TILLAGE AND PLANTER EFFECTS ON SUGAR BEET SEEDLING EMERGENCE AND UNIFORMITY OF BEET SIZE

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ABSTRACT

Sugar beet crops were established in 1999 and 2000 at the Saginaw Bean and Beet Research Farm in a Zilwaukee Silty Clay soil to evaluate the effect of seedbed tillage, planter selection and seed treatment on seedling emergence, uniformity of plant spacing and beet size, and recoverable sugar. In 1999, increasing spring seedbed tillage intensity created a drier seed bed throughout the early growing season. When averaged across tillage systems, 83% of the final stand had emerged by May 10 in the stale seedbed, but only 37% had emerged in the most intensively tilled plots. Use of the Accord planter improved the uniformity of plant spacing. The Accord planter provided significantly more plants within a 4 to 6 inch spacing and fewer plants with spacings of less than 4 or more than 8 inches than the general purpose planter. Although there were no consistent differences among specific treatments, less intensive tillage tended to produce more roots in the 1 to 2.5 lb. range and less exceeding 2.5 pounds. Averaged over tillage systems the most intensively tilled plots provided 45% of roots in the 1 to 2.5 lb. range and 40% greater than 2.5 pounds. The stale seedbed yielded 57% of roots between 1and 2.5 lb. and 25% in the larger range. Beet root yield was similar among tillage and planting treatments although percent sugar tended to be higher in the stale seedbed. There were no differences in recoverable white sugar per acre among the tillage and planting treatments.

INTRODUCTION

Michigan sugarbeet fields are generally not irrigated. Growers often sow 50-60,000 seeds per acre to obtain harvestable stands of 26,000 plants per acre. Sugarbeet plants fail to emerge or survive for many reasons: a percentage of seeds die before planting, some seeds germinate but fail to emerge, others emerge yet die of disease, insect and other damage. This high level of seed mortality can lead to wide variations in plant spacing, beet size, sugar content and harvestable yield.

Tillage and planter performance influence beet stands. Under dry conditions, a coarse, loose and deep seedbed resulted in poor emergence (Gummerson, 1986; Smith et al., 1999). Establishment was best when seedbed tillage was planned to minimize the time between tillage and planting. Planting directly into a fall prepared seedbed with no or very shallow spring seedbed tillage was reported to be a reliable way to obtain a seedbed conducive to beet emergence (Gummerson, 1987). Smith (1999) reported that minimal spring tillage which left a firm seedbed at seed depth provided the most rapid emergence, highest final emergence and highest yield. When adequate rainfall occurred within a few days of planting there was little difference among tillage systems (Gummerson, 1986; Smith et al., 1999).

Planter design affects seed placement and plant stand. In Michigan, general purpose planters designed for corn and soybeans are generally used for sugarbeet. Such planters are designed to operate at a seeding depth of 1½ to 2½ inches and may have a seed drop of as much as 24 inches. Precision seeders are available which have furrow openers, depth control mechanisms and press wheels designed for small seeded crops such as sugarbeet. Beet emergence near 90% of the seeding rate was possible on irrigated land when using these seeders in a firm, level, shallow seedbed (Smith et al., 1991). Gummerson (1989) reported that 70% of the variation in beet emergence could be explained by variation in depth of seed placement. The best depth control was in a firm, level seedbed. In Michigan, use of a precision seeder increased plant stand, improved uniformity of plant spacing, provided a smaller, more uniform beet size with a higher sugar content and increased yield compared to a general purpose planter (Harrigan and LeCureux, 1998). A need exists to evaluate alternative tillage and seeding technologies for the establishment of sugar beet stands in Michigan.

This report provides an update of ongoing sugarbeet tillage and planting work in Michigan at the Saginaw Bean and Beet research farm. Specific objectives of this research were to evaluate the effects of tillage, planter, and seed treatment on: 1) seedling emergence, 2) uniformity of plant spacing, 3) size of harvested roots, and 4) recoverable sugar.

