Trial Type: Cover Crop
Growing Season: 2024

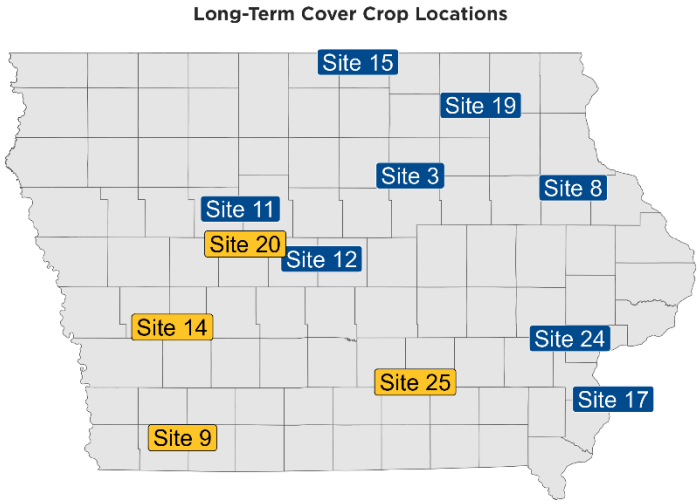
Project Objective: Quantify the effects of long-term use of cover crops on nutrient stratification and soil compaction.

Project Insights:

1. Nitrate (NO^-_3) levels were significantly reduced with a cover crop at all sampling depths in early-spring sampling.
2. Cover crops did not appear to impact nutrient stratification at these sites.
3. Organic matter was significantly increased in the top two inches.
4. Soil compaction was significantly reduced in the top 12 inches.
5. None of the sampled sites had yield limiting soil compaction.

Overview

The multi-year cover crop project has been ongoing with initial sites established between 2014 and 2019. Currently, there are 14 locations actively participating in the project, with a combined 117 site years comparing strips of cover crops and no cover crops. Discussions with trial participants resulted in ISA RCFI investigating the effects of cover crops on soil compaction and nutrient stratification (uneven nutrient distribution within the soil profile). In collaboration with the Iowa Corn Growers Association, four sites were selected for additional sampling in 2024. These sites were selected based on the current crop (soybean), previous crop (corn), and a history of consistent cover crop establishment while involved in the project. Cereal rye had been used at these locations during most of the project, but in the fall of 2023 a blend of Cereal Rye, Triticale, and Winter Camelina was used. Locations for all sites sampled are shown in Figure 1, along with the additional sites involved in the long-term cover crop project. Additional details on each of the sampled sites are shown in Table 1.



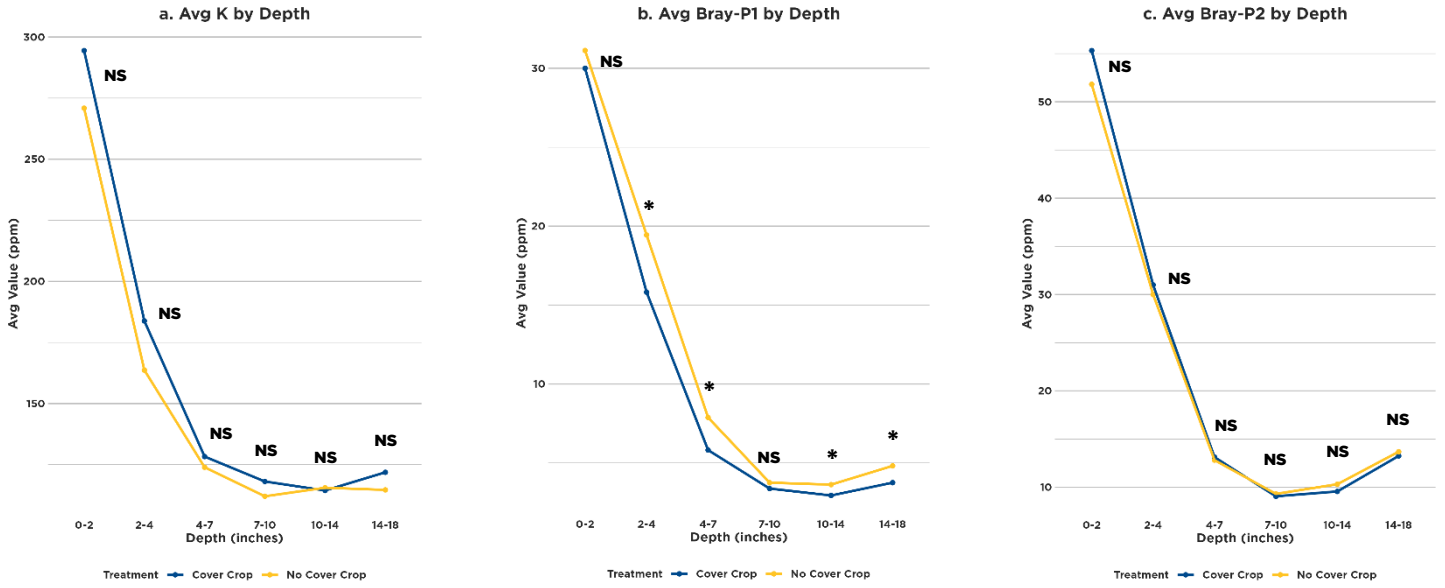
	County	Years in Project
Site 9	Adams	9
Site 14	Audubon	7
Site 20	Webster	8
Site 25	Mahaska	6

