

1946 MECHANICAL THINNING EXPERIMENTS

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The Foundation Board of Directors met early in 1946 to map out the experimental program that should be conducted under Foundation sponsorship in 1946. A mechanical thinning test was one of the things felt necessary. The objective being to determine the difference in yield when thinning was done by hand as compared to the more complete mechanical methods or long handled hoe or mechanical and long handled hoe combinations. In order to increase replications as well as get tests spread out over a large number of growing conditions, 14 such tests were planned. Due to extreme weather conditions in the spring and early summer, two of the tests had to be discontinued leaving 12 to go on for harvest data.

The 12 tests being reported on were located in the following processor areas:

1. Billings, Montana Great Western Sugar Company
2. Windsor, Colorado Great Western Sugar Company
3. Longmont, Colorado. Great Western Sugar Company
4. King City, California Spreckels Sugar Company
5. Twin Falls, Idaho Amalgamated Sugar Company
6. Idaho Falls, Idaho. Utah-Idaho Sugar Company
7. Draper, Utah. Utah-Idaho Sugar Company
8. Rocky Ford, Colorado. American Crystal Sugar Co.
9. Torrington, Wyoming Holly Sugar Corporation
10. St. Louis, Michigan Lake Shore Sugar Company
11. Saginaw, Michigan Michigan Sugar Company
12. Deshler, Ohio Great Lakes Sugar Company

Tests were conducted by the individual processor companies based on recommendations received from the Mechanical Thinning and Standardization Committee of the Foundation. Similar tests were conducted at some colleges this past season. Results from these tests are not included in this paper. These tests were conducted at the following colleges:

1. Montana State College
2. Utah State College
3. University of Nebraska

A second test at Nebraska had to be discontinued after unfavorable conditions in the spring.

The following plan was outlined as standard procedure for each of the tests:

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OUTLINE OF TESTS.

I. MAIN TEST:

A. Treatments.

1. Hand Block and thin.
2. Long handled hoe thinning with no finger work.
3. Dixie thinning (no trimming).
4. Cross thin with knives, duckfeet, etc. No trimming.
5. Cross block with knives, duckfeet, etc. Long handled hoe trimming.
6. Cross block with knives, duckfeet, etc. Cross cultivate at least once ahead of weeding and hoe trimming.
7. Mechanical thinning with special tools using 1 to 2 inch width tools (knife-edge bull-tongues) on cultivator, harrow or other similar tool. No trimming.

The above treatments were made at the 2 to 4 leaf stage (early thinning). The same treatments were repeated at the 8 leaf stage (delayed thinning). These treatments were numbered from 11 to 17, the last digit referring back to the 7 treatments listed above.

B. Seeding rate: 6 to 8 seed portions per foot (based on local per cent emergence expected).

C. Seed: Common to locality, having high germination and high per cent of single cells.

D. Row widths: 18" to 22" depending on local practices.

E. Experimental design: Randomized complete block. Six replications.

F. Plots: Approximately 16 feet long and 60 rows wide (plots extended cross-wise of the rows). The length of the cross blocked plots was determined by making one complete round of the cultivator. Roadways or 12 rows on each side were provided for turning.

G. Data required: Germination stand counts, thinned stand counts, root yield per acre, percentage of sugar, total sugar yield per acre and time studies. Time study included both thinning and subsequent hoeing. Germination stand counts were based on 10-100 inch counts and thinned stand counts were made on the entire plot.

II. SUPPLEMENTARY TEST.

A. Purpose: To compare (1) no thinning on beets planted at a seeding rate of 3 seed portions per foot with (2) long handled hoe thinning on beets planted at 6 to 8 seed portions per foot. Investigation was desired as to possibility of elimination thinning by using low seeding rates.

- B. Seed: Same as for "Main Test".
- C. Row widths: Same as for "Main Test".
- D. Thinning dates: Same as for "Main Test".
- E. Replicates: Same as for "Main Test".
- F. Experimental Design: Alternate plots of each treatment. Analyzed as paired comparisons. Compared with treatments in "Main Test" using "long handled hoe" for a check.
- G. Plots: 4 to 6 rows in width (depending on planter used) and at least 300 feet in length.
- H. Data required: Same as for "Main Test".

STAND COUNTS.

The pre-thinning and after-thinning counts have been summarized in Table 13. Treatments 3, 4, 7, 13, 14 and 17 which are all mechanical thinning treatments, with no hand or long handled hoe trim show as an average of all tests, up to 55% more plants per 100 feet of row than the hand block and thin treatments. A reflection of the after thinning stand count is apparent in the total number of beets per acre at harvest time. These data are reported for each of the tests. It is a logical assumption that the rather wide difference in plant population becomes a factor in influencing yields as well as the way in which the different treatments were thinned. The excessive population would in many instances depress yields.

