EFFECT OF STRIP TILLAGE, ROW ORIENTATION, AND SEED PRIMING ON SUGARBEET YIELD AND QUALITY

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Introduction/Objectives

2009 was the second year of a strip tillage and row orientation study, with some modifications from the previous year. This study was initiated in fall 2007 at the Prosper research experiment station to determine if strip tillage and row orientation directly affect soil temperature and moisture at the seeding depth in the first four weeks following sugarbeet planting. We also wanted to determine if tillage management and row orientation would affect sugarbeet seedling emergence, final stand, root yield, and sugar content. Other researchers have investigated the effect of tillage and row orientation on soil warming and drainage, but no such studies have been conducted for sugarbeet production in the Red River Valley using the high precision instrumentation (dual probe heat pulse sensors) employed in this study. Reduced tillage systems have seen minimal implementation in the Red River Valley due in large part to 1) the perception of cooler soil temperatures in spring and 2) the reality of frequent spring flooding and soils that retain water longer under high residue conditions. Despite real and perceived risks, there are a number of advantages provided by strip tillage including reduced soil erosion, reduced wind-related crop damage, lower fuel costs, decreased fertilizer costs, improved phosphorus and potassium fertilizer uptake efficiency, improved soil conditions (increased aggregate stability and improved soil structure), reduced soil crusting, conservation credits, and improved water infiltration and drainage over time.

As a modification to the study conducted in 2008, we included a seed priming treatment to compare with non-primed sugarbeet seeds. A number of independent research studies have determined that sugarbeet seed priming effectively accelerates seed germination and emergence and can result in greater harvestable root yield and sucrose content. Effective seed priming is particularly beneficial during cold, wet springs and in reduced tillage systems where cool, wet soil conditions may inhibit rapid and even germination of non-primed sugarbeet seed. Although some seed companies have recently converted to selling only primed seed, the priming process does come at an added cost and so we would like to investigate the benefit of seed priming specifically for strip tillage systems in the event that seed priming does not become a standard industry practice.

We planned to replicate the dual probe study again in 2009. However, the fall 2008 conditions were too wet to allow for fall strip tillage. Spring 2009 conditions were as unfavorable as the fall of 2008. We had to apply strips in the spring (not a recommended practice) and the soil seedbed for both strip till and chisel plow treatments was poor. We weren’t able to plant the row orientation study until May 22. By that time, we felt that we had missed the window of opportunity to capture significant soil temperature and moisture differences between tillage and row orientation treatments. We made the decision not to install the dual probes. Here, we report the results of seed emergence, final stand, and yield and sugar quality values determined from the tillage, seed priming, and row orientation treatments.

The objectives of this project were to determine if row orientation is related to soil warming and moisture content in early season fields under strip tillage and conventional tillage and to determine if observed early season differences affect final yield and quality in sugarbeet production. Additionally, we wished to determine if primed seed can overcome moisture and temperature differences that make germination conditions less favorable in strip tillage systems.

Materials and Methods

The experiment was established at two locations, the NDSU research station near Prosper, ND, into wheat residue chopped to about 7 inches high on a Beardon-Perella silt loam (coarse-silty, frigid Aeric Calciaquoll), and a grower farm near Amenia, ND, on a Glyndon-Tiffany silt loam (coarse-loamy, mixed, frigid Typic Haplaquoll). Tillage treatments were established shortly before planting. Strips were applied in a single pass into wheat residue. Conventional tillage was conducted by cultivating with a harrow in the spring. Soil nitrogen levels were adjusted to 130 lb N/a to a depth of 4 feet with urea. Phosphorus fertilizer was applied as triple super phosphate (0-45-0) according to recommendations in the Sugarbeet Production Guide at the Amenia location, but was not required at Prosper. Potassium fertilizer was not required at either location. Fertilizer was applied in a band with the strip tiller in the strip tillage treatments and in the conventionally tilled treatments by surface broadcasting fertilizer and incorporation.

The trial was planted on May 22nd at Prosper and June 1st at Amenia. The experimental design was a randomized complete split plot design with 4 replications. Individual treatment plots measured 11 feet wide and 30 feet long and contained 6 rows per plot with a spacing of 22-inches between rows. SESVanderHave Roundup Ready variety M822207 seed (primed and non-primed from the same seed lot) was planted with a John Deere MaxEmerge II planter. Sugarbeet was placed 1.25 inches deep, and was planted to stand at a 4.5-inch in-row seed spacing. Three fungicide applications, Eminent, Supertin/Topsin and Headline were applied for Cercospora leaf spot control.

The middle two rows were harvested for root yield determination and sugar quality evaluation on September 29, 2008. Yield determinations were made and quality analysis performed at the American Crystal Sugar Quality Lab, East Grand Forks, MN.

Results and Discussion

<u>Review of previous year's results:</u> According to anecdotal wisdom, it was expected that soil temperatures in strip tilled fields would be cooler than in conventionally tilled fields, regardless of row orientation. The 2008 agronomic data produced from this study provided some interesting insights and encouraging results to support future research for sugarbeet production using strip tillage. Even under unfavorable conditions which produced lower-than-average yields regardless of the tillage system, strip tillage was not statistically disadvantaged in terms of sugarbeet root yield or sugarbeet quality. The best-yielding strip tillage treatment produced essentially the same sugarbeet tonnage as the best-yielding conventional tillage treatment in this study (strip-till with north-south oriented rows = 26.2 ton/a; Chisel Plow with north-south oriented rows = 26.3 ton/a). Between these two best treatments, strip tillage yielded slightly greater net sugar than the chisel plow treatment (14.8% compared to 14.5%). These factors combined to result in recoverable sugar per acre values of 7665 lb/a for conventional tillage and 7767 lb/a for strip tillage.