Figure 1 - All active long-term cover crop sites, sites sampled in 2024 are indicated in yellow. Table 1 - County where each site is located, and number of years site has been in the project.

Spring sampling for nutrient stratification occurred in early April before planting. Each sample location was sampled to a depth of 24 inches with subsamples taken at 0-2, 2-4, 4-7, 7-10, 10-14, 14-18, and 18-24 inches. Samples were submitted for testing on macronutrients, micronutrients, Cation Exchange Capacity (CEC), Organic Matter (OM), and soil pH. In early June, late spring soil nitrate and ammonium testing was conducted at varying growth stages from 0-7 and 7-14 inches to understand the changes in soil nitrogen following cover crop termination.

Nutrient Stratification

Phosphorous (P) and Potassium (K) are both immobile nutrients that can build up at the soil surface without incorporation. Sampling showed the presence of stratification across all sites (Figure 2a-c). For both treatments, nearly 50% of the total K and more than 64% of the total P (Bray-P2) was found in the top four inches of the soil (Table 2a-c). Changes in nutrient availability between the cover crop and no cover crop treatments were not significant for K or P (Bray-P2). The Bray-P1 test (plant available P) was significantly reduced with a cover crop between the 2-7 and 10-18 inch depths (Figure 2b). Uptake from the actively growing cover crop may have contributed to the changes seen in P1, but ultimately, there was no indication that the cover crop helped alleviate issues with nutrient stratification.



a. K	Cover Crop	No Cover Crop
0-4 inches	49.6%	48.5%
4-14 inches	37.7%	38.8%
14-18 inches	12.7%	12.7%

b. Bray-P1	Cover Crop	No Cover Crop
0-4 inches	74.4%	71.5%
4-14 inches	19.7%	21.6%
14-18 inches	5.9%	6.9%

c. Bray-P2	Cover Crop	No Cover Crop
0-4 inches	65.7%	64.0%
4-14 inches	24.4%	25.1%
14-18 inches	9.9%	10.9%

*Figure 2a-c – Average nutrient concentration for Cover Crop and No Cover Crop treatments at each depth for K, Bray-P1, and Bray-P2. * Indicates a statistically significant difference between treatments; NS indicates no significance. Table 2a-c – Percent Distribution of K, Bray-P1, and Bray-P2 for Cover Crop and No Cover Crop treatments in top 4 inches, middle 10 inches, and lowest 4 inches sampled.*

Among additional nutrients, only NO^-_3 (Figure 3) consistently showed significant differences between treatments across all sites and depths. Organic matter, Boron, and Magnesium were only significantly different in the top 2 inches of the soil, while Sulfur, Sodium and Calcium showed significant differences at depths below 7 inches.

Early vs Late-Spring Nitrate Sampling

Among all sites, NO^-_3 was the only nutrient that had a significant change at all depths when comparing cover crop and no cover crop treatments (Figure 3). These results consistently indicated the cover crop treatment significantly reduced soil nitrate levels compared to the no cover crop treatment in early spring when the cover crop was actively growing and scavenging available NO^-_3. These results agree with other research that has shown that cover crops are effective at scavenging residual nitrogen.

Late spring samples were collected at 0-7 and 7-14 inch depths following planting and cover crop termination. When compared to the same depth range from early-spring sampling, the top 7 inches showed an increase in NO^-_3 under both the cover crop and no cover strips (Figure 4) while the 7-14 inch depth was reduced for both treatments. Given the wet conditions experienced in the spring of 2024, a significant nitrate loss was observed under no-cover crop treatment at the 7-14 inch depth from Spring to In-Season sampling dates as compared to no change under the cover crop treatment. This shows the effect cover crops can have on nitrate leaching during periods of wet weather.