METHODS

Sugar beet crops were established in 1999 and 2000 at the Saginaw Bean and Beet Research Farm in a Zilwaukee Silty Clay soil to evaluate the effect of seedbed tillage, planter selection and seed treatment on seedling emergence and recoverable sugar. All tillage plots were fall moldboard plowed. Three seedbed tillage treatments were used: 1) fall tillage with a spring tooth harrow, no spring tillage (stale seedbed), 2) fall tillage with a spring tooth harrow followed by spring seedbed tillage with a single, shallow pass of a Danish tine field cultivator, and 3) spring seedbed tillage with a conventional field cultivator followed by a single pass of the danish tine to level and firm the seedbed. In 2000 a fourth spring tillage treatment was added on fall plowed and leveled land: a single pass with a combination spike tooth/rolling harrow to break the crust and firm and level the seedbed. All spring tillage was done within a few hours of planting to conserve seedbed moisture. The single, shallow pass with the danish tine cultivator was at a depth of 1-2 inches to level the surface yet avoid excessive drying of the seedbed. An objective with this tillage system was to till the soil no deeper than the depth of seed placement.

Stand establishment goals included early season emergence and growth, a high plant population and a uniform spacing between plants in the row. Planting was with a John Deere 7300 general purpose vacuum planter and an Accord plate-type beet planter. The variety E-17 was used with either a Celpril (1999) or Fasonated (2000) seed treatment (film coated with a fungicide and color dye) or a pelleted PAT treatment. The PAT process initiates the germination process then inhibits it before the radical ruptures the seed coat. This process has been shown to speed germination early in the season in cool soil. The PAT seed was used with both the John Deere and the Accord planter. The Celpril treated seed was used with the John Deere planter. Each of the tillage/planter/seed treatment combinations was replicated six times.

Planting, harvest and crop care information are provided in Table 1. Soil moisture in the seed zone (surface two inches) was monitored during the 30-day stand establishment period. Stand counts were made on May 10, May 17 and May 28 (1999) and April 28, May 8 and May 22 (2000). Following the final stand count, the spacing between individual plants in the row were recorded.

Following root topping, representative root samples were hand-dug and individual weights recorded as a measure of size uniformity. Root yield and sugar content were based on machine harvested samples.

Table 1. Planting, harvest and crop care information.

Planting and Harvest			Crop Care		
	1999	2000		1999	2000
Planting date	April 28	April 18	**Fertilizer**	200 lb/ac 46-0-0, 3/12	120 lb/ac 46-0-0, 3/3
Row spacing	28 inches	28 inches	**Herbicides**	2 qt/ac Nortron, 4/30	2 qt/ac Nortron, 4/20
Seed spacing	5.5 inches	5.5 inches		5 lb/ac Pyramin DF, 4/30	5 lb/ac Pyramin DF
Planting depth	1 inch	1 inch	**Row cultivate**	6/8	6/23
Planting speed	4 mph	4 mph		6/17	
Seed variety	E-17	E-17	**Fungicides**	.5 lb/ac Benlate, 7/20	13 oz/ac Eminent, 7/24
Seed treatment	4M PAT pellet	4M PAT pellet		2 lb/ac Manzate, 7/20	5 oz/ac SuperTin, 8/8
	#3 Celpril	#3 Fasonated		5 oz./ac SuperTin, 8/6	5 lb/ac Topsin, 8/25
Harvest date	September 22	---		2 lb/ac Manzate, 8/31	2 lb/ac Manzate, 8/25
Soil series	Zilwaukee silty clay	Zilwaukee silty clay			

Results

Increasing tillage intensity created a drier seed bed throughout the early growing season. More intensively tilled soil dried faster and remained drier throughout the stand establishment period than less tilled soil. This lack of soil moisture likely contributed to a delay in emergence of the spring tilled plots in 1999. Seeds in the stale seedbed emerged more quickly and achieved a higher population than in the more intensively tilled plots. When averaged across tillage systems, 83% of the final stand had emerged by May 10 in the stale seedbed, but only 37% had emerged in the most intensively tilled plots (Table 2). Within tillage systems there were no consistent differences due to planter or seed treatment. However, the Accord planter provided a higher plant stand following a single, shallow pass of the danish tine tillage tool.

