STRIP TILLAGE IN SUGARBEET ROTATIONS

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Introduction

There were many growers considering strip tillage as an alternative to full width tillage in 2008. High fuel and fertilizer prices were strong influences in peaking grower interest in strip tillage. Because of the volatility of fuel and fertilizer prices in recent months, strip tillage is still a practice of interest to growers. Sugarbeet producers who farm silty and sandy soil types prone to wind erosion were among those particularly interested in strip tillage. A wind storm occurred on May 17th, 2008, affecting thousands of acres in the Red River Valley and causing affected growers to reconsider the importance of reduced tillage, cover crops, and other practices that reduce susceptibility to wind erosion. Additionally, autosteer technology is becoming common on many sugarbeet farms in ND and MN and is particularly beneficial in strip tillage systems because it assures that growers can plant seeds directly into the middle of the strips that were made the preceding fall or earlier in the spring. Roundup Ready sugarbeet varieties reduce grower dependence on cultivation as a weed control method, which also makes weed control in strip tillage more manageable. Because sugarbeet growers are also soybean, corn, and wheat growers, we included these other commonly grown crops to determine their productivity potential in strip tillage cropping rotations with 22-inch row spacings.

In strip-tillage, narrow strips, usually 7-10 inches wide, are tilled and then planted with standard planting equipment, often modified with row cleaners. The area between rows remains undisturbed throughout the growing season. Strip-tillage is optimal in well-drained soils prone to wind erosion. Additionally, strip-tillage allows the cultivated strips of soil to warm up and dry faster than no-till systems in the spring for early-seeded crops. During dry periods, the inter-row areas retain moisture, which is available for crop use. This is a particular benefit in the spring, when dry soil conditions may result in reduced or uneven seedling emergence and consequently poorer stand establishment. These properties of strip-tillage make this method well-suited for the soils of the RRV, which are frequently cold and wet early in the planting season and are also highly susceptible to wind and flood-water induced soil erosion in the spring. Advantages that growers will experience directly by implementing strip-tillage are reduced fuel expenditures, less labor, time and machinery use, improved soil structure, and the potential for conservation payments through federal programs and carbon credit trading boards.

Many areas of the U.S. Corn Belt utilize strip-tillage for corn production and it has been shown to result in corn yields similar to conventional tillage while also providing the benefits of wind protection and accurate placement of N, P, and K beneath the soil surface (unlike no-till). Additionally, strip-tillage has the potential to enhance use of P by optimizing placement, which may result in recommendations for reduced P fertilizer rates for strip tillage production in ND and MN.

Economically, strip tillage allows for fuel savings because primary and secondary tillage operations with chisel plow, field cultivators, etc. are eliminated. Strip tillage also eliminates additional fuel inputs associated with fertilizer application and weed cultivations in conventional tillage systems. Labor costs may be reduced in association with fewer field operations. Fertilizer savings may be realized if fertilizer banding increases N and/or P uptake efficiency, allowing a fertilizer rate reduction. However, an early season chemical burn-down operation unneeded in full width tillage systems may add additional cost to strip tillage systems. Planting and harvesting operations are the same for strip till and conventional till systems. Converting to strip-till production requires investment in new equipment associated with equipment cost, insurance, and storage.

The objective of this study was to evaluate three regionally-important crops (sugarbeet, corn, and soybean) through a full crop rotation using strip-tillage and conventional tillage systems. 2008 was the second year of this study.

Materials and Methods

The study was designed as a randomized complete split plot with two whole plot treatments: strip-tillage vs. conventional tillage. Split plot treatments are each of the four crops used in the rotation. 2008 was the second year of a four year study designed so that each crop is present in each year of the study. The rotation sequence for this study is wheat/sugarbeet/soybean/corn. The study is replicated at two locations: the NDSU Prosper Research Station and a grower farm east of Moorhead, MN.

Strips were applied in October 2007. The conventionally tilled treatment was chisel plowed twice in the fall and lightly cultivated in the spring with a harrow/packer combination. Conventional tillage treatment plots were fall-fertilized with urea by broadcasting and incorporating. In strip tillage treatments, N fertilizer was applied at the same time strips were made using 28-0-0 UAN. Soil P and K levels were determined to be sufficient at both sites. Cultivation during the growing season for weed control was included as needed for the non-Roundup Ready sugarbeets. The rows at the Moorhead location were oriented east-west, while rows were oriented north-south at the Prosper station. On May 5th at Prosper and May 8th at Moorhead, strips were planted to sugarbeet, wheat, corn, and soybean. All crops were planted to stand. The sugarbeet variety was Betaseed 1305R; corn variety was Pioneer Hybrid 39D85; soybean variety was 07008RR from Peterson Seeds, and wheat variety was Alsen. All crops were planted with 22-inch row spacing. The average corn population at harvest was 35,400 plants per acre. Wheat was drilled at 100 lb of grain per acre. The target soybean population was 165,000 seeds per acre. Sugarbeet and corn emergence counts were taken early in the growing season at both sites.