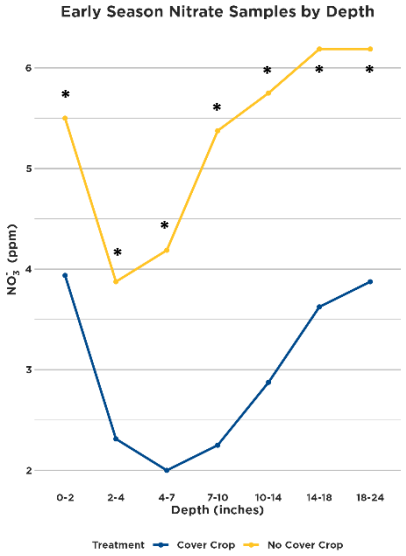


*Figure 3 – Average NO^-_3 concentration for Cover Crop and No Cover Crop treatments at each depth. * Indicates a statistically significant difference between treatments*

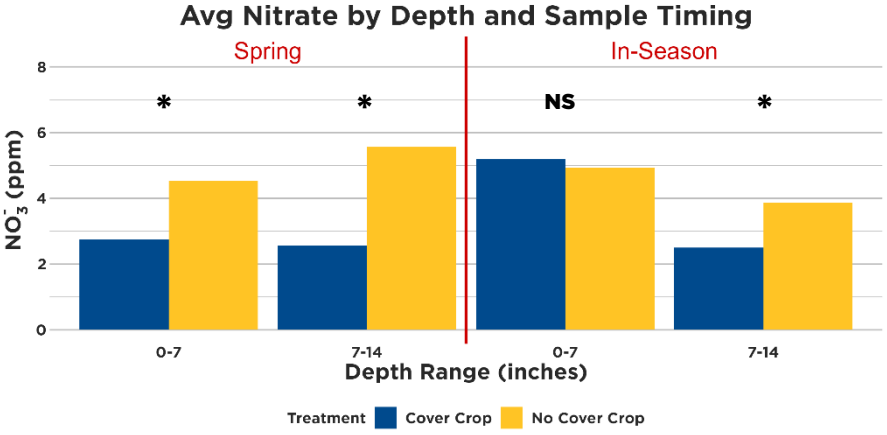


*Figure 4 – Average NO^-_3 for Cover Crop and No Cover Crop treatments at each depth range and sample collection timing. * Indicates a statistically significant difference between treatments; NS indicates no significance.*

Compaction Results

In addition to the nutrient stratification sampling, the four sites were also sampled to look at soil compaction through a collaboration with Terraform Tillage. This work was completed in early May, with readings collected at 4-inch increments on a field grid pattern to a depth of 24 inches. An example layout of the site in Webster County is shown in Figure 5.

Figure 5 – Layout of sampling points for site in Webster County.

Results demonstrated that the inclusion of a cover crop reduced compaction at all depths compared to the no cover strips (Figure 6) with significantly reduced compaction between 0-12 inches. All locations and all treatments were absent of yield limiting compaction, or readings above 300 psi.

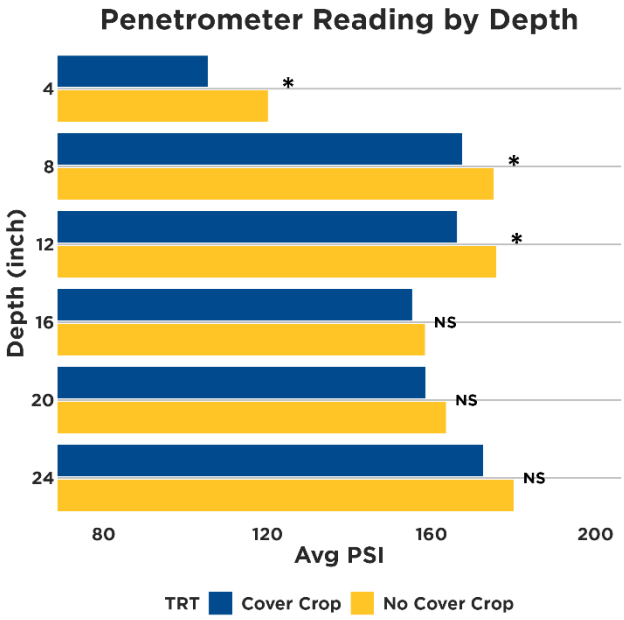


*Figure 6 – Penetrometer readings for Cover Crop and No Cover Crop treatments at each depth. * Indicates a statistically significant difference between treatments; NS indicates no significance.*