A Preliminary Evaluation of Precision Hill Planting of Sugar Beets

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Recent work at Davis has indicated that stands containing 50 percent doubles and 25 percent multiples (3 or more beets) did not reduce root or sugar yield when a 12-inch spacing was maintained between beet hills (4)[2]. This led to the concept that thinning might be eliminated, or the labor requirements substantially reduced, by planting groups of seeds in hills spaced 8 to 12 inches apart. In this manner, a reasonably high seeding rate could be maintained and, depending on the degree of field emergence, thinning might be eliminated or reduced to a long-hoe operation. A preliminary experiment to test this procedure was conducted at Davis, California, in 1955; the results are reported herein.

Procedure

Standard blank plates for a John Deere Model 66 planter were drilled to establish the desired hill spacings. The distance between adjacent cells was the same as for the regular 72-cell plate. For one set of plates, 3 consecutive cells were drilled, the next five spaces were left blank, then 3 more drilled, and so on around the plate. For another set, 5 cells were drilled, 7 skipped, and so on. A gear ratio was selected to place the seeds 1 inch apart within the hills. This gave center distances of 8 inches and 12 inches for the 3-seed and 5-seed hills, respectively, and an average of about 5 seeds per foot of row in each case. With standard 72-cell plates and the same gear ratio, 12 seeds per foot were planted in the control plots for hand thinning to an ideal stand. Another gear ratio with the 72-cell plates gave a theoretically uniform spacing of single seeds, 2.6 inches apart, for the same number of seeds per foot as with the hill plantings. The same planter was used for all plots.

The seed was of the variety US 22/3, processed and graded to 7-10/64 inch. The six treatments indicated in Table 1 were arranged in a randomized block design with six replications. Individual plots were 4 rows wide by 80 feet long. Seedling emergence was good. Accurate counts were not made to indicate emergence, but from counts made on unthinned plots later in the season, emergence was estimated at from 40 to 50 percent.

About three weeks after thinning, stand counts were made on the center 25 feet of all four rows of each plot. These counts reflected the number of four-inch blocks containing single, double, and multiple plants, as well as total length of unoccupied row in excess of 16 inches per gap. This procedure for stand evaluation has been reported in another paper (3) and is discussed further below.

Harvest data were taken on the center 50 feet of each plot. Beets two inches or less in diameter were counted, weighed, and discarded as unmarketable. The remaining roots were counted and weighed as marketable. For sucrose and tare determination, four samples were taken from each plot.

Results were evaluated by analyses of variance. The relationships of certain stand factors to root yield were determined by multiple correlation analysis (1).

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[2] Numbers in parenthesis refer to literature cited.

Table 1.—Effect of Seed Distribution Pattern and Long-Handled-Hoe Thinning on Yield, Stand, and Percent Sugar, Davis, California, 1955.

	Theoretical Distribution of Seed by Planter			Stand After Thinning Number of 4-inch Blocks Per 100 Feet							Stand at Harvest			
											Beets Greater Than 2 Inches in Diameter	Beets 2 Inches or Less in Diameter		
Treatment Number	Seeds Per Hill	Hill Spacing, Inches	Thinning Treatment	Singles	Doubles	Multiples	Total	Percent of Row Unoccupied	Yield of Clean Beets (Over 2 Inches Diameter), Tons Per Acre	Sugar Content, Percent	Number Per 100 Feet	Number Per 100 Feet	Percent of Total Number	Tons Per Acre
1	1	1[1]	short hoe	135	14	1	150	0.6	29.4	14.9	156	9	5.4	0.2
2	1	2.6[1]	none	53	49	50	152	1.1	23.9	15.3	216	97	31.0	2.3
3	5	12	none	28	30	56	114	2.5	23.0	15.1	202	79	28.1	1.9
4	3	8	none	44	42	40	126	3.2	25.7	15.1	201	45	18.3	1.2
5	5	12	long hoe	59	33	14	106	1.2	28.7	15.1	150	14	8.5	0.4
6	3	8	long hoe	67	38	10	116	2.4	28.8	15.0	159	19	10.7	0.6
Significant differences, 19:1						9		1.7	1.9	ns.[4]	19	23		0.4
Partial correlation coefficients[2]						−0.789[3]		0.219						
Regression equation[3]			Y	29.77 − 0.202 Xg		0.101 Xm								

[1] Single seeds, uniformly spaced.
[2] Based on multiple correlation of tons per acre with multiples (Xm) and percent row unoccupied (Xg) Y = Yield in tons roots per acre.
[3] Significant at odds of 999:1
[4] Not Significant

Results and Discussion

All results are reported in Table 1. With seeds uniformly spaced 2.6 inches apart and the stand not thinned, the root yield was 5.5 tons per acre less than in the plots that were carefully thinned to almost all singles spaced 8 inches apart. The unthinned plots with 5-seed hills on 12-inch centers showed a similar reduction of 6.4 tons per acre. With 3-seed hills on 8-inch centers, the yield reduction was only 3.7 tons per acre, which was significantly better than the yield produced by the 5-seed hills. Beets planted by both hill spacing methods, when thinned with long-handled hoes, produced yields essentially equal to that produced by carefully hand-thinned beets. None of the treatments had a significant effect on sucrose percentage.

