**NREC – 2020**
**Building a South Dakota Corn No-tillage N Recommendation Algorithm that Considers Improvements in Soil Health**
**Report – Work Progress**
**6/26/20**

## Research goal:

The long-term goal of this project is to improve South Dakota N recommendation in reduced tillage systems. The objectives are to : 1) build a corn reduced tillage N recommendation algorithm for South Dakota; and 2) as recommended by the board, assess if similar changes are needed for P and K fertilizers.

## Justification:

In 2018, North Dakota released corn N recommendations that reduced the recommended rate for long-term no-tillage fields (https://www.ag.ndsu.edu/publications/crops/north-dakota-fertilizer-recommendation-tables-and-equations). Our research will determine if similar guidelines are appropriate for South Dakota. Many long-term South Dakota no-tillage farmers report that their fertilizer recommendations have decreased. A common perception is that these practices are linked to improved soil health resulting from the adoption of cover-crops and the adoption of reduced or no-tillage systems. In response to this perception, some soil testing laboratories are conducting soil health assessments, the NRCS and the SD Soil Health coalition has been demonstrating the impact of tillage on soil health and resiliency using the rainfall simulator and the buried underwear tests (http://igrow.org/agronomy/corn/tighty-whities/), and commercial products have been created that allows farmers to estimate N mineralization (https://solvita.com/soil/).

The impacts of cover crops, tillage, and plant diversity on soil and plant health is well documented in the scientific literature. For example, research indicating that crop management affects the soil micro-community was conducted in Andover and Trail City, South Dakota showing the bacteria to fungi ratio (measured using the PLFA technique) could be increased by planting a winter cover crop containing a Brassica (mustard family). Changes in the microbial composition are important because different organisms have different responsibilities in the soil. For example, bacteria decompose soil organic materials and release organic acids and siderophores that increase the availability of many nutrients, whereas in addition to increasing nutrient solubility, fungi enhance the transport of nutrients to the plant roots.

Benefits from a diverse microbial community can be integrated into fertilizer recommendations through multiple mechanisms including creating system recommendations (for example, tillage based recommendations in North Dakota) or basing the recommendation on changes in a measured soil property (carbon recommendation in Nebraska). We will explore both techniques in the creation of an algorithm that considers how interactions between management and soil biology affects N cycling. We believe that integrating soil health into the N recommendation will improve accuracy and reduce costs.

In year 1 (2019), experiments were completed at seven South Dakota sites. At this point, we are in the process of analyzing the soil and plant results from year 1.

**Work Progress – Year 2:**

Similar to 2019, the experiment is being conducted at 7 sites (Table 1) and at each site, six different N treatments (0, 40, 80, 120, 160 and 200 lbs. N acre$^{-1}$) are replicated four times (except for one site, DLI) and arranged in RCB design. Urea (46:0:0) fertilizer (treated with urease inhibitor) were broadcasted as the source of N before corn V4 growth stage. Each site was applied with recommended rate of P and K fertilizers based on soil test results. Based on 2019 corn yield, we have made a few adjustments on N treatments; we have also added a control plot (0 lb. N acre$^{-1}$). We are working with soil health research group from Missouri on P, K and S study at the same sites. Each field is in no-tillage for at least 6 years and the plot had the dimension of 15 by 50 ft.

**Table 1.** List of different farmer's field, their location and GPS coordinates.

| SN | Farmer's name | Field Name | GPS coordinates | Location |
|---|---|---|---|---|
| 1 | Bryan Jorgensen (Cover Crop) | BJC | 43.571695, -99.941256 | Ideal |
| 2 | Bryan Jorgensen (no CC) | BJO | 43.572251, -99.941283 | Ideal |
| 3 | Dan Forgey | DFO | 44.937546, -100.123753 | Gettysburg |
| 4 | Dennis Hoyle | DHO | 45.490052, -99.215640 | Roscoe |
| 5 | Dakota Lakes Dryland | DLD | 44.292695, -99.996898 | Pierre |
| 6 | Dakota Lakes Irrigated | DLI | 44.291651, -100.001732 | Pierre |
| 7 | Scott Carlson | SCA | 44.499152, -97.300031 | Badger |

At DLI site, there was no uniform corn emergence (Fig. 6) because of mechanical issues; we had to reduce our replication to three blocks. Despite the modification made, we will be able to harvest corn from 100 sq. ft. area. Compared to 2019, we have added a cover crop treatment at Bryan Jorgensen's field while we could not conduct the experiment at Bob Speck's site as the farmer could not plant corn. At Bryan Jorgensen's field, corn in the experiment without cover crop were planted at 30 inches row spacing whereas the one with cover crops were planted at 60 inches row spacing and cover crops were planted at corn V3 growth stage. The cover crop species planted were oats (12 lbs. acre$^{-1}$), flax (2 lbs. acre$^{-1}$), mung bean (4 lbs. acre$^{-1}$), gaur (2 lbs. acre$^{-1}$) and red clover (1 lb. acre$^{-1}$).

Soil samples from four depths (0-2", 2-6", 6-12", and 12-24") from each block were taken prior to the application of fertilizers. These initial soil samples will be analyzed for 24-hr microbial respiration (0-2"), soil nitrate-N and ammonium-N (all depths), soil pH and EC (all depths), total N and total C analysis (all depths). In addition, soil samples (0-2") from each block were taken before planting corn and at corn V6 growth stage for phospholipid fatty acid (PLFA) analysis.