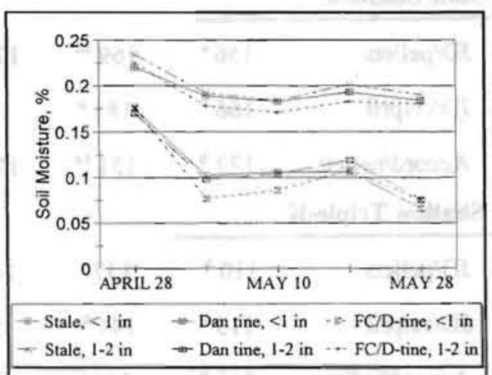

Figure 1. Seed zone soil moisture, 1999

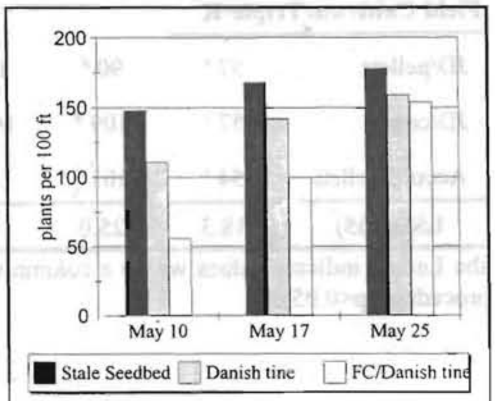

Figure 2. Emergence and stand, 1999.

In 2000, heavy rains left standing water and a crusted soil surface within a few days of planting. An attempt was made to break the crust over the seed furrow. Stands of 25 to 62% of the seeding rate were obtained (Fig 3). Pelleted seed generally provided a lesser stand than fasonated seed, presumably due to greater mechanical damage in the crust breaking process. The pelleted seed was likely at a more vulnerable stage of growth than the fasonated seed.

Viewed across tillage methods and planters the best stands were obtained when planting fasonated seed into a stale seedbed (Fig. 3). The 2000 trial was abandoned after recording the 30-day stand count.

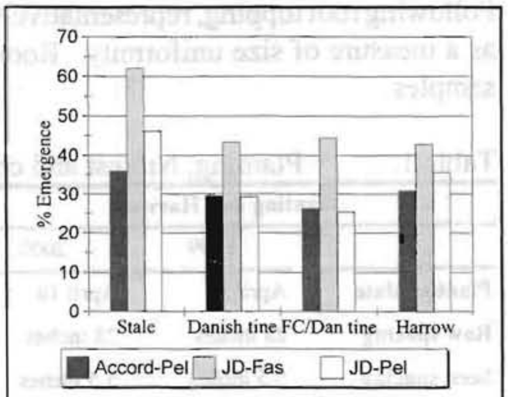

Figure 3. 30-day stand, 2000

The desired seed spacing was about 5.5 inches. Use of the Accord planter improved the uniformity of plant spacing (Table 3). A uniform spacing contributes to a uniform size by providing each plant an equal area to compete for sunlight and nutrients. The Accord planter provided significantly more plants within the 4 to 6 inch spacing than the general purpose planter. The Accord planter also provided fewer plants with spacings of less than 4 or greater than 8 inches than the John Deere planter. There was little difference in plant spacing uniformity between pelleted and Celpril seed when using the John Deere planter. The Accord planter performed better in the less intensively tilled seedbed.

Table 2. Seedling emergence, yield of roots, percent sugar and clear juice purity, and recoverable sugar, 1999.

