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

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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:

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.

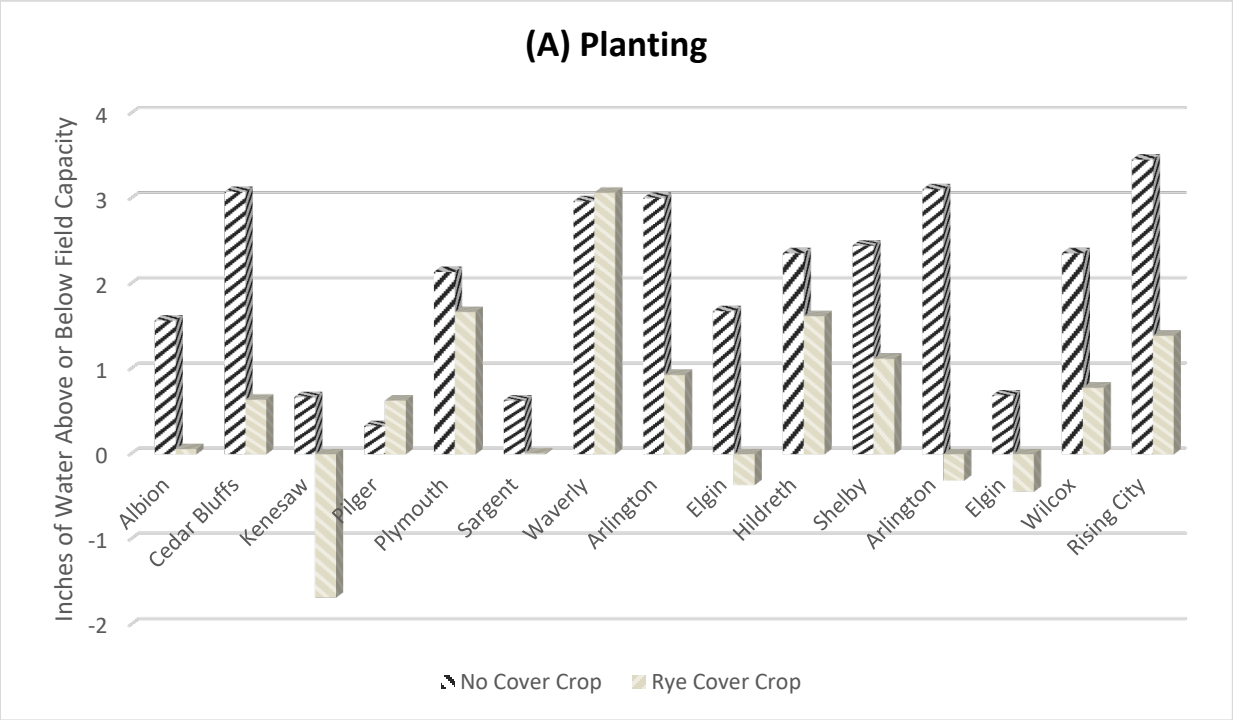
Looking at planting time, the majority of the sites had soil water contents for the rye plots that were closer to field capacity while the no cover plots were significantly wetter. In wet years, this may result in better planting conditions with the use of cover crops, which was evident in 2021 at the 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.

