NDSU Campus Tillage Trials, Year 4

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Introduction

Although no-till is common west of the Red River Valley, adoption of reduced tillage systems in traditional sugarbeet-growing areas has been hampered due to concern with stand establishment problems, cold soils, wet soils, seedling sprangling, and weed control. Strip-till is a relatively new tillage system that uses a fall pass with a specialized tillage tool that sweeps the residue from a narrow strip, lightly tills to a depth of about 8-inches in the strip, and forms a slight berm in the strip. Fertilizer can be applied in the strip during the same pass using the same tool. In the spring, the planter seeds into the middle of the strip. Experiments in other states have shown similar soil moisture and seeding depth temperatures in the strip-till strip compared to the conventionally tilled soil. This experiment was initiated to evaluate the short- and long-term effectiveness of producing sugarbeet and associated rotational crops using no-till, strip-till, and conventional tillage systems in a heavy Fargo-Ryan soil complex in 22-inch rows.

Methods

A tillage trial was initiated on the NDSU campus in the spring of 2004 to compare no-till, strip-till and conventional tillage. Corn was grown the first season (2004) to establish residues and rows. In 2005 and 2006, sugarbeets and soybean were rotated between north and south halves of the area. Results of previous years' data have been published in the Sugarbeet Research and Extension Reports (Franzen et al., 2006; 2007). In this previous work, no differences in sugarbeet yield or quality or soybean yield was found. The soils in this study are a close association of Fargo silty clay loams (fine, smectitic, frigid Typic Epiaquerts) and Ryan silty clay loams(fine, smectitic, frigid typic natraquerts).

In 2007, sugarbeet was seeded in the north half, into last year's soybean ground, and corn was seeded in the south half, on last year's sugarbeet ground. Each half was treated as a separate experiment, with the experimental design as a randomized complete block with three tillage treatments and twelve replications. Each plot was 25-feet long and 11-feet wide (one six-row, 22-row planter width). Fall tillage in the conventional plots was conducted with a chisel plow with straight shanks, set for a 10-inch depth. Spring tillage in the conventional plots was conducted using a field cultivator with a 3-gang spring-tooth harrow within a day of seeding. The strip-till pass was conducted in the fall, the same day as the conventional-till chisel plow operation, using a Yetter Maverick™[1] Strip-Till tool. Fall tillage was conducted in late October, 2006.

In spring 2007, Roundup was applied on May 2 at 2 qt/a to both the strip-till and no-till plots as a pre-seed burn-down practice. Fertilizer N was applied at a rate of 80 lb N/a to corn and sugarbeet as urea using a drop-fertilizer applicator to all plots. Residual N and P levels in the corn-half of the field were 33 lb N/a and 18 ppm, respectively. Residual N and P on the half of the field being planted with sugarbeet was 75 lb N/a and 22 ppm, respectively. No additional P was applied to sugarbeet plots; however, the corn received 3 gal/a 10-34-0 as a seed-placed starter. Fertilizer urea was incorporated into the soil as described above in the conventional plots, but no additional tillage was used to incorporate the urea in the no-till or strip-till plots other than the minimal soil disturbance (about 2 inches in width) of the planter.

On May 15, an additional 2 qt/a Roundup was applied on the strip-till and no-till plots that were to be planted with corn, and some spot-application of 2 qt/a Roundup was applied to plots that were to be planted with sugarbeet. Corn and sugarbeet were both seeded May 16. Corn was seeded at 32,000 pl/ha with Pioneer Hi-Bred® variety 39D81. Sugarbeet was seeded at 1.5 seeds/ft with variety SESVanderHave® variety SVDH64519 with Tachigaren® seed treatment (Bayer Crop Science).

Weed control in sugarbeets was achieved with three applications of micro-rates, applied 5/30, 6/10 and 6/20. Weed control in corn was achieved with a post-application of Option® (Bayer Crop Science) at 1.5 oz/a w/MSO and 28% at recommended rates on 6/5, followed by 1 pt/a Buctril® (Bayer Crop Science) on 6/12. The low residue in both the corn and sugarbeet plots allowed a cultivation of all plots on 6/22. Eminent® (Sipcam Agro USA, Inc.) fungicide was applied for Cercospora control 7/24 on sugarbeets. Weed control in both sugarbeet and corn was excellent.

