Relative Yields of Reduced Stands of Sugar Beets Planted at a Normal Date and of Replanted Sugar Beets

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Each year as the time for thinning the sugar-beet crop approaches, there are usually some fields in which the initial stands are so poor that good stands of thinned plants can not be obtained. Adverse weather conditions which have favored seedling diseases, poorly prepared seedbeds, seedings made at too light a rate, or some combination of these factors are usually responsible for the condition. Whatever the cause, the grower is faced with the necessity of deciding what is to be done.

The alternatives are: (1) To attempt by careful thinning to save as many properly spaced plants as possible, (2) to replant the field with sugar beets, or (3) to abandon the sugar-beet crop for the year and plant some other crop in the field. Information on the relative yields which can be expected from reduced stands of sugar beets which have been planted early or medium early as contrasted with the yields obtainable from late plantings may aid in making decisions in such situations.

Certain experiments conducted at Fort Collins, Colorado, by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Colorado Agricultural Experiment Station, have given information applicable to the problems involved. One series of tests, conducted in 1937, 1938, and 1939, dealt with the effects of varying populations, per unit area, on yield. In a second series of tests, conducted in 1938 and 1939, the yields of full stands of normal and late plantings were obtained. In 1941 a third series of tests, combining the factors in series one and two, was started in which the yields of 4 levels of plant population of normal planting date are compared with the yield from a reasonably full stand obtained in a late planting. This paper reports only the results from the first year of the test and is therefore in the nature of a progress report. It is expected that the test will be conducted for several additional seasons.

In the first series of experiments involving variable plant populations, an excellent initial stand was first thinned according to a randomized-plot arrangement to 8-, 12-, and 16-inch spacings in the rows. Following this thinning, one-third of the plots of each spacing

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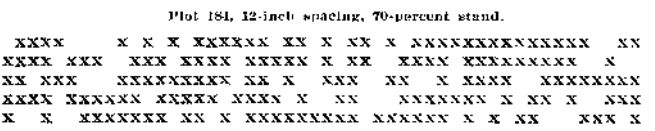
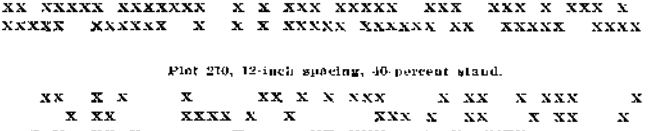
type was left as thinned, one-third of the plots was reduced to 70-percent stands, and the other third of the plots was reduced to 40-percent stands of the respective spacings. These reductions in stand were made by cutting out plants in each row at random. Thus, each row and each plot of the 70 and 40-percent stands contained the appropriate number of plants, but the plants were not uniformly spaced and the stand of any short section of any row might vary from a full stand for the spacing to a complete blank. The following diagrams are representative of the actual spacings obtained on the plots with reduced stands. Sugar-beet plants are represented by X and blanks are represented by a space.

Figure 1.—Diagrams of plots 184 and 210 representing[1] 70-percent and 40-percent stands, respectively. Plants left in place are shown by X; blanks indicate plants removed, at random, to establish the particular stand relationship desired.





These treatments resulted in plant populations varying, as an average from as few as about 30 plants per 100 feet of row in the case of the 40-percent stand of the 16-inch spacings to about 140 plants per 100 feet of row when the 8-inch spacings were left as originally thinned. Results in each of the 3 years of this test were very similar and the 9 plot averages of each treatment in each year of the test are given in the following summary as the 3-year average of averages.

Although the stands as originally thinned are called full stands, they were, of course, not perfect stands for the space interval chosen.

As an average, they were **91.1,** 95.3, and 97.3 percent of complete stands for 8-, 12-, and 16-inch spacings, respectively, and certainly approximate the best stands obtainable in the field for the respective spacings.

When the stands were uniform, as with the full stands for the 3 spacing patterns, and there were very few skips in the rows, the differences in yield were very small, irrespective of whether 72, 95, or 137 plants were left for 100 feet of row. When 30 percent of each row was blank, that is 70-percent stands, there was little difference in yield from averages of about 71 and 104 beets per 100 feet of row, and also only a relatively small reduction in yield in comparison with the full stands of 72, 95, and 137 beets per 100 feet of row as indicated for the 12-inch, 16-inch, and 8-inch spacings, respectively. However, when the 16-inch spacings were reduced to 70-percent stands, corresponding to an average of 53 beets per 100 feet of row, an appreciable loss in yield resulted. In the 40-percent stands for the various spacings, there was a marked reduction in yield. The decline in yield increased as the number of beets per 100 feet of row dropped from an average of 61 to an average of 31.

