment, soybean maturity group, and herbicide application treatments at the Rising City location.**

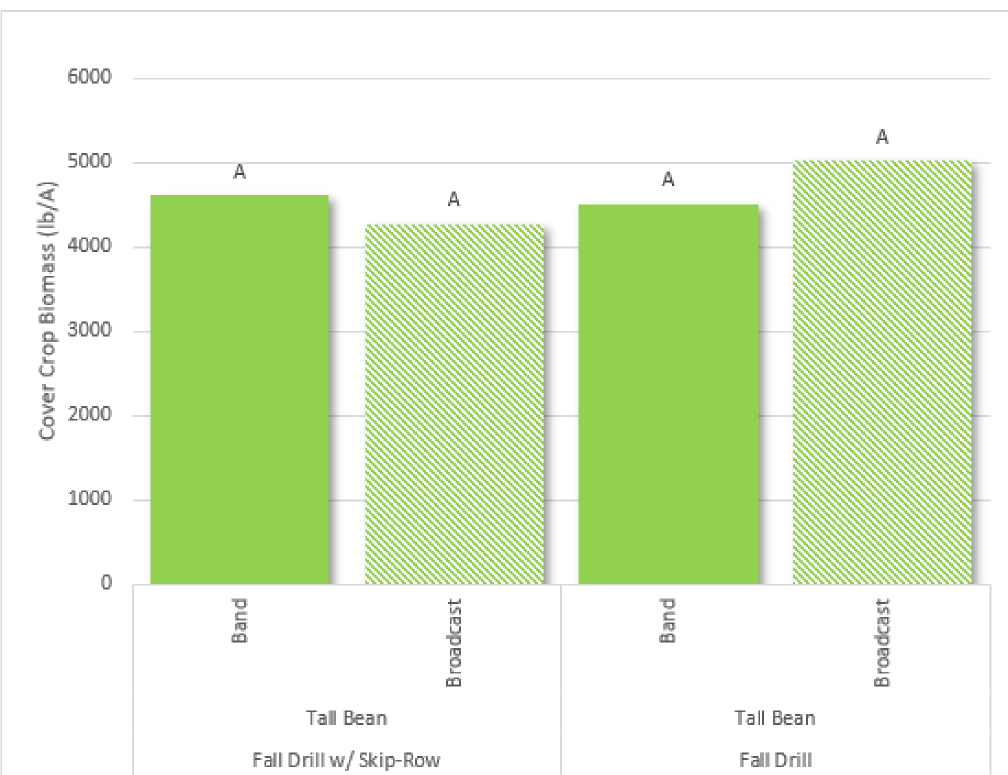
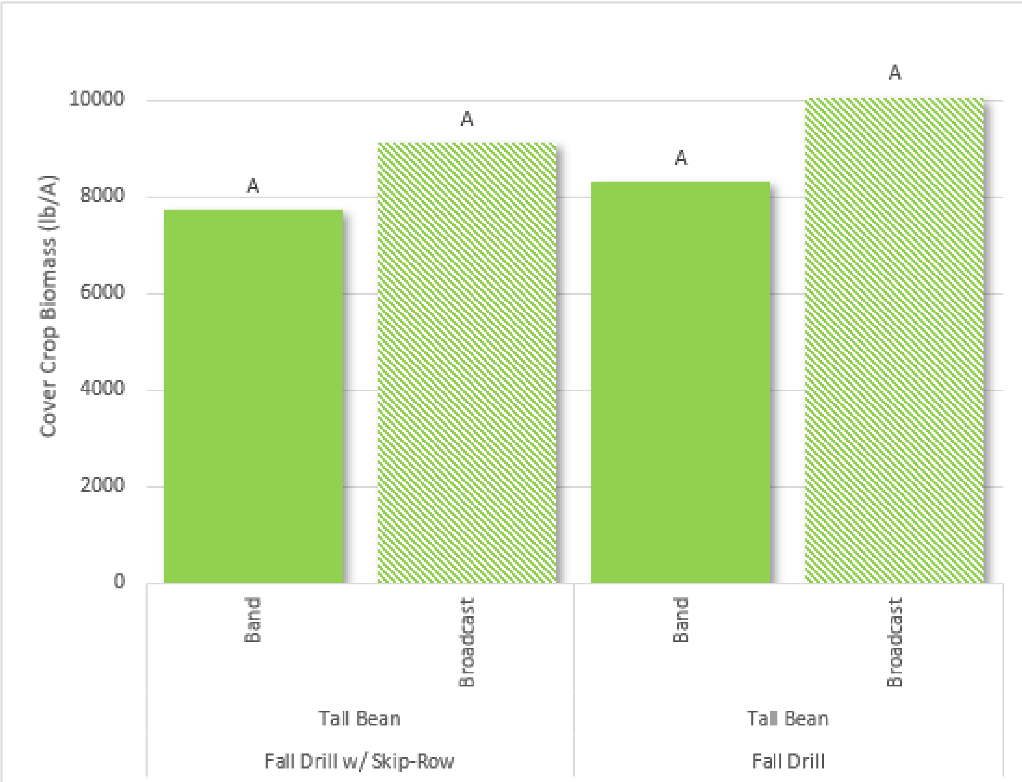


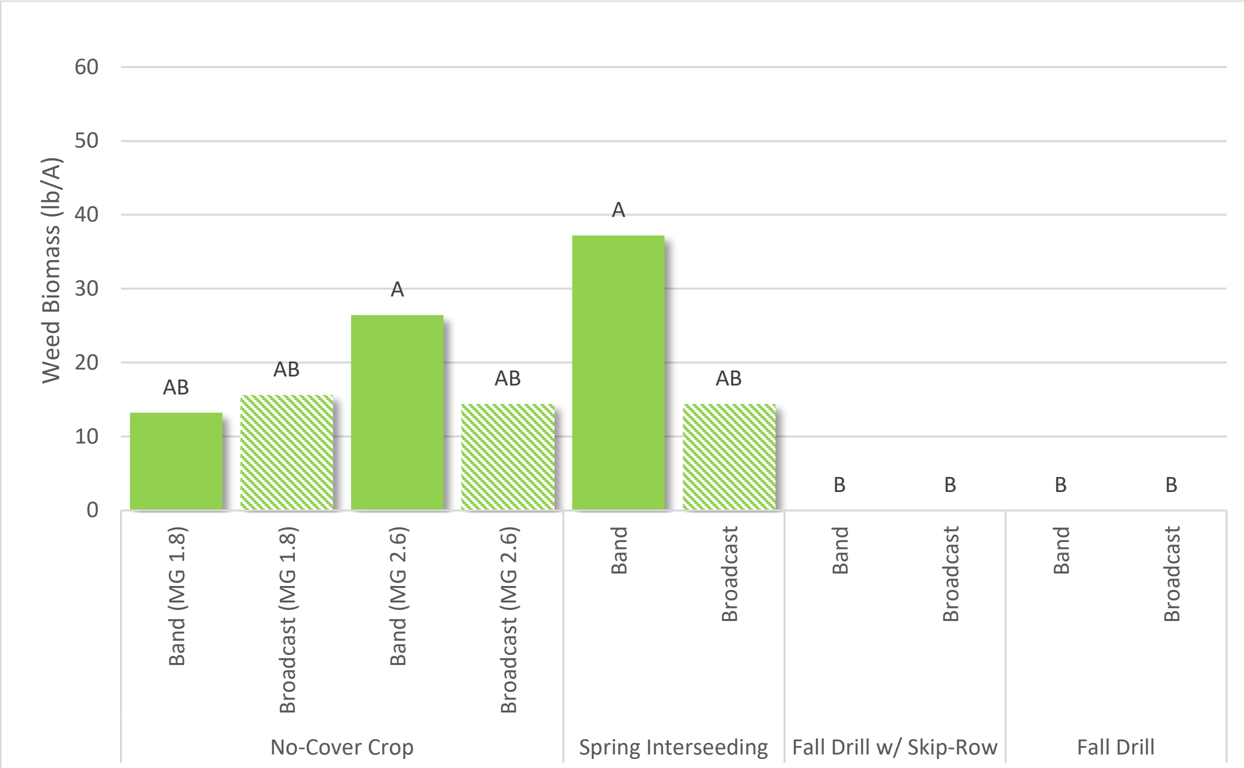
Figure 10. **Cover crop biomass (lb/acre) by cover crop treatment, soybean maturity group, and herbicide application treatments at the Wilcox location.**



Weed Biomass

Wilcox was the only location with weed biomass to measure. The primary weed species at the Wilcox location was Palmer amaranth. The no-cover crop treatments and the spring interseeding treatments with banded PRE had more weed biomass than either of the fall drilled cover crop treatments (Fig. 11).

