Effect of Plant Spacing on Performance of Six Sugarbeet Hybrids

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Sugarbeet plant population per unit of area varies and is not always optimum for maximum production, since it is dependent on stand establishment and the desire of the grower as to row width to facilitate the use of mechanical equipment. Large beets are no longer necessary for efficient hand topping but are necessary for the reduction in loss from mechanical handling. The size sought may be larger than that which results in maximum total production.

Determination of the optimum plant population is one of the first areas of research conducted when new conditions for growing sugarbeets are being investigated. Coons (2)[2] reviewed the literature up to 1948 in which the optimum plant population was determined by many to be from 24,000 to 25,000 plants per acre spaced in rows 20-22 inches wide. Draycott, et al (4) determined a population of 33,500 plants per acre to be about optimum. Friehauf, Bush, and Remmenga (6) found 35,000 plants per acre to be about optimum for commercial beets where the plants are not necessarily spaced uniformly.

Most investigators found a wide range in plant populations to result in equal production indicating beets can efficiently compensate for space. Nelson and Wood (7) in 1958 at Longmont, Colorado found no difference in productivity per acre from populations ranging from 13,000 to 23,000 plants per acre in an experiment in which the plants were relatively uniformly distributed. Draycott and Currant (5) found that under English conditions plant populations from 16,000 to 32,000 *or more* give equal yields of sugar per acre.

When greater sophistication developed in sugarbeet culture, sugarbeet agronomists began to wonder whether varieties of beet responded differently to varied spacing. Deming (3) compared a small topped hybrid variety, a European commercial variety, and a three times selfed inbred line at three different spacings. The inbred line failed to fully compensate at the wider spacing. Skuderna and Doxtator (8) compared two varieties at two spacings and re-

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[2]Numbers in parentheses refer to literature cited.

ported some apparent although not great indication that a spacing x variety interaction exists.

With this background, an experiment was designed with the objective of determining whether ranking of hybrid varieties being developed would be affected by plant population. If no interaction existed, the mean population level, within limits, would be irrelevant in variety testing. This test by the nature of its design would also reaffirm the effect of plant population on yield, sugar content, and juice purity.

Materials and Methods

Six varieties were selected for diversity of sugar content and yield of roots:

Variety	*Sugar Content*	*Yield of Roots*
Mono Hy A1	Medium	Medium
Mono Hy D2	Medium	High
68MSH143	Low	High
68MSH152	Low	High
67MSH118	High	Low
68MSH128	Low	Medium

The target spacings were 6, 12 and 18 inches in rows spaced 22 inches apart. A split plot experimental design was utilized with varieties as main plots and spacings as sub plots. Plots 6 rows wide and 20 feet long were replicated 6 times. Spacing of plants in the plots was accomplished by using 1" x 2" boards with marks at the desired intervals to indicate where a plant should be left. The plots were thinned when most of the plants had 4 true leaves. Stands were adequate to establish the 12 and 18 inch spacings in all cases but the six inch spacing was not always attainable. Loss of plants through the season was not observed to be abnormal.

The plots were harvested with a modified Scott-Urschel machine. The beets were precleaned over a Rienks screen, washed, and crowned to specification before they were counted, weighed, and analyzed.

Thin juice purity was determined by the method developed by Brown and Serro (1) except phosphoric acid was used for pH adjustment instead of oxalic acid.

Results and Discussion

The tabulation of numbers of beets harvested in Table 1 indicates three quite distinct spacings were achieved for all varieties. Only 67.5% of the target number of beets was harvested for the 6

Table 1.—Average number of roots per plot.

Target Spacing	Mono Hy A1	Mono Hy D2	68MSH143	68MSH152	67MSH118	68MSH128	Mean No./ Plot	Mean Achieved Spacing
6 Inch	159	185	142	161	157	169	162	8.9 in.
12 Inch	122	123	121	116	118	117	119	12.1 in.
18 Inch	94	92	90	87	87	85	89	16.2 in.

Table 2.—Effect of plant spacing and variety on root yield (Tons/A)

Average Spacing (Inches)	Mono Hy A1	Mono Hy D2	68MSH143	68MSH152	67MSH118	68MSH128	Mean
8.9	22.9	27.4	24.2	25.4	20.0	23.1	23.8
12.1	25.7	28.8	27.5	26.8	22.0	24.3	25.9
16.2	24.4	26.8	27.3	27.1	22.0	25.4	25.5

Spacing LSD (p.05) = 0.85 Tons/A
Variety x Spacing Interactions (p.05) N.S.

inch spacing on the average. Some differences in beet numbers existed between varieties at that spacing.