Wheat, soybean and corn plots were harvested on August 13th, September 28th and October 22nd, respectively from both locations. Sugarbeet were harvested September 29th at Prosper and October 10th at Moorhead.

Results and Discussion

Table 1 displays corn and soybean yields from each location. The United States Department of Agriculture National Agricultural Statistics Service reported the North Dakota average soybean yield to be 29 bu/a in 2008, down from 35.5 bu/a in 2007. Average corn grain in North Dakota in 2008 was 124 bu/a, up from the 2007 average yield of 116 bu/a. Soybean yields at the Prosper location were very good for both tillage treatments and corn yields were exceptional for both tillage treatments. Soybean yields were above average and corn yields were very good for both tillage treatments at the Moorhead location. High corn yields were observed in many parts of the U.S. in 2008 and are thought to be the result of cooler night temperatures. Yields were significantly greater at the Prosper location compared to the Moorhead location for both corn and soybean. Corn grain moisture content was approximately 20% at harvest. One factor that may explain the difference in yields between locations is the earlier planting date at Prosper, which coincided with slightly more soil moisture for improved germination and stand establishment. There was a period with no rainfall lasting several weeks after planting which could have reduced seed germination and/or seedling emergence and establishment in the later-planted and better-drained soils at the Moorhead site. Favorable soil moisture in the strip tilled treatments resulted from residue between strips which reduced evaporation from the soil and increased water-holding capacity of surface soil. Therefore, faster and more even seedling emergence was observed in the strip tilled treatment compared to the conventionally tilled treatment for corn, soybean, and sugarbeet.

Table 2 displays sugarbeet yield and quality information from each location. Tonnage values were close to the average for the region. There were no significant differences between locations or tillage treatments for tonnage. Tonnage was non-significantly lower in strip till compared to conventional tillage, which is related to (non-significantly) lower stand obtained in strip till compared to conventional tillage. Rhizoctonia was observed in sugarbeet treatments and appeared slightly worse in strip tilled compared to conventional tillage. Gross sugar did not differ significantly between tillage treatments. Gross sugar did, however, differ between locations, being higher at the Moorhead location which corresponded with a non-statistically lower tonnage value compared to the Prosper location. Sugar loss to molasses did not differ between tillage treatments or location. Net sugar was greater at the Moorhead location and was associated with the higher gross sugar and slightly lower tonnage harvested at Moorhead relative to Prosper. Recoverable sugar per acre (RSA) did not differ between tillage treatments or location. Recoverable sugar per ton (RST) did not differ between tillage treatments, but was significantly higher at the Moorhead location. Sugarbeet stand was lower than desired at the Prosper location. Reduced stand may be the result of high soil moisture content lowering seedling vigor and resulting in death after seedling emergence from damping off fungus. Sugarbeet stand was higher than expected at Moorhead and was observed to result in many small sugarbeet roots. All beet treatments were planted to stand and the same variety, planter, and planter settings for population were used at each location. Differences are the result of different soil and climate conditions at each location.

On May 16th, all crops were beginning to emerge in the strip-tilled treatments at Prosper, but almost no emergence was observed in the conventionally tilled treatments. Sugarbeet emergence counts were taken at both locations on May 19th, 12 days after planting. At that time, 78 plants and 58 plants had emerged per 100 feet of row for strip-tillage and conventional tillage, respectively, at Prosper. On May 19th at the Moorhead location, 119 plants and 100 plants had emerged per 100 feet of row in strip tillage and conventional tillage, respectively. Counts were highly variable between reps in all cases.

