LONG-TERM TILLAGE STUDIES IN FARGO-RYAN SILTY CLAY LOAM SOILS IN THE 2011-2012 CROP YEAR

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Conservation tillage management in high clay soils is particularly challenging due to concerns regarding delay in spring planting and slower growth due to cooler soil conditions. The campus tillage studies were established in 2005 and were expanded in 2007 so that each of the three-year rotation crops would be represented in each year. The study consists of three separate experiments, one in sugarbeet the year following corn, one in corn the year following soybean and one in soybean the year following sugarbeet. In addition to tillage concerns, timing of N application was included beginning in 2010 in plots that had sufficient plot number to accommodate a split-plot design (Franzen et al., 2010, 2011).

METHODS

All three experiments were conducted on Fargo-Ryan soils (Fargo-fine, smectitic, frigid Typic Epiaquerts; Ryan-fine, smectitic, frigid Typic Natraquerts) in an area on the North Dakota State University Fargo Experiment Station farm bordered by 15th Ave N on the north, the Fargo NDAWN station on the west and the new greenhouse complex on the east. The two eastern experiments (corn and soybean in 2012) are larger than the western experiment (sugarbeet 2012). The two eastern experiments consist of 36 experimental units each and the western experiment consists of 18 experimental units.

Sugarbeet

The experimental design was a randomized complete block with three treatments and six replications. Each experimental unit was 25 feet long and 11 feet (6 rows) wide. Tillage treatments were conventional, strip-till and no-till. Conventional treatments for the 2011-2012 year consisted of two chisel plow passes, straight shanks operated at a depth of 8 inches, about October 15, 2011. In the spring the plots were tilled using a field cultivator set to a 3 inch depth May 9, 2012. Strip-till consisted of conducting the strip-till operation about October 15, 2011, with the shank set about 6 inches deep, and the residue managers sweeping residue from a 6 inch wide strip between each row.
Soil test P and K were in the high range, so no P and K were applied to the plot area. Soil test nitrate-N to 2 feet was 31 lb N/acre. Target N was 170 lb/acre, so considering the soybean N credit, a side-dress treatment of 100 lb N/acre as UAN (28-0-0) streamed between the rows on June 18.
Sugarbeet variety Crystal 985 RR was seeded at a population of 4 ¾ inches between seeds 5/9/2012.
A burndown treatment of 22 oz/acre Roundup Max with 22 oz/acre of ammonium sulfate solution was applied to no-till and strip-till plots on May 14. A second treatment of 22 oz/acre Roundup Max with 22 oz/acre of ammonium sulfate solution was applied on May 21. A third 22 oz/acre Roundup Max with 22 oz/acre of ammonium sulfate was applied July 1. The middle two rows of the plots had a lower stand count compared to the four outer rows, so harvest consisted of rows 2 and 5 of each plot September 17 using a two-row sugarbeet harvester. Gross yields were recorded at the field for each row harvested separately; harvest stand was recorded immediately after beet top defoliation. Quality samples were taken from each plot to the East Grand Forks Sugarbeet Quality Laboratory. Statistics were conducted using SAS for windows with the general linear model procedure.

Soybean

The soybean experiment was conducted in one of the two larger studies within the experimental area. The experimental design was three treatments- conventional, strip-till, and no-till continuous for eight years, with twelve replications. An experimental unit was 25 feet long and 11 feet (6X22 inch rows) wide. Soybean variety PFS 11 R08 was seeded at 90,000 seeds per acre in 22 inch rows on May 10. A burndown application of Round Max was applied May 14 at 22 oz/acre Roundup Max with 22 oz/acre ammonium sulfate solution (2.5 lb AMS per gallon) applied at 10 gallon per acre with water to no-till and strip-till plots. A second application of the same herbicide mix was applied May 21 and a final application was applied July 1. Soybeans were harvested October 10 using a plot harvester with a 4 foot cutting head. Soybean harvest from each plot was dried for two days at 40 degrees C, then cleaned using appropriate screens, weighed, and test weight and moisture measurements obtained using a Dickey-John GAC 500 XT moisture/test weight meter. Statistical analysis was conducted using SAS for Windows with the general linear model procedure.

