Effect of Row Spacing and Nitrogen Rate on Root and Sucrose Yield of Sugarbeets in Southern Idaho[1]

J. N. CARTER, M. E. JENSEN, and S. M. BOSMA[2]

Received for publication July 29, 1974

Research results at other locations in western U.S. indicate that a plant spacing of approximately 12 inches within rows and 20 or 22 inches between rows is necessary to obtain near maximum yields of sugarbeets (*Beta vulgaris* L.) and yet maintain adequate space for machinery operation (4, 6, 10).[3] Increasing row and plant spacings with corresponding decreases in plant population have reduced root and sucrose yields (1, 9, 11). Decreasing row and plant spacings with consequent increases in plant populations may augment yields (5). The optimum row spacing and plant population for maximum sucrose production by varieties currently used by the Amalgamated Sugar Company[4] under a high fertility level, controlled irrigations, and the climatic conditions of southern Idaho are unknown.

In southern Idaho, most sugarbeets are grown in 22- or 24-inch rows with plants thinned to 9- to 12-inch spacings within the row. With these plant spacings, the factory average beet root yield from1966 to 1969 was 20.9 tons in southwestern, 18.3 in south central and 17.8 tons in southeastern Idaho. Experimental plots and many farm fields during the same period produced 5 to 8 tons more than the average when stand, fertilizer, and irrigation water were optimized. A substantial part of the lower average yield may be due to a poor plant stand at maturity on farmers' sugarbeet fields rather than to fertility or irrigation practices. Narrower rows at optimum fertility and irrigation levels, while maintaining adequate space for modern farm machinery, may improve average yields by increasing yield compensation (when frequent skips occur) and by providing an earlier full leaf canopy.

This experiment was conducted to determine the effect of plant population, as varied by row width while maintaining a uniform within-row stand, and N level on beet root and sucrose production under the climatic conditions of southern Idaho.

---

[1]Contribution from the Western Region, Agricultural Research Service, USDA; University of Idaho College of Agriculture Research and Extension Center cooperating.

[2]Soil Scientist, Agricultural Engineer, and Physical Science Technician, respectively, Snake River Conservation Research Center, Kimberly, Idaho 83341.

[3]Numbers in parentheses refer to literature cited.

[4]Mention of trade names or companies is for the benefit of the reader and does not imply endorsement by the U. S. Department of Agriculture.

Materials and Methods

A field experiment involving six row spacings and two N levels was conducted on a Portneuf silt loam soil (Xerollic Calciorthid; coarse-silty, mixed, mesic) near Twin Falls, Idaho in 1970. The area had been cropped to barley without fertilizer the previous year and was slightly deficient in N and P for maximum yields. A uniform application of concentrated superphosphate (70 lbs P/A) and potassium sulfate (83 lbs K/A) was broadcast before seedbed preparation.

Six replications of two N levels as main plots and six row spacings as subplots were used. Ammonium nitrate was broadcast at rates of 100 and 200 lbs N/A on April 3 and disked into the soil. Sugarbeets were planted on April 7 using 24- and 20-inch single-row beds; and 16- × 24-inch, 14- × 22-inch, 12- × 20-inch, and 10- × 20-inch double-row beds. In the double-row beds, the first number is the distance between plant rows in the bed and the second is the distance between beds. The beets were thinned early in June to a within-row spacing of approximately 12 inches.

Alternate furrow irrigation was used for the first and second irrigations; sprinkler irrigation was used during the remainder of the season. Plots were irrigated when the soil moisture reached prescribed levels, based on estimated evapotranspiration (8). The duration of each irrigation was based on soil moisture depletion and the amount of water to be applied.

From each plot, 24 of the youngest fully mature petioles were sampled at random on August 18 and cut into ¼-inch sections, dried at 65° C, ground to pass through a 40-mesh sieve, sub-sampled, and analyzed for NO_3-N (12).

On October 20, the beets were harvested and yield determined from all roots exceeding 1.5 inches in diameter in six 10-foot rows. Beet roots were selected at random during harvest for quality analysis. Impurity index determinations and sucrose analyses were made by the Amalgamated Sugar Company[4] using their standard procedures.

Results

Root yields were essentially the same for all treatments (Table 1). The small differences that occurred between treatments were within experimental error. Petiole analysis indicated a slight deficiency in N (2, 3, 12) on the 100-lb N treatment, but not enough to reduce root or sucrose yields.

Average root size decreased proportionally as the average row spacing decreased (Figure 1), which accounted for the same root yields on all plant population treatments. Neither plant population nor average size of the harvested beet roots affected sucrose content (Table 1). Sucrose percentage tended to be lower at the higher N level, but the tendency was not consistent throughout the experiment. The differences in sucrose production between treatments were not significant at the 5% level.

