Influence of Planting Date on Stand, Yield and Quality of Sugarbeet[1]

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ABSTRACT

Field studies were conducted at four locations each year in 1991, 1992 and 1993 in the sugarbeet growing regions of the Nebraska Panhandle to examine yield difference due to planting date. Sugarbeet was planted on five different dates for each site beginning the first week of April and continuing at 10 to 15 day intervals, depending on weather. Sugarbeet was planted to stand and thinned to stand. The varieties Monohikari and Beta KW3778 were compared for each planting date and planting method. Plant population was greater in the thinned to stand treatments but did not influence the final yield. The first planting period, April 1 to 10, provided the highest sugar yield for the Monohikari variety. For the Beta KW3778 variety, the first three planting periods provided the highest sugar yield. Variety Monohikari had a greater yield than Beta KW3778 when planted early, but had a lower yield when planted late.

Additional Key Words: *Beta vulgaris* L., plant-to-stand, replanting date, plant population

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Sugarbeet producers are looking for methods to increase sugar yield and reduce production inputs. Selecting the optimum planting date can maximize the growing season, utilize available soil moisture for germination and emergence and reduce the risk of frost damage to young seedlings. Nuckols (1946) conducted a date of planting study at Torrington, Wyoming between 1938 and 1945. Sugarbeet was planted on March 20, April 1, 10, 20 and 30. Results indicated no significant difference in root yield from sugarbeet planted in March as compared to plantings made April 1 and 10. A loss of 4.5 and 9.0 Mg/ha occurred when planting was delayed until April 20 and April 30, respectively. The main cause for low yields from late April plantings was the lack of adequate moisture for seed germination.

Harris et al. (1956) compared planting sugarbeet on April 2, 16 and May 2 at Mitchell, Nebraska from 1948 through 1953. An additional treatment was irrigation or no irrigation after planting. Sugarbeet planted April 2 and April 16 produced about the same root yield but a 4.5 Mg/ha yield loss occurred when planting was delayed until May 2. Over the six years of study, sugar yields from plots irrigated for emergence were similar to plots not irrigated. Irrigated sugarbeet emerged earlier than sugarbeet that was not irrigated but the incidence of severe frost influenced stands and yields accordingly. Poorest stands were associated most often with early planting and irrigation for emergence.

In a more recent study at Crookston, Minnesota, Smith (1979) examined the effects of planting date and plant population on sugarbeet yield. In this two-year study, planting dates in mid April compared with early May and June resulted in higher sugarbeet yield and higher sugar content. The gross sugar production was greatest for the April planting date and the lowest for the June planting date.

To aid in the development of a crop growth model, Lee et al. (1987) compared two planting dates, April 22 and May 27, in a study near Fort Collins, CO. The later planting date reduced gross sugar by 46%. During the growing season, root yield increased faster for sugarbeet planted on April 22. In two associated studies, Dunn et al. (1990) and Bravo et al. (1992) studied the effect of planting date on carbohydrate concentrations and total content of five micronutrients in sugarbeet, respectively. Sugarbeet yield was not measured in these studies.

Since those studies were completed, a number of factors have occurred which influence stand establishment and production. New varieties are constantly being developed for higher sugar content and improved quality and may be influenced by date of planting differently than standard varieties used years ago. Recent projections for returns on sugarbeet emphasize percent sugar rather than tonnage of roots.

In the study by Smith (1979), the sugarbeet yield was also related to plant population. Yield tended to be lower when plant population was either too high or too low. Plant population is affected by environmental conditions during the plant establishment period. The correct stand is necessary to realize maximum sugar content. Contractually, higher sugar content results in higher return to producers. In recent years producers have tended to plant fewer seeds per hectare as a result of planting to stand. However, when planting to stand, the risk of a killing spring frost can result in replanting because too few plants survive.

Sugarbeet is sensitive to temperatures of -2.2°C or below when the hypocotyl is bent pulling the cotyledons through the soil. Table 1 gives the last spring -2.2°C for three areas within the Panhandle of Nebraska (Meyer and Dutcher, 1996)

Table 1. Date of last spring -2.2°C temperature for sugarbeet growing regions in Nebraska Panhandle.

