EFFECT OF ELIMINATING SPRING TILLAGE ON SUGARBEET PRODUCTION AND EMERGENCE IN STALE SEEDBEDS – FINAL REPORT

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Introduction/Objectives

Stale seedbeds are seedbeds that receive primary tillage in the fall and are planted in the spring without any additional tillage. This is not a common practice in ND and MN for sugarbeet production for several reasons. In wet springs, fields are tilled lightly with a field cultivator or similar tool prior to planting in an effort to dry the soil. Some growers believe that they cannot achieve good stand counts with a stale seedbed because the soil is not fractured enough to provide adequate seed-to-soil contact to ensure germination. Another reason for a spring tillage operation is to kill early weed flushes in the field. The latter reason is less relevant when Roundup Ready sugarbeet can be grown. Poor seed to soil contact in stale seedbeds, may be a legitimate concern in some areas and following certain crops. When sugarbeet follow corn in a cropping rotation there may be enough corn residue remaining in the spring to cause planting and/or seed emergence problems. Spring tillage to enhance corn residue decomposition is sometimes necessary to ensure effective planting and high stand counts. However, when sugarbeet are preceded by soybean or other low residue crops, there is little need for tillage to enhance the rate of residue decomposition.

Just as there are legitimate reasons for spring tillage operations, there can be negative consequences as well. In a dry spring, moisture is lost as a result of spring tillage. Seedbeds lose 25-35% of the plant-available water in the top 1 inch of soil within 72 hours following tillage (American Crystal Ag Notes #419). Since sugarbeet seeds typically germinate 5-12 days after planting, even planting immediately following spring tillage results in substantial loss of water available to the newly-emerged seedlings under moisture-limiting conditions. Stale seedbed planting conserves soil moisture in the early spring and makes it available for seed germination and seedling emergence.

Another spring tillage issue that is a considerable concern in recent years is that hard rains after a spring tillage event can create significant crusting problems on the surface of clay, clay loam, and silt loam soils. Crusting can significantly reduce sugarbeet stand establishment on these soil types. Soil type, soil condition, and velocity of raindrop impact during a storm are deciding factors in determining if a soil will produce a crust that inhibits germination and/or emergence. Eliminating spring tillage with stale seedbeds reduces crusting potential and extent of crusting in prone soils. A final benefit of stale seedbed planting is that soils in fields that were not tilled in spring are generally less susceptible to wind erosion during wind events.

Diesel fuel prices have fluctuated erratically since 2006 but, in general, average agricultural prices for bulk delivery of diesel fuel in the Northern Plains states has increased from $0.78 to $1.66 per gallon from 1990 to 2009 (http://www.neo.ne.gov/statshtml/187.htm). A record price of $3.54 per gallon was recorded in 2008; similar or higher prices are likely in the future. The average cost for spring tillage operations in 2007 was $8.16/a (2007 American Crystal Grower Cost Survey – Red River Valley Averages). By eliminating unnecessary spring tillage growers will save money, wear to machinery, and time. **The objective of this study is to investigate differences in stand establishment and general production potential of sugarbeet planted into stale seedbeds compared to conventional spring-tilled seedbeds.**

Materials and Methods

This year, 2010, was the third and final growing season for this study. In 2008 and 2009, the study was established at the Prosper Research Station on a Beardon Perella silt loam (coarse-silty, frigid Aeric Calciaquoll) and crop rows were oriented in a north-south direction. The 2010 study was planted near Amenia, ND on a sandy loam soil and rows were planted in an east-west direction. Three treatments were established: 1) sugarbeet planted into a spring field cultivated seedbed (check); 2) sugarbeet planted directly into a stale seedbed without residue managers (row cleaners) on the planter; and 3) sugarbeet planted into the stale seedbed with row cleaners installed on the planter. Individual treatment plots measured 11 feet wide and 30 feet long. Planting was arranged in a randomized complete block design with 6 replications. Seeds were placed 1.25 inches deep, and were planted to stand at a 5-inch in-row seed spacing. Row spacing was 22 inches between row centers. The two middle rows of the 6-row plots were harvested and yield determinations were made and quality analysis performed at the American Crystal Sugar Quality Lab, East Grand

Forks, MN. Specific tillage, cultivars, and planting and harvest dates for previous years are provided in each yearly report for years 2008-2009.