	Emergence, plants/100 ft							
	May 10	May 17	May 25	Yield ton/acre	Sugar %	CJP %	RWST	RWSA
Stale Seedbed								
JD/pellets	156 ^{a}	169 ^{ab}	174 ^{abc}	27.0 ^{a}	18.73 ^{a}	92.40 ^{ab}	262 ^{abc}	7070 ^{a}
JD/celpril	166 ^{a}	185 ^{a}	184 ^{a}	28.3 ^{a}	18.71 ^{a}	92.75 ^{a}	264 ^{a}	7482 ^{a}
Accord/pellets	122 ^{b}	151 ^{bc}	175 ^{abc}	27.3 ^{a}	18.74 ^{a}	92.52 ^{ab}	263 ^{ab}	7172 ^{a}
Shallow Triple-K								
JD/pellets	110 ^{b}	137 ^{c}	148 ^{d}	26.3 ^{a}	18.47 ^{ab}	92.01 ^{b}	256 ^{cd}	6730 ^{a}
JD/celpril	113 ^{b}	144 ^{bc}	155 ^{cd}	28.2 ^{a}	18.17 ^{b}	92.29 ^{ab}	253 ^{d}	7152 ^{a}
Accord/pellets	110 ^{b}	143 ^{c}	175 ^{ab}	27.8 ^{a}	18.28 ^{b}	92.23 ^{ab}	255 ^{d}	7078 ^{a}
Field Cultivate/Triple-K								
JD/pellets	57 ^{c}	90 ^{d}	145 ^{d}	27.5 ^{a}	18.39 ^{ab}	92.36 ^{ab}	257 ^{bcd}	7061 ^{a}
JD/celpril	57 ^{c}	109 ^{d}	161 ^{bcd}	27.5 ^{a}	18.27 ^{b}	92.38 ^{ab}	255 ^{d}	7014 ^{a}
Accord/pellets	54 ^{c}	101 ^{d}	155 ^{cd}	27.2 ^{a}	18.36 ^{ab}	92.32 ^{ab}	256 ^{cd}	6972 ^{a}
LSD (.05)	18.3	25.0	19.7	2.24	0.38	0.62	6.3	614

abc Letters indicate values within a column which are not significantly different by the Least Significant Difference procedure ($p<0.05$).

Beet root sugar content decreased as the roots grew larger (Fig. 4). A favorable root size relative to ease of harvest and high sugar content ranged from about 1 to 2.5 pounds. Although there were no consistent differences among specific treatments, less intensive tillage tended to produce more roots in the 1 to 2.5 lb. range and less exceeding 2.5 pounds. Averaged over tillage systems the most intensively tilled plots provided 45% of roots in the 1 to 2.5 lb. range and 40% greater than 2.5 pounds. The stale seedbed yielded 57% of roots between 1and 2.5 lb. and 25% in the larger range.

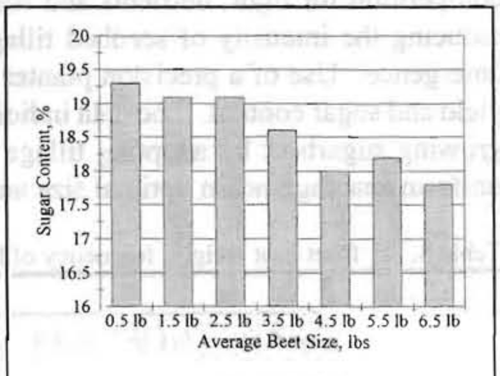

Figure 4. Sugar content by beet size, 1999.

Beet root yield was similar among tillage and planting treatments although percent sugar tended to be higher with the stale seedbed. And, although there were no consistent differences in clear juice purity among treatments there was a trend toward greater recoverable white sugar from the crop grown in a stale seedbed. There were no differences in recoverable white sugar per acre among the tillage and planting treatments.

Table 3. Thirty-day plant spacing, 1999

	30-Day Plant Spacing (% of total stand)							
	<2 in.	2-4 in.	4-6 in.	6-8 in.	8-10 in.	10-12 in.	12-14 in.	>14 in.
Stale Seedbed								
JD/pellets	3.8^{a}	13.5^{a}	32.0^{cde}	26.3^{a}	10.7^{a}	4.5^{d}	3.8^{bc}	5.7^{bc}
JD/celpril	3.3^{ab}	14.8^{a}	36.5^{c}	23.5^{a}	9.3^{ab}	4.3^{d}	3.8^{bc}	4.3^{bc}
Accord/pellets	0.8^{c}	3.0^{c}	54.7^{a}	23.3^{a}	1.0^{c}	9.5^{bc}	3.5^{bc}	3.7^{c}
Shallow Triple-K								
JD/pellets	2.3^{abc}	9.5^{b}	33.8^{cd}	21.3^{a}	7.0^{b}	6.3^{cd}	8.0^{a}	11.7^{a}
JD/celpril	3.7^{ab}	11.7^{ab}	29.5^{de}	22.8^{a}	9.2^{ab}	7.7^{bcd}	3.3^{c}	12.5^{a}
Accord/pellets	1.5^{bc}	1.5^{c}	51.2^{a}	26.2^{a}	1.5^{c}	10.7^{b}	3.8^{bc}	3.2^{c}
Field Cultivate/Triple-K								
JD/pellets	1.8^{abc}	11.2^{ab}	30.0^{cde}	20.8^{a}	11.0^{a}	6.3^{cd}	5.8^{ab}	12.8^{a}
JD/celpril	2.2^{abc}	13.7^{a}	26.5^{e}	25.5^{a}	10.8^{a}	5.3^{d}	6.7^{a}	9.2^{ab}
Accord/pellets	1.7^{abc}	0.8^{c}	44.2^{b}	22.7^{a}	2.2^{c}	16.2^{a}	3.3^{c}	9.5^{ab}
LSD (.05)	2.2	3.9	6.6	6.1	3.4	3.4	2.4	5.5

