SPLIT APPLICATION OF N ON SUGARBEET GROWN ON FARGO SOILS

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The campus long-term tillage project began in the fall of 2005. The experiment that was planted to sugarbeet in 2013 and corn in 2013 has been in conventional tillage, strip-tillage or no-tillage for 9 consecutive years through the 2013 season. The experiment that was seeded to soybean in 2013 has been in similar treatments since 2007, for this the 7th consecutive years. The reason for the experiments has been to evaluate conservation tillage methods against the industry standard conventional till method to determine whether improvements in production of crops, including sugarbeets might be improved with their adoption, or at least that they might not be detrimental to grower crop production if they were adopted. High clay soils, such as the Fargo series, are particularly demanding in regards to tillage due to their wetness, the sticky nature of working them when too wet, and the poor structure that can result from tillage when too wet. The improvement from strip-tillage and no-tillage on these plots compared to conventional tillage in terms of improved biological activity was documented by Awale et al., 2013. Starting in 2012, split application of N treatments have been imposed on some experiments do determine whether this strategy improves production.

METHODS

Soybean-

The soybean experiment consisted of three tillage treatments: conventional, strip-till and no-till. Soybeans followed sugar beet from the 2012 growing season. The experimental design was a randomized complete block, with three tillage treatments and six replications. Individual experimental units were 25 feet long by 11 feet (6X22 inch rows) wide. The conventional treatment was a chisel plow in the fall in mid-October, 2012. Within one day of seeding, a field cultivator was set about 3 inches deep and pulled across conventional treatments to produce the final seed bed. The strip-till was conducted in mid-October using a shank set about 6 inches deep, forming a 2 inch berm. The no-till treatment received no tillage of any kind. The no-till and strip-till treatments received a burn-down herbicide treatment of 22 oz Roundup Max with 22 oz per acre 4 pound per gallon ammonium sulfate applied with 10 gallon water per acre May 24. Soybean cultivar Peterson Farms Seeds RR24 was planted in 22 inch rows at 140 plants per acre on May 29. Roundup Max was applied at the same burn-down rates June 13 and again on July 5. The plots were harvested using a two-row plot combine October 3. The grain was cleaned, then weighed and moisture was obtained the same day.

Corn-

The corn experimental design was a split-plot, with three tillage treatments, similar to the description in the soybean methods as main treatments, and three N timings as split treatments, and four replications. Individual experimental units were 25 feet long and 11 feet (6 X 22 inch rows) wide. The three N timings were: full rate N early (70 lb N/acre as ammonium nitrate), half rate N early (35 lb N/acre as ammonium nitrate) and half rate at side-dress (35 lb N/acre as UAN), and full rate N sidedress (70 lb N/acre as UAN). Corn followed soybean in this study. The complete N requirement of was determined fulfilled with a 40 lb N/acre previous crop credit from soybean and the residual nitrate to 2 feet in depth of 70 lb N/acre. Zinc sulfate 36% was applied to all corn plots at 75 pounds of product per acre May 23. A burndown herbicide application of 3 pt/acre Harness, 22 oz/acre Roundup Max with 22 oz/acre 4 lb/gallon ammonium sulfate was applied May 24. The corn hybrid Pioneer P8906HR was seeded at 38,000 plants per acre May 29. Roundup Max at similar rates as burn-down was applied again June 13 and July 5. Due to flooding in late June, high N losses were anticipated, so the full rate of N at sidedress was increased to 150 pound N per acre, and the half rate was increased to 120 pound N per acre. Side-dress rates were applied July 5 using stream nozzles between the rows. Corn was hand harvested October 22. One row was harvested in each plot, shelled and then weighed, with moisture and test weight determine directly after weighing using a Dickey-John moisture/test weight meter.

