30 IN. VS. 18 IN. ROW SUGARBEET PRODUCTION NEBRASKA RESEARCH AND GROWER EXPERIENCES

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Introduction

Most sugarbeet production in the U.S. in recent decades has been in row spacings between 22 in. and 30 in. Research in a number of growing areas has shown that root yield is generally about 1 ton/A higher in 22 in. row spacing compared to 30 in. row spacing, if other factors remain the same. Examples of row spacing data reported include those by Yonts and Smith (1997); Fornstrom and Jackson (1983); and Cattanach and Schroeder (1980). Despite the predicted sugarbeet root yield advantage of 22 in. row spacing compared to 30 in. row spacing, there are still a number of growing areas in the U.S., including Nebraska, where sugarbeets are grown in 30 in. rows. Why? Sugarbeet producers who use 30 in. rows cite several reasons. They raise other crops, such as corn and dry edible beans, prefer to use 30 in. row spacing for those other crops, and do not want to maintain field equipment and tractors for two row spacings. Producers are now using high horsepower, and thus high axle weight, tractors for row crop operations which require significant tire-to-soil contact surface area to effectively support the tractor weight and horsepower. It is easier to accommodate tires for large tractors between crop rows spaced 30 in. apart than rows spaced 22 in. apart. Producers with furrow irrigation often believe it is easier to form furrows and to irrigate with 30 in. rows than 22 in. rows. Some producers are using conservation tillage practices and find that the wider row spacing is easier to accommodate surface residue with planting and cultivating equipment.

In contrast, there are also reasons why today's successful sugarbeet grower would favor 22 in. row spacing over 30 in. row spacing. Increased root yield is at the top of the list. Narrower rows compete better with weeds, especially late season weeds. There are advantages of producing other rotational crops in 22 in. rows. Availability of tall, narrow tractor tires, precise auto-steer systems, and planters and cultivators capable of handling surface residue also help accommodate 22 in. sugarbeet production. Even more "extreme" than 22 in. row spacing, 18 in. is the most popular row spacing for sugarbeet production in western Europe. With several row spacing options, and increasing technology to help facilitate some of the practical concerns of narrower rows, some 30 in. row sugarbeet producers are asking if they make the decision to reduce their row spacing, should they convert to 22 in. or go even further to perhaps 18 in. rows?

A research project and a demonstration project evolved from this renewed interest in narrow row sugarbeet production. The purpose of the research project was to compare 30 in. row sugarbeet production to 18 in. row production in replicated field strips at the University of Nebraska. The demonstration project was initiated by and conducted by several Nebraska sugarbeet producers who wanted to learn firsthand some of the practical issues of raising sugarbeets in 18 in. row spacing.

Procedure for Research Project

This project was conducted in 2003, 2004, and 2005 at the "Mitchell Station" of the University of Nebraska Panhandle Research and Extension Center, located 5½ miles north of Scottsbluff, NE. The soil is generally described as a fine sandy loam with a pH of 8.0 and 1.0% organic matter. The previous crop was corn harvested for grain before the 2003 and 2004 sugarbeet crop, and dry beans before the 2005 sugarbeet crop. The fields were soil tested and nitrogen applied as needed. The 2004 field tested very high (300 lb/A nitrogen available!) in consecutive soil testings for nitrogen and none was applied in 2004. In all three years the fields were moldboard plowed and one pass was made with the German-made BBG seedbed preparation implement. Nortron was broadcast applied and incorporated by a second pass with the BBG implement just prior to planting. The field area was divided into 16 strips each year, in a randomized complete block statistical design with eight replications of 18 in. rows and 30 in. rows. Each 18 in. row strip was 12 rows wide and each 30 in. row strip was 8 rows wide. Strip length was approx. 800 ft. Both row spacings were planted with Deere 71 Flexi-Planters, a four row planter for 30 in. rows and a six row planter for 18 in. rows. The variety used was Hilleshog 1639 in regular pellet form in 2003 and 2004. Hilleshog 1639 was used for four replications on one side of the field and Hilleshog 7172 was used for the other four replications on the other side of the field in 2005. Target seed population was 58,000 seeds/A for 18 in. rows and 42,000 seeds/A for 30 in. rows. This difference was intended to represent the potential for the respective row spacings. In practice 30 in. row spacing fields rarely have above 32,000 established plants/A or roots will be too close. In contrast, 18 in. row spacing will spatially accommodate 42,000 plants/A or higher. This difference was considered an intentional part of the row spacing potential and comparison. The strips were planted on April 22, 2003, April 16, 2004, and April 25 & 26, 2005.