The three unthinned treatments, all averaging approximately 5 seeds per foot (treatments 2, 3, and 4, in Table 1), produced essentially the same number of beets greater than 2 inches in diameter at harvest. The lower root yield of treatments 2 and 3 are apparently due to smaller average root size. The higher yield produced by treatment 4 was accompanied by a lower percentage of unmarketable beets when compared to treatments 2 and 3.

In considering the effect of stand on root yield, there are two obvious factors that can cause yield reduction, namely: crowding plants too close together, and excessive row space not occupied by plants. Based on other experiments at Davis (3), a 4-inch space was selected as the criterion for determining "too close." Adjacent plants spaced 4 inches or greater were counted as singles, whereas two plants in a 4-inch space were considered a double, and three or more within a 4-inch length were multiples. To evaluate skips in stand, Demings' procedure for calculating percent of row unoccupied was used (2). In this procedure, only skips greater than 16 inches are considered; the unoccupied length of each gap being taken as the actual gap length less 16 inches. The unoccupied lengths thus determined are accumulated to determine feet of row unoccupied per 100 feet. Based on the counts shown in Table 1, there is no consistent relation between root yields and either singles or doubles. As noted above, emergence in this trial was good, consequently multiples are high and row unoccupied is low. Perhaps the only truly significant difference among the treatments with respect to row unoccupied is between hand thinning and the hill-planting treatments. Even this difference is minor. Root yields, however, are closely associated with differences in the number of multiples. A multiple correlation analysis relating the root yield of individual plots to determinations made for each plot for multiples and row unoccupied indicates a highly significant negative correlation between root yield and multiples. The correlation coefficient for row unoccupied is low, indicating that in this trial, row unoccupied was a relatively unimportant factor in yield reduction. When estimated values for root yield are calculated, using the treatment averages for multiples and percent row unoccupied in the regression equation given in Table 1, values for root yield are obtained that closely approximate those actually observed.

In this experiment, the effect of hill planting upon the ease of long-handled hoe thinning was not evaluated. It would seem, however, that stands obtained by precision hill planting should be considerably easier to thin than stands obtained by planting in the conventional manner. The fact that the basic hill spacing is already established (see Figure 1) should eliminate many of the decisions of the thinner as to which plant to leave, thereby speeding up the work and enabling him to do a job of higher quality. Under conditions of less favorable field emergence, little or no trimming may be needed. Based on experience to date, it would appear that multiple hills up to 20 per 100 feet of row will have little effect on yield (3), (4).

Figure 1.—Unthinned stand of 3-seed hills on 8-inch centers. Such a stand is easily thinned with long-handled hoes. The white marks on the tape between the two rows are 4 inches apart.

Summary

A field experiment was conducted to evaluate the effect of precision hill planting on sugar beet yields, using specially-drilled seed plates in a John Deere Model 66 planter. Two hill distribution patterns were employed: (a) 3 seeds 1 inch apart within each hill, with 8-inch hill centers, (b) 5-seed hills on 12-inch centers. With each of the two hill planting patterns, some plots were untrimmed and others were trimmed with long handled hoes. Yields were compared with those from plots that had been planted in the conventional manner and carefully hand thinned.

In these trials, field emergence was excellent, resulting in 40 to 60 hills of 3 or more plants per 100 feet of row. There were very few skips in any of the stands. Under these conditions, both hill planting patterns, when not thinned, reduced root yields in comparison with yields from hand-thinned beets. The yield reduction was less with 3-seed hills on 8-inch centers than with 5-seed hills on 12-inch centers. Long-handle-hoe trimming of both hill spacings resulted in yields essentially the same as that obtained with hand-thinned plants and reduced multiples to an average of 10 to 14 per 100 feet of row. There was a high negative correlation between root yield and the number of multiple-plant hills.

References

(1) BROWNLEE, M. A. 1949. Industrial Experimentation. Chemical Publishing Company, Inc., Brooklyn, New York.

(2) DEMING, G. W. 1954. Estimate of space occupied as a measure of sugar beet stands. Proc. Amer. Soc. Sugar Beet Tech. pp. 151-156.

(3) HILLS, F. J., RIRIE, DAVID, MORSE, M. D., and HOLMBERG, D. M. 1957. An evaluation of mechanical thinning of sugar beets in California. Jour. Amer. Soc. Sugar Beet Tech. IX (4): 337-344.

(4) RIRIE, DAVID, and HILLS, F. J. 1957. Effect of in-the-row-spacing of single, double, and multiple plant hills on beet sugar production. Jour. Amer. Soc. Sugar Beet Tech. IX (4): 360-366.