Sugar beets

The sugar beet experimental design was a split-plot, with three tillage treatments, similar to the description in the soybean methods as main treatments, and three N timings as split treatments, and four replications. Individual experimental units were 25 feet long and 11 feet (6 X 22 inch rows) wide. The three N timings were: full rate N early (40 lb N/acre as ammonium nitrate), half rate N early (20 lb N/acre as ammonium nitrate) and half rate at side-dress (20 lb N/acre as UAN), and full rate N side-dress (40 lb N/acre as UAN). Sugar beet followed corn in this study. Phosphate was applied as 100 pounds per acre 11-52-0 on May 23. The complete N requirement of was determined fulfilled with a 40 lb N/acre previous crop credit from soybean and the residual nitrate to 2 feet in depth of 80 lb N/acre. A burn-down herbicide application of 22 oz/acre Roundup Max with 22 oz/acre 4 lb/gallon ammonium sulfate was applied May 24. The sugar beet cultivar Crystal 985RR with Tach 45 and Poncho Beta was seeded May 29 at 63,360 plants per acre. Roundup Max at similar rates as burn-down was applied again June 13 and July 5. Due to flooding in late June, the full rate of side-dress N was increased to 120 pounds N per acre and the half rate side dress rate was 100 pounds N per acre. These side-dress rates were applied July 5 using stream nozzles which applied the application between rows. Sugar beets were harvested hand October 18, by choosing 10 foot of row in an interior row of each plot, cleaning the sugar beet roots as practical and sending the harvest to the East Grand Forks Tare Laboratory for weights and analysis.

RESULTS

The plots were flooded with meltwater during the spring thaw, but the seed bed was moist but not wet at seeding. Little precipitation was received until June 18. The plots remained wet that entire week, then a 3 inches of rain fell within a few hours the early morning of June 25, which covered the plots initially to a depth of six inches.

Figure 1. Aftermath of flooding rainfall June 25. Image taken June 28. The plots with water still standing were conventional tillage plots. All of the conventional tillage plots had water standing at this date. None of the no-till or strip-till plots had standing water 72 hours after the rainfall.