Irrigation was provided with a lateral move sprinkler system. Water was applied in multiple applications as needed to obtain high emergence. Both row spacings were roughened several times each year to prevent wind erosion and plant damage. The 18 in. row strips were cultivated one time each year. The 30 in. row strips were cultivated two times each year because of the longer time period and potential for weed development prior to row closure by the sugarbeet plants. Three applications of broadcast micro-rate herbicides were applied each year in each row spacing for weed control. Irrigation water was not available during the last half of May and most of June in 2003 and 2004. After the first of July, the crop was irrigated as needed each year. Irrigation was available as needed during the entire season of 2005. No Cercospora or powdery mildew fungicide applications were required.

Plant counts were made each year when the seedlings were in the 4-6 true leaf stage to determine established plant stand. Plant counts were made in 50 consecutive feet of two adjacent rows in three adjacent locations of each strip of each row spacing each year. Sections of row containing 100% emergence were located and the number of plants were counted in a measured length of row. This information was used to determine the seed population, which when divided into the established plant population, provided a calculated percent field emergence.

Soil water content in the top 4 in. of soil was measured through late June of 2003 and 2004. Samples were collected using a portable TDR soil probe between adjacent planted sugarbeet rows.

Soil water content was measured in each of two adjacent rows of sugarbeets. Between the 18 in. rows, three additional measurements, spaced 4.5 in. apart, were taken. For the 30 in. rows, five measurements spaced 5 in. apart were collected between the rows. Water content measurements were collected at three sites in each of the replicated row spacing field strips. Measurements were combined to reflect soil water content from a single row of sugarbeets to the center point between two adjacent rows of sugarbeets.

Two types of disease measurements were made in the two row spacings in 2004 — Cercospora leaf spot severity and the presence of an unknown, soilborne problem. Early in June, 2004, a noticeable number of plants within the field began to exhibit symptoms consisting of stunting, and upwardly-cupped leaves. Affected plants were randomly scattered throughout the field, but were additionally observed to be found occurring in groups or clusters. These symptoms were reminiscent of curly top, but the distribution of symptomatic plants suggested a cause originating in the soil. Because of the number of affected plants observed, it was decided to evaluate the relationship between the row spacings and the appearance of affected sugarbeet plants. Each of the 16 field strips was examined and the total number of stunted plants for the entire strip was recorded.

Beginning in late July, 2004, Cercospora leaf spot measurements were collected. A 100 ft. section of the field length was marked within each field strip and leaves were randomly selected from a sugarbeet plant in every 10 ft length of row. Leaves were taken into the lab and scored on a 0-9 scale, based on the percentage of the leaf surface area covered with typical lesions produced by *Cercospora beticola* (0 indicating no disease and 9 indicating leaves completely covered and dead). Three additional samplings were performed at approximately two week intervals within the same areas of each field strip throughout August and September, 2004.

A three row defoliator and two row harvester were set up for the 30 in. rows. A four row defoliator and three row harvester were assembled for the 18 in. rows. The lifter wheels were designed by and provided by Amity Technology specifically for 18 in. row spacing. The full field length, center six rows of the 18 in. row strips and the center four rows of the 30 in. strips were harvested and weighed in a Richardson 20 ton weigh cart for root yield. Four tare samples were taken from the weigh cart from each strip to the Western Sugar Cooperative tare lab for evaluation of root soil tare, percent sugar, and sugar loss to molasses.

Results from Research Project

Measured established plant population and calculated percent field emergence are shown in Table 1.

Table 1. Measured established plant population and calculated field emergence for 18 in. and 30 in. row spacings in the 2003, 2004, and 2005 studies.

	18 in. Row Spacing		30 in. Row Spacing	
Year	Measured Established Plant Population (plants/A)	Calculated Field Emergence (%)	Measured Established Plant Population (plants/A)	Calculated Field Emergence (%)
2003	46,800	83.4	32,500	76.9
2004	43,400	77.1	33,100	78.7
2005 (1639)	45,900	79.3	35,700	78.6
2005 (7172)	40,300	69.6	30,100	66.5
Average	44,100	77.5	32,800	75.2

The range of field emergence values is relatively consistent for the three years and two row spacings. The average field emergence attained in this study is higher than the average field emergence for the regional production area (approx. 65%).