The respiration test will be computed as g $CO_2$-C ha$^{-1}$ hr$^{-1}$ using LI-8100A and LI-8150 soil $CO_2$ flux system (LICOR Biosciences). Soil nitrate-N and ammonium-N will be extracted with 1M KCl (10:1). Soil PLFA will be extracted following a modified Buyer and Sasser (2012) protocol.

Detailed agronomic information and soil characteristics for each site are presented in Table 2 and Table 3, respectively.

**Table 2.** Agronomic information of different experiment sites.

| SN | Field name | Planting Date | Fertilizer application | Previous crop(s) | Corn maturity | Plant population (per acre) |
|---|---|---|---|---|---|---|
| 1 | BJC | 4/29/20 | 5/19/20 | Wheat | 100 days (AV5799) 104 days (P046AM) | 24500 |
| 2 | BJO | 4/29/20 | 5/19/20 | Wheat | 100 days (AV5799) 104 days (P046AM) | 24500 |
| 3 | DFO | 5/11/20 | 5/21/20 | Wheat | 96 days (DK 46-18) | 25000 |
| 4 | DHO | 5/15/20 | 6/17/20 | Sorghum + Oats+ millet | 88 days (Organic) | 27000 |
| 5 | DLD | 4/30/20 | 6/11/20 | Oats + Barley | 99 CRM (P9998AM) | 21000 |
| 6 | DLI | 4/24/20 | 6/15/20 | Oats + Barley + Peas + Rape | 104 CRM (P0421AM) | 35000 |
| 7 | SCA | 4/27/20 | 5/12/20 | Soybean | 97 days (AP970) | 32000 |

CRM – Comparative Relative Maturity for Pioneer corn

**Table 3.** Soil series and soil test results of different experiment sites, Spring 2020.

| SN | Field name | Soil series | Depth | OM | pH 1:1 | EC 1:1 | $NO_3$-N | Olsen-P | K | CEC |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | | dS $m^{-1}$ | lbs. $a^{-1}$ | ppm | ppm | meq $100g^{-1}$ |
| 1 | BJC and BJO | Fine, smectitic, mesic Typic Haplusterts | 0-6 | 4.8 | 8.0 | 0.60 | 4.00 | 11.00 | 572.00 | 35.80 |
| | | | 6-24 | -- | -- | -- | -- | -- | -- | -- |
| 2 | DFO | Fine-silty, mixed, superactive, mesic Typic Argiustolls | 0-6 | 2.7 | 5.8 | 0.24 | 7.40 | 18.90 (Bray) | 393.73 | 23.51 |
| | | | 6-24 | 1.7 | 7.3 | 0.46 | 25.60 | 5.50 | 164.98 | 27.84 |
| 3 | DHO | Fine-loamy, mixed, superactive, frigid Typic Argiustolls | 0-6 | 2.4 | 6.7 | 0.34 | 4.40 | 19.00 | 533.03 | 14.19 |
| | | | 6-24 | 3.0 | 7.0 | 0.29 | 17.92 | 8.00 | 215.90 | 14.42 |
| 4 | DLD | Coarse-silty over clayey, mixed, mesic Fluventic Haplustolls | 0-6 | 3.4 | 6.9 | 0.30 | 10.00 | 19.50 | 500.00 | 17.10 |
| | | | 6-24 | 2.7 | -- | -- | 12.00 | -- | -- | -- |
| 5 | DLI | Coarse-silty over clayey, mixed, mesic Fluventic Haplustolls | 0-6 | 3.4 | 7.6 | 0.42 | 20.00 | 9.40 | 322.00 | 17.10 |
| | | | 6-24 | -- | -- | -- | 18.00 | -- | -- | -- |
| 6 | SCA | Fine-silty, mixed, superactive, frigid Calcic Hapludolls | 0-6 | 4.5 | 5.7 | 0.32 | 8.44 | 55.40 (Bray) | 221.25 | 30.16 |
| | | | 6-24 | 2.3 | 7.2 | 0.59 | 25.60 | 6.00 | 161.83 | 32.05 |

Despite the unusual condition created by COVID-19, we were able to initiate our experiment while following safety guidelines. We have been following social distancing in lab, which has delayed the efficiency of lab-work compared to normal days. At the meantime, we have completed collecting plant samples at corn V6 growth stage and drying them for total C and total N analysis.

**Plans:**

We will continue to work on soil and plant samples analysis. We will do periodic field visit to collect soil samples for PLFA analysis, to measure corn leaf reflectance and chlorophyll content. We will keep contacting farmers about the field condition and visit all sites periodically before harvest.

**Field photos:**

**Fig 1.**
Field mapping at Dan Forgey's site.

**Fig 2.**
Spring soil sampling at Hoyle's field.

**Fig 3.**
Bryan Jorgensen's site with 60" row spacing.

**Fig 4.**
Bryan Jorgensen's site with 30" row spacing.

**Fig 5.**
Dryland experimental site at Dakota Lakes.

**Fig 6.**
Irrigated experimental site at Dakota Lakes (patches with no corn can be seen).

**Fig 7.**
Fertilizer application at Carlson's site.

**Fig 8.**
Deep soil sampling for soil characterization.