Location	Earliest	Median	Latest
Alliance	April 2	April 28	June 2
Bridgeport	April 5	April 29	June 2
Mitchell	April 5	April 29	May 29
Kimball	April 4	May 1	June 3

Some sugarbeet growers desire to start planting during early April or late March based on the following: 1) Establishing the sugarbeet plant earlier in the season can provide a wider window to receive precipitation and avoid early irrigation for germination. 2) A warm period in late March and early April may allow plants to get large enough to withstand frost damage that might occur in mid to late April. 3) If plants are killed due to frost, planting early allows time for replanting during the early part of the growing season. As a result of these factors, planting early is considered a method to extend the growing season and increase production. For many growers this is possible because larger field equipment is being used which can reduce the time required to prepare the soil and to plant.

Soil moisture and temperature are key factors that determine rate of germination and final number of plants to emerge. Yonts et al. (1983) found in a laboratory study that maintenance of soil moisture tension of

600 kPa or less would result in 60% emergence when other emergence factors remained constant. If adequate soil moisture for germination is lacking at planting time, many producers have the option of irrigation. When soil moisture is inadequate for germination, the effective planting date occurs when irrigation or rainfall is applied. A center pivot or furrow irrigation system both provide a mechanism to apply water and start seed germination. Surge, a process of intermittently applying water in furrow irrigation, reduces the intake rate of the soil and allows the irrigator to become more efficient and reduce labor during an early irrigation period.

In this same study Yonts et al. (1983) also concluded that soil temperature had more effect on the rate of emergence than final emergence. Little can be done to alter soil temperature in the field, other than planting later in the growing season. Planting later in the growing season increases the rate of accumulated heat units. Based on average air temperature between 1960 and 1990 and an April 1 planting date at Scottsbluff, NE, it requires 20 days to accumulate approximately 85 heat units (HU) (Fornstrom and Pochop, 1974). This level of accumulated heat units, according to Yonts et al., (1983), is required to reach a 50% emergence level. In contrast, if planting is delayed until April 15, it requires only slightly more than 10 days to reach 85 HU. This means that delaying planting from April 1 to April 15 results in only a five-day difference in accumulated heat units to reach a 50% emergence level.

When soil moisture and temperature are not favorable for germination in the spring, uneven stands due to low emergence and different emergence rates result. When planting conditions are favorable, germination and emergence occur in a short period of time. Although climatic conditions may be favorable at planting time, freezing temperatures during emergence or shortly after can result in total stand loss. Therefore, early spring planting increases the risk of undesirable climatic conditions and can often result in having to replant.

The primary reason for planting early is to increase the length of the growing season and increase total production. However, the cost of replanting plus the reduction in length of growing season and yield due to replanting, can result in less income to the grower as compared to sugarbeet that were planted later to avoid weather related problems. Planting later in the spring provides faster germination and emergence and decreases the potential for frost injury. Thus the questions, "Should I plant early?" and "What yield can I expect if replanting is necessary?" The objective of this study was to examine sugarbeet yield difference due to planting date.

MATERIALS AND METHODS

Field studies were conducted at four locations in western Nebraska during April, May and June of 1991, 1992, and 1993. Experimental plots were located at the University of Nebraska Panhandle Research and Extension Center near Scottsbluff on a Tripp very fine sandy loam soil (Typic Haplustolls), the John Maser farm near Bayard on a Tripp very fine sandy loam soil (Typic Haplustolls), the Harvey Schnell farm near Alliance on a Keith loam soil (Aridic Argiustolls), and the Don Rein farm near Gering on a Mitchell silt loam soil (Typic Ustorthents). Each location was plowed and packed in preparation for sugarbeet planting. Plots were treated with the preplant herbicide ethofumesate at either 1.1 or 1.2 kg/ha depending on the soil type. The lower rate was utilized at the Scottsbluff and Bayard sites and the higher rate at the Alliance and Gering sites. The herbicide was incorporated immediately after application with a roller packer.

Sugarbeet planting began during the first week in April. Subsequent plantings continued at approximately 10 to 15 day intervals. A total of five plantings were conducted each year at each site. The exact schedule was dependent on weather and equipment availability. The planting date intervals that resulted are included in Table 3.

Sugarbeet was planted using a John Deere 71 flexi planter at two seeding rates. Seeding rates were selected to represent "plant-to-stand" and "thin-to-stand" populations. At Alliance and Bayard sugarbeet rows were spaced at 76 cm. Seeds were planted at 525 and 985 seeds per 50 m of row for "plant-to stand" and "thin to stand" treatments, respectively. At Scottsbluff and Gering where row spacing was 56 cm, 375 and 720 seeds were planted per 50 m of row for "plant-to-stand" and "thin-to-stand" treatments, respectively.