For the 2010 growing season, all treatments were prepared in fall 2009 by chisel plowing twice in a manner consistent with common grower practices. Soil nitrogen levels were adjusted in Fall 2009 with urea fertilizer to approximately 130 lbs/acre of available residual soil test plus added fertilizer N. Soil test levels indicated that no P or K fertilizer was required but 3 gpa of 10-34-0 was applied at planting. The study was harvested September 22, 2010.

A major difference between the study conducted in 2008, 2009, and 2010 was the level of tillage conducted in the fall prior to the growing seasons. In fall 2007 and 2009, the study was prepared by chisel plowing the area two times in a manner consistent with common grower practices. The fall of 2008, however, was excessively wet. The NDAWN weather station at the study location recorded 11 inches of precipitation during the months of September and October. The historic average for the same time period is 4 inches. Fields were near saturation or flooded the entire fall season of 2008; as a result, only one light tillage pass was permitted in the fall prior to the 2009 study. In the spring, the field still had unusually high levels of wheat residue and a very uneven surface area for planting. The check treatment (two spring tillage operations with a cultivator/ harrow combination) was implemented on May 22, 2009, and created a smooth soil surface, incorporated most of the wheat residue, and left a visually well-fractured seedbed. The stale seedbed treatments, in contrast, were very uneven with obvious tire tracks, high levels of wheat residue, and a poorly fractured seedbed. The stale seedbed treatments created in 2009 were, by all accounts, a worst case scenario for stale seedbed planting conditions. By contrast, all treatments were planted much earlier in 2010, on April 21, with Hillshög Syngenta variety 4012 Roundup Ready sugarbeet seeds. In the stale seedbed treatment with residue managers on the planter, the residue managers were set on a less aggressive setting than in 2009 to lightly move wheat residue out of the crop row. In the check treatment residue managers were not used on the planter.

Results and Discussion

Review of previous years' results: **2008:** At Prosper in 2008, soils remained dry for more than three weeks after planting; the stale seedbed treatments displayed faster and more even seedling emergence than the spring tillage treatment. The use of residue managers on planters in combination with stale seedbed planting provided an additional benefit to early-season seedling emergence, as well. On May 19th, 2 weeks after planting, the stale seedbed treatment planted without residue managers displayed about the same seedling emergence rate as the spring tillage treatment (117 plants/100 ft vs. 112 plants/100 ft). The stale seedbed treatment with residue managers resulted in 27% greater seedling emergence than the spring tillage treatment. By May 23rd, there were 172 (stale seedbed without res. managers) and 176 (stale seedbed with res. managers) seedlings emerged per 100 feet of row compared to 150 seedlings per 100 feet of row in the spring tillage treatment. Stand counts at harvest indicate that there was little difference in final stand between treatments (Table 1), but counts were still slightly higher in the stale seedbed treatments. Recoverable sugar per ton (RST) and gross return per ton (GRT) were not different among the treatments (Table 1). Recoverable sugar per acre (RSA) and gross return per acre (GRA) were lower for the stale seedbed+residue managers but the stale seedbed without residue managers provided the same RSA, GRA, and all related parameters as the check treatment.

2009: Considering the poor seedbeds created in spring 2009, the stale seedbed treatments produced remarkably good results. Stale seedbed planting (with or without using residue managers on the planter) gave statistically equal values for sugarbeet root yield and sugar content compared to the spring tillage treatment (Table 1) for all sugarbeet yield and quality parameters except final stand count (Beets per 100 ft), which was lower for stale seedbed+residue managers compared to other treatments. Root yield was very good for all treatments. Net sugar in the stale seedbed treatments was equal to or higher than net sugar determined for the spring tillage treatment. There were no significant differences between treatments for gross return per ton or gross return per acre. In terms of early season sugarbeet seedling emergence, stand counts taken June 16th, 25 days after planting, showed lower stand counts in stale seedbed treatments, but the values were not statistically significant. By harvest, there were statistically fewer sugarbeet per 100 ft. of row for stale seedbed treatments (Table 1). Stale seedbed stand count values taken at harvest were 9% and 12% lower (without residue managers and with residue managers, respectively) than spring tilled seedbeds. Despite fewer sugarbeets, the root yield per acre and gross revenue per ton were no different between stale seedbeds and spring tilled seedbeds.