Figure 11. **Weed biomass (lb/acre) by cover crop treatment, soybean maturity group, and herbicide application treatments at the Wilcox location.**



DISCUSSION

Fall drilled cover crops did not decrease soybean grain yields when compared to the no-cover crop treatments even though significant cover crop biomass (>4000 lbs./A) was produced. Soybean are able to adapt to green-planting into cover crops which provide a good opportunity to generate additional cover crop biomass in the spring. The fall planted cover crops also provided good control of Palmer amaranth at the Wilcox location. Due to delayed planting of soybean 8,000 to 10,000 lbs./A of cereal rye biomass was produced which was very effective at controlling Palmer amaranth when compared to the no-cover crop treatments. As cover crop biomass increases, its ability to suppress weeds like Palmer amaranth also increases and will either suppress or delay emergence, reduce total number of weeds emerged, and/or reduce weed biomass when compared to not growing cereal rye cover crop. Spring interseeding of cover crops into soybean at the V3 growth stage was not successful season-long. There was good emergence of the wheat and red clover cover crop mix, however after the soybean closed the canopy the light available for the cover crop was too limiting and it was not able to survive until harvest. There may be opportunity to interseed at the VE or VC stage of soybean to allow more time for the cover crop to establish before canopy closure which may allow the cover crop to survive the entire season until soybean harvest.

SOYBEAN PRODUCTION & COVER CROPS IN IRRIGATED SOYBEAN-CORN SYSTEMS: PLANTING DATE, MG, ROW SPACING, SEEDING RATE & IRRIGATION MANAGEMENT

Authors: Jim Specht, UNL Emeritus Professor of Agronomy and Horticulture,
Aaron Nygren, Nebraska Extension Educator, Cropping Systems,
Steve Melvin, Nebraska Extension Educator, Cropping Systems.

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

TAKE HOME POINTS:

- A cereal rye cover crop (CC), when fall-planted into a 2019 or 2020 no-tilled corn fields, and then terminated after the planting of a soybean crop, did not depress nor enhance yield in 2020 or 2021.
- A reduction in soybean row width from 30 to 15 to 7.5 inches generated linear yield responses that, when averaged over test sites, were 70 to 74 to 78 bu/ac in 2020 and 72 to 80 to 89 bu/ac in 2021.
- An increase in the viable seeding rate from 75 to 150 to 225 seeds/ac resulted in emerged plant populations that, when averaged over test sites, were 68K, 128K, & 193K plants/ac in 2020, and 56K, 107K, & 158K plants/ac in 2021, and yields of 73, 74, & 75 bu/ac in 2020 and 76, 82, & 83 bu/ac in 2021.
- These yield response findings indicate that, in irrigated soybean production systems, a narrowing of row width would likely be economically worthwhile, whereas increasing the seeding rate beyond what is needed to attain emerged plant population of about 100K/ac would not likely be a cost-effective choice.

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 (https://cropwatch.unl.edu/soybean-planting-tips-optimal-yield-2015). 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 SMFD presentation videos of 2020 (https://go.unl.edu/2020soydays) & 2021 (https://enrec.unl.edu/2021soybeanmanagementfielddays)

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 has consistently led 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, a key focus of SMFD in **2020 & 2021** 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 viable seeding rates (SR)** that were chosen with the expectation of being able to generate a respective **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 & 2021 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 (2020)** or **MG 2.6 (2021)** was planted in NE fields located near **Arlington** (**A**), **Hildreth** (**H**), **Shelby** (**S**), & **Elgin** (**E**) on **May 11, 12, 18, & 19, 2020**, and **May 25, Jun 04, May 26, & May 12, 2021**, respectively. A mid-May planting date was optimally desired at all sites (to minimize the yield penalty that accrues when soybean planting is delayed after May 1), but not achievable due to rainfall events that delayed planting until after May 15 at sites **S** & **E** in 2020, and at sites **A**, **H**, & **S** in 2021. Agronomic data were collected each year from each of the 72 total plots at each site. These data included emerged plant counts (plants/acre), mature plant height (inches from ground to stem tip), seed mass (number of seed/pound), seed yield (bushels/acre @13% moisture content), plus seed protein (%) and seed oil (%). 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 soil water data, along with seasonal rainfall data, are summarized and interpreted in the subsequent report (see booklet pages 22-27).

EXPERIMENTAL RESULTS & DISCUSSION

Soybean seed was planted two inches deep (**leftmost 2020 photo**) each year, as per UNL Extension recommendations (https://cropwatch.unl.edu/2019/corn-and-soybean-planting-considerations), using a 15-inch planter to plant both the 30-inch plots (**leftmost 2021 photo**) and the 15-inch plots (**middle-left 2020 photo**), but using a drill to plant the 7.5-inch plots (**middle-right 2020 photo & middle-left 2021 photo**). Note the degree to which the soil surface with its overlying CC plant tissue and prior corn crop residue was "tillage-disrupted" (**middle 2020 photos & leftmost 2021 photo**) by each planter unit, with the "disruption" being greater, on a per area basis, in the drilled row plots. The tractor wheels compressed the soil surface ahead of row units 2 & 6 in the 7-row 15-inch planter, and row units 2 & 3 and 10 & 11 of the 12-row 7.5-inch drill, which subsequently depressed the observable seedling emergence in those tire-track-compacted rows (**rightmost 2020 photo**). The height of the cereal rye crop when soybean was planted in 2020 was about 12-15 inches at all sites, but because of rainfall-delayed planting in 2021, it was about 50-60 inches tall at all sites but Elgin (**left two 2021 photos**).

2020 Photos: 2-inch seed depth; 15-inch 7-row planter; 7.5-inch 12-row drill; plots after emergence

2021 Photos: 30-inch 4-row planter (Elgin); 7.5-inch 12-row drill (Hildreth); post-emergence (Shelby)

The soil moisture conditions during the **2020** planting dates were ideal at all four sites (**leftmost 2020 photo**), due to timely rainfall events the week before planting, coupled with gentle rain events that occurred after planting. Similar soil conditions were encountered during the **2021** planting dates, but a heavy splash rain event the day after planting at the Arlington & Shelby sites, coupled with above-normal next-day temperatures, led to significant soil crusting that greatly impeded/reduced seedling emergence, particularly at Shelby where there was a significant loss of both cotyledons when seedling hypocotyls were attempting to pull those cotyledons through the crust (**center-right 2021 photo**). Dry conditions after planting at Hildreth also resulted in a lessened seedling emergence there.

Three seeding rates, spanning **75K, 150K, & 225K** **viable** seed per acre, were desired for this experiment. However, the limited range of gear/sprocket settings available on the planter and drill did not allow an exact calibrated prescription of each of these three choices, and instead resulted in the delivery of **75,200, 141,000, & 213,400** **viable** seed per acre. Readers will recognize that the number of actual seeds planted per acre does not ordinarily translate into an equivalent number of seedlings per acre, because (**1**) not all planted seed will germinate (the variety seed tag each year indicated **90%**

germination), and (**2**) not every seed that does germinate will result in a fully emerged seedling (a nominal assumption is that only **95%** or less of the **viable** seed emerges). 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 **85%** or lower have been documented in many seeding rate studies (see pages 62-88 of 2019 NE On-Farm Research Network https://go.unl.edu/6am8).

Seedling emergence counts were collected in all plots at all sites in mid-June 2020 **(rightmost 2020 photo**), but this had to be delayed until mid-July 2021 (**rightmost 2021 photo**), due to the later planting dates that year. Averaged over sites, the **emerged seedling populations were 68K, 128K, & 193K/ac in 2020**, thereby reflecting a seed-to-seedling translation factor of about **91%** of the calibrated actual seeding rates of 75K, 141K, & 213K/acre. In contrast, the **emerged seedling populations were 56K, 107K, & 158K/ac in 2021**, reflecting a translation factor of about **75%**. 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 same regard, **only the two center rows of 4-row 30-inch plots**, **only the three center rows of the 7- row 15-inch plots**, and **only the six center rows of the 12-row 7.5-inch plots** were harvested with the plot combine. The plots in each replicate were 37.5 feet long but were end-trimmed to a central harvested length of 25-ft (2020) or 30-ft (2021).

