A Report On Tests of Mechanical Weeding and Thinning Equipment in Michigan[1]

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In Michigan and throughout the eastern area mechanization of the sugar beet harvest has progressed much more rapidly than elimination of hand labor in the spring work. However, in 1951 mechanization made some very important advances in this area. For several years prior to 1950 various methods of thinning were experimented with by the beet sugar industry, the Michigan Agricultural Experiment Station, and the United States Department of Agriculture. In 1950, 2.9 percent of the commercial acreage was worked mechanically before hand thinning. In 1951, 26.1 percent of the total acreage was mechanically worked, nearly a tenfold increase over 1950.

Mechanical **Thinning Methods and Implements**

Two approaches have been made to the problem of mechanized working of sugar beets in the eastern area. One method which has been experimented with is blocking with machines which would theoretically leave undisturbed beet-containing blocks at the desired plant intervals for the final stand and remove all sugar beet plants and weeds between blocks. Several types of blockers have been tested. They may be classified as (a) cross-row and (b) down-the-row blockers. The removal of the plants in spaces between blocks may be accomplished by (a) burning, (b) chemically, or (c) mechanically.

Another approach to mechanization which has been tested extensively is that of random stand reduction. The principle of random thinning differs from blocking in that the removal of plants, including weeds, occurs in several short increments in the length of row equal to the desired plant interval of the final stand. The resulting row strip following random thinning thus will have several possible beet-containing block per foot of row. Several kinds of implements have been used for random thinning. These may be classified as (a) cross row, and (b) down the row. Examples of implements used for cross-row thinning are spike tooth harrows and finger weeders. Down-the-row thinners are machines which have been built specifically for the purpose of sugar beet thinning.

History of Experimental Stand Thinning

A few years ago there was considerable interest in blocking with both cross blockers and down-the-row machines. Irwin[3] reported, on tests conducted in 1946, that yields from the machine-blocked plots were equal to the hand-thinned plots. However, the labor requirements were not appreciably reduced on the mechanically-blocked plots and nearly as much time was spent on hoeing the machine-blocked plots as was required for blocking, hoeing and thinning the hand-thinned plots.

In 1947 the writer conducted tests with three types of down-the-row machine blockers. They were (a) a flame blocker, (b) a chemical blocker, and (c) a Dixie cotton chopper. These machines were all adjusted to leave

[1] The study reported in this paper was conductd as a cooperative project of the Michigan Agricultural Experimental Station (Agricultural Enginering Department) and the Bureau of Plant Industry, Soils and Agricultural Engineering (Farm Machinery Division) of the U. S. Department of Agriculture, East Lansing, Michigan.

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3-inch blocks at 12-inch intervals. In comparing the results with the long handle hoe-thinned checks it was found that there was a reduction of 20 percent in the hand labor on the hoeing of the machine-thinned plots. However, there was an average for all machine-blocked plots of 21 percent fewer beet-containing blocks per 100 feet of row as compared with the hand-thinned plots.

In addition to the blocking tests described above numerous experiments with random thinning methods have been conducted *in* Michigan and Ohio in the past three years.

In order to accept random thinning it is necessary to revise our concept of final stand requirements. It is necessary to think of the final stand in terms of the number of beets in a given length of row rather than of uniform spacing of beets. It is also necessary for labor to thoroughly understand this principle if the best results are to be obtained from the use of random thinners.

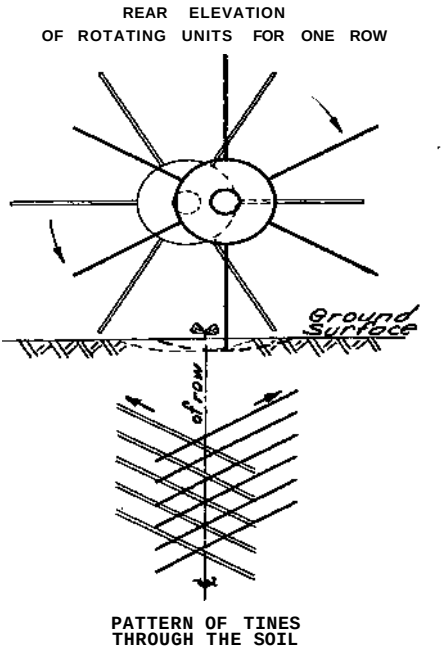

Figure 1. Principle of operation of counter-rotating spring tine thinner. Directions of rotation shown in A. Pattern of scratches across row shown in B. Axes of rotation are parallel to each other **and** to the row.