Plants in the higher seeding rate at both row spacings were manually thinned to 20 or 15 cm in-row spacing for 56 and 76 cm row spacings, respectively. Thinning for all fields was completed when plants were in the four to eight leaf stage of growth. All "thin-to-stand" treatments at a given site were thinned at the same time. In addition, two varieties of sugarbeet, Monohikari and Beta KW3778 were planted at each location on each date at the two seeding populations. During the balance of the season, sugarbeet plots were hand weeded, cultivated, ditched, and irrigated in a conventional manner.

The Scottsbluff and Alliance sites were grown under sprinkler systems while the Gering and Bayard sites were with furrow irrigation systems. Irrigation for germination and emergence was used at the Scottsbluff and Alliance sites to insure adequate soil water for emergence after planting.

The experimental design was a split block with date of planting and method of planting being the main plots and sugarbeet variety the sub-plots. Each treatment was replicated six times. Emerged sugarbeet plants were counted twice weekly beginning five days after planting. Plant stand counts continued until mid-June to assure that final emergence was recorded. Sugarbeet was hand harvested at all locations during the first week of October. Total root weight was determined by harvesting 4.6 m from the middle two rows in each plot. Sub-samples were taken to the Western Sugar Company tare lab for analysis of sugar content and tare.

RESULTS

The effect of location, method of planting, and sugarbeet variety on plant population and sugarbeet yield and quality during the 1991 to 1993 growing seasons is given in Table 2. The Scottsbluff and Alliance locations tended to produce more sugar than the Bayard and Gering locations, except in 1993. Soil moisture was a limiting factor at the Gering and Bayard location in 1991 and 1992 during the period of seed germination and emergence. In 1992, a severe July hail storm at the Gering location resulted in a complete loss of the sugarbeet crop.

Sugarbeet plant population tended to be higher in the "thin-to-stand" treatment after thinning than the "plant-to-stand" treatment. Yield was not influenced by the difference in plant population caused by the method of planting.

When comparing Monohikari and Beta KW3778 varieties, Monohikari had a higher plant population per acre at harvest time. Root yield of Monohikari was 1.4 Mg/ha higher then Beta KW3778 and sugar yield of Monohikari was 0.2 Mg/ha higher than Beta KW3778. Sugar content, however, was 0.1 percent higher for Beta KW3778 compared to Monohikari.

The variety by planting date interaction was significant for all yield parameters, Table 3. For Monohikari, root yield was highest for the April 1 to 10 planting date interval. The next two planting date intervals had similar root yield and were 5.6 and 6.5 Mg/ha less than the first planting date interval. During the fourth and fifth planting date intervals, root yield decreased compared to the first planting date interval by 17.7 and 28.0 Mg/ha, respectively. Plant population for Monohikari variety was lowest on the first and fourth planting date intervals and highest on the second, third and fifth planting date intervals.

Table 2. Effect of location, method of planting, and sugarbeet variety on sugarbeet stand, yield, and quality during 1991 to 1993.

Variable Examined		Harvest Population	Root Yield	Sugar	Sugar yield	Tare
		plants/ha	Mg/ha	(%)	Mg/ha	(%)
Location						
1991	Scottsbluff	79200	65.9	15.7	10.4	11.1
	Bayard	42600	40.8	17.5	7.2	8.3
	Alliance	57700	64.1	18.2	11.7	10.5
	Gering	62000	53.8	15.8	8.6	8.0
1992	Scottsbluff	106000	55.6	17.9	10.0	13.6
	Bayard	61000	30.3	19.9	6.9	7.1
	Alliance	66800	45.7	19.1	8.8	10.5
1993	Scottsbluff	96600	46.0	15.9	7.4	9.5
	Bayard	71500	44.6	17.1	7.7	6.0
	Alliance	94300	42.4	16.2	6.9	10.3
	Gering	58200	20.0	12.7	2.6	15.9
LSD at 5%		6500	4.0	0.4	0.7	1.9

[a]NS = Indicates the difference between means was not significant at the 5% level of confidence.

Table 2. (Continued)

Variable Examined	Harvest Population	Root Yield	Sugar	Sugar yield	Tare
	plants/ha	Mg/ha	(%)	Mg/ha	(%)
Method of Planting					
Plant to stand	69400	46.6	17.0	8.1	10.0
Thin to stand	75000	46.2	17.0	8.0	10.2
LSD at 5%	1900	NS[a]	NS	NS	NS
Variety					
Monohikari	75200	47.1	16.9	8.1	10.1
Beta KW 3778	69700	45.7	17.0	7.9	10.2
LSD at 5%	1400	0.9	0.1	0.2	NS

[a]NS = Indicates the difference between means was not significant at the 5% level of confidence.