Corn harvest was performed by hand on October 4 by collecting all ears from one of the middle two rows. The corn was shelled by a mechanical corn sheller and the grain weighed and grain moisture determined. The cobs were returned to the row from which they were taken.

[1] Use of a product does not constitute an endorsement by the authors.

Sugarbeet harvest was conducted October 15 using a two-row sugarbeet harvester. The middle two rows of each plot were harvested for yield and a tare sample was obtained from each plot and sent to the East Grand Forks Tare Laboratory for quality analysis. The remaining sugarbeets were removed from the plot area and shipped to the Moorhead factory.

Following harvest on October 25, the relative soil density was measured in each plot using a Spectrum Technologies, Inc. Fieldscout SC900® soil compaction automatic logging penetrometer. A measurement was obtained with the instrument in the center of each plot in-between rows to a total depth of 10 and 11 inches for sugarbeet and corn, respectively, with individual measurements at each inch of the depth.

Statistical analysis was conducted in SAS 9.1 for Windows, using the PROC MIXED procedure with the REPEATED instructions to compensate for spatial variation not accounted for with blocking.

Results

Rainfall from seeding until mid-June was sometimes heavy and nearly continuous. Herbicide applications were made during rain-free periods, but the plots were often muddy at the time of application. The surface (non-incorporated) urea applications initially benefitted from these early rains (Figure 1), however, the continuously wet plot area resulted in significant denitrification, especially in the corn plot area, and reduced sugarbeet stand in some plots. The plot wetness prevented side-dress of N in the corn plots. The corn plots were therefore N deficient for most of the season and this probably contributed to lower yields.

Corn

Yield, test weight, moisture and June 25 stand counts are presented in Table 1.

Table 1. Corn measurements as affected by tillage treatment, 2007.

Tillage treatment	Stand, plants/a	Test weight, lb/bu	% Grain moisture	Yield, bu/a
Conventional	34,960	54.4	18.7 b	80.6 ab
Strip-till	34,930	54.8	18.0 a	84.6 b
No-till	35,010	54.5	18.6 ab	73.4 a
F, treatment	0.03	1.50	2.8	3.2
LSD	NS	NS	0.7	9.2

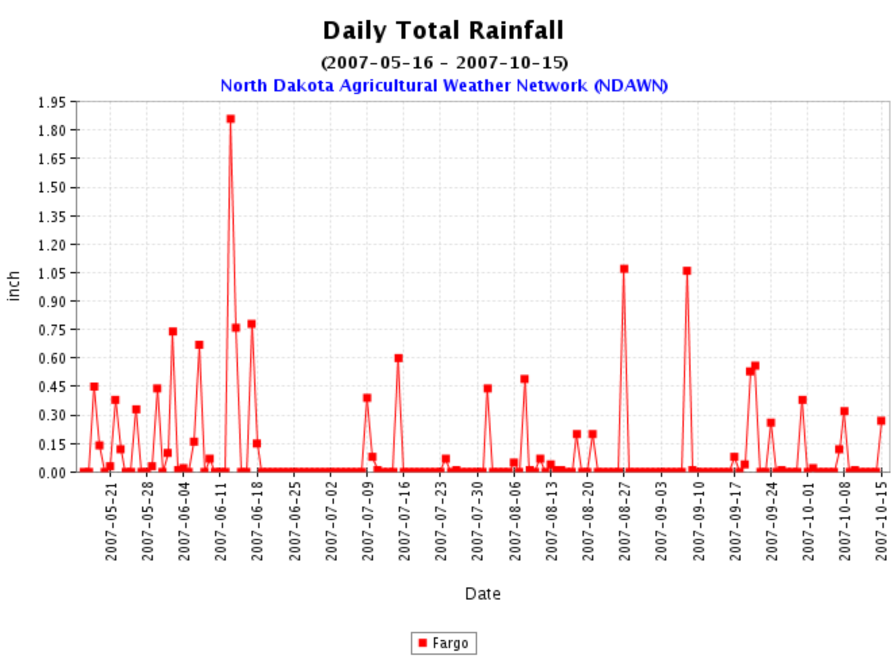

Figure 1. Rainfall at the NDSU campus tillage plots from seeding to harvest.

The highest corn yield was achieved with strip-till, with no-till having the lowest. There were no differences in corn test weight or plant stand. Strip-till had the lowest grain moisture, being 0.7 % lower moisture than the conventional till plots.