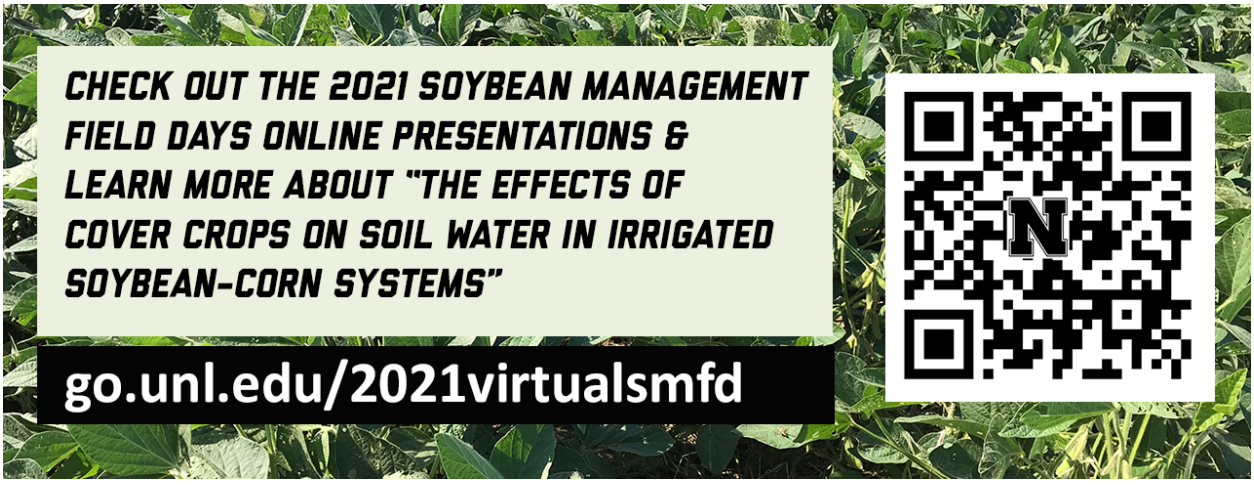
It is important to note the experiment was conducted on irrigated fields that are usually wetter after harvest the previous fall and only require a few inches of precipitation to refill the soil profile. Non-irrigated fields or land in the pivot corners will usually be drier resulting in different findings.

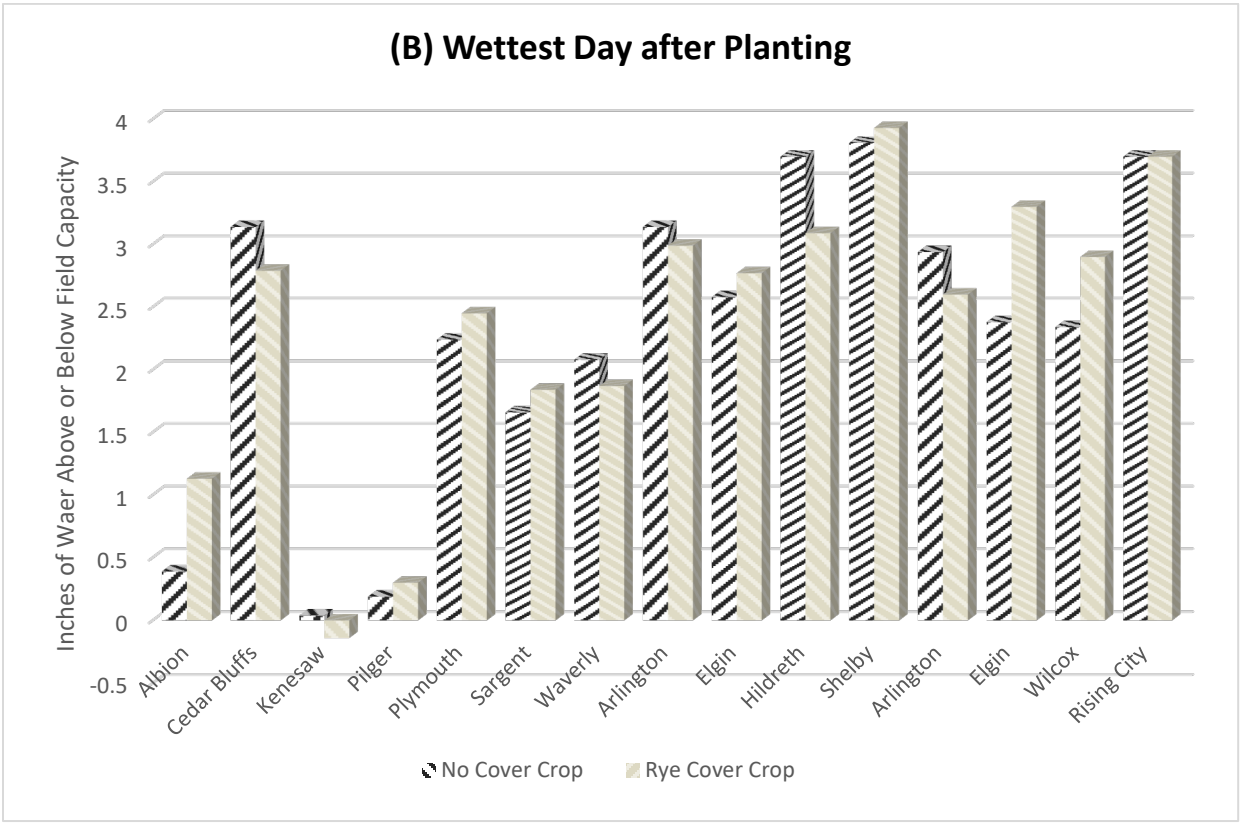
In all four years, rainfall exceeded crop water use amounts for a few weeks after planting while the soybean plants were small, which resulted in the soil water profile being refilled to either near or above field capacity. This is expected to happen most years in the eastern half of Nebraska given our 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 (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.**






