Row Widths and Sugar Beet Production

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In recent years there has been a growing tendency among sugar beet growers both to widen row widths and to increase the spacing between beets within the row. The tendency to widen the spacing of beets within the row has no doubt resulted from the fact that increased spacing speeds both the hand-thinning and hand-topping operation. Increased row width spacing has largely developed along with the development and use of mechanical harvesting equipment. Most of the harvesting equipment in present use harvests one row at a time, and a reduction of the number of rows per acre has great appeal to the operator of this type of harvesting equipment. There is also a general feeling that rows should be wider than 20 inches for machines and power equipment to operate most efficiently.

The above considerations were largely responsible for the row width and spacing studies which have been conducted during the past 3 years in the mountain states area. The main purpose of these tests has been to investigate the effect of increased row widths on production and to find out whether the spacing between beets within the row should be decreased as spacing between the rows is increased.

Experimental Methods and Procedures

All the row width and spacing tests utilized a split plot design. Each row width plot was 8 rows wide and 400 to 800 feet long. These strips were then divided into three or four sub-plots to accommodate the within-the-row spacing treatments. This made each sub-plot 8 rows wide and approximately 200 feet long. The four center rows of each 8-row plot were weighed for the yield record, so that the yield record from each sub-plot was based on the weight of beets from 500 to 600 feet of row. The sugar analysis made on each plot was based on two 10-beet samples. In each test there was a minimum of four replicated plots of each treatment, and in the 1946 and 1947 tests there were six replicated plots of each treatment. Row widths tested varied for each of the 3 years, and the treatments are apparent from the various tables in which the experimental results are presented.

Tests in 1945

The row width and spacing tests conducted at Granger, Utah, in 1945 included a comparison of 20-, 26-, 32- and 38-inch row widths, and on each row width 8-, 10-, 12- and 15-inch spacing of beets within the row was compared. A general view of this plot is shown in figure 1, and the complete set of treatments and the data for each treatment are given in table

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1. It is evident from the data that maximum yield of beets per acre and maximum yield of sugar per acre were produced on 20-inch rows with 12-inch spacing of beets within the row. Increasing spacing within the row and increasing the spacing between rows decreased both tonnage and the sucrose content of the beets produced. There was a decrease of from 600 to 800 pounds of sugar per acre as row width was widened from 20 to 26 inches, and the loss of sugar per acre approached 2,000 pounds, or 20 to 25 percent of the yield on 20-inch rows as the row width was widened to 38 inches.

Figure 1.—General view of row width plot, Granger, Utah, 1945. This section of the plot shows a contrast of the 20-inch rows with the 38-inch rows. Final yield for the 20-inch rows was 29.1 tons per acre as compared with 25.6 tons per acre on the 38-inch rows. Some of the various within-the-row spacing treatments are apparent from the differences in density of population which account for the square-shaped block effects.

It is also very evident from the data that optimum spacing within the row remained more or less constant regardless of row width. This fact indicates that distribution of beets per acre is more important than number of beets per acre. A distribution approaching a square, such as 12-inch spacing on 20-inch rows, was much more efficient than where the space allotment per beet was extremely rectangular in shape as was obtained with 8-inch spacing on 38-inch rows. Under the conditions of this test, 12-inch spacing of beets within the row gave maximum yields.

A more complete presentation and discussion of these data have been previously reported (5).[2]

[2]The numbers in parentheses refer to literature cited.

Table 1.—Effect of row width and spacing of beets within the row on the yield and sucrose content of sugar beets grown at Granger, Utah, 1945.

Spacing in row	Row widths as indicated				Average for spacing in the row
	20 inches	26 inches	32 inches	38 inches	
8-inch spacing					
Beets per acre	36,540	29,136	24,560	20,253	27,622
Tons per acre	28.48	26.14	25.56	25.35	26.38
Sucrose percentage	17.24	16.78	16.24	16.16	16.60
Gross sugar per acre	4.910	4.374	4.149	4.096	4.382
10-inch spacing					
Beets per acre	30,697	24,774	20,807	16,639	23,229
Tons per acre	28.26	26.89	26.48	25.24	26.72
Sucrose percentage	17.15	16.75	16.28	15.93	16.53
Gross sugar per acre	4.844	4.500	4.315	4.015	4.418
12-inch spacing					
Beets per acre	25,784	20,938	16,090	13,862	19,168
Tons beets per acre	30.07	28.40	26.98	25.76	27.80
Sucrose percentage	16.98	16.41	15.98	15.78	16.29
Gross sugar per acre	5.106	4.665	4.312	4.060	4.536
15-inch spacing					
Beets per acre	21,010	16,636	12,312	10,626	15,146
Tons per acre	29.50	28.48	25.76	26.25	27.50
Sucrose percentage	16.60	16.20	15.61	15.18	15.90
Gross sugar per acre	4.901	4.614	4.019	3.975	4.377
Average for row widths					
Beets per acre	28,508	22,871	18,442	15,345	
Tons per acre	29.08	27.48	26.20	25.65	
Sucrose percentage	16.99	16.54	16.03	15.76	
Gross sugar per acre	4.940	4.538	4.199	4.036	

Replicated test with four replications of each treatment.

Tests in 1946

The decrease in yield in the 1945 test was so rapid as row width was increased that further tests were conducted in 1946 to investigate a much smaller variation in row widths and to determine whether yields could be increased by increasing the number of rows per acre through the use of wide and narrow row width combinations. Row widths studied included a 12-20-inch wide and narrow combination, 20-inch rows, and 24-inch rows. Three variations on spacing within each row width were compared. These within-the-row spacing comparisons were 9.5 inches, 12 inches, and 16 inches. Maximum yields were again obtained with 12-inch spacing within the row, and there was no indication that as row width was increased that there was any advantage in spacing the beets closer than 12 inches in the row.

