SOME MATHEMATICAL OBSERVATIONS IN CONNECTION WITH MECHANICAL THINNING

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In the thinning of beets the two objectives are to leave the minimum number of beets which will produce the maximum yield and to leave the maximum number of these beets as singles. For many years we had the idea that these beets should be spaced uniformly, but in recent years this theory has been more or less disproved. We have all seen enough cases where spacing between individual beets was somewhat erratic with the total population within the optimum range to know that yield does not suffer as long as the irregularity of spacing is within certain limits.

During the past few years a great deal of attention has been given to the mechanical blocking of beets. Essentially at the beginning this operation consisted of leaving a beet-containing block for every desired beet after thinning. The operation was then followed by a hand job of eliminating the extra beets in each of these blocks to bring the population to the optimum point. Variations of this method were then devised to reduce the amount of singling required by basing the original calculations on a thinned stand made up of an average of more than one beet per block, to be obtained by leaving doubles where they could not be singled with a long-handled hoe.

With the advent of sheared seed plantings, much thought was given to leaving a job of mechanical blocking without any further hand work. In such cases the objective was ordinarily to leave 100 blocks per 100 feet of row with little regard to the total population of beets. Under carefully controlled experimental conditions this method proved satisfactory, but practical field results showed a yield loss, particularly where beets were harvested by hand, because the labor refused to handle many of the small beets. It was often accompanied by a demand on the part of hand labor for an increased price for harvesting because of the increased number of beets to be handled. Likewise, a high percentage of blocks containing more than one beet presented a problem from a standpoint of mechanical harvest due to the inability of the harvester to properly top more than one beet of a cluster.

In 1941, a number of practical field studies of cross-blocking were carried on throughout the various districts of the Utah-Idaho Sugar Company. An acre plot toward the center of each of 99 fields was cross-blocked, with hand work following on some and in other cases not being employed. An acre plot immediately adjacent was carefully thinned by hand and used for the check plot. In all cases these two plots were surrounded by beets. Blocking schedules used were 1-1/2-inch blocks on 5-inch centers, 1-1/2-inch blocks on 8-inch centers, 2-1/2-inch blocks on 10-inch centers, and 4-inch blocks on 20-inch centers. Regardless of the

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1/ Utah-Idaho Sugar Company.

blocking schedule used, average yields compared with check yields followed a definite pattern when correlated with after thinning stands. Where stands were in the range of 90 to 110 beets per 100 feet of row, yields were highest. Yields dropped as stands decreased. Yields of marketable beets dropped and harvest costs increased as stands became higher. Results of these studies were reported in the February 1942 issue of the U and I CULTIVATOR. Similar results have been reported from other field trials.

It would then appear that the objectives set up at the outset for a thinning job would apply to mechanical thinning as well as hand thinning, namely, to leave the minimum number of beets which will produce the maximum yield and to leave the maximum number of these beets as singles.

The problem of mechanically thinning the field to leave the desired number of beets is comparatively simple. While the optimum after-thinning stand will probably vary from one area to another, for purposes of this paper let us assume it to be 100 beets per 100 feet of row, or an average spacing of 12 inches. With an average pre-thinning or germination stand of 40 beets per 10 feet of row, it will be necessary to remove 30 or 3/4 of the beets to leave the desired 10 beets in the 10 feet. If 3/4 of the row length is blocked out and 1/4 of the row length is left in the form of blocks, averagly speaking, 3/4 of the beets will be removed and 1/4 will be left. If the first 7-1/2 feet were blocked out and the re aining 2-1/2 feet were left, or if 9 inches were blocked out and 3 inches left alternately, as far as the number of beets remaining is concerned, the result would be the same on the average. The extent to which this would be true for any individual 10 feet or 100 feet of row would be dependent upon the distribution of the seedlings in the row, which is in turn dependent on the performance of the planter employed, the quality of the seed used, and the uniformity of field germinating conditions.

As far as leaving the desired number of beets is concerned, two conditions must be known. First, the average pre-thinning or germination stand in total number of beets must be known and second, the desired after thinning stand must be known. The proportion of the total length of row to be left in the form of blocks then becomes the same as the proportion of the total number of beets in the pre-thinning stand to be left in the after-thinning stand. The length of the block left does not affect the remaining population as long as the ratio of total length of blocks to total length of row remains constant for a given condition.