The analysis of the experimental yield data in each year generated the factor treatment means displayed as solid circle symbols in **Figure 1** (**2020**) and **Figure 2** (**2021**). Averaged over the experiment each year, soybean yield was higher in 2021 (80 bu/ac) than in 2020 (74 bu/ac), and this was true for all sites but Hildreth (see **Panel A in both figures**). The use of a fall-planted cereal rye cover crop prior to a soybean crop did not economically enhance (nor depress) the yield of the cash crop in either year (**Panel B in both figures**), irrespective of site, row spacing and/or seeding rate. The finding 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 soybean crop yields will eventually become large enough over time to offset the yield penalty that will still be incurred by having to delay soybean planting in **CC** production scenarios from early May to mid-May (or later when rainfall events delay soybean planting & **CC** termination as was the case at three sites in 2021).

Soybean yield was significantly impacted by row spacing (**RS**) and by seeding rate (**SR**) in both years (**Panel C & D in both Figures**), but more so for **RS**, wherein halving the width from 30 to 15 inches and thence again to 7.5 inches resulted in linear enhancement in soybean yield by about 4 bu/ac in each step in 2020, but by about 8 bu/ac in each step in 2021. An obvious question of producer interest is whether the magnitude of these yield increases achieved by narrowing the row width 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 from low to medium to high by 60K/acre increments resulted in stepwise increases of just 1 bu/acre per increment in 2020, which are simply too small, relative to the current soybean price, to warrant the purchase cost of the extra seed planted per acre. Though yield increased by 6 bu/ac in the first step of the **SR** increase in 2021, it should be noted that this was more likely the result of the plant stand falling to less than about 65K/ac in the lowest **SR** treatment (due to a lessened seedling emergence that year). The current NE Extension recommendation is to use a seeding rate that will ensure generation of about 100,000 to 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 100K to 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 plant density drop from 100K to about 65K/acre, a finding to keep in mind relative to soybean plant-loss-based replant decisions. A significant interaction between row spacing and seeding rate was detected (**Panel E in both Figures**) 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 upward yield response to the narrowing of row width differed amongst sites (**Panel F in both Figures**); in both years, the yield responses to **RS** were steeper at Elgin (green) and Shelby (violet) that those at Hildreth (blue) and Arlington (red), leading to **Site x RS interaction**. The slightly upward yield response to seeding rate was similar amongst the four sites in 2020, but in 2021, the linear response at Arlington for the 56K to 107K/ac populations differed from those at the other three sites (**Panel G in both Figures**), resulting in a significant **Site x SR** interaction.

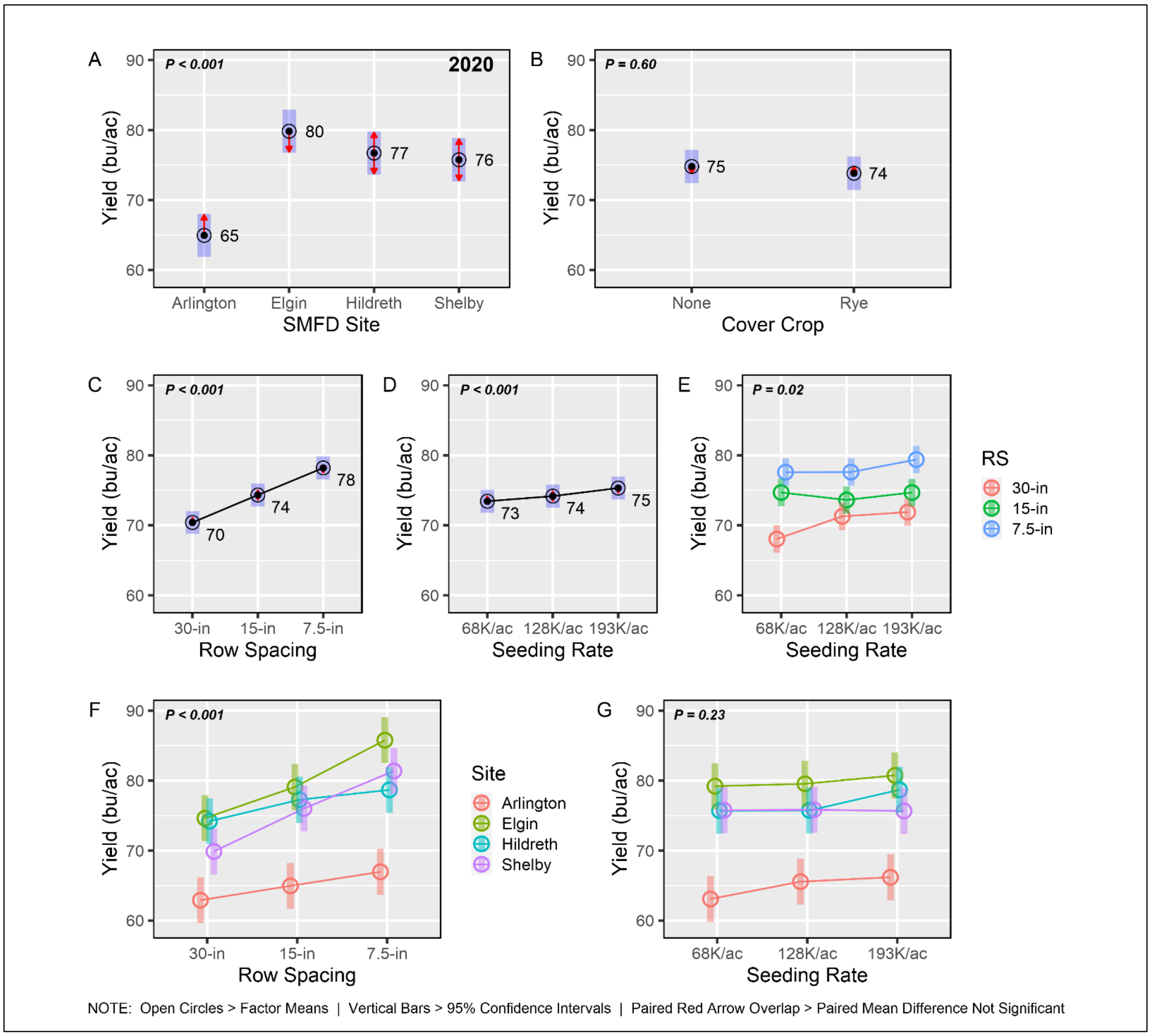


Figure 1. Charts of **2020** mean yields for the factors of **Site** (**Panel A**), **Cover Crop** (**B**), **Row Spacing** (**C**), and **Seeding Rate** (**D**), and for the interactions of **RS x SR** (**E**), **Site x RS** (**F**), and **Site x SR** (**G**). The probability values reflect significance of the analysis of variance F-test of the given factor or interaction.