The detailed data on within-the-row spacing are not presented inasmuch as it can be summarized by stating that within the limits of 75 to 125 beets per 100 feet of row, there were no significant differences in either yield or sucrose content.

Row width, however, did have a significant effect on the yield of both beets and gross sugar per acre. A summary of the row width data for 1946 is given in table 2. Yields decreased when row widths varied either way from 20 inches. Increasing row widths from 20 inches to 24 inches resulted in a decrease of sugar per acre as follows: Washington 790 pounds; Idaho 1,332 pounds; South Dakota 250 pounds; and Utah 676 pounds. If this loss in sugar per acre is projected over the entire acreage harvested by farmers

under contract to the Utah-Idaho Sugar Company in 1947, the total loss in sugar would be in excess of 75,000,000 pounds or 750,000 bags of sugar, and this sugar would have a cash value of approximately $7,500,000.

Table 2.--Effect of row width on the yield and sucrose content of sugar beets grown in four western states in 1946.

Location of tests	Tons of beets per acre			Sucrose percentage			Tons gross sugar		
	12-20 inch comb.	20-inch rows	24-inch rows	12-20 inch comb.	20-inch rows	24-inch rows	12-20 inch comb.	20-inch rows	24-inch rows
Washington	27.23	30.02	27.66	15.78	15.72	15.63	4.297	4.718	4.323
Idaho	23.82	25.52	21.35	17.30	17.50	17.80	4.121	4.466	3.800
South Dakota	10.96	12.73	12.44	17.00	17.30	16.70	1.863	2.202	2.077
Utah	26.43	28.47	26.48	14.01	13.70	13.45	3.703	3.900	3.562
Average	22.11	24.18	21.98	16.02	16.05	15.90	3.496	3.821	3.441

Tests in 1947

As a result of the 1946 tests, interest in the 1947 tests was centered around various wide and narrow row width combinations, which would average the equivalent of 20- to 22-inch rows. The complete set of row widths tested is listed in table 3. The data from the two 1947 tests indicate that uniform width rows 20 inches apart produced higher yields than did any of the wide and narrow combinations averaging 20 inches. The data also support all previous data which indicated a loss in production on all row widths wider than 20 inches. The 20-inch rows produced an average of 504 pounds more gross sugar per acre than the next closest row width treatment. These tests indicated that wherever possible 20-inch rows should continue to be the standard row width, and that where a change is necessary to adjust to machines and power equipment, the next best row widths from the standpoint of maintaining production would be one of the following: 18-24-inch or 20-22-inch wide and narrow combinations, or straight 22-inch.

Table 3. Effect of various row widths and row width combinations on the yield and sucrose content of sugar beets as shown by tests in Utah and Idaho 1947.

Row widths tested	Tons of beets per acre			Sucrose percentage			Tons gross sugar		
	Utah	Idaho	Average	Utah	Idaho	Average	Utah	Idaho	Average
16-22-inch combination--19	26.48	19.50	22.99	13.00	18.90	15.95	3.450	3.686	3.568
16-24-inch combination--20	26.15	19.49	22.82	13.10	18.84	15.97	3.426	3.674	3.550
18-22-inch combination--20	27.76	20.08	23.92	12.86	18.87	15.87	3.454	3.791	3.623
18-24-inch combination--21	27.58	19.81	23.70	12.97	18.86	15.92	3.584	3.733	3.659
20-inch rows--20	29.96	20.43	25.20	13.29	18.75	16.02	3.987	3.834	3.911
22-inch rows--22	28.16	19.01	23.59	13.18	18.40	15.79	3.716	3.497	3.607
20-22-inch combination--21	26.70	19.77	23.24	13.10	18.82	15.96	3.504	3.716	3.610
20-24-inch combination--22	26.73	18.39	22.56	12.93	18.61	15.77	3.437	3.421	3.429

Discussion and Summary

One of the fundamental objectives of sugar beet production is to establish the industry so that both the farmer and the processor can make a consistent, profitable cash return on the capital and labor which they invest. Some of the factors on which the attaining of the above objective depends are:

1.—High production per acre of high-quality beets.
2.—Low production costs per ton of beets produced.
3.—Full assurance that the crop can be produced by the combined use of hand and machine labor.

When these three fundamentals have been assured, the industry will likely find the stabilization which it so much desires.

Any program which would achieve this goal must give due consideration to all three of the above factors. We might attain complete mechanization and still be handicapped by high production costs, or a low level of production combined with decreased quality.

Data presented in this paper indicate that row width is one of the factors which has an influence on both the level of production and the quality of the beets produced. In all tests, maximum yields of both beets and sugar per acre resulted from 12-inch within-the-row spacing on 20-inch rows. Other tests conducted in the mountain and inter-mountain area support these results (1) (2) (3) (4).

It is recognized that row widths must be wide enough to permit the use of machines and power equipment. It is felt, however, that thought should be given to adapting machines and power equipment to those row widths which will maintain, as near as is possible, maximum production.

More careful attention to field layout, and doing a precision job of drilling will facilitate the use of machines on the narrower row widths. In many cases where machines have had difficulties on 20-inch rows, most of the difficulty has occurred because of crooked rows and because of guess-rows, which in many places were narrower than 20 inches.

In no case should farmers in the mountain states widen row widths more than is absolutely necessary to make it possible to successfully operate their power equipment.

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