Table 2 shows the average soil water content through late June for the 2003 and 2004 growing seasons. Soil water content was similar in the planted row for both 18 and 30 in. rows within a given year. Water content increased to similar levels for both 18 and 30 in. rows at the 4.5/5.0 in. distance and the 9.0/10 in. distance. This would reflect a uniform extraction of soil water by the sugarbeet for a distance of 9.0/10 in. from the planted row. In the 30 in. row treatment, soil water content in 2003 increased an additional 0.1in. at 15 in. distance compared to the 10 in. distance. In 2004, water content at the 15 in. distance increased only sightly compared to the 10 in. distance. Early in the season before row cover occurs, water held near the soil surface in the area between two adjacent rows of sugarbeets can be removed in two ways — through plant water uptake or evaporation from the soil surface. The moderate increase in soil water content in the center of adjacent rows of the 30 in. row treatment compared to the 18 in. row treatment would indicate that soil water movement from that location to the plants was slow. Maintaining higher water content levels in the soil surface could mean more water lost to evaporation and therefore unavailable to the plant for transpiration. The result is that more irrigation water must be applied to meet the needs of the plant and to replace the water lost to evaporation in 30 in. rows compared to 18 in. rows.

Table 2. Soil water content at different locations between the rows of 18 in. and 30 in. sugarbeet rows. The measurements were taken in increments of 4½ in. from the row between 18 in. rows and in increments of 5 in. between 30 in. rows.

Distance of Soil Water Measurement from the Planted Row (in.)	Soil Water Content (in.)			
	2003		2004	
	30 in. Rows	18 in. Rows	30 in. Rows	18 in. Rows
In the Planted Row	0.62	0.58	0.52	0.51
4.5/5.0	0.61	0.62	0.55	0.55
9/10	0.79	0.73	0.60	0.63
15	0.90	—	0.63	—

Stunted plants observed throughout the field strips in 2004 were found to occur more commonly in the 18 in. rows as shown in Table 3. These values were significantly different for the two row spacings, but it is not known what caused these symptoms. It is hypothesized that some type of nematode might have been responsible. Those affected plants never completely recovered and were severely damaged. However, the numbers of affected plants were not high enough to influence yield.

Overall, Cercospora leaf spot was not a major problem for sugarbeet production in this field, likely due to the cool temperatures experienced in August. One of the four sampling dates indicated that plants within the 18 in. rows were more severely diseased (Table 3) as would be expected. However, the disease readings observed over the season from the two row spacings were not significantly different. This relationship will need to be further investigated, and may yield more representative results in a year more conducive for disease development.

Table 3. Disease counts taken in 2004 of an unknown soilborne disease in the field strips and Cercospora leaf spot ratings for the two row spacings.

Row Spacing (in.)	Average Number of Plants per Strip with 'Stunted' Appearance*	Cercospora Leaf Spot Disease Rating (0 = no disease, 9 = leaves completely covered and dead)				
		First Sampling Date	Second Sampling Date	Third Sampling Date	Fourth Sampling Date	Cumulative Disease Rating
18	158 a**	0.08 a	0.52 a	1.89 a	2.46 a	4.96 a
30	52 b	0.12 a	0.62 a	1.61 a	1.77 b	4.14 a

* This is the total number of plants per field strip, averaged over all eight replications, that exhibited the 'stunted' appearance. It is estimated that there were approximately 13,000 plants in each 18 in. row strip and 10,000 plants in each 30 in. row strip.

** Numbers in columns followed by the same letter are not significantly different according to LSD tests (0.05).

Sugarbeet yield data comparing 18 in. and 30 in. row spacing are shown in Tables 4, 5, and 6 for 2003, 2004, and 2005, respectively.

Table 4. Yield data for the 2003 narrow row project.

Row Spacing (in.)	Soil Tare (%)	Sugar Content (%)	SLM (%)	Root Yield (ton/A)	Sugar Yield (lb/A)
18	4.6	19.5	1.27	28.9	11,300
30	3.7	18.4	1.34	27.0	9,900
Statistically Different? (p=0.05)	*yes*	*yes*	*yes*	*yes*	*yes*

Table 5. Yield data for the 2004 narrow row project.

Row Spacing (in.)	Soil Tare (%)	Sugar Content (%)	SLM (%)	Root Yield (ton/A)	Sugar Yield (lb/A)
18	6.8	15.7	1.47	36.8	11,600
30	4.4	15.3	1.55	34.3	10,500
Statistically Different? (p=0.05)	*yes*	*no*	*yes*	*yes*	*yes*

Table 6. Yield data for the 2005 narrow row project, averaged over both varieties.