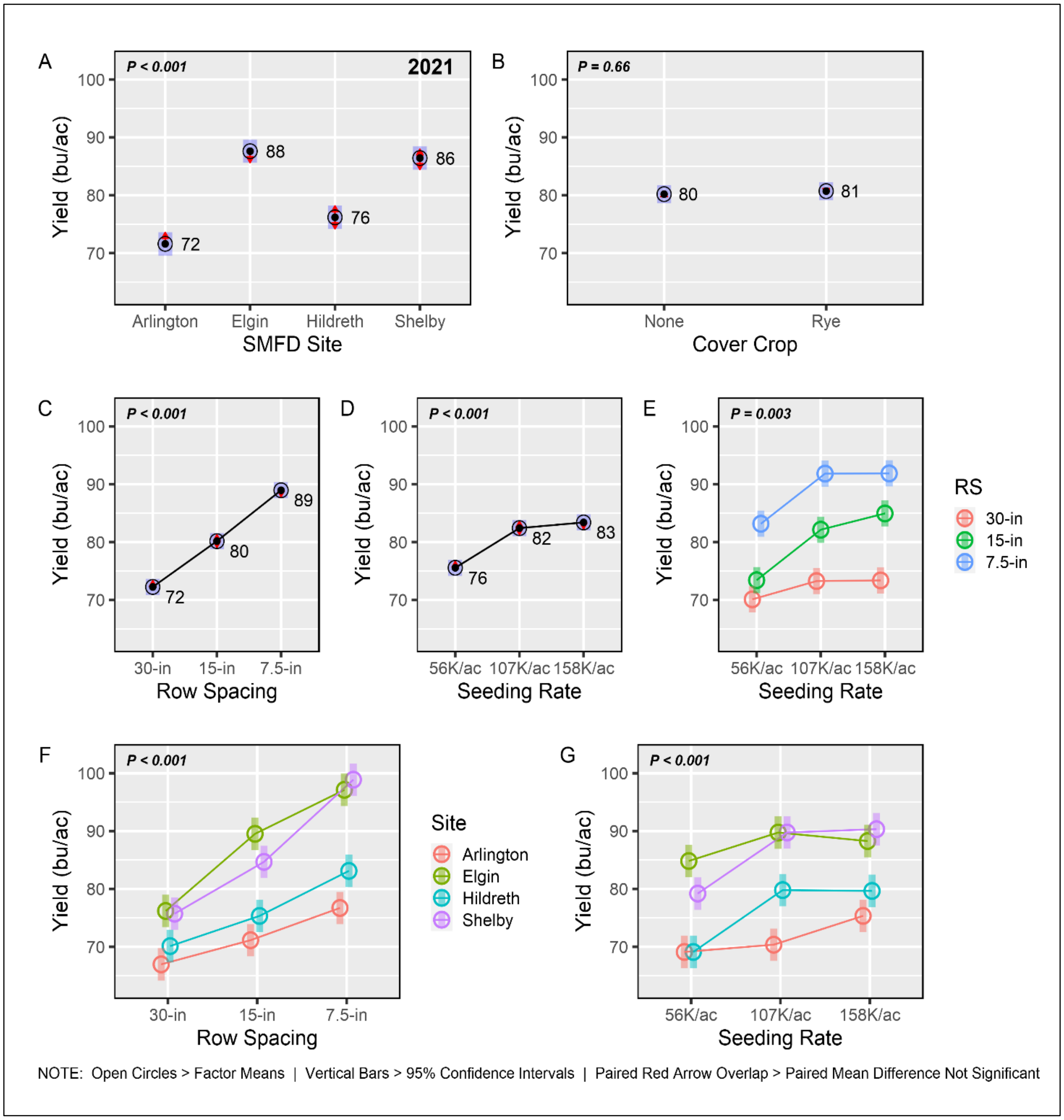


Figure 2. Charts of **2021** mean yields for the factors of **Site** (**Panel A**), **Cover Crop** (**B**), **Row Spacing** (**C**), and **Seeding Rate** (**D**), and for the interactions of **RS x SR** (**E**), **Site x RS** (**F**), and **Site x SR** (**G**). The probability values reflect significance of the analysis of variance F-test of the given factor or

Seed mass, which is measured as number of seeds per pound, was not impacted by any experimental factor (i.e., **CC**, **RS**, nor **SR**) in 2020, but in 2021, significantly more seeds/lb (i.e., smaller seed) were produced in the **CC** than in the **non-CC** main plots, whereas the 7.5-inch **RS** generated fewer seeds/lb (i.e., larger seed). Seed mass is typically greatly influenced by the degree of plant water availability during flowering (water stress during that time will lessen seed set, and in the absence of later water stress, the fewer seed will typically have greater mass). In 2021, rainfall during flowering was overly abundant at Arlington, and the seed/lb there averaged 2830 (i.e., smaller seed) compared to the averages of 2414, 2512, & 2531 at Elgin, Hildreth & Shelby, respectively.

Plant height differed among sites. The tallest plants were generated at Elgin in both years (42 & 43 inches), with Arlington exhibiting the shortest plants in 2020 (32 inches) and Hildreth doing so in 2021 (33 inches). Aside from planting date differences among the sites, which influences main stem node number, plant height is also a function of internode length, which is influenced by seasonal rainfall and/or irrigation event timing differences among the sites (i.e., main stem growth in indeterminate varieties ceases at stage R5, when seed-fill starts). Of additionally interest was the observation that in both years the narrowing the row spacing resulted in shorter plants, presumably because of lessened within-row plant-to-plant competition. Decreasing the seeding rate resulted in shorter 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 likely not consequential, given the absence of any significant plant lodging in either year.

The 2020 SMFD experiment did result in one surprising finding of interest, which was that the narrowing of row spacing resulted in a reduction in seed protein along with an expected correlated enhancement of seed oil. In contrast, increasing the seeding rate led to an enhancement in seed protein in conjunction with a correlated reduction in seed oil. However, these responses were not observed in 2021. Moreover, the 2020 changes in seed protein and seed oil were relatively small (i.e., in the 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).

CAVEAT

Readers are reminded that the 2-year results reported here for these four NE sites might not be exactly repeatable at other NE sites that may differ in climate, soil, and farm management practices. 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 if implemented on their own farm.

ACKNOWLEDGEMENTS

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

EFFECTS OF COVER CROPS ON SOIL WATER IN IRRIGATED SOYBEAN-CORN SYSTEMS

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

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 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
- 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.
- 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.
- 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), 2019 (2020 SMFD), and 2020 (2021 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 four 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: Using a significance level of .05, there were significant differences in soil water content at planting time at nine of the fifteen site years. At sites with significant 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 -3.42 inches for Arlington in 2021 (Table 1). In 2021, the Arlington and Rising City sites had significant differences of 3.42 and 2.08 inches less water at planting time for the cover crop plots, respectively. At both these sites, this difference in water content was evident at planting time, with wetter than ideal soil conditions in the no-till plots. This was then followed by heavy rain and high temperatures that resulted in soil crusting and lower emergence (For more data on emergence, see following report on pages 17 and 18).

While differences existed in total water content at planting, both the no cover crop and cover crop soils at eleven of the fifteen site years were above field capacity. The four exceptions were Kenesaw in 2018, Elgin in 2020, and

Arlington and Elgin in 2021. At these 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 fifteen 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. Twelve of the fifteen sites had water contents of more than 1.5 inches above field capacity after planting (Figure 1 (B)). In 2021, the four sites ranged from 2.34 to 3.70 inches above field capacity.

Driest Day of the Summer after Planting: There were no significant differences in Watermark sensor readings at any of the fifteen 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.

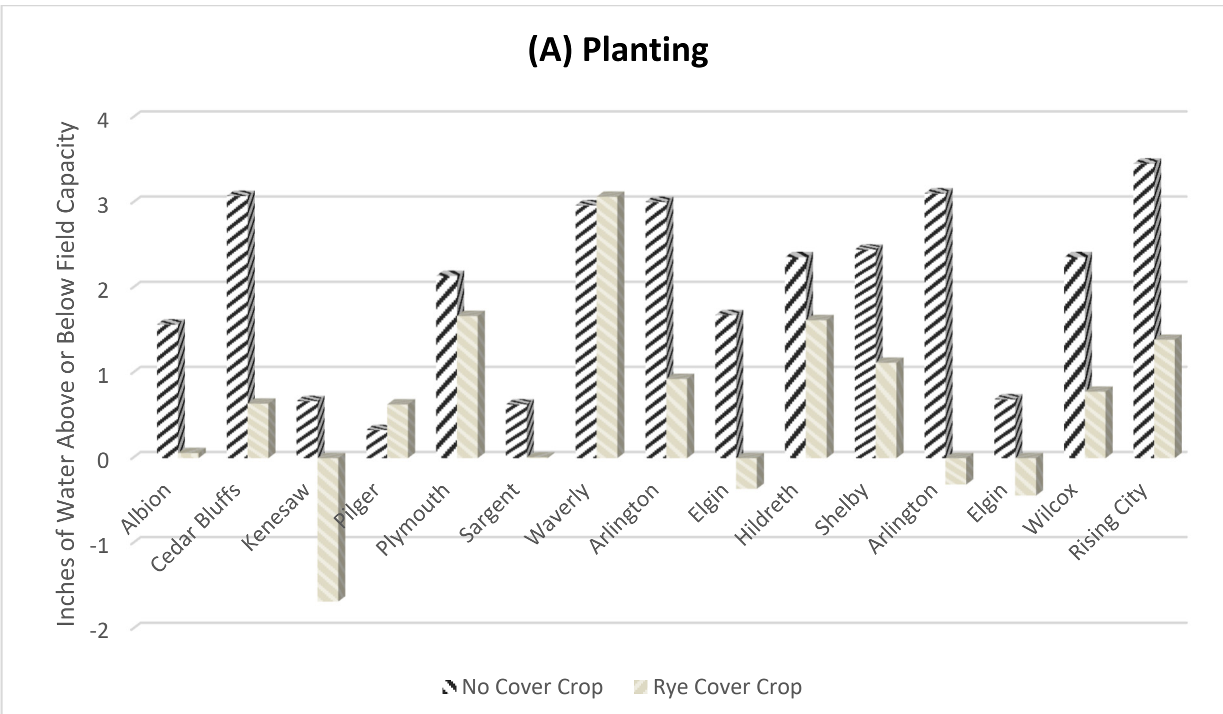
The largest differences in soil water content at planting were seen in the top six inches of soil. Reductions in soil water content have the potential to affect the planter getting the seed planted well and soybean germination and growth after planting. Only four sites experienced soil water contents 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 either a pre-determined later termination date or weather conditions prevented earlier planting dates, resulting in additional biomass growth. 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.