Differences between tillage treatments were either less apparent or reversed (better in the conventionally tilled treatments) for sugarbeet vigor later in May at both locations. On May 29th, at the Moorhead location, there were many weeds in the strip tilled sugarbeet treatments, especially dandelions and kochia (Roundup Ready sugarbeet varieties were not available for research studies in 2008). Grasses were the dominant weed species at the Prosper location in the sugarbeet strip-tilled treatments. Weeds were effectively controlled with cultivation in the conventionally tilled treatments. At the Moorhead location on May 29th and again on June 18th, crops were observed to be larger and more vigorous in the conventionally tilled treatment plots compared to the strip tilled treatments in 3 out of 4 replicates. On June 23rd at Prosper, crops were observed to be about equal in terms of growth and vigor for both tillage treatments with the exception of corn. Corn appeared shorter and more yellow in the strip tilled treatment relative to the conventionally tilled treatment. In July, August, and September, however, strip tillage developed an advantage and the corn looked better than the conventional treatment. By the end of July, when corn was tasseling, the strip tilled corn treatment was developmentally slightly ahead of the conventionally tilled corn. We suggest that the residue in strip tilled plots may have immobilized nitrogen in the earlier part of the growing season, creating the smaller, more yellow appearance of plants in June. However, the immobilized N was protected from leaching and denitrification after the heavy rains of June through October, resulting in relatively higher N availability for uptake during the time that the ears were filling with grain, resulting in improved grain fill in the strip tilled treatment relative to the conventionally tilled treatment. Soil samples from corn plots taken at the end of the growing season did not reveal significantly different N values between treatments. Nitrogen values to the 2 foot depth were low (6 to 11 lb/a) for all treatments. It is not possible to determine from this data what percentage of N was lost to plant uptake versus leaching and/or denitrification.

Observations for sugarbeet and soybean during the growing season at Prosper did not reveal a clear advantage in either tillage system. More surface crusting and soil cracking was observed in the conventionally tilled treatment than the strip tilled at the end of June at Prosper for all crops.

Table 3 shows the surface residue cover in each tillage system and each crop. As expected, there was significantly more residue cover in strip tilled treatments relative to conventionally tilled treatments. Of all residues in this study, sugarbeet tops decompose most rapidly, leaving only 4.6% and 7.7% surface cover for the following crop in conventionally tilled and strip tilled treatments, respectively. There was 75% more soybean residue remaining in the strip tillage treatment compared to conventional tillage. There was 2.5 times more wheat residue remaining in the strip tilled treatment relative to the conventionally tilled treatment. There was 2.3 times more corn residue remaining in the strip tilled treatment relative to the conventionally tilled treatment.

These data suggest that strip tillage is a viable alternative to conventional tillage for all crops tested in this study – sugarbeet, soybean, and corn.

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SUMMARY STATISTICS OF MULTI-CROP STRIP-TILLAGE STUDY, 2008 DATA (YEAR 2)

Table 1. Strip-tilled and Conventionally-tilled Soybean Yields at 2 locations. 2008 Growing Season

Location – Tillage Treatment	Average Yield SOYBEAN (bu/a)	Average Yield CORN (bu/a)
Prosper – Strip Till	53.25a	230 b
Prosper - Conventional	55.61a	205a
Moorhead – Strip Till	44.23 b	197a
Moorhead - Conventional	36.46 c	163 c

Table 2. Strip-tilled and Conventionally-tilled Sugarbeet Yields at 2 locations. 2008 Growing Season
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Location – Tillage Treatment	Root Yield (Tons/a)	Gross Sugar (%)	SLMº (%)	Net Sugar (%)	RSA* (lb/a)	RST** (lb/ton)	Stand (Beets/100ft)
Prosper – Strip Till	29.3a	14.8a	1.2a	13.6a	7947a	272a	97a
Prosper - Conventional	32.1a	15.5ab	1.2a	14.3ab	9190a	286ab	122a
Moorhead – Strip Till	25.5a	16.1 bc	1.3a	14.8 b	7551a	296 b	178 b
Moorhead - Conventional	26.0a	16.6 c	1.4a	15.2 b	7913a	304 b	168 b

º Sugar Loss to Molasses; * Recoverable Sugar per Acre; ** Recoverable Sugar per Ton

Table 3. Residue Levels Measured as Percent Surface Cover Using Line-Transect Method. Measurements are the average of two replications at the Moorhead location taken May 16, 2008.

Tillage	2007 Crop	2008 Crop	% Surface Cover
Conventional	Beets	Beans	4.6
Conventional	Beans	Corn	12.3
Conventional	Corn	Wheat	14.6
Conventional	Wheat	Beets	8.5
Strip	Beets	Beans	7.7
Strip	Beans	Corn	21.5
Strip	Corn	Wheat	33.8
Strip	Wheat	Beets	21.5