Row Spacing (in.)	Soil Tare (%)	Sugar Content (%)	SLM (%)	Root Yield (ton/A)	Sugar Yield (lb/A)
18	3.3	15.4	1.72	30.0	9,100
30	2.7	15.4	1.65	28.9	8,900
Statistically Different? (p=0.05)	*no*	*no*	*no*	*no*	*no*

In 2005, one side (half) of the field was planted to Hilleshog variety 1639 (used in the entire fields in 2003 and 2004) and the other half was planted to Hilleshog variety 7172. These two varieties have contrasting performance history for root yield and sugar content, as shown by the 2005 results in table 7. Four replications of one site and one year do not represent enough data to make conclusions, however this data might suggest that different varieties could produce different responses from these two row spacings.

Table 7. Yield data for the 2005 narrow row project separated by variety. Varieties were not randomized within the study so statistical comparisons cannot be made between the two varieties. Values are average of four replications of each variety.

Row Spacing (in.)	Soil Tare (%)		Sugar Content (%)		SLM (%)		Root Yield (ton/A)		Sugar Yield (lb/A)	
	Variety		Variety		Variety		Variety		Variety	
	1639	7172	1639	7172	1639	7172	1639	7172	1639	7172
18	2.9	3.8	14.3	16.5	2.03	1.41	33.8	26.2	9,600	8,600
30	3.1	2.3	14.3	16.6	1.78	1.51	31.1	26.7	8,900	8,800
Statistically Different? (p=0.05)	*no*	*yes*	*no*	*no*	*no*	*no*	*yes*	*no*	*yes*	*no*

Yield data combined over all three years are provided in Table 8. Combined over the three years, there was no statistical difference in SLM, but tare, sugar content, root yield, and sugar yield were all higher in 18 in. rows than 30 in. rows.

Table 8. Yield data averaged over all three project years 2003, 2004, and 2005.

Row Spacing (in.)	Soil Tare (%)	Sugar Content (%)	SLM (%)	Root Yield (ton/A)	Sugar Yield (lb/A)
18	4.9	16.9	1.49	31.9	10,700
30	3.6	16.4	1.51	30.1	9,800
Statistically Different? (p=0.05)	*yes*	*yes*	*no*	*yes*	*yes*

<u>Summary of Research Project</u>

Sugarbeets produced in the 18 in. row system had higher soil tare, percent sugar, and root yield when compared to the 30 in. row system when averaged over the three years of this study. Production practices and field equipment were similar for both systems except plant population was intentionally higher for the 18 in. row system. Averaged over three years, the 18 in. row system produced nearly 2 ton/A and 0.5 % sugar content more than the 30 in. row system. These yield results are slightly higher than results from referenced studies comparing 22 in. and 30 in. row spacing — likely because 18 in. rows were closer to the optimum row spacing, and because plant populations were intentionally different between 18 in. and 30 in. treatments in this current study.

Two years of data suggest that prior to reaching row closure, there is potential for more loss of water through evaporation when wider row spacings are used. One year of data reported here indicates that row spacing may also influence incidence of certain sugarbeet diseases.

References

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Brief Description of Demonstration Project

The purpose of this demonstration project was for growers to experience first-hand any practical issues that might exist with 18 in. rows. They chose not to use replicated strips within their fields but instead plant part of a field in 18 in. rows and the remainder in their conventional 30 in. rows. The growers wanted to learn about issues such as residue clearance, narrow tires, and harvesting in 18 in. rows in their own fields with full sized field equipment. Thus this demonstration was designed to provide growers with observations, and not rigorous statistical results.

Three Nebraska sugarbeet growers who currently used 30 in. row systems for sugarbeets and their rotational crops, produced a total of 230 A of 18 in. row sugarbeets in four fields in 2003. All four fields were irrigated with center pivot sprinkler systems. Each grower used his typical tillage system to prepare the field for planting both row spacings. Each grower selected roughly half of the field for 30 in. rows and the remainder of the field was planted in 18 in. rows, using the same variety for both row spacings. The target seed population was 20% higher for the 18 in. rows than for the 30 in. rows. The growers planted their own 30 in. rows but all 18 in. rows were planted by a custom operator using a 12 row Deere MaxEmerge planter equipped to apply a broadcast application of herbicide at the rear of the planter. This herbicide was incorporated with an application of irrigation water. The grower conducted all field operations for the 30 in. row portion of the field. Each grower used the same cultivator to cultivate all 18 in. rows one time. The 30 in. rows were cultivated either two or three times. The growers applied all post-herbicides to both row spacings.

The 30 in. rows were harvested by the individual growers but all 18 in. rows were harvested by a custom operator with a new Amity Technology (WIC) six row harvester, designed for 18 in. row spacing. The 18 in. row defoliator was a six row, three drum model (front steel flail drum and two rubber flail drums), with row spacing adjustments made to a six row 22 in. machine.