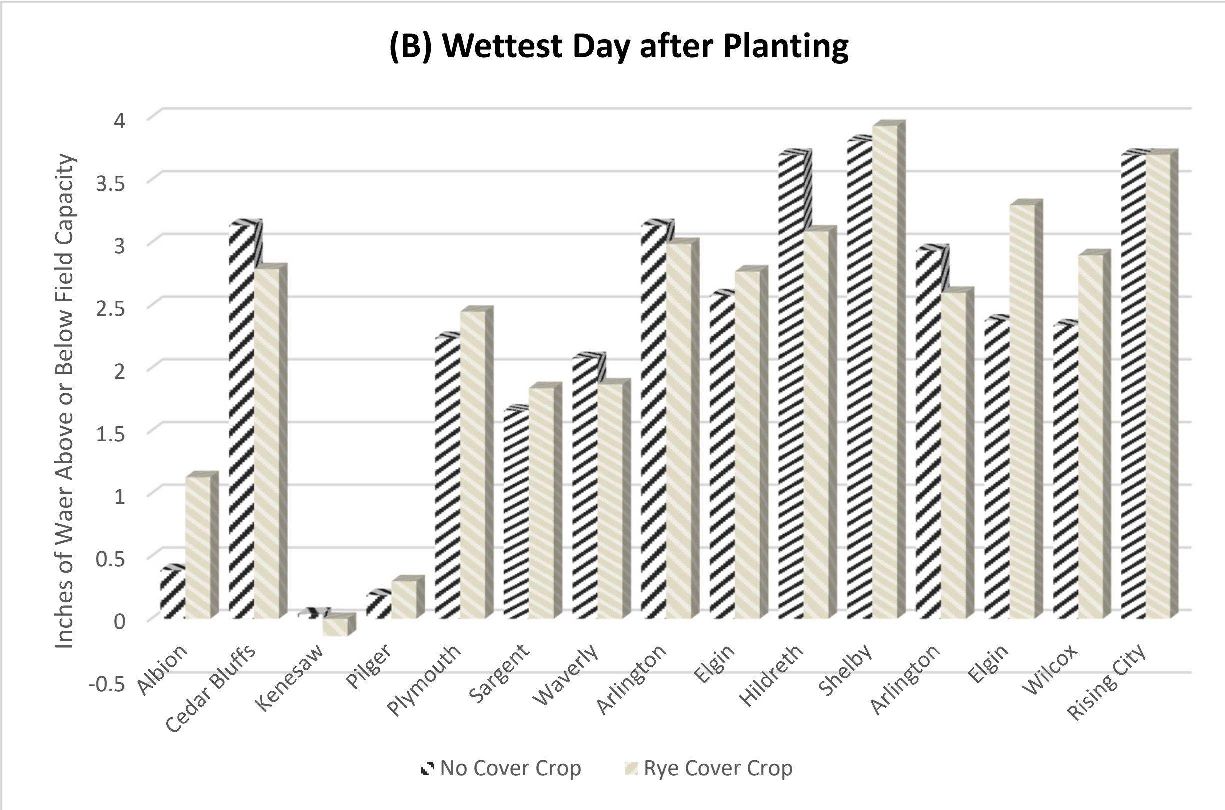
Looking at planting time, the majority of the sites had soil water contents for the rye plots that were closer to field capacity while the no cover plots were significantly wetter. In wet years, this may result in better planting conditions with the use of cover crops, which was evident in 2021 at the Arlington and Rising City sites. 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 four 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 patterns on field that were irrigated the year before. Rainfed field will usually be a different story because they are left much dryer at the end of the previous growing season and in heavy rainfall springs, may be able to store more water than would irrigated fields. This is important, as the most critical water period for soybeans is much later in the season beginning at R3. Cover crops did not impact soybean yields at the four SMFD sites in both 2020 and 2021, which was documented in the prior report (see booklet pages 15-27).

Figure 1. **Average soil water content in relationship to field capacity for eleven sites years at <u>(A)</u> planting time, <u>(B)</u> wettest day of the growing season, and <u>(C)</u> 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.**




(B) Wettest Day after Planting
Inches of Waer Above or Below Field Capacity
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
Albion
Cedar Bluffs
Kenesaw
Pilger
Plymouth
Sargent
Waverly
Arlington
Elgin
Hildreth
Shelby
Arlington
Elgin
Wilcox
Rising City
No Cover Crop
Rye Cover Crop

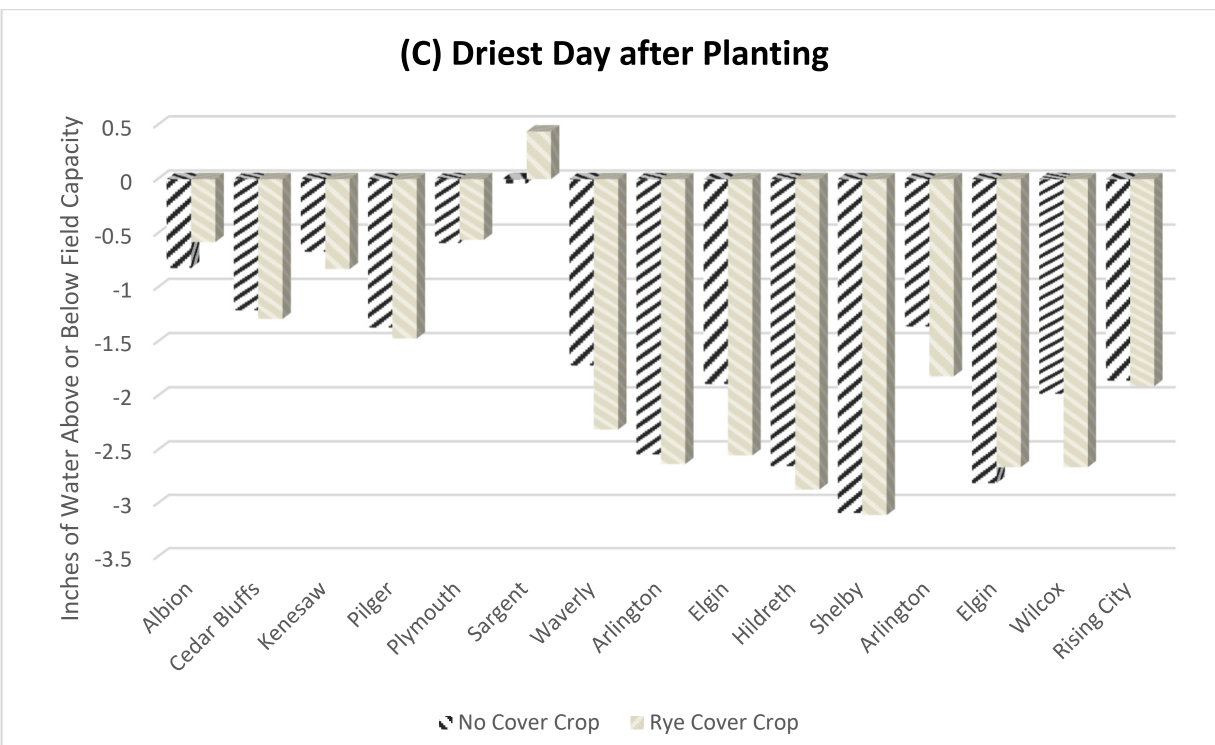

(C) Driest Day after Planting
Inches of Water Above or Below Field Capacity
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
Albion
Cedar Bluffs
Kenesaw
Pilger
Plymouth
Sargent
Waverly
Arlington
Elgin
Hildreth
Shelby
Arlington
Elgin
Wilcox
Rising City
No Cover Crop
Rye Cover Crop

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
Wilcox (2021)	+2.36 a	+0.78 a	-2.04
Elgin (2021)	+0.69 a	-0.44 a	-1.12
Arlington (2021)	+3.11 a	-0.31 b	-3.42
Rising City (2021)	+3.46 a	+1.39 b	-2.08

IMPACTS OF FOLIAR FUNGICIDES ON FROGEYE LEAF SPOT DISEASE OF SOYBEAN

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Talon Mues (Undergraduate Research Assistant)

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

TAKE HOME POINTS:

- The most consistently effective fungicides for managing frogeye leaf spot were those containing active ingredients with a mixture of fungicide classes, especially containing class(es) 1, 3, and/or 7.
- Fungicides with active ingredients from a single fungicide class, especially Group 7 or 11, may not provide adequate frogeye leaf spot control when used alone.
- Cereal rye cover crop did not reduce frogeye leaf spot severity at any location.
- Crop rotation to nonhost crops (like corn, sorghum, small grains, alfalfa) and selection of disease-resistant soybean varieties are additional management strategies that may reduce the need for fungicides to control some diseases.