<u>Results of current year:</u> Agronomic results from the two locations were significantly different for most parameters, so results of the two locations were analyzed separately and are displayed in Table 1. In most cases, primed seed yielded about 0.85 ton per acre greater root yield than unprimed seed. Additionally, there was a visual advantage for primed seed treatments for early season seedling vigor and growth rate. East-west oriented rows yielded significantly greater root yield in the chisel plow treatment at Prosper, but not in the strip tillage treatment. This was the only significantly different root yield due to row orientation. Probably due to the poor seedbed conditions resulting from spring strip tillage (as opposed to the recommended practice of fall strip tillage), most strip tillage treatments yielded significantly lower root yields compared to chisel plowed treatments at Amenia; the average difference was 2.75 ton per acre. At Prosper, strip tillage root yield was equal to the chisel plow treatment (34.0 ton/acre) for north-south oriented rows, but was 1-2 ton/acre less than chisel plow in east-west oriented rows.

Gross sugar content did not differ between any treatments at Amenia. Although the Chisel Plow/East-West oriented row treatment gave the greatest root yield of all the treatments, it produced the least sugar content of all treatments, also resulting in the lowest recoverable sugar per ton (RST) of all treatments. As has been noticed in other tillage studies in other years, there was greater sugar loss to molasses (SLM) in strip tillage treatments compared to chisel plowed treatments at Amenia. This was not observed at Prosper. This has become a recognized trend and could result from several factors 1) poorer defoliation of beets at harvest in strip tillage plots, probably resulting from greater variability in beet sizes and smaller beets retaining more beet top than desired; 2) reduced sugarbeet stand in strip tillage resulting in larger than desired beets with lower sugar content and/or higher impurities, and 3) too much fertilizer applied in the strip tillage system; it may be appropriate to reduce the N fertilizer recommendation for strip tillage due to the banded application of fertilizer in this system. The lower number of beets per row at harvest for strip tillage at Amenia suggests that the greater loss to molasses may have resulted from fewer beets that were larger. Recoverable sugar per acre (RSA) was lower for strip tillage than for chisel plowing at Amenia. The RSA values were statistically the same for the tillage methods at Prosper.

Conclusions: Although not significant, there was a consistent benefit observed from seed priming, both in root yield and early season vigor and growth. Row orientation did not result in consistent differences in sugarbeet yield or sugar values. Regarding tillage, this study indicates that spring strip tillage may result in lower sugarbeet yield and stand compared to conventional chisel plowing practices.

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Table 1. Sugarbeet yields from 2 locations (analyzed independently) examining effects of 2 Tillage Treatments (chisel plow and strip tillage), 2 Row Orientations, and 2 priming treatments. Due to space limitations at Prosper, the CHISEL PLOW treatment with unprimed seed (in both row orientations) was eliminated. Least significant difference (LSD) is determined for alpha=0.95 (P<0.05). 2009 Growing Season.

Location	**Tillage Treatment**	**Row Orientation**	**Primed/ Unprimed Seed**	**Root Yield (Tons/a)**	**Gross Sugar (%)**	**%SLM (%)**	**Net Sugar (%)**	**RSA* (lb/a)**	**RST** (lb/ton)**	**Stand (Beets/100ft)**
Amenia	CHISEL PLOW	N/S	Primed	34.7	15.85	0.8697	14.98	10386	300	208
Amenia	CHISEL PLOW	N/S	Unprimed	33.8	15.92	0.8635	15.05	10187	301	204
Amenia	CHISEL PLOW	E/W	Primed	35.1	15.73	0.8644	14.87	10432	297	198
Amenia	CHISEL PLOW	E/W	Unprimed	34.3	15.69	0.8393	14.85	10190	297	198
Amenia	STRIP TILL	N/S	Primed	31.7	15.43	0.9018	14.53	9210	291	176
Amenia	STRIP TILL	N/S	Unprimed	30.9	15.83	0.8791	14.95	9247	299	175
Amenia	STRIP TILL	E/W	Primed	31.8	15.70	0.8961	14.81	9430	296	153
Amenia	STRIP TILL	E/W	Unprimed	32.5	15.76	0.8612	14.90	9704	298	158
AMENIA LSD (P<0.05)				1.68	NS	.0434	0.24	521	5	10
Prosper	CHISEL PLOW	N/S	Primed	34.0	15.41	1.1974	14.21	9673	284	168
Prosper	CHISEL PLOW	E/W	Primed	36.3	14.91	1.2644	13.64	9936	273	176
Prosper	STRIP TILL	N/S	Primed	34.0	15.75	1.0623	14.69	9978	294	159
Prosper	STRIP TILL	N/S	Unprimed	35.1	15.60	1.0946	14.50	10206	290	152
Prosper	STRIP TILL	E/W	Primed	35.2	15.58	1.0996	14.48	10172	290	141
Prosper	STRIP TILL	E/W	Unprimed	34.3	15.40	1.1326	14.27	9786	285	150
PROSPER LSD (P<0.05)				2.26	0.50	0.0547	0.54	NS	11	17

* Recoverable Sugar per Acre
** Recoverable Sugar per Ton