Table 3. Effect of planting date and sugarbeet variety on sugarbeet yield and quality during the 1991 to 1993 growing seasons.

	Variety					
	Monohikari			Beta KW 3778		
Variable Examined	Root Yield	Sugar	Sugar Yield	Root Yield	Sugar	Sugar Yield
	Mg/ha	%	Mg/ha	Mg/ha	%	Mg/ha
Planting Date Interval						
April 1 to April 10	58.7	17.4	10.2	50.7	17.8	9.0
April 12 to April 21	53.1	17.7	9.4	48.4	17.5	8.4
April 22 to May 1	52.2	16.9	8.9	51.3	16.9	8.7
May 2 to May 13	41.0	16.0	6.8	43.7	16.3	7.3
May 14 to June 10	30.7	16.5	5.4	34.1	16.8	6.1
LSD at 5%	2.2	0.2	0.4	2.5	0.3	0.5

For Beta KW3778, the first, second, and third planting date intervals produced the highest root yield and averaged 50.1 Mg/ha. The fourth and fifth planting date intervals reduced sugarbeet root yield by 6.4 and 16.0 Mg/ha, respectively, when compared to the average of the first three planting date intervals. Plant population for variety Beta KW3778 responded similarly to the Monohikari variety in that plant population was lowest on the first and fourth planting date intervals and highest on the second, third and fifth planting date intervals.

Sugar content for Monohikari was greatest for the second planting date interval. For Beta 3778, the first and second planting date intervals were similar and produced the greatest sugar content. For both varieties, sugar content was the least for the fourth planting date interval. Overall, sugar yield declined with the latest date of planting for both Monohikari and Beta 3778.

The estimated linear regression between root yield, sugar content and sugar yield and planting date is given for the varieties Monohikari and Beta KW3778. No significant difference was found in the regression between sugar content and date of planting for either Monohikari or Beta KW3778 varieties. For root yield, a significant difference was found in the regression between both Monohikari and Beta KW3778 and date of planting. Fig 1 shows the results of linear regression between root yield and planting date for the varieties Monohikari and Beta KW3778. Regression between sugar yield and planting date, which is a result of root yield and sugar content, also revealed a significant difference for both varieties tested. Fig 2 shows the estimated linear regression between sugar yield and planting date for Monohikari and Beta KW3778 varieties.

DISCUSSION

Plant population and sugar yield tended to be higher over the three-year period at Scottsbluff and Alliance compared to Bayard and Gering. The ability to irrigate and replace soil moisture immediately after planting was a contributing factor to greater yields at Scottsbluff and Alliance.

During the 1991 to 1993 growing seasons, the two methods of planting, "plant-to-stand" and "thin-to-stand," had no effect on the yield of the varieties grown. All planting dates for the "thin-to-stand" treatments at a given site were thinned on the same date.

The two tested varieties influenced yield in different ways. Beta KW3778 had a greater sugar content than Monohikari, while Monohikari had a greater root yield than Beta KW3778. Overall, the Monohikari variety produced 0.2 Mg/ha more sugar than Beta KW3778.