Penetrometer measurements following corn showed that soil density in no-till was higher at the 2-inch depth than conventional or strip-tillage. Below 2 inches, no-till and strip-till soil densities were similar statistically. At the 4, 5 and 6 inch depths, strip-till had lower soil density compared to conventional tillage. This suggests that there may be a tillage pan developing under the conventionally tilled plots that is not present in the strip-till and no-till plots. The strip-till and no-till plots may also be demonstrating more stable aggregates following four years of reduced tillage , which is not being duplicated in the conventionally-tilled plots.

Sugarbeet

There were no differences in early stand, harvest stand, tons/acre, recoverable sugar per ton (RST), recoverable sugar per acre (RSA), gross return per ton (GRT), and gross return per acre (GRA) between any tillage treatments (Table 2).

Penetrometer measurements following sugarbeet harvest showed that the soil density in conventional tillage was higher than strip-till at all depths (Figure 3). Significant differences in bulk density between conventional and strip-tillage were present at the 1, 5, 6, and 7 inch depths. No-till had significantly higher soil bulk density than strip-till at the 2, 3 and 4 inch depth. Although no-till seems to have a higher density than conventional tillage at shallow depths, these differences were not significant.

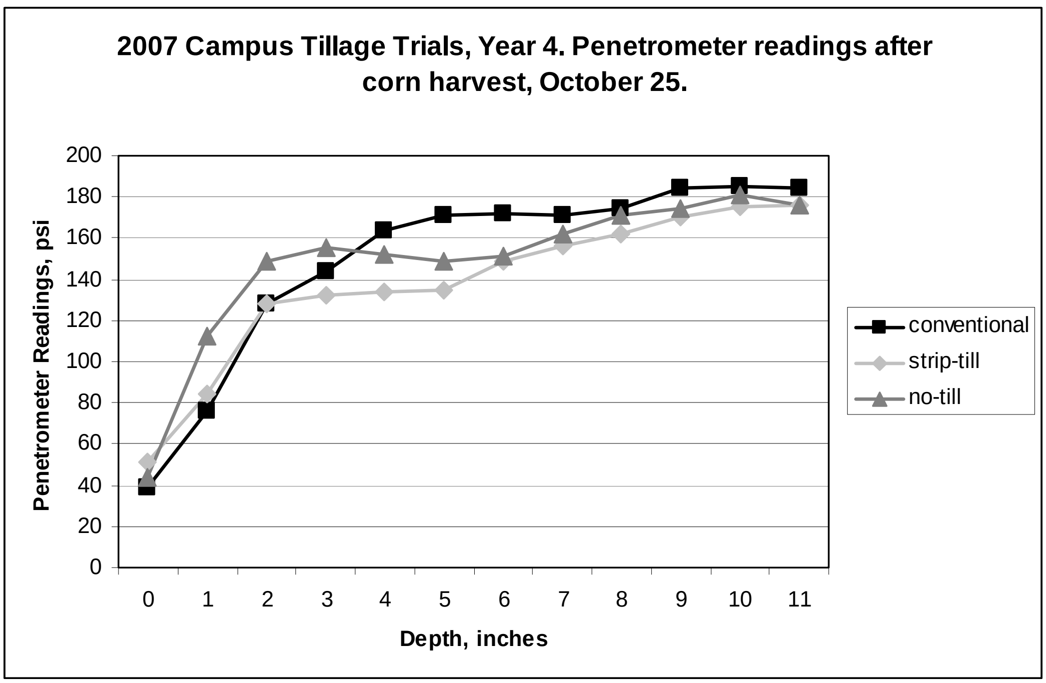

Figure 2. Penetrometer readings after corn in conventionally tilled, strip-till and no-till plots in the campus tillage trials, October 25, 2007.