INTRODUCTION

In 2020, frogeye leaf spot samples were collected from soybean fields across 48 counties of Nebraska (Figure 1). Fungicide resistance to the common fungicides from Group 11 QoI, formerly called strobilurins, was confirmed in the fungus in *every sample* representing 128 fields (Mane et al. 2021). Those results indicate that Group 11 QoI fungicide resistance is likely widespread in frogeye leaf spot in soybean-producing areas of Nebraska and may impact how well some foliar fungicides perform versus frogeye leaf spot.

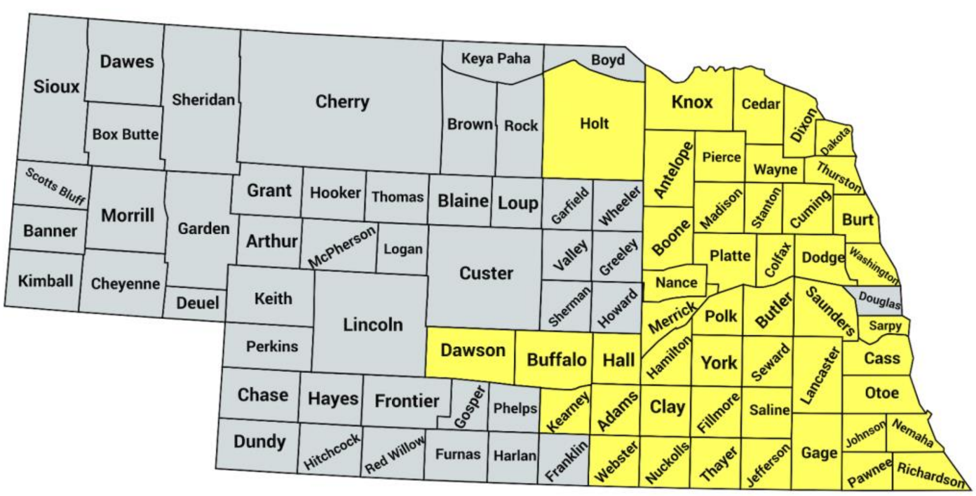


***Figure 1.* Group (class) 11 QoI fungicide resistance has been confirmed in the soybean frogeye leaf spot pathogen from 48 Nebraska counties.**

With the confirmation of fungicide resistance in Nebraska and other states, there's increased interest in investigating alternative disease management strategies. With the increased use of cover crops in Nebraska, there's been more questions on the potential impacts that cover crops may have on some crop diseases.

METHODS

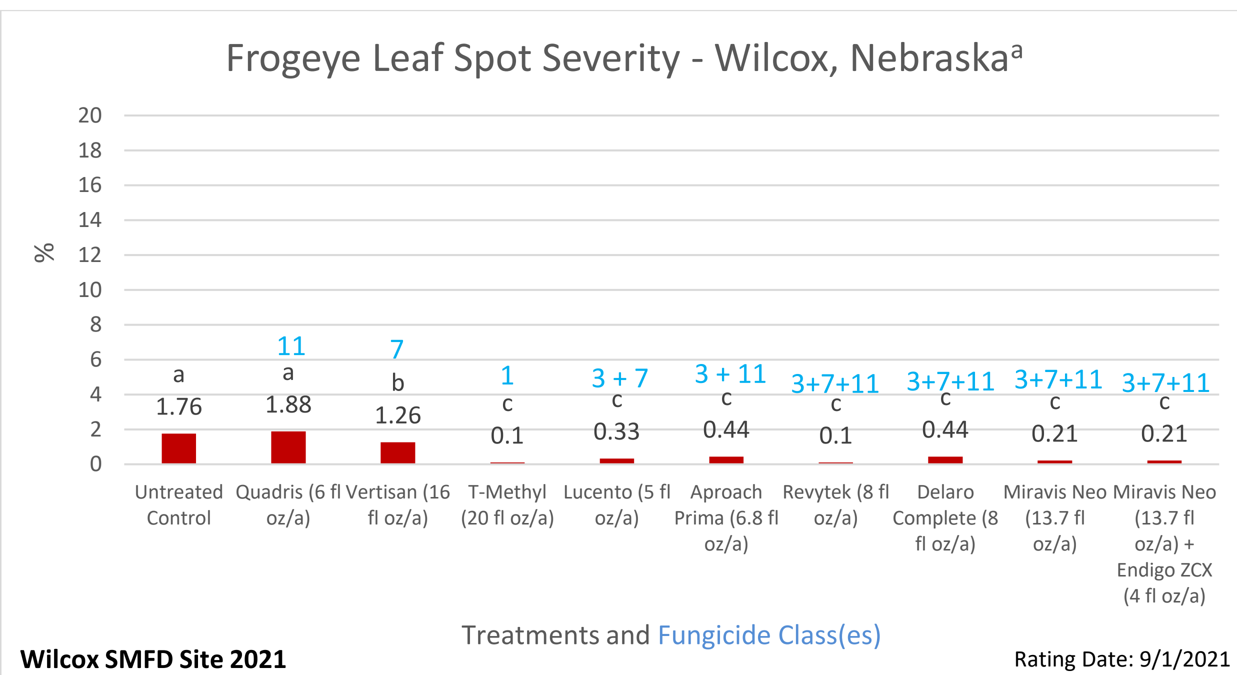
Experiments were conducted at each of the four Soybean Management Field Day sites (SMFD - Elgin, Wilcox, Rising City, and Arlington) to evaluate the effects of fungicide treatments and cereal rye cover crop on soybean leaf diseases in split-plot designs. At each site, the soybean variety Asgrow 30XF0 was planted from maturity group 3.0 and a rating of 6 out of 9 for frogeye leaf spot (rating of 1 is "excellent"). There were 20 treatment combinations (10 fungicide treatments x 2 cover crop treatments). Fungicide treatments consisted of a nontreated control and 8 commercially available fungicides representing single or combinations of fungicide classes. One fungicide, Miravis Neo, was included as a duplicate treatment at all sites with and without the insecticide Endura as a tank mix. Cover crop treatments consisted of either a cereal rye cover crop or no cover crop as a main plot, by replication block, with the fungicide treatments randomized within each of the four replications. Fungicides were applied at the R3 stage by backpack sprayer with 20 gallons per acre (GPA) of water. Disease severity was visually estimated as the percent of each disease across the entire plot area.