Experiments with spacings and doubles have yielded results that support the reliability of random thinning. Frakes (3) in 1946 and 1947 found only slight differences in yields with spacings from 10 inches to 20 inches and that up to 20 percent doubles did not cause any significant reduction in yield. P. A. and H. B. Reeve (4) in 1950 recorded no significant differences in yield in spacings from 10 to 20 inches. Davis (5) in 1950, recorded no differences in yields on muck soil with spacings from 12 inches to 20 inches. However, it was observed that weed growth later in the season was markedly less with the closer spacing. This was apparently due to shading of the ground by the sugar beet leaves. The results obtained in these tests for the effects of spacing and doubles demonstrate that there is considerable latitude without reduction in the yield.

Tests with Experimental Stand Reducer and Weeder

The writer, in 1950, with the cooperation of J. G. Lill[4] conducted mechanical thinning tests using an experimental stand reducer and weeder constructed with two counter-rotating heads on each row. The principle of the counter-rotating heads is shown in Figure 1. A second machine built this year and using the same principle is shown in Figure 2.

The tests reported in Table 1 were made on some plots for variety studies by Mr. Lill. The time required for hand trimming the plots and the yield data were contributed by Mr. Lill.

In 1951 the writer conducted additional tests similar to those reported in Table 1. There were six replications of paired plots planted on May 16, each plot being .0203 acres in area. In this case the beets were worked once

Table 1. Thinning Time After Thinning Stands, Yield, and Number of Marketable Roots of Mechanically Thinned Plots Compared with Plots Thinner and Weeded Entirely by Hand. 1950.

Plot[b]	Thinning Time—Man Hours/Acre	Final Stand Blocks/Acre	Marketable Roots/Acre	Yield Tons/Acre
1-h	—a	—a	28,423	11.492
1-s	—a	—a	24,241	11.892
2-h	32.9	27,027	29,543	12.088
2-s	15.4	21,567	18,818	9.834
3-h	38.8	25,326	24,405	11.075
3-h	38.8	25,326	24,045	11.075
4-h	26.9	25,788	29,543	12.709
4-s	17.5	22,911	23,588	10.781
5-h	33.2	26,775	26,397	12.447
5-s	15.4	18,396	15,551	9.736
Average				
Hand Thinned	33.0	26,229	27,587	11.911
Stand Reduced	16.6	21,021	20,608	10,585
Percent of Check	50.3	83.3	75.0	89.5
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*—Significant Difference. **—Highly Significant Difference.

a—Not included in Thinning Time Study.

b—Hand Thinned Only —h.
Machine Thinned Plus Long-handled Hoe Trimming —s.

Note: Time Study on plots .0477 acre in area, yield on .05153 acre plots.

The counter rotating heads were geared to strike the row at intervals of 1.86 inches and at an angle with the row of 44°. The gauge wheels were set for 1" penetration of the tines. The beets were in 4 to 6 leaf stage. These plots were planted on June 18, and machine-thinned on July 11, 1950. Pre-thinning stand counts indicated an average stand of 32 plants per 100 inches of row.

[3] Numbers in parentheses refer to literature cited.

[4] Agronomist, United States Department of Agriculture, Division of Sugar Plant Investigations.