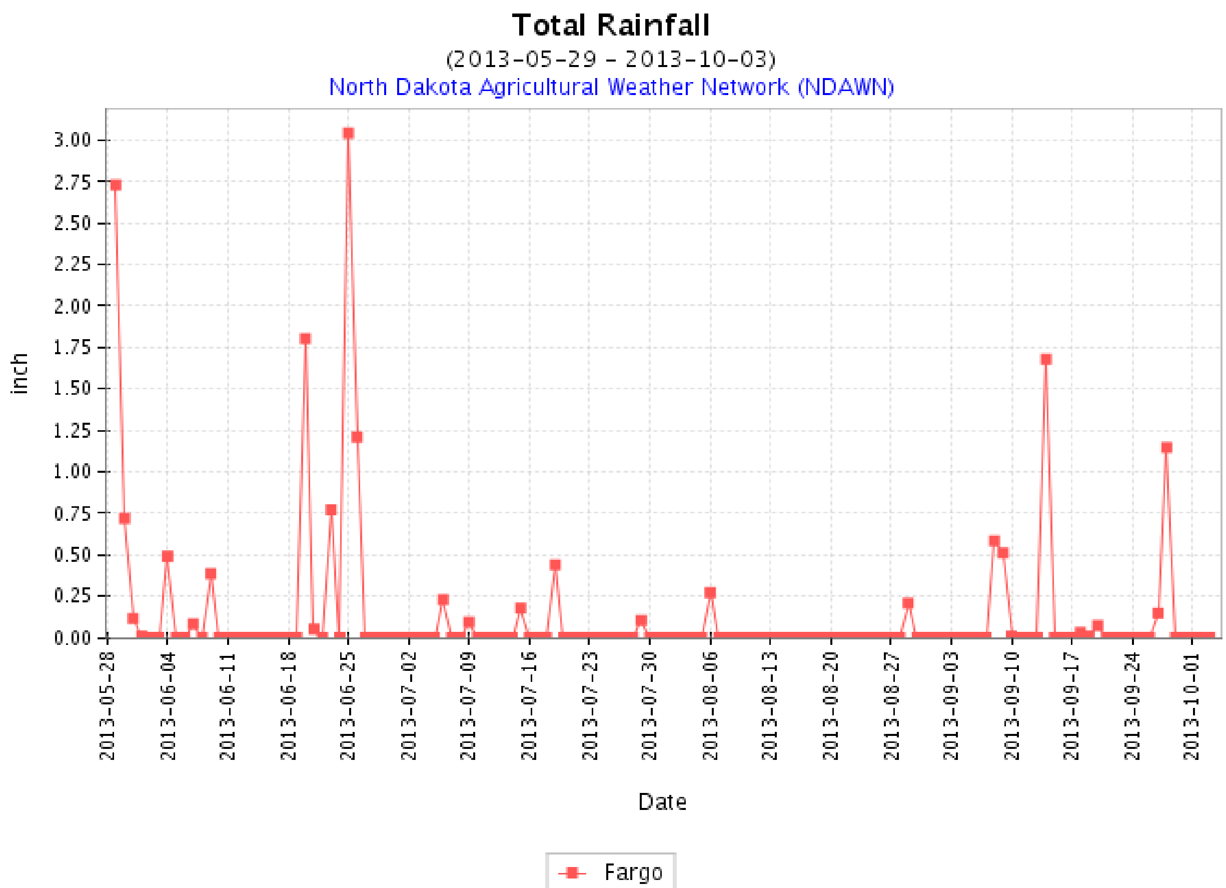

Figure 2. Rainfall at Fargo, recorded within 100 feet of the campus tillage plots. Note the flooding rainfall June 25.

Only small rainfall occurred after June 25. From August 6 until August29, no rainfall was recorded. The flooding rainfall followed by relatively dry conditions was the primary reason for some of the odd yield results in 2013.

Soybean

Soybean yield was poor. The soybeans appeared tall enough to produce more than the 10 bushels per acre they achieved, but the top half of all plants was filled with pods containing no soybeans. The wet soil conditions following flooding limited rooting depth, and that followed by dry conditions produced plants that could not yield to their potential. There were no statistical difference in yield due to tillage treatments.

Table 1. Soybean yield, moisture at harvest and test weight effects due to tillage treatment

Treatment	Yield, bushels per acre	Moisture, percent	Test weight, pounds per bushel
Conventional	9.9	12.1	55.4
Strip-till	12.1	12.1	55.3
No-till	11.5	12.5	55.3
F	0.50	0.30	0.01
P>F	0.62	0.75	0.99
Significance	NS	NS	NS

Corn
There were no significant differences between N timing treatments and tillage treatments. Average corn yield was 130 bushels per acre.

Sugar beets

Table 2. Yield and quality of sugar beets with tillage treatment and N timing.

Treatment	Yield, tons per acre	Per cent net sucrose	Recoverable sugar per ton	Recoverable sugar per acre
Conventional till	20.7	15.1	303	6274 b
Strip Till	20.6	15.6	312	6420 ab
No Till	21.9	15.6	312	6827 a
	NS	NS	NS	LSD 5% 513
All N Early	21.3 ab	16.1 a	322 a	6848 a
Split N Timing	22.2 a	15.4 b	309 b	6835 a
All N Late	19.8 b	14.7 c	295 c	5838 b
	LSD 5% 1.6	LSD 5% 0.6	LSD 5% 12	LSD 5% 513

Conventional till was lower in recoverable sugar per acre compared to strip till and no till treatments. Split N timing treatment achieved the greatest tonnage and the greatest recoverable sugar per acre yield. The all N early treatment had similar recoverable sugar per acre as the split N timing. The amount of N lost during the early season flooding was probably overestimated as evidenced by lower sugar content in the split N timing and late N timing treatments. The all N late sidedress treatment resulted in the lowest tonnage, the lowest sugar content, the lowest recoverable sugar per ton and the lowest recoverable sugar per acre.
An unmeasured advantage of strip till and no till over conventional till was the soil condition at harvest. On the date that hand harvest was conducted, it would have been difficult to harvest the plots with the NDSU beet lifter. However, when walking over the plots, the no till and strip till plots were firm enough that the footing was very good. When one entered the conventional plots, the consistency of the soil was like walking into a bowl of pudding. Worms evidently noticed a similar difference in soil condition. Nearly every beet pulled in the no till and strip till plot had an earthworm on it. There were no earthworms on any conventional tilled beets.

Summary
Tillage did not influence soybean or corn yield in 2013. Corn yield was not affected by N timing. Sugar beet quality was affected by tillage, with no till achieving the highest recoverable sugar per acre. N timing affected sugar beet yield and quality. Split N application resulted in highest tonnage. The decision to increase the side dress rate of N based on a guess was probably a mistake. This emphasizes the need for a better metric to determine the side dress rate necessary to optimizing sugar beet yield and quality.

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