Corn

The corn trial was conducted on one of the eastern larger experimental areas. The experimental design was a split plot, with main plots as nitrogen timing (Preplant and sidedress treatments) and subplots as tillage (conventional, strip-till and no-till). Soil P, K and Zn levels were high, so no fertilizers other than N were applied to the plots. Residual nitrate-N to 2 feet in depth was 72 lb N/acre. Preplant N was applied to the preplant N main plots on May 9 as 90 lb N/acre ammonium nitrate. Conventional till plots were field cultivated on May 10 and all plots were seeded that afternoon. Corn variety Pioneer P8906 HR was seeded at 38,000 seeds per acre. A side-dress streamer application was applied to side-dress plots at a rate of 90 lb N/acre as UAN (28-0-0) on June 18, when the corn was in the 5-6 leaf stage. A burndown herbicide application of 22 oz Roundup Max with 22 oz ammonium sulfate solution (2.5 lb AMS per gallon) was applied to no-till and strip-till plots on May 14. A second herbicide application for the no-till and strip-till plots, and the first herbicide application using the same mixture was applied May 21 and the last herbicide application using the same mix was applied June 18. Weed control in all plots was excellent. Any escapes noted following the June 18 application were hand weeded.

The interior 2 rows of each plot had lower stand due to a planter error, so row 2 or row 5 were hand harvested October 12. Ears were immediately shelled using an Almaco corn sheller, and harvest weight, moisture and test weight were determined. Grain moisture and test weight were determined using a Dickey-John GAC 500 XT moisture/test weight meter. Statistical analysis was conducted using SAS for Windows with the Mixed Model split plot procedure.

RESULTS

Sugarbeet

This was the sixth consecutive year of tillage treatments in this experiment. There were no differences in sugarbeet yield, per cent net sugar, recoverable sugar per acre, recoverable sugar per ton, gross revenue per ton or gross revenue per acre with tillage treatment (Table 1). Although the conventional till plots were much harder to sample during a mid-season attempt at soil sampling compared to strip-till and no-till plots, the difference in soil condition had little effect on final yield and quality results for the sugarbeet experiment. There were no differences in harvest stand between tillage treatments (data not shown).

Table 1. Sugarbeet yield and quality with tillage treatment, 2012.

Treatment	Yield, tons/acre	Per cent Net Sugar	Recoverable Sugar Per Acre	Recoverable Sugar per Ton	Gross Revenue per Ton, $	Gross Revenue per Acre, $
Conventional	19.1	16.6	6690	332	56.95	1139
Strip-Till	19.7	17.1	6744	341	59.82	1185
No-Till	21.0	16.8	7093	337	58.37	1231
F	0.60	0.35	0.38	0.35	0.50	0.50
Pr>F	0.57	0.71	0.69	0.71	0.62	0.62

Soybean

This was the eighth consecutive year of tillage treatments in this experiment. Soybean yield was highest in strip-till and lowest in the conventional till treatments (Table 2). Although the soil was too dense in conventional till treatments for in-season penetrometer readings, it was noted that the soil under conventional tillage was much more dense and harder to penetrate than either the strip-till or no-till treatments. This could have resulted in greater rooting depth for the conservation tillage treatments compared to the conventional treatment producing a greater yield.

Table 2. Soybean yield and test weight with tillage.

Treatment	Yield, bu/acre, 14% moisture	Test weight, lb/bu
Conventional	20.2 a	57.2
Strip-Till	25.6 b	57.1
No-Till	22.7 ab	57.2
F	2.61	0.03
Pr > F	0.097	0.97
Significance	Significant at 10% probability	NS

Corn

This was the eighth consecutive year of tillage treatments in this experiment. Tillage treatment did not affect corn yield or harvest stand (Table 3). Moisture at harvest was highest in the conventional till treatment with over 1% difference separating the conventional till treatments with the strip-till and no-till treatments. The preplant N treatment overall yielded higher than the sidedress treatment. The overall effect was greatly influenced by a significant interaction with tillage and N timing with respect to the no-till sidedress. No-till preplant yields were generally higher than the conventional preplant yield; however the no-till side-dress yields were very low. No-till side-dress yield was about 100 bu/acre. Strip-till and conventional till preplant and side-dress yields were similar in tillage treatment and in N timing yield. Lack of rainfall following the side-dress stream UAN application probably was the primary reason for lack of superiority over preplant seasons observed in wetter growing seasons. The plots received about 0.8 inches of rain the night after side-dress (Figure 1), which apparently was enough to move N into the rooting zone in the strip-till and conventional till plots. In the no-till plots, undecomposed soybean residue from the 2011 season may have hampered N movement into the soil.