The consideration of leaving the maximum number of singles in the after-thinning stand is directly related to regularity of spacing and is a little more involved. For any given ratio of total length of blocks to total length of row, as the individual block length decreases the number of blocks increases and the average number of beets per block decreases. Therefore,

as the individual block length decreases the percentage of singles increases. The maximum number of singles would then be obtained where the shortest practical block length is used. Where the Dixie machine is used this minimum practical block length varies somewhat with soil conditions, but for reasonably friable soils where thinning is done when the beets are in the six- to eight-leaf stage is probably in the neighborhood of 1-1/2 to 2 inches.

The process of mechanical thinning involves determining the ratio of total length of blocks to total length of row from the ratio of total number of beets desired in the after-thinning stand to the total number of beets in the pre-thinning stand and setting up the lengths of the individual cut and block on the basis of the shortest practical block.

The practicability of such a method is entirely contingent upon the distribution of seedlings in the pre-thinning stand. The distribution of seedlings is determined by three major factors, (1) uniformity and quality of field germination conditions, (2) quality of seed planted as regards both overall germination and percentage of single germ segments and (3) distribution of seed segments as planted. It is doubtful that sheared seed stands obtained generally in the spring of 1943 would produce satisfactory results with such a thinning method due to the tendency toward bunches separated by relatively wide gaps. In experimental plantings made with 7/64-inch to 9/64-inch gravity separated seed of approximately 90 percent germination and 90 percent singles in a Cobbley planter designed for this seed satisfactory results were obtained. A tabulation of these results follows:

SUGGESTED BLOCK AND CUT LENGTHS FOR MECHANICAL THINNING OF VARIOUS PRE-THINNING STANDS

No. of Beets per 10 Feet of Row Before Thinning	Desired Number of Beets per 100 Feet After Thinning					
	100 Beets per 100 Feet			120 Beets per 100 Feet		
	Block Centers	Length of Block	Length of Cut	Block Centers	Length of Block	Length of Cut
50	7"	1-7/16"	5-9/16"	7"	1-11/16"	5-5/16"
45	7"	1-9/16"	5-7/16"	7"	1-7/8"	5-1/8"
				6"	1-5/8"	4-3/8"
40	7"	1-3/4"	5-1/4"	7"	2-1/8"	4-7/8"
	6"	1-1/2"	4-1/2"	6"	1-13/16"	4-3/16"
35	6"	1-3/4"	4-1/4"	6"	2-1/16"	3-15/16"
30	6"	2"	4"	6"	2-7/16"	3-9/16"
				5"	2"	3"
25	6"	2-7/16"	3-9/16"	6"	2-7/8"	3-1/8"
	5"	2"	3"	5"	2-7/16"	2-9/16"
20	6"	3"	3"	6"	3-5/8"	2-3/8"
	5"	2-1/2"	2-1/2"	5"	3"	2"

MECHANICAL THINNING RESULTS FROM STANDS PLANTED WITH COBBLEY UNIT AND 7/64" to 9/64" GRAVITY SEPARATED SEED

Pounds per Acre	Germination Stand Seedlings Per 10 ft.	Blocking Schedule	Portion of Row Length Left Uncut	Theoretical Beets Left Per 100 Ft.	Actual No. of Blocks per 100 Ft.	Actual No. of Beets Per 100 Ft.	Percentage of Blocks Containing				Number of Spaces per 100 Feet of Row										
							1 Beet	2 Beets	3 Beets	4 Beets	5" to 9"	10" to 14"	15" to 19"	20" to 24"	25" to 29"	30" to 34"	35" to 39"	40" to 44"	45" to 49"	50" to 54"	55" to 59"
6.0	55.8	4" Cut 2" Bl.	1/3	186	118	184	59	30	8	3	69	26	12	4		2	1	1			
6.0	55.8	5" Cut 1" Bl.	1/6	93	69	87	81	16	2		26	16	9	7		4	2	3	2	1	
6.0	55.8	4" Cut 1" Bl.	1/5	112	87	110	79	17	3	1	30	21	14	9	6	2	2	2	1		1
4.0	35.6	4" Cut 2" Bl.	1/3	119	87	123	65	30	4	1	43	20	7	10		4	2	2	1		
3.3	32.0	4" Cut 2" Bl.	1/3	107	77	112	65	26	7	2	31	19	13	4		3	4	1	2		2