2010 Growing Season: The 2010 growing season was very favorable for sugarbeet production. Yields and sugar content were good, providing high recoverable sugar per acre. The stale seedbed treatments performed as well or better than the conventional spring tillage check treatment for yield and all other measurements (Table 1). No statistical differences were noted among any sugarbeet yield or quality values, indicating again that stale seedbed planting is a highly favorable alternative to conventional spring tillage.

Conclusions

These data suggest that stale seedbed planting should certainly be considered by growers, since even a very poor stale seedbed did not result in any significant reductions in root yield, sugar content, or revenue compared to conventional spring tillage. The site locations selected for this study were silty loams or sandy loams susceptible to crusting and wind erosion. Wheat was the previous crop in all instances. There is an expected net increase in per acre revenue from stale seedbed planting as a result of savings in diesel fuel. The intangible benefits of more time, reduced wear and tear to machinery, and greater flexibility in spring as a result of eliminating unnecessary machinery passes across each acre are additional incentives for growers to consider testing stale seedbed planting on a small part of a field in coming years.

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Table 1. Sugarbeet yield and quality parameters resulting from stale seedbed planting for years 2008-2010. In all years except 2009 primary tillage (conducted the previous fall) for all treatments was chisel plowing two times in a manner consistent with common grower practices. In fall 2008, however, conditions were extremely wet and only one shallow chisel plow operation was possible, resulting in a very cloddy seedbed in spring 2009. 'Check' indicates standard spring tillage practice accomplished with a cultivator with a rolling crumbler bar; 'Stale – no res. mngrs' indicates that sugarbeet seed was planted into a stale seedbed employing a planter without residue managers; 'Stale – w/ res. mngrs" indicates that sugarbeet seed were planted into a stale seedbed using a planter equipped with residue managers. LSD values indicate the least significant statistical difference between treatments (P<0.05). If LSD is recorded as *NS*, then no treatment differences were significant.

Year	Tillage Treatment	Root Yield (Tons/a)	Gross Sugar (%)	SLM (%)	Net Sugar (%)	Beets (100 ft)$^{-1}$	RSA* (lb/a)	RST** (lb/ton)	GRT† ($/ton)	GRA‡ ($/acre)	Tare (%)
2008	CHECK	32.92	16.1400	1.1291	15.0109	170.3	9875.14	300.22	39.68	1304.36	6.13
2008	STALE – NO RES. MNGRS	33.22	16.0333	1.1888	14.8446	171.7	9885.79	296.89	38.86	1296.46	6.36
2008	STALE – W/ RES. MNGRS	30.93	15.8717	1.1007	14.7710	177.8	9113.86	295.42	38.49	1184.89	7.25
2009	CHECK	38.66	14.5667	1.4050	13.1617	153.9	10186.53	263.23	30.53	1182.61	1.53
2009	STALE – NO RES. MNGRS	38.30	14.6167	1.3850	13.2317	140.0	10139.63	264.63	30.87	1183.34	1.50
2009	STALE – W/ RES. MNGRS	37.44	14.9167	1.4167	13.5000	135.6	10083.85	270.00	32.20	1199.55	1.78
2010	CHECK	35.31	16.1850	0.9982	15.1868	170.0	10724.00	303.74	54.70	1931.15	5.06
2010	STALE – NO RES. MNGRS	35.49	16.1667	1.0201	15.1466	169.2	10759.83	302.93	54.46	1935.51	5.72
2010	STALE – W/ RES. MNGRS	34.76	16.2383	1.0144	15.2239	169.7	10579.55	304.48	54.92	1907.92	4.20
	LSD	**1.64**	**0.4101**	**0.0720**	**0.4715**	**10.8**	**563.19**	**9.43**	**2.37**	**81.83**	**1.15**

* Recoverable Sugar per Acre; ** Recoverable Sugar per Ton; †Gross Return per Ton; ‡Gross Return per Acre