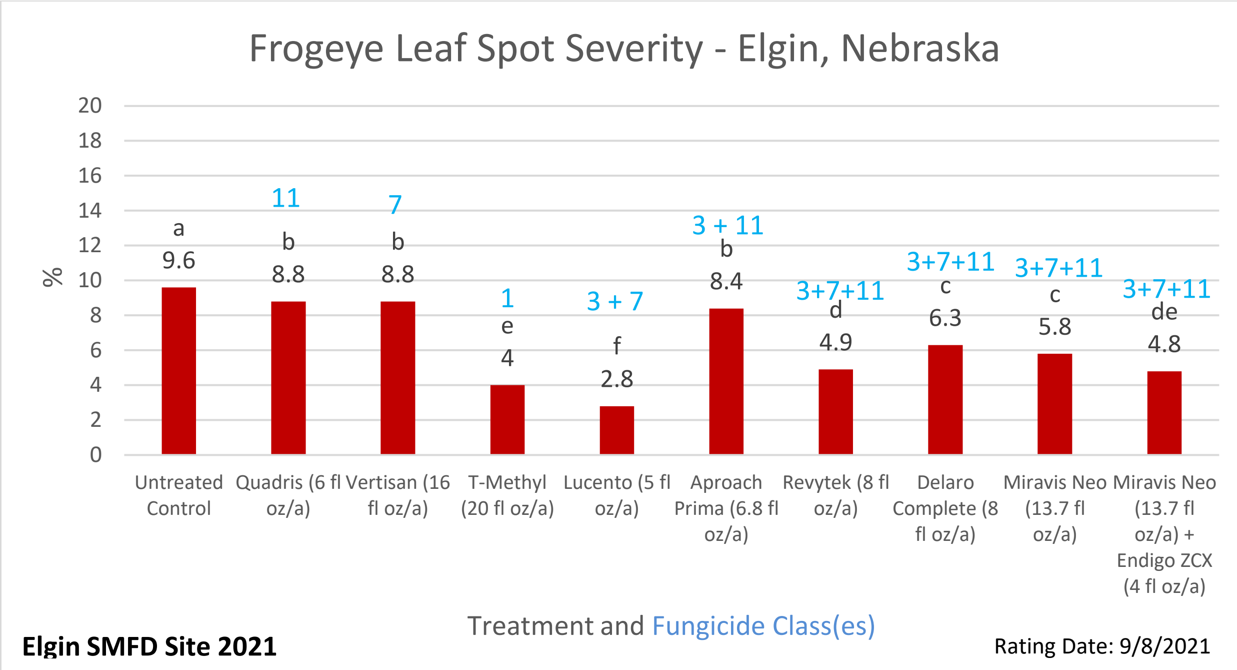
RESULTS

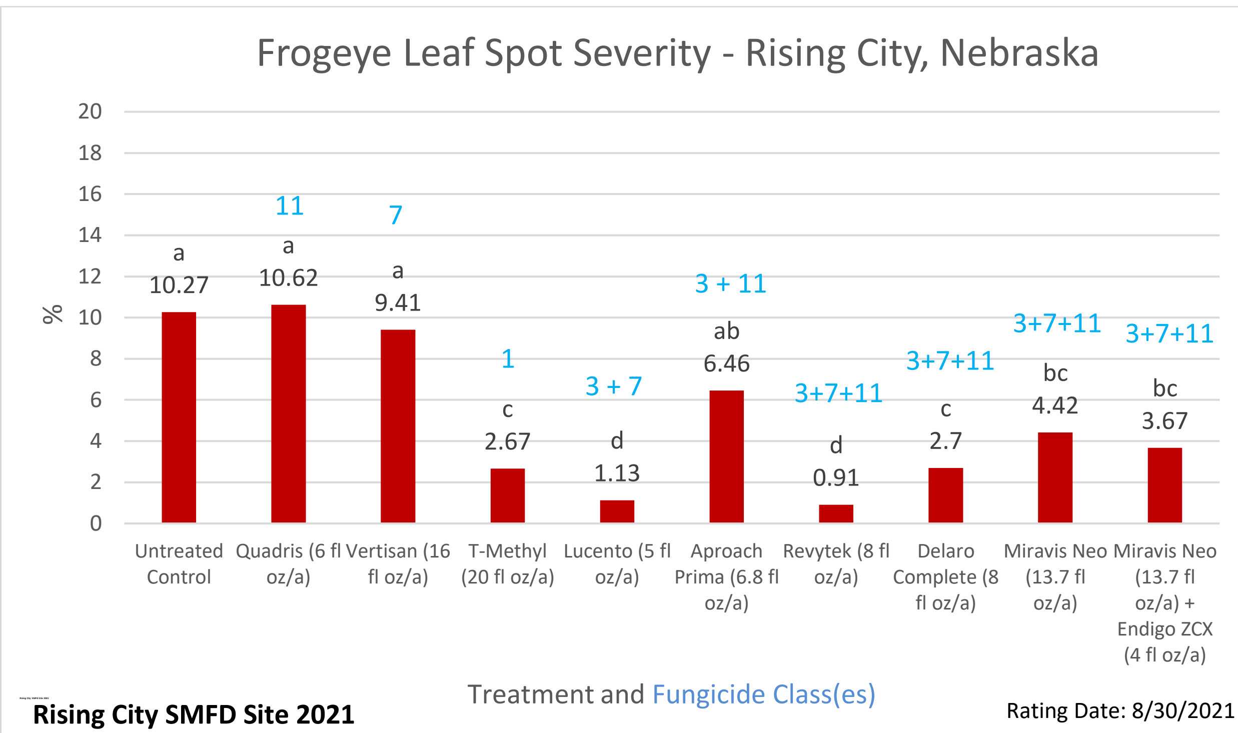
Cover Crop Treatments

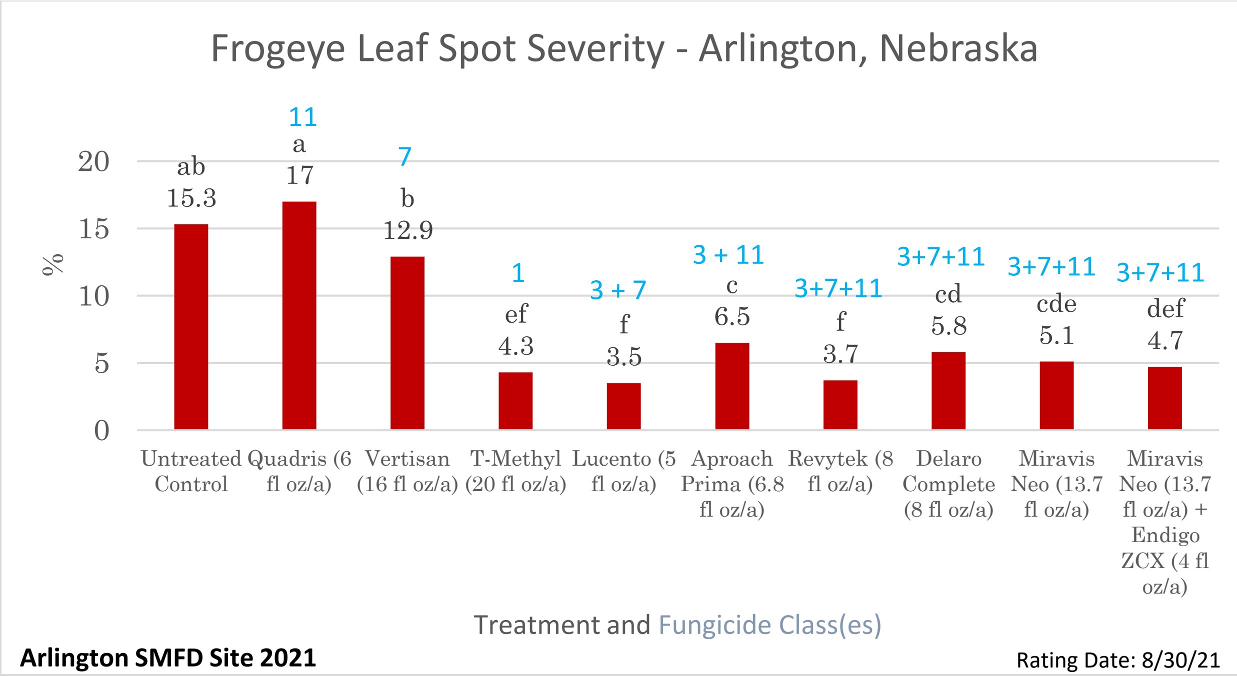
Frogeye leaf spot severity was not impacted by cover crop at Elgin, Wilcox, and Rising City locations. At the Arlington location, the cover crop treatment had slightly greater (8.3%) frogeye leaf spot severity than the non-cover crop treatment (5.5%). There was no difference in yield among the cover crop treatments at any location.

FUNGICIDE TREATMENT EFFECTS ON FROGEYE LEAF SPOT




Frogeye Leaf Spot Severity - Elgin, Nebraska
%
20
18
16
14
12
10
8
6
4
2
0
a
9.6
11
b
8.8
7
b
8.8
1
e
4
3 + 7
f
2.8
3 + 11
b
8.4
3+7+11
d
4.9
3+7+11
c
6.3
3+7+11
c
5.8
3+7+11
de
4.8
Untreated Control
Quadris (6 fl oz/a)
Vertisan (16 fl oz/a)
T-Methyl (20 fl oz/a)
Lucento (5 fl oz/a)
Aproach Prima (6.8 fl oz/a)
Revytek (8 fl oz/a)
Delaro Complete (8 fl oz/a)
Miravis Neo (13.7 fl oz/a)
Miravis Neo (13.7 fl oz/a) + Endigo ZCX (4 fl oz/a)
Treatment and Fungicide Class(es)
Elgin SMFD Site 2021
Rating Date: 9/8/2021


Frogeye Leaf Spot Severity - Rising City, Nebraska
%
20
18
16
14
12
10
8
6
4
2
0
a
10.27
11
a
10.62
7
a
9.41
1
c
2.67
3 + 7
d
1.13
3 + 11
ab
6.46
3+7+11
d
0.91
3+7+11
c
2.7
3+7+11
bc
4.42
3+7+11
bc
3.67
Untreated Control
Quadris (6 fl oz/a)
Vertisan (16 fl oz/a)
T-Methyl (20 fl oz/a)
Lucento (5 fl oz/a)
Aproach Prima (6.8 fl oz/a)
Revytek (8 fl oz/a)
Delaro Complete (8 fl oz/a)
Miravis Neo (13.7 fl oz/a)
Miravis Neo (13.7 fl oz/a) + Endigo ZCX (4 fl oz/a)
Treatment and Fungicide Class(es)
Rising City SMFD Site 2021
Rating Date: 8/30/2021



[a]Any two bars within a graph that have 1 or more of the same letters above them indicate that they are not statistically different (p≤0.10).