Tire width was 12.4 in. for front and rear tires on the planter, defoliator, and harvester tractors, including front duals on the harvester tractor. The cultivator tractor used 9.5 in. width rear tires.

Observations from Demonstration Project

Established plant populations were higher in the 18 in. rows (intentionally) than in the 30 in. rows for all four fields, and averaged 46,700 plants/A in the 18 in. rows and 38,600 plants/A in 30 in. rows. Row closure was at least two weeks earlier in the 18 in. rows depending on the field and variety, and in one field, the 30 in. rows never completely closed the rows. There were no large differences observed in weed pressure between the two row spacings at the end of the season or in disease pressure.

Sugarbeet yield was estimated/measured with two methods in each field for each row spacing. The University of Nebraska hand harvested eight sections (ten feet of one row per section) of each row spacing of each field. These row sections were randomly located, while intentionally avoiding any areas with low stand or noticeable growth problems. We were interested in comparing yield potential. These samples were taken in late September and early October. Averaged over all four fields, the hand dug sampling indicated that the 18 in. rows had 0.4% higher sugar content and 4.3 ton/A higher root yield than the 30 in. rows.

Each row spacing section of each field was given a contract number and the associated acreage measured. Yield information from each row spacing of each field using whole field machine harvest was then available from each contract. Contract information indicated that the 18 in. rows had 0.3% higher sugar content than the 30 in. rows and that the root yield was numerically the same for both row spacings.

Why the difference in root yield estimated by the hand dug samples and those measured by the whole field machine harvest? There could be a number of reasons suggested, including non-representative sites for hand sampling. However, careful observation of all four fields, and limited measurements, indicated that the harvest system for 18 in. rows had an estimated 1½ ton/A higher harvest loss than the 30 in. row system.

The participating growers identified five field equipment issues that caused problems for them with the 18 in. rows:

1. Lack of clearance between rows for equipment. Because there is so little clearance between row elements for equipment such as planters and cultivators for 18 in. rows, plugging with residue and weeds was a problem. Similarly, there is little room for soil to move from the sides of the harvester lifter wheels and plugging in wet soils or weeds occurred more often in 18 in. rows.

2. Issues with narrow tires. Narrow tires, 12.5 in. or less, must be used for cultivating, defoliating, and harvesting. Duals (including the front tires) and even triples are necessary to accommodate the tractor weight and power with current high horsepower tractors. Duals and triples should be spaced two row widths apart to avoid creating a raised row between tires. Narrow tires should also be used for planting to avoid soil compaction directly in the row area. These narrow tires limit traction and floatation, especially at harvest.

3. Guess rows. If a guess row is 2 in. narrow in 30 in. rows, it is not noticeable and rarely causes a problem with field operations. However, if an 18 in. guess row is 2 in. narrow, it becomes a problem with cultivation, defoliating, harvest, and harvest loss. Accurate guess rows are important.

4. Defoliating problems in 18 in. rows. One of the fields or varieties had closed the row to such an extent that the defoliator tractor operator could not see to drive. He had to overlap so one front tractor tire was between already topped rows. If the amount of leaf material was high in the 18 in. rows, there was not enough room between rows for the defoliator to "windrow" the leaf material to allow the row area to remain clean for the digger. This caused too much leaf material to go into the harvester in several fields.

5. Harvest loss. By limited measurements and observations, it was clear that harvest loss was higher in the 18 in. row areas than in the 30 in. rows. Most of this extra field loss was attributed to a combination of inaccurate guess rows and tires pushing roots sideways, sometimes loosening or breaking roots.

Are there solutions to these problems experienced in 18 in. rows? Three new technology items offer solutions to the above five problems:

1. Auto steer. RTK level auto steer, now available, can eliminate inaccurate guess rows and is probably necessary for the large equipment and sloping fields.

2. Roundup Ready sugarbeet varieties. Roundup Ready varieties would eliminate the need for cultivation and attendant problems with cultivator clearance and narrow tractor tires, and promises to provide overall better weed control.

3. European style self-propelled sugarbeet harvesters. Self propelled harvesters have defoliating, scalping, and digging functions in front of the machine tires. They have "feeling" type row finders that register on the petioles to accurately keep the machine positioned on the row. These features would eliminate the need for narrow tires on the harvest equipment, would reduce harvest loss, and would eliminate the problem of excessive leaf material between the rows.

This new technology offers new opportunities to access the advantages of 18 in. row sugarbeet production and to reduce or eliminate some of the practical concerns expressed by growers who currently use 30 in. row spacing.