Table 1.—The effect of plant population and N level on sugarbeet production in southern Idaho.

Row Spacing		Plants Per Acre	100 lbs N/A					200 lbs N/A				
			Root Yield	Sucrose Yield	Sucrose	Impurity Index[1]	Petiole NO_3-N 8/18	Root Yield	Sucrose Yield	Sucrose	Impurity Index[1]	Petiole NO_3-N 8/18
Inches			Tons/A		%		ppm	Tons/A		%		ppm
24	(24)	21,800	24.2	4.31	17.8	520	550	25.7	4.62	18.0	550	1890
20	(20)	26,100	24.0	4.40	18.3	460	470	24.7	4.37	17.7	530	1630
16×24[2]	(20)[3]	26,100	24.2	4.38	18.1	450	340	25.5	4.51	17.7	560	1290
14×22	(18)	29,000	24.2	4.49	18.5	440	880	25.7	4.65	18.1	510	1620
12×20	(16)	32,700	26.0	4.65	17.9	530	610	26.0	4.63	17.8	540	960
10×20	(15)	34,800	25.4	4.53	17.8	490	730	25.0	4.45	17.8	530	1270
Average			24.7	4.46	18.1	482	597	25.4	4.54	17.9	537	1443

[1]Impurity Index = $\frac{10\ (\text{Amino N}) + 3.5\ (\text{Na}) + 2.5\ (\text{K})}{\text{Sucrose \%}}$

[2]Alternate rows of 16 and 24 inches

[3]Average row spacing

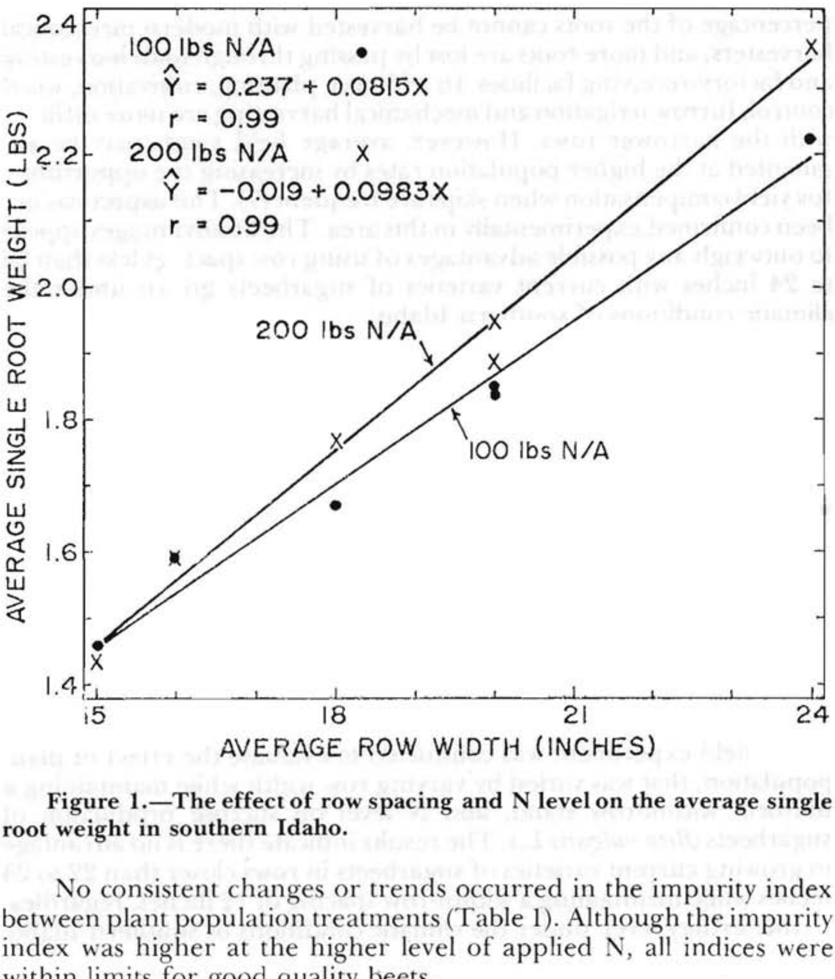

Figure 1.—The effect of row spacing and N level on the average single root weight in southern Idaho.

No consistent changes or trends occurred in the impurity index between plant population treatments (Table 1). Although the impurity index was higher at the higher level of applied N, all indices were within limits for good quality beets.