Table 1.—Effect of stand on aero-yields of roots and sugar and on sucrose percentage of sugar beets grown in 16-inch, 12-inch, and 8-incli spacings. (Tests made at Fort Collins, Colo., 1937, 1938, and 1939. with results given as 3-year averages).

Type of stand sought	Spacing	No. of roots harvested in 100 feet of row	Acre-yield		
			Gross sugar	Roots	Sucrose
			pounds	tons	percentage
Full	16-inch	72.0	4,870	16.33	14.22
Full	12-inch	95.3	4,715	16.35	14.15
Full	8-inch	136.7	4,636	16.20	14.14
70 percent	16-inch	53.3	4,177	14.84	14.00
70 percent	12-inch	70.7	4,516	15.91	14.19
70 percent	8-inch	103.7	4,447	15.61	14.13
40 percent	16-inch	31.0	3,182	11.67	13.56
40 percent	12 inch	40.7	3,600	12.92	13.90
40 percent	8-inch	61.0	3,931	13.95	14.11
Difference required for significance[1]			211	0.61	0.35

[1]For odds of 19 to 1.

Under the conditions of these tests, the differences in yield were small when the minimum space between the beets was 8 inches and the plant population varied from about 70 to about 140 beets per 100 feet of row. All stands of less than about 70 beets per 100 feet of row produced yields lower than the yields from any of the stands in excess of about 70 beefs per 100 feet of row.

The yield of **11.67** tons of roots and 3,182 pounds gross sugar per acre from an average of 31 beets per 100 feet of row is of importance

with respect to the question of the minimum stand which may be necessary. In these tests, the average of 31 beets per 100 feet of row is only % of the full stand for the 12-inch spacing and less than 1/2 of the full stand for the 16-inch spacing which produced the highest yields in the test; yet, in these tests, the yield even with such a reduced stand was about 70 percent of the highest yield from any stand.

When stands are thin, a somewhat lower sucrose percentage commonly is obtained and these tests show no exception to this rule. However, in this case, the reduction in sucrose percentage was not very great, except in the cases of the 2 lowest stands, 41 and 31 beets per 100 feet of row.

In 1938 and 1939, planting-date tests were conducted. In each year, these were located immediately adjacent to the stand tests. March, April, and May plantings were compared. The April planting is considered timely for this district; the stand test was planted the same day as the April planting of the date-o£-planting test. Apparently because of soil variability the general level of yields in the date-of-planting test was slightly higher than in the stand test. Even when stands were comparable, the yields were probably not strictly comparable between these tests. Data from the early (approximately April 20) planting and the late (May 17) planting are given in table 2. The variety is the same as that used in the stand test.

Table 2,—Comparison of acre-yields and sucrose percentages of early, timely plantings with those obtained from late plantings. (Tests made at Fort Collins, Colo., 1938 and 1939 with results given as 4-plot averages).

Planting	Spacing	No. of beets harvested per 100 feet of row	Acre-yield		Sucrose
			Gross sugar	Roots	
			pounds	tons	percentage
Early, timely (1938)	10-inch	117	5,899	18.04	14.96
Eurly, timely (1939)	12-inch	93	6,370	18.68	17.15
Average		105	5,884	18.36	16.00
Late (1938)	10-inch	119	3,037	12.47	14.58
Late (1939)	12-inch	93	4,180	11.90	17.56
Average		106	3,009	12.18	16.07

Since 10-inch spacing was used in 1938 and 12-inch spacing was used in 1939, it is evident that excellent and comparable stands were obtained in each year of test. The stands obtained on the May 17 plantings were particularly good in view of the difficulty often encountered in getting a good stand from late plantings in the Port Collins district. In both 1938 and 1939 a heavy loss in yield resulted when planting was delayed to mid-May. In 1938 the yield in gross

sugar from the May planting was just over 2/3 of the yield from the earlier, timely planting. In 1939 a similar comparison shows the May planting to be just under 2/3 of the earlier, timely planting.