(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

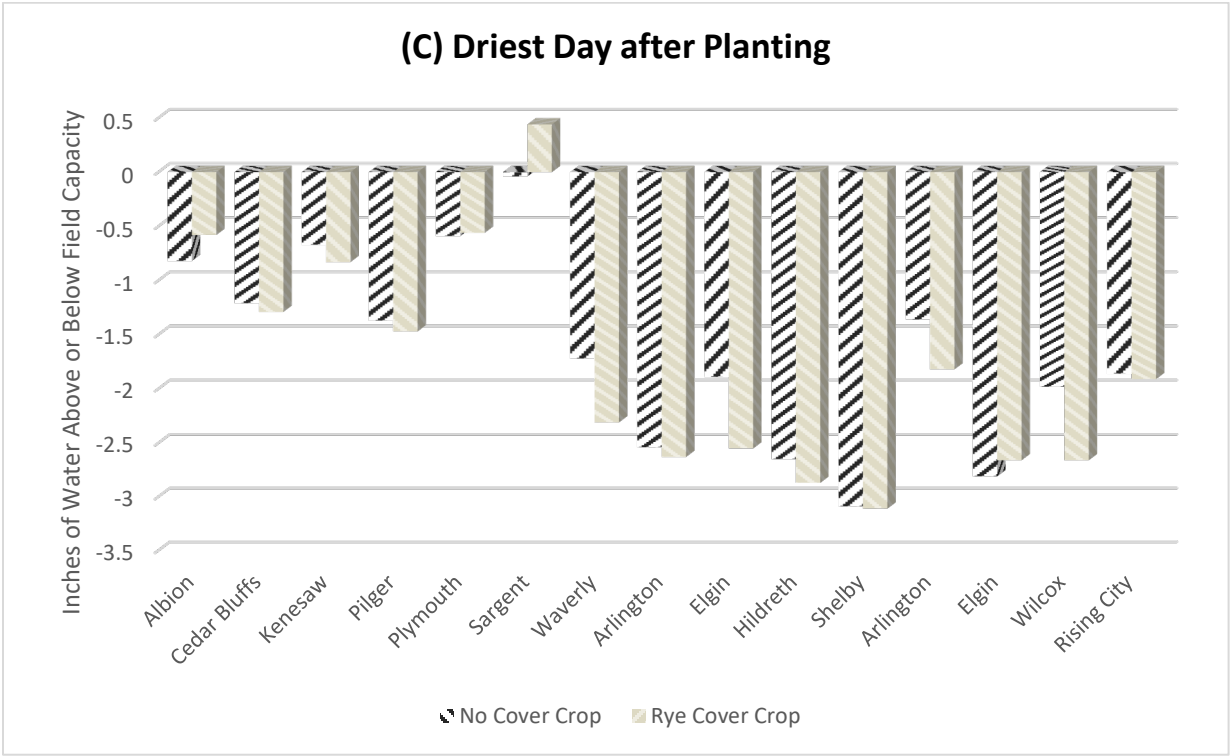

(C) Driest Day after Planting
Inches of Water Above or Below Field Capacity
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
Albion
Cedar Bluffs
Kenesaw
Pilger
Plymouth
Sargent
Waverly
Arlington
Elgin
Hildreth
Shelby
Arlington
Elgin
Wilcox
Rising City
No Cover Crop
Rye Cover Crop

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