Discussion

The results of this experiment indicated that with current varieties and adequate within-row stand, fertility, and moisture, no advantage results from growing sugarbeet plants with rows closer than 24 inches under the climatic conditions of southern Idaho. These results support those obtained in a 2-year study in 1968 and 1969 in Colorado by Dillon and Schmehl (4) and the earlier studies in Utah by Tolman, Johnson, and Bigler (11). Root yields, sucrose percentages, impurity indices, and sucrose yields of the beet roots grown at all row spacings used were comparable to the 24-inch row width. Narrower rows, which increase plant populations, proportionally decreased the size of the beet roots. Small roots (≤ 2 inches in diameter) are undesirable because a higher percentage of the roots cannot be harvested with modern mechanical harvesters, and more roots are lost by passing through both harvesting and factory-receiving facilities. In addition, planting, cultivation, weed control, furrow irrigation and mechanical harvesting are more difficult with the narrower rows. However, average field yields may be augmented at the higher population rates by increasing the opportunity for yield compensation when skips are frequent (7). This aspect has not been confirmed experimentally in this area. The disadvantages appear to outweigh any possible advantages of using row spacings less than 22 to 24 inches with current varieties of sugarbeets grown under the climatic conditions of southern Idaho.

Analysis of Variance

		Mean Squares			
Component	**df**	**Root Yield**	**Sucrose Yield**	**Sucrose %**	**Impurity Index**
Replication	5	19.6	1.09	1.68**	32,651**
Fertilizer (F)	1	10.2	0.12	0.73**	56,000**
Error (a)	5	14.6	0.47	0.04	2,368
Spacing (S)	5	3.7	0.10	0.43	6,575
F × S	5	1.9	0.06	0.27	4,074
Error (b)	50	2.5	0.10	0.24	4,055
TOTAL	71				

**Significant at the 1% level.

Summary

A field experiment was conducted to evaluate the effect of plant population, that was varied by varying row width while maintaining a uniform within-row stand, and N level on sucrose production of sugarbeets (*Beta vulgaris* L.). The results indicate there is no advantage to growing current varieties of sugarbeets in rows closer than 22 to 24 inches while maintaining a within-row spacing of 12 inches, regardless of the fertility level, under the climatic conditions of southern Idaho.

Literature Cited

(1) BECKER, C. F. 1968. The influence of planting rate and thinning method on sugarbeet stand. J. Am. Soc. Sugar Beet Technol. 15: 177-185.

(2) CARTER, J. N., M. E. JENSEN, and S. M. BOSMA. 1974. Determining nitrogen fertilizer needs for sugarbeets from residual soil nitrate and mineralizable nitrogen. Agron. J. 66: 319-323.

(3) CARTER, J. N., M. E. JENSEN, B. J. RUFFING, S. M. BOSMA, and A. W. RICHARDS. 1972. Effect of nitrogen and irrigation on sugarbeet production in southern Idaho. J. Am. Soc. Sugar Beet Technol. 17: 5-14.

(4) DILLON, M. A. and W. R. SCHMEHL. 1971. Sugarbeet as influenced by row width, nitrogen fertilization, and planting date. J. Am. Soc. Sugar Beet Technol. 16: 585-594.

(5) HADDOCK, JAY L. 1953. Sugar beet yield and quality as affected by plant population, soil moisture condition and fertilization. Utah State Agr. Exp. Sta. Bul. 362.

(6) Herron, G. M., D. W. Grimes, and R. E. Finkner. 1964. Effect of plant spacing and fertilizer on yield, purity, chemical constituents and evapotranspiration of sugar beets in Kansas. 1. Yield of roots, purity, percent sucrose and evapotranspiration. J. Am. Soc. Sugar Beet Technol. 12: 686-698.

(7) Hills, F. J. and G. F. Worker. 1974. Spacing sugar beets for maximum production. Calif. Agr. 28: 14-15.

(8) Jensen, M. E. 1969. Scheduling irrigations using computers. J. Soil Water Conser. 24: 193-195.

(9) Nelson, J. M. 1969. Effect of row width, plant spacing, nitrogen rate and time of harvest on yield and sucrose content of sugarbeets, J. Am. Soc. Sugar Beet Technol. 15: 509-516.

(10) Nichol, G. E., L. M. Burtch, and D. J. Traveller. 1971. Seedbed preparation, planting and thinning. p. 49-67. *In* R. T. Johnson, J. T. Alexander, G. E. Rush, and G. R. Hawkes (ed.) Advances in Sugarbeet Production: Principles and practices. The Iowa State University Press, Ames, Iowa.

(11) Tolman, Bion, Ronald Johnson, and A. J. Bigler. 1948. Row widths and sugar beet production. Proc. Am. Soc. Sugar Beet Technol. 5: 282-286.

(12) Ulrich, Albert, D. Ririe, F. J. Hills, A. G. George, M. D. Moore, and C. M. Johnson. 1959. I. Plant analysis, a guide for sugar beet fertilization; II. Analytical methods for use in plant analysis. Calif. Agr. Exp. Sta. Bul. 766.