DISCUSSION

Frogeye leaf spot developed in all four SMFD locations in 2021. Disease severity was moderate at the Elgin location and low to moderate at Wilcox, Rising City and Arlington. Fungicide products significantly impacted disease severity at all locations, varying by treatment. The fungicide Quadris (Group 11) provided little (Elgin) to no control (Wilcox, Rising City, and Arlington) of frogeye leaf spot compared to the nontreated control. Because fungicide resistance was reportedly widespread in the recent frogeye leaf spot survey (Mane et al. 2021), it is likely also a problem for the SMFD farm sites, as well, and is the likely explanation for the lack of control from the product Quadris. Based on previous research, resistance to any Group 11 fungicide also indicates resistance to other members of that fungicide class. Thus, no other Group 11 products would be expected to provide better control and should not be used alone to control frogeye leaf spot.

Performance of the fungicide Vertisan (Group 7) varied somewhat by location for its control of frogeye leaf spot. The product provided marginal control in Wilcox and Elgin, but frogeye leaf spot severity did not differ from that of the nontreated control at Rising City and Arlington. Most other treatments provided improved control compared to Vertisan. The inconsistency by location may be an indication of pathogen variability and potential loss of sensitivity to the product or generally low efficacy by the product when used alone.

T-methyl (thiophanate methyl), a generic Class 1 fungicide, was included at all locations. It reduced frogeye leaf spot severity at all locations compared to the nontreated control and performed similarly to other treatment with mixed fungicide classes. This or similar products from class 1 may be effective and economical options for tank mixes with products from other fungicide classes to manage frogeye leaf spot. Because of the tendency of the frogeye leaf spot pathogen to mutate and overcome some fungicide products, it's not recommended to use this or any product from a single fungicide class (and mode of action) to manage frogeye leaf spot.

Five additional products were included that contain mixtures of active ingredients from various fungicide classes. Generally speaking, these products provided effective, usually the best control of frogeye leaf spot compared to the nontreated control. These products contain active ingredients from fungicide classes 3, 7, and/or 11. Note that the active ingredients in products from fungicide class 11 are not expected to provide control of frogeye even in mixtures, so disease control was provided by companion products in the mixes from class 3 and/or 7. Product efficacy may vary among active ingredients within a fungicide class, as well. You can find the disease control efficacy ratings for fungicides in the 2022 Guide to Weed, Disease, and Insect Management in Nebraska (pages 282-283) or in the Crop Protection Network publication, Fungicide Efficacy for Control of Soybean Foliar Diseases at: https://tinyurl.com/2p97h9fy

The insecticide Endigo ZCX was tank mixed with a duplicate treatment of Miravis Neo. This tank mix combination reduced disease severity of frogeye leaf spot at one (Elgin) of the four locations compared to Miravis Neo alone.

There were no treatment impacts on yield at any location. This could be the result of inadequate disease pressure to impact yield or the need for an increased number of experimental replications to overcome statistical error effects.

LITERATURE CITED

Mane, A., Jackson-Ziems, T. A., and Everhart, S. E. 2021. Determining the detection threshold when pooling samples for rapid detection of QoI resistance in *Cercospora sojina*. Phytopathology 111:10(S) 172.

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If you didn't make it to Soybean Management Field Days
or if you did attend and need a refresher -
you can check out the 2021 SMFD presentations online

http://go.unl.edu/2021virtualsmfd

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2021 SOYBEAN MANAGEMENT FIELD DAYS RESEARCH UPDATE

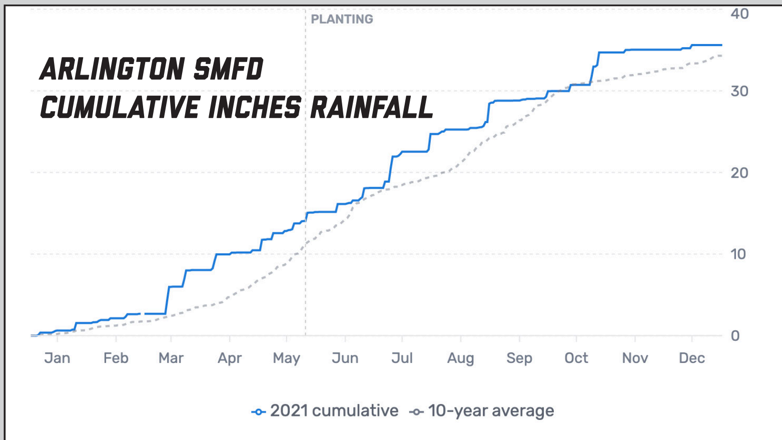
2021 Soybean Management Field Days Research Locations:

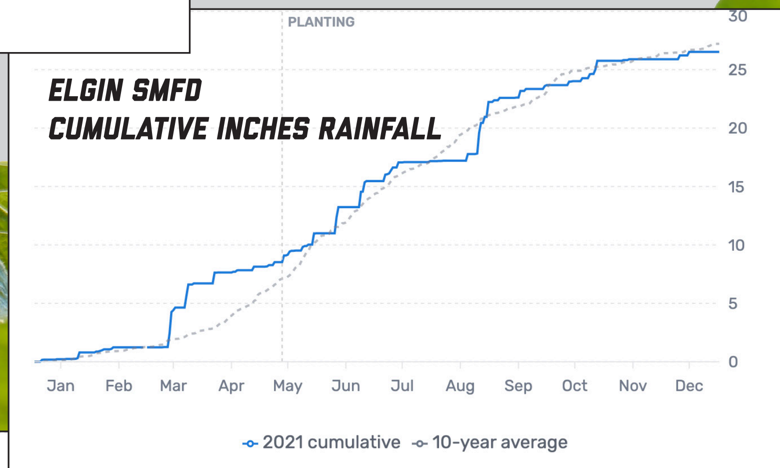
ARLINGTON, NE - Mike Fuchs Farm * ELGIN, NE - Kevin Dinslage Farm

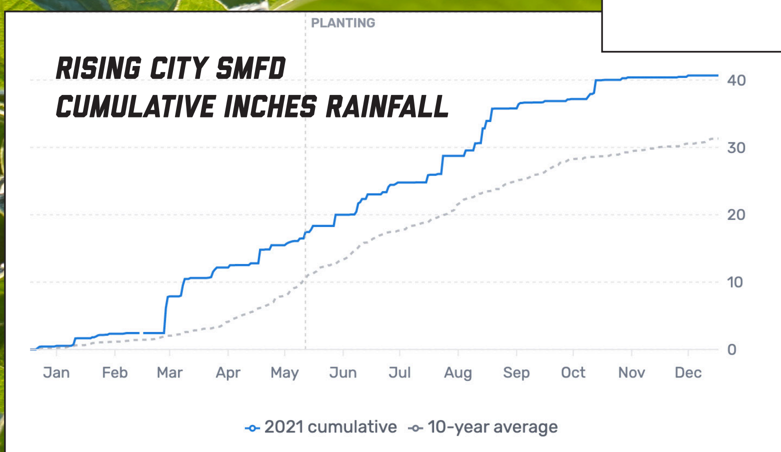
RISING CITY, NE - Bart & Geoff Ruth Farm * WILCOX, NE - Jerome Fritz Farm

For more information, contact the Nebraska Soybean Board at 402-441-3240 or Nebraska Extension at 402-624-8030

CUMULATIVE RAINFALL TOTALS

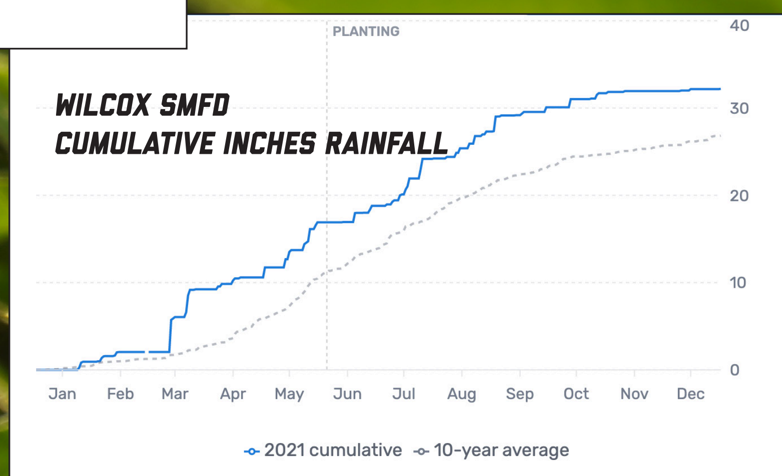






Rainfall data is provided for each study based on the field location. The rainfall graphs are developed using data from National Weather Service radar and ground stations that report rainfall for 1.2 × 1.2 mile grids.

FarmLogs https://farmlogs.com



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