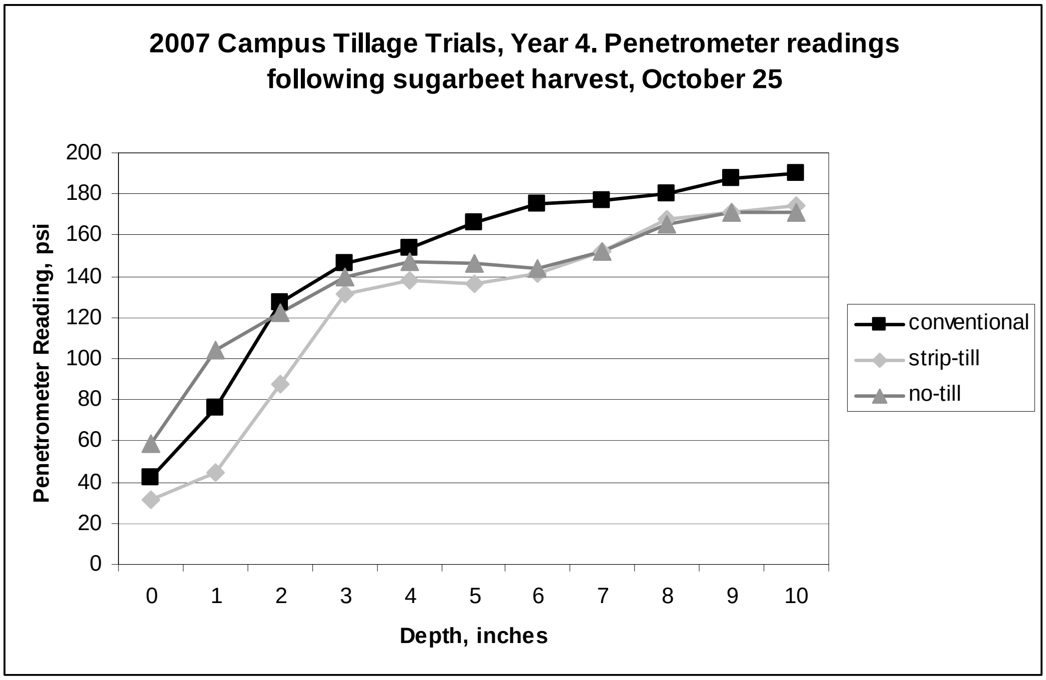

Figure 3. Penetrometer readings after sugarbeet harvest in conventionally tilled, strip-till, and no-till plots in the campus tillage trials, October 25, 2007.

Table 2. Sugarbeet measurements as affected by tillage treatment, 2007.

Tillage treatment	ES*, beets /100 ft	HS, beets /100 ft	Tons/a	RST lb/t	RSA lb/a	GRT $/t	GRA $/a
Conventional	140	148	22.1	333	6450	41.47	773
Strip-till	151	164	22.7	334	6690	41.71	806
No-till	136	154	22.1	333	6420	41.37	770
F, treatment	1.58	1.38	0.17	0.10	0.25	0.09	0.24
LSD	NS	NS	NS	NS	NS	NS	NS

*ES= early stand count, HS= harvest stand count, RST=recoverable sugar/ton, RSA=recoverable sugar/acre, GRT=gross revenue/ton, GRA=gross revenue/acre.

Following harvest and penetrometer readings, strip-till and conventional tillage operations were conducted in preparation of spring planting. A new trial area directly to the west of the current two tillage trials was established in 2007 using sweet corn. This area will be planted to corn in 2008. The area planted to corn in 2007 will be sugarbeet in 2008, and the area planted to sugarbeet in 2007 will be in soybean in 2008. Urea was applied during the strip-till operation for 2008 corn and sugarbeet at 50 lb N/a using a Gandy Orbit-air fertilizer applicator. Soil P levels remain high, so no additional P was added to the fall fertilizer. The remaining N for corn and sugarbeet will be applied in the spring.

The strip-till unit used in fall 2007 was a Wil-Rich 6-row unit. The residue from both the corn and sweet corn did not prevent excellent strips from being made. It is the plan in 2008 to produce a high yield of corn so that high residue corn will be present for 2009 trials.

Summary-

Conventionally-tilled, fall strip-till and no-till plots in sugarbeet and corn production were compared. Corn yield was higher and grain moisture was lower for strip-till compared to conventionally

tilled plots. No-till corn yield was lower than both conventional and strip-till corn. Corn yield suffered from continuous wetness and occasional heavy rains during the first 30-days of growth. Sugarbeet yield and quality were not affected by tillage treatment. Highest overall soil density was measured in the conventional till treatment, with no-till being denser at shallow depths, but often lower in density compared to conventional till at deeper depths (greater than 4 inches).

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