Root yields were significantly affected by both varieties and plant spacings, Table 2. The variety x plant spacing interaction was not significant. The 12.1 and 16.2 inch spacings were about equal in tons per acre, while with the 8.9 inch spacings root yield was significantly lower. The lower yield for the close spacing can to some extent be attributed to a loss of small beets during harvest or precleaning over the Rienks screen. Small diameter beets are regularly lost through the Rienks screen and are occasionally lost in the field although considerable care was taken to pick up all beets in the test. On an acre basis the close-spaced plots averaged about 15,000 fewer plants than the target of 47,000. Some of the 15,000 were probably never established but the loss of some small ones could account at least in part for the differences in yield. Losses could occur at any spacing but with high populations more small beets are produced.

The mean sugar content of the three spacings, Table 3, were nearly identical and differences were not statistically significant. Differences between varieties were highly significant, p.01. Significant variety x spacing interaction was not detected although lower tonnage types, 67MSH118 and 68MSH128, tended to be lower in sugar content at the wider spacing.

Differences in juice purity (Table 4) caused by varieties and by spacings were highly significant, p.01, but again the variety x spacing interaction was not significant. The 8.9 inch spacing differed from the other two while the 12.1 and 16.2 inch spacings did not differ. Under the conditions of the test, higher purity resulted from higher populations where greater intraplot competition occurred.

Discussion and Conclusion

A variety x plant spacing interaction was not found for any character under trial including yield of roots, sugar percentage, and juice purity. This finding is strong evidence that within limits variety trials with relatively uniform stands will produce valid results for comparing varieties regardless of plant population. The varieties in this trial did not differ greatly in vigor and leaf canopy.

The varieties as expected were significantly different for all the characters tested.

Plant spacing had a major and significant effect on yield of roots and juice purity.

Harvested population had no significant influence on sugar percent as also reported by Nelson and Wood (7). Draycott, et al (4) did find a small but significant reduction in sugar percent as spacing increased.

Table 3.—Effect of plant spacing and variety on sugar content (%).

Average Spacing (Inches)	Mono Hy A1	Mono Hy D2	68MSH143	68MSH152	67MSH118	68MSH128	Mean
8.9	15.9	16.0	15.4	15.9	16.8	16.0	16.0
12.1	16.2	16.3	15.8	16.2	16.5	15.7	16.1
16.2	16.6	16.2	15.6	15.5	16.1	15.4	15.9

Spacing LSD (p.05) N.S.
Variety x Spacing LSD (p.05) N.S.

Table 4.—Effect of plant spacing and variety on thin juice purity (%).

Average Spacing (Inches)	Mono Hy A1	Mono Hy D2	68MSH143	68MSH152	67MSH118	68MSH128	Mean
8.9	93.3	93.8	92.8	93.7	94.2	93.6	93.6
12.1	93.0	93.1	92.4	93.4	93.3	93.1	93.0
16.2	92.8	93.1	92.4	93.1	93.3	92.9	92.9

Spacing LSD (p.05) = .38%
Variety x Spacing LSD (p.05) N.S.

Juice purity was reduced as spacing increased, quite like the results of others (4) (7).

The negative effect on yield at high plant density is contrary to results of other investigations (2, 4, 5, 7, 9). The loss of small beets at harvest and precleaning is a possible explanation but cannot be verified and there is a possibility that spacings as close as six inches are detrimental to root yield under the conditions of the test. Regardless of the cause of yield loss, the samples were handled in the same manner as most other Great Western variety tests. Therefore plots or treatments with different plant populations within a trial could result in a higher experimental error and possibly an incorrect interpretation of results. Care should be taken to have relatively uniform spacing throughout a test. With uniform stands plant populations could vary within a range of perhaps 10 inches to 18 inches without major effect on production and consequent confounding of varietal and spacing differences.

Summary

A sugarbeet variety x plant spacing experiment was designed to determine if interactions of variety x spacing exist for yield of roots, sugar content, and juice purity. The varieties were selected for their differences in root yield and sugar percentage. The target spacings in 22 inch rows were 6, 12 and 18 inches. Based on count before weighing for root yield, the actual spacings were 8.9, 12.1 and 16.2 inches. No significant interaction occurred for any character. Varieties did differ significantly for all characters. Juice purity was significantly higher at the closest spacing and the yield of roots significantly lower; reduced yield was at least partially attributed to the loss of small beets during harvest and laboratory handling.

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