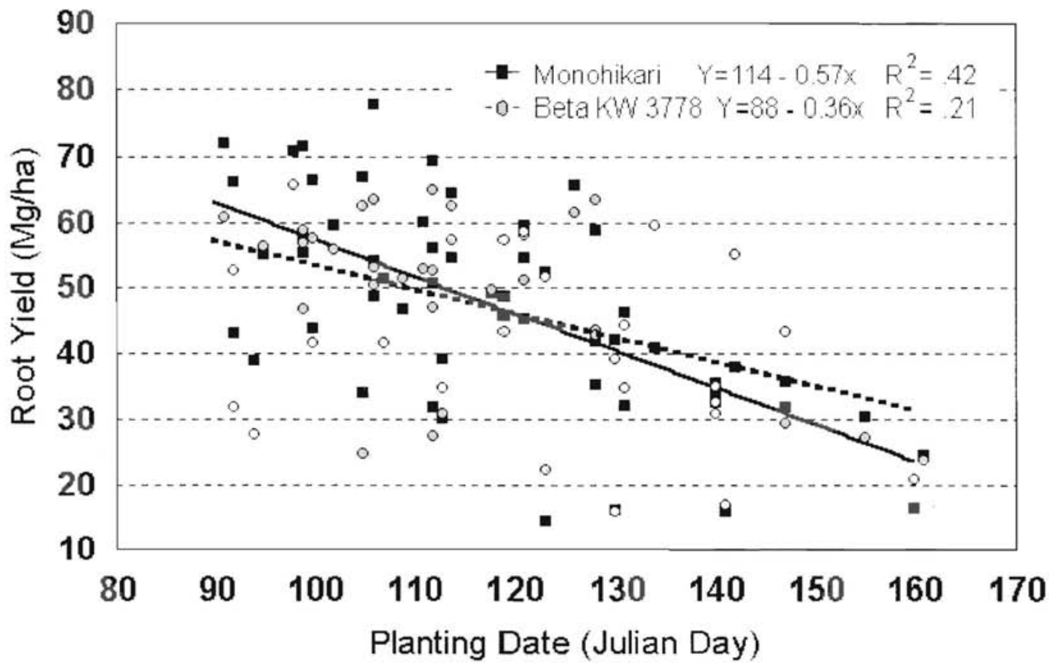

Figure 1. Estimated regression between root yield and planting date for Monohikari and Beta KW 3778 varieties.

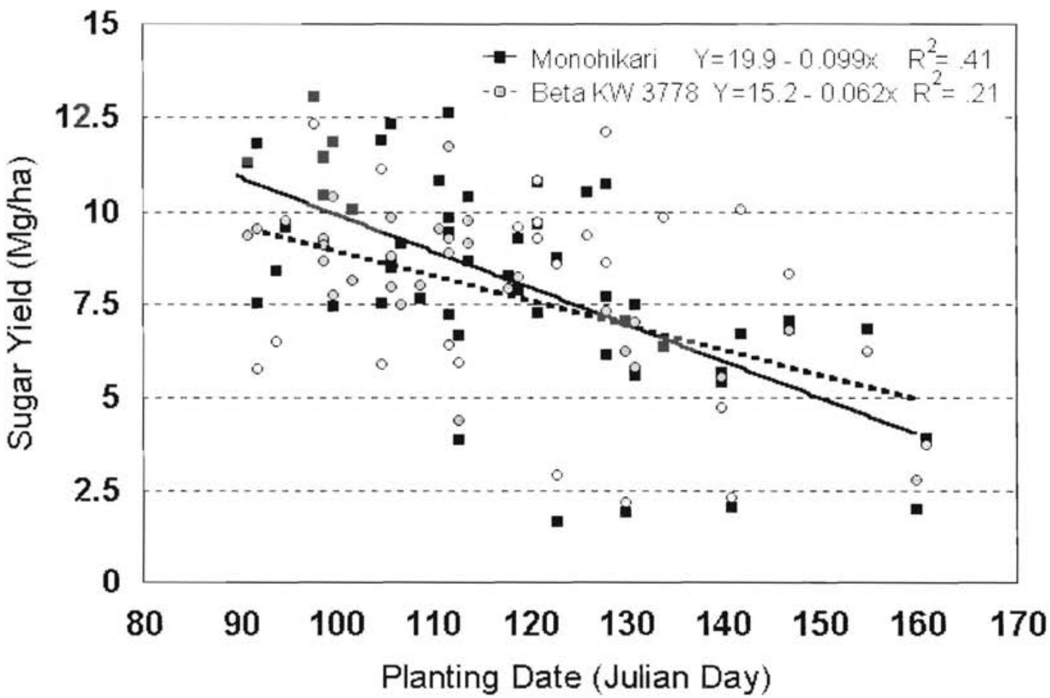

Figure 2. Estimated regression between sugar yield and planting date for Monohikari and Beta KW 3778 varieties.

Although the varieties reacted differently to the five planting date intervals, planting during the month of April provided a substantial increase in sugar yield over planting in May and June for a given variety. The Monohikari variety provided the greatest yield and also the greatest yield variation. Sugar yield ranged from 10.2 Mg/ha when planted early, to 5.4 Mg/ha when planted late. The range of sugar yield for the Beta KW3778 variety was smaller and varied from 9.0 Mg/ha when planted early to 6.1 Mg/ha when planted later. These results suggest that some varieties are better suited than other varieties for late planting dates or replanting.

During the planting dates tested, root yield decreased 0.57 Mg/ha (R^2=0.42) for each one day planting was delayed for the variety Monohikari. For Beta KW3778, root yield decreased 0.36 Mg/ha(R^2=0.21) for each one day later planting date.

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