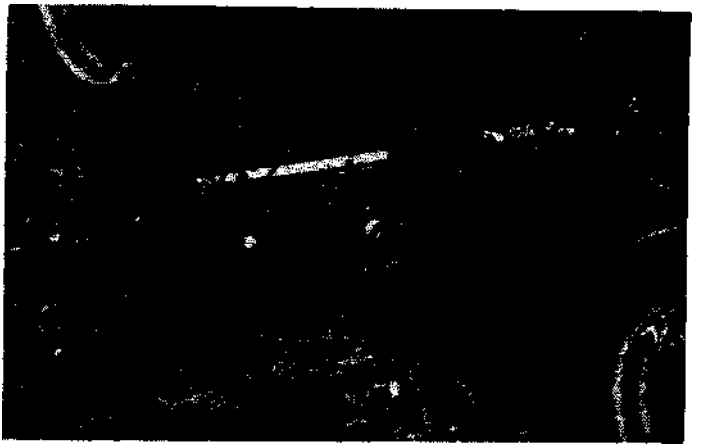

Figure 2. Experimental counter-rotating sugar beet stand reducer. This two-row tractor-mounted unit is power-take-off driven from the tractor engine. Parallelogram linkage and pivot allow adjustment to profile of row and at the same time keep both heads on each row perpendicular. Xhis results in uniform penetration of the tines on both heads. The depth gauge wheel runs directly over the row. Part of the weight of the floating parts is counter-balanced by a spring thus reducing downward force on wheels. The weight (140 lbs.) of floating parts is such that the inertia reduces the tendency to bounce upon encountering hard ground or clods in the row.

with the counter-rotating head experimental machine and then once with a 50 percent thinning head made especially for this experimental thinner. At the time of the first thinning on June 5 the beets were in the four to six leaf stage. The 50 percent thinning head was used 13 days later. The plots were worked with a long-handled hoe in the period June 25-29. The initial pre-thinning stand was about twice as heavy as in the case of plots reported in Table I. The average stand was 61 beets per 100 inches of row. Only the averages are reported in Table 2.

Discussion of Experimental Results

It will be noted from Tables 1 and 2 that there were substantial savings in labor in both experiments (49.7 percent in 1950 and 30.6 percent in 1951) and there was also some reduction in yield. Part, at least, of the reduction in yield may be attributed to failure on the part of the hand laborer to clearly understand the necessity of leaving some beets closer than the average interval to compensate for gaps.

In both of these tests the hand thinning of the machined plots and also the hand thinning of the check plots was done before the beets reached a size where excessive numbers of plants would result in a diminished rate of

Table 2. Average Thinning Time, Yield and Number of Marketable Beet Roots of Mechanically Thinned Plots Compared with Plots Thinned and Weeded entirely by Hand. 1951. Average of 6 pairs of Plots each .0203 acre **in Area.**

	Thinning Time Man Hours/Acre	Marketable Roots/Acre	Yield Tons/Acre
Hand Thinned (Check)	21.8	19,800	13.45
Machine Thinned	15.1	14,700	12.50
Machine Thinned (%) Hand Thinned	69.4	74.4	92.55

growth. Had the thinning of both sets of plots been delayed until the competition for plant nutrients and moisture in the unthinned plots was a serious factor it is quite possible that the yields of the unthinned plots would have been reduced more than the yields of the thinned plots.

In both the 1950 and 1951 tests lower yields were recorded for the machine-thinned plots but the yield per man-hour of labor was greater in the case of the machine-thinned plots. On the basis of the 1950 results 98.0 percent more acreage with 74.6 percent greater total tonnage could be produced with a given amount of spring labor when the beets are first mechanically thinned. The corresponding figures for 1951 are 44.0 percent and 25.6 percent. The wide differences in the results obtained on these two different years cannot be entirely explained. It is to be noted, however, from a comparison of Tables 1 and 2 that the man-hours per acre and the man-hours per ton were both lower in the 1951 tests. It was observed that the individual who did the hand thinning on the plots in the 1951 tests was an unusually efficient worker.

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Note: In addition to the references listed it should be noted that several other individuals in the eastern area have conducted equally valuable experiments related to mechanical thinning.

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