From the 2 series of tests which have been outlined, it appears that it would be more profitable to save a field of early planted beets having even less than half of a stand than to replant as late as mid-May. However, in many cases in which fields are to be replanted, the reseedings could be made somewhat earlier than the date of the late planting in the above test.

To test further the relative yields from reduced stands of earlier and timely planted sugar beets and the yields obtainable from plantings made later and comparable to ordinary dates of replantings, a test combining these treatments was conducted in 1941. In this test, the five treatments were as follows: (1) Timely planting, with the best obtainable stand approximating 300 beets per 100 feet of row; (2) timely planting with stand reduced to approximately 70 beets per 100 feet of row; (3) timely planting with stand reduced to approximately 50 beets per 100 feet of row; (4) timely planting with stand reduced to approximately 30 beets per 100 feet of row, and (5) timely planting with original seeding cultivated out, and replanted at a date approximating a replanting date as determined by conditions for the year.

The test was arranged as a 5x5 Latin square. The plots were 8 rows wide and 90 feet long, the inside 4 rows being harvested. A planting date of April 11 was considered as timely for the conditions. Replanting was made May 13, which coincides closely with the replanting of a considerable acreage of sugar beets in this part of the State on which the earlier plantings were destroyed by a severe hailstorm on the evening of May 10. Excellent stands were obtained on all plots of the timely plantings and very good to excellent stands on each of the 5 replanted plots. The test was harvested November 4. Although fairly high-root yields were obtained, the quality was relatively low because weather conditions during the fall of 1941 were unfavorable for the production of beets with a high-sucrose percentage. A moderately severe attack of leafspot developed in September. The attack appeared to be most severe on the heavier stands in the plots of timely planted heels and least severe on the replanted plots. In this region, late-planted sugar beets frequently show a higher-sucrose percentage than early planted sugar beets. This difference in favor of the replanted beets in 1941 was somewhat greater than usual. A summary of the 1941 test of replanted versus timely planted beets is given in table 3.

Under the conditions of this test, the yield of roots from replanting exceeded the yield from a stand of approximately 31 beets per 100 feet of row of timely planting by 2.44 tons per acre, a difference

which is probably highly significant. The replanting, with its full stand, was exceeded in yield by normally planted beets with stands of approximately 50, 70 and 100 plants per 100 feet of row by 0.19, 1.68, and 3.41 tons of roots, respectively. The difference between the full stand in the replanted and the half stand in the earlier-planted plots is certainly not significant. On the basis of this test the yield of roots from a timely planting in which about 50 plants are saved on most 100-foot sections of row would at least equal the root yields that could be obtained by replanting.

Table 3.—Results obtained from early, timely planted plots using 4 types of stand as contrasted with results obtained from full stands in replanted plots. (Test made at Fort Collins, Colo., 1941 with results given as 5-plot averages)

Treatment	No. of roots harvested per 100 feet of row	Acre-yield		
		Gross sugar	Roots	Sucrose
		pounds	tons	percentage
Timely planting, full stand	99.0	3,603	16.25	11.27
do. , 70% stand	70.4	3,256	14.52	11.20
do. , 50% stand	50.0	2,707	13.03	10.63
do. , 30% stand	30.0	2,053	10.40	9.82
Replanted , full stand	98.4	3,303	12.84	12.82
General Mean	—	3,008	13.41	11.15
F value[1]	—	26.39**	46.27**	13.97**
Difference required for significance[2]	—	343	0.90	0.83

[1]Double asterisks indicate F value exceeds the 1-percent point.
[2]For odds of 19 to 1.

Sucrose percentage in the replanted beets exceeded sucrose percentage in the timely planted beets by 3.00, 2.19, 1.62 and 1.55 for the 30, 50, 70 and 100 plants per 100 feet of row, respectively.

Acre-yield of gross sugar from the full stand obtained by replanting exceeded that from reduced stands in the earlier, timely planting by 536 pounds for the 50-percent stand and 47 pounds for the 70-percent stand. The larger of these differences appears to be highly significant.

On the basis of the 1941 tests, no increase in sugar production would have been obtained from replanting if 70-percent stands could have been saved in this field on the majority of 100-foot row sections. In these tests, the data indicate that no increase in root yield would have come from replanting if the stands which could have been saved were as great as 50 percent on most 100-foot row sections. However, because replanted beets in this test showed higher-sucrose percentage, the acre-yield of sugar was significantly greater in the replants than was obtained from the 50-percent stands of the earlier-planting date.