abc Letters indicate values within a column which are not significantly different by the Least Significant Difference procedure ($p<0.05$).

DISCUSSION

Improving cultural practices will allow Michigan beet growers to reduce risk and improve profitability by increasing yield and sugar content. Improving seed spacing will minimize plant competition for light, nutrients and soil moisture, and facilitate weed control. Data indicate that reducing the intensity of seedbed tillage will conserve soil moisture and speed the rate of plant emergence. Use of a precision planter improves the uniformity of beet size which could increase yield and sugar content. The data indicate that there are opportunities to improve the profitability of growing sugarbeet by adopting tillage and planting systems which provide for rapid emergence, uniform spacing and an optimal size and sugar content.

Table 4. Beet root weight, frequency of hand-harvested samples, 1999.

	Beet Size Frequency (% of stand)									
	<.5 lb	.5-1 lb	1-1.5 lb	1.5-2 lb	2-2.5 lb	2.5-3 lb	3-3.5 lb	3.5-4 lb	4.5-5 lb	>5 lb
Stale Seedbed										
JD/pellets	2.9^{a}	10.3^{ab}	26.0^{a}	18.4^{a}	17.7^{ab}	12.0^{a}	5.2^{b}	1.6^{c}	2.5^{b}	3.5^{b}
JD/celpril	7.6^{a}	14.1^{ab}	25.0^{ab}	18.9^{a}	12.8^{b}	9.5^{a}	5.6^{b}	1.7^{c}	2.6^{b}	2.3^{b}
Accord/pellets	7.4^{a}	10.8^{ab}	15.0^{cd}	17.2^{ab}	19.1^{ab}	11.7^{a}	5.6^{b}	5.9^{abc}	4.4^{ab}	3.0^{b}
Shallow Triple-K										
JD/pellets	4.3^{a}	13.1^{ab}	13.6^{cd}	15.7^{ab}	16.7^{ab}	11.2^{a}	11.9^{a}	5.9^{abc}	3.7^{ab}	4.0^{b}
JD/celpril	3.4^{a}	12.2^{ab}	21.2^{abc}	19.0^{a}	17.1^{ab}	9.3^{a}	5.4^{b}	2.7^{bc}	5.2^{ab}	4.6^{b}
Accord/pellets	7.5^{a}	14.5^{ab}	13.4^{d}	16.5^{ab}	13.9^{b}	10.2^{a}	11.7^{a}	5.8^{bc}	3.3^{ab}	3.3^{b}
Field Cultivate/Triple-K										
JD/pellets	2.6^{a}	9.3^{b}	11.8^{d}	13.9^{ab}	14.7^{ab}	12.2^{a}	11.1^{a}	10.9^{a}	3.3^{ab}	11.1^{a}
JD/celpril	5.7^{a}	16.8^{a}	17.7^{bcd}	14.7^{ab}	14.6^{ab}	11.6^{a}	7.3^{ab}	6.8^{ab}	2.4^{b}	2.1^{b}
Accord/pellets	2.7^{a}	10.4^{ab}	17.0^{cd}	10.5^{b}	21.3^{a}	9.1^{a}	8.7^{ab}	7.0^{ab}	8.7^{a}	4.7^{b}
LSD (.05)	5.4	7.1	7.6	7.3	6.9	6.4	5.1	5.0	5.9	5.9

abc Letters indicate values within a column which are not significantly different by the Least Significant Difference procedure ($p<0.05$).

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