Table 3. Corn yield, moisture and harvest stand with tillage.

Treatment	Yield, bu/acre	Per cent Moisture	Plants/acre
Conventional	143	20.1	34.4
Strip-Till	141	18.6	37.4
No-Till	135	18.9	34.7
F	0.19	4.47	0.50
Pr>F	0.87	0.03	0.76
Significance	NS	Yes	NS

Table 4. Corn yield with N timing, and interactions between tillage and N timing.

Comparison	N Timing	Yield, bu/acre
N timing	Preplant	155
	Sidedress	124
F		0.05, significant
Conventional	Preplant	157
	Sidedress	129
F		NS
Strip-Till	Preplant	146
	Sidedress	136
F		NS
No-Till	Preplant	163
	Sidedress	108
F		0.01 Significant

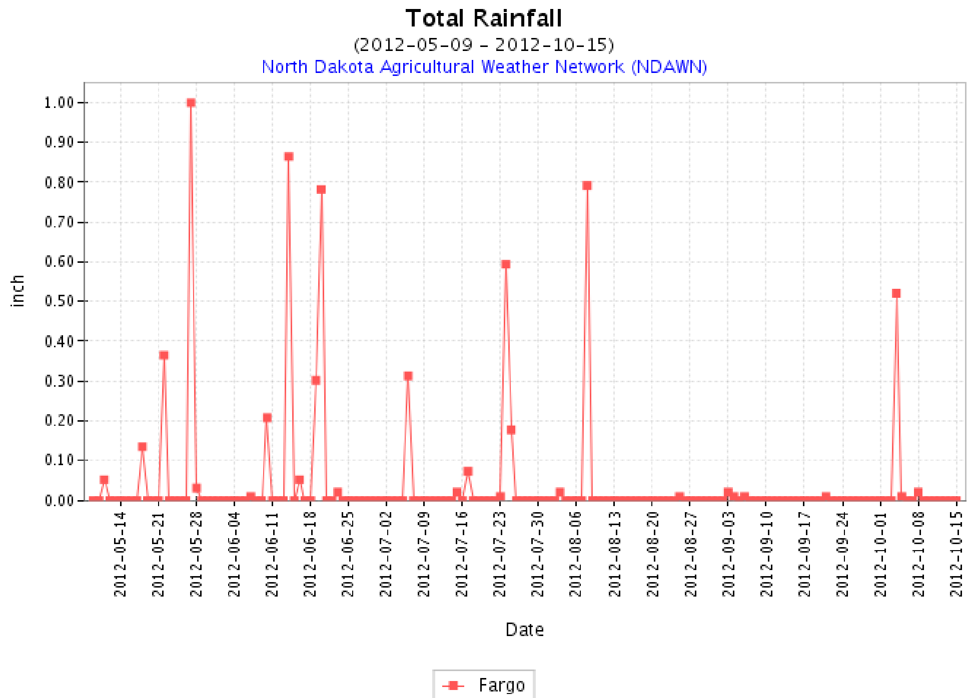

Figure 1. Growing season rainfall from the Fargo NDAWN station located within 100 feet of the long-term tillage plots.

Summary

There were no yield differences due to tillage for sugarbeet. Tillage also had no effect on per cent net sugar, recoverable sugar per ton, recoverable sugar per acre, or gross revenue per ton or per acre. Tillage also had no effect on corn yield. However, there was an interaction between tillage treatments and N timing in corn. No-till side-dress, using a stream surface application of UAN as three-quarters of the total N requirements was much lower yielding than the preplant application, even though the plots received 0.8 inches of rainfall the night following application. Conventional till and strip-till treatments had similar yield for preplant and sidedress applications. The dry winter with minimal soybean residue breakdown may have had a role in preventing higher efficiency of the sidedress application compared to that of strip-till and conventional till conditions. These results suggest that a coulter application in some year would be expected to be superior to a stream surface application of UAN.
Strip-till yield for soybean was higher than conventional till. The superior soil condition may have facilitated greater rooting depth in the strip-till treatment may have contributed to higher yield in this very dry year.

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References

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