HARVEST RESULTS

Tables 1 to 12 give summarized harvest data for each of the tests. It is important to note that the coefficient of variability (standard error divided by general mean) tends to run higher for number of marketable beets per acre than for tons of beets per acre, in other words, there is greater variation in the number of beets per acre than in yield in tons per acre. Examining these tables one can frequently find two treatments significantly different in respect to number of marketable beets per acre but with no significant difference in their yields.

The test conducted at King City, California, gives some interesting results on the use of the Dixie. (See Table 7). This test, unlike the other 11 in that it was planted on beds, used the Dixie as the only mechanical device for thinning. The tonnage varies very little for all of the treatments with Dixie thinning alone, (Treatments 3 and 13) holding its own even with a high acre population. Comparing the "Tons Per Acre" column with the "Number of Marketable Beets Per Acre" column; it appears that the higher populations have the advantage and that not enough beets per acre had been left in most cases.

The other 11 tests are summarized in Chart 1. The treatment yields are here expressed in terms of per cent when delayed hand block and thin is taken as 100%.

Delayed hand block and thin (Treatment 11) was selected as the check in that it was felt that it most nearly represented the time when the bulk of the thinning was normally done commercially. Timely thinning shows up favorably in all treatments with Treatments 4 and 5 being only 8% and 6% less respectively than the check. Thinning with narrow tools (Treatments 7 and 17) as well as Dixie thinning falls off somewhat. How much of this is due to the heavier acre populations is difficult to determine.

TIME COMPARISONS.

Time studies are summarized in Charts 2 and 3. Chart 2 gives the actual time in hours per acre for each treatment and Chart 3 expresses time in per cent when Treatment 11, delayed hand block and thin is taken as 100. Treatments 3, 4, 7, 13, 14 and 17, all straight mechanical treatments without any hand work or long handled hoe show up most favorably as would be expected. These treatments required between 40% and 50% less labor than the delayed hand block and thin. Time required for long handled hoeing following cross blocking was a great deal more for delayed thinning. In some cases, the long handled hoe trim time requirement with delayed blocking treatments was greater than long handled hoe used alone.

SUCROSE RESULTS.

There appears to be no pronounced effect between treatments on sucrose percentage. Although there are significant sucrose differences within given tests, this difference between any set of treatments does not hold true with other tests. If you were to arrange the treatments in order of their sucrose per cent for each test, you would get a table showing a different sequence for each test with no one treatment holding constant top place. Treatments 7 and 17, if any, might be considered as being most uniformly near the top and Treatments 6 and 16 most constantly near the bottom. This apparently can be linked up with plant population per acre.

SUPPLEMENTARY TEST RESULTS.

Five of the tests report harvest yields on the "Supplementary Test". The light seeding rate (3 seeds per foot) compares very favorably with the long handled hoe treatment which becomes the check and the means for comparing with treatments in the "Main Test". The average time requirement based on all tests was 14.4 hours for long handled hoe and 10.8 hours for the light seeding rate. In two of the tests, however, it became necessary to use long handle hoe trim on the light seeding rate. If time on these two tests were not considered, the time requirement would be 14.43 hours for long handled hoe and 6.77 hours for light seeding, a saving of 53% on labor as compared to long handled hoe and with a yield decrease of only 5%. The yield of the light seeding rate was 90% of the long handled hoe yield when all five tests were considered.

The pattern of the pre-thinning stand counts varies between tests with some tests having a large number of single plant hills and relatively few blank gaps. Other tests had more spotted emergence. The uniform spacing of plants is an important factor favoring mechanical thinning and was evidenced in some of these results.

ECONOMIC COMPARISON.

It is interesting to apply a few economic factors to the results of tests like these. The average yield taken from all tests for Treatment 11, delayed hand block and thin, which we shall use as the check, is 16.07 tons per acre. The average yield for Treatment 4, early cross thin with knives, is 14.80 tons. The number of hours required for thinning and subsequent hoeings is 23.5 hours for Treatment 11 and 13.5 hours for Treatment 4 (see Chart 2). Assuming the price of beets as established for 1947, which \$14.50 per ton, and labor at 70¢ per hour, the following table is formulated:

<u>Treatment</u>	<u>Gross Return Per Acre</u>		<u>Labor Cost</u>		<u>Return per acre after spring thinning and hoeing have been paid.</u>
11	\$ 233.02	-	\$ 16.45	=	\$ 216.57
4	214.60	-	9.45	=	205.15

This shows a decrease in earning of \$11.42 for the straight mechanical treatment. One should keep in mind, however, that processed seed in itself has served to decrease the labor requirement a great deal. The industry is not far removed from the time when all planting was made with ungraded whole seed, in fact, about 30% of the acreage was still planted with this seed in 1946, with a great deal of acreage at heavy seeding rates. Previous studies show that yields from such plantings are in excess of one ton less than the processed seed plantings and that time required is at least 30% greater than processed seed when hand blocking and thinning is used on both types of seed. Based on these assumptions another comparison can logically be made as in the following table:

<u>Treatment</u>	<u>Gross Return Per Acre</u>		<u>Labor Cost</u>		<u>Return per acre after accounting for deduction of labor costs.</u>
11	\$ 233.02		\$ 16.45	=	\$ 216.57
4	\$ 214.60		\$ 9.45	=	205.15

Ungraded whole
seed, hand

block and thin \$ 217.50 \$ 21.35 = \$ 196.15

This table shows mechanical thinning in a more favorable position; a position which it has established itself in some commercial areas and justly so. We should make comparisons using processed seed combined with mechanical thinning as against the old standard whole seed planting to get the true picture.

SUMMARY.

1. The tests conducted are representative of several beet growing areas and even though rather large variations show up between some of the tests, the average of all of them gives a reliable guide as to what can be expected when spring work is accomplished by the described methods.

2. It is apparent that much can be done in improving the tools used for mechanical thinning and more specifically in setting the tools accurately so that

the resulting plant populations will favor maximum tonnage. In mechanical work the tendency is to leave too many beets. Where populations are held down by proper tool settings a greater saving in labor can be secured as well as making possible comparable yields with hand blocking and thinning.

3. Uneven distribution of plant population due to planter deficiency and uneven emergence of the seed is reflected in most of the tests.

4. Economically, the straight mechanical treatments give slightly lower returns than hand block and thin but exceed hand block and thin when ungraded whole seed at the old seeding rates is used as the standard of comparison.

Table 1. Mechanical Thinning Test 1946, Billings, Montana (Great Western Sugar Co.)

Treat. No.	Treatment	Main Test				Unmar- ketable		Hand labor Man Hrs. Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.	Total Beets Per A.	
1	Hand block and thin. Early	20.24	17.6	7103	26372	178	26550	17.1
2	Long-handled hoe. No trim. Early	19.17	17.9	6853	33698	178	33876	16.6
3	Dixie thinning. No trim. Early	17.18	18.1	6206	31996	218	32214	9.7
4	Cross thin with knives. Early	17.66	17.9	6315	32827	357	32571	4.7
5	Cross-block, long-handled hoe trim. Early	17.93	17.8	6366	27600	218	27818	11.3
6	Cross-block, cross-cultivate, long-handled hoe trim. Early	17.67	17.6	6215	24195	317	24512	15.3
7	Mechanical thin-narrow tools. Trim. Early	18.76	17.6	6589	27640	178	27818	17.9
11	Hand block and thin. Delayed	20.27	17.5	7103	26174	158	26332	20.3
12	Long-handled hoe. No trim. Delayed	19.41	17.6	6930	32663	178	32846	16.6
13	Dixie thinning. No trim. Delayed	16.77	17.6	5904	29778	297	30075	10.5
14	Cross thin with knives. Delayed	16.88	17.7	5970	30451	238	30748	4.7
15	Cross block, long-handled hoe trim. Delayed	17.93	17.6	6306	24393	158	24551	17.9
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	17.59	17.5	6152	23323	158	23481	19.7
17	Mechanical thin-narrow tools. Trim. Delayed	17.23	17.6	6069	25818	198	26016	18.9
	General Mean	18.19	17.7	6434	28352	216		
	CV (%)	6.13	5.66	6.23	7.89			
	Sm in % of General Mean	2.50	2.31	2.54	3.22			
	LSD 5% point	1.26	*	327	2580			
	LSD 1% point	1.67	*	434	3429			

*No significant differences.

Supplementary Test

1	Segmented Seed, 3 per ft. Long handle hoe thinned.	24.63	17.2	8481	26433		26433	5.4
2	Segmented Seed, 6-8 per ft. Long-handled hoe thinned.	24.44	16.9	8277	27423		27423	6.3
3	Whole Seed, Graded 7-10/64", 6-8 ft. Long handled hoe thinned.	24.41	17.4	8490	25800		25800	6.3
4	Whole Seed, 15# per Acre. Hand thin.	25.29	17.5	8833	25245		25245	9.2

Notes on Billings, Montana Test

Main Test

Tool Settings:

- Treatments 1 & 11 - Hand block and thin
" 2 & 12 - Long-handle hoe
" 3 & 13 - Dixie. Setting on 9 inch centers with a 7 inch cut and a 2 inch block.
" 4 & 14 - Cross thin. Universal knives and flat, cross-blocking duck feet. 7 inch cut and 2½ inch block for duck feet and 8 inch cut and 2 inch block for knives. Both tools used simultaneously, the knives being placed ahead of the tractor rear wheels to give slight additional space for the tire.
" 5 & 15 - Cross block, long-handled hoe trim. Same cross-blocking tools as in treatment 4.
" 6 & 16 - Cross block, cross-cultivate, long-handled hoe trim. Same tool set-up as in treatments 4 and 5 except that the tire track was cut out to about 10 inches in width to facilitate subsequent cross cultivation. Cross cultivation made use of 4 inch duck feet to fit in the 7 inch cut.
" 7 & 17 - Mechanical thinning - narrow tools. Treatment was attempted with the spike tooth harrow but even the early date of thinning was too late to make possible the removal of a sufficient portion of the plant population. A cultivator set with knife-edge bull tongues gave somewhat better results but still insufficient reduction in stand was obtained. Going over the plot the second time was even not successful. The treatments were trimmed with the long-handled hoe to make it acceptable to the grower.

General Remarks:

Hand work was done by local Mexican labor which was considered as excellent labor. There was one subsequent hoeing and 2 subsequent cultivations.

Supplementary Test

Two extra treatments added. One was the adding of a treatment seeded with graded whole seed at the rate of 6 to 8 seeds per foot and then long-handled hoed and the other seeding 15 pounds of whole seed and hand thinning. The 3 seeds per foot treatment was too heavy and had to be long handle hoed. Plots had one subsequent hoeing and no extra cultivations.

Notes on Rocky Ford, Colorado Test

Main Test

Tool Settings:

- | | | |
|------------|--------|---|
| Treatments | 1 & 11 | - Hand block and thin |
| " | 2 & 12 | - Long-handled hoe |
| " | 3 & 13 | - Dixie |
| " | 4 & 14 | - Cross thin with knives. Used regular 6 inch knives making a 9 inch cut and 3 inch block. |
| " | 5 & 15 | - Cross-block with Knives, long-handled hoe trim. Same tool setting as in 4 & 14. |
| " | 6 & 16 | - Cross-block, cross-cultivate, long-handled hoe trim. Same tool settings. |
| " | 7 & 17 | - Mechanical thinning. Used special Mervine cross-blocking tool with 4 inch cut and 2 inch block. |

General Remarks:

Knives were set up in pairs on a bar for each block. Both tool bars were used. Duck feet were used for cross-cultivation, and small duck feet were also set up on the back tool bar in the crossblocking. Tool used in treatment 7 is hard to adjust for depth and consequently cutting was made quite deep. Immediately after treatment 7 had been thinned a heavy local rain came giving about one inch of rainfall in 10 minutes. Checking the field two days later it was found that many of the cut beets had taken root again and were growing.

Early thinning was on the delayed side hence early and delayed thinning dates were only one week apart.

Long-handle hoe thinning was new to the laborers which made for faster time with short hoe than with the long hoe. There were 3 subsequent hoeings and 3 subsequent cultivations.

Table 3. Mechanical Thinning test 1946, Windsor, Colorado (Great Western Sugar Co.)

Main Test

Treat. No.	Treatment	Marketable				Unmar- ketable	Total Beets Per A.	Hand Labor Man Hrs. Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.		
1	Hand block and thin. Early	15.20	13.12	3988	23232	73	23305	17.4
2	Long-handled hoe. No trim. Early	15.05	13.13	3952	25120	218	25338	11.6
3	Dixie thinning. No trim. Early	12.42	13.00	3229	23232	460	23692	8.3
4	Cross thin with knives. Early	13.17	13.28	3498	27007	895	27902	5.5
5	Cross-block, long-handled hoe trim. Early	13.67	12.93	3535	22506	339	22845	8.4
6	Cross-block, cross-cultivate, long-handled hoe trim. Early	12.23	12.82	3136	18005	97	18102	12.5
7	Mechanical thin-narrow tools. Early	12.15	13.08	3178	27298	629	27927	6.3
11	Hand block and thin. Delayed	14.01	13.15	3685	23232	145	23377	30.8
12	Long-handled hoe. No trim. Delayed	14.18	13.18	3738	32234	1089	33323	19.8
13	Dixie thinning. No trim. Delayed	11.60	13.08	3035	23813	750	24563	9.2
14	Cross thin with knives. Delayed	12.25	13.20	3234	25410	581	25991	6.3
15	Cross-block, long-handled hoe trim. Delayed	13.09	12.83	3359	24829	411	25240	15.8
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	12.94	13.35	3455	20038	411	20449	15.4
17	Mechanical thin-narrow tools. Delayed	11.16	13.52	3018	36445	2977	39422	6.9
General Mean		13.08	13.12	3432	25172			
CV (%)		8.40	4.12	9.39	9.60			
Sm in % of General Mean		3.43	1.68	3.83	3.92			
LSD 5% point		1.27	*	372	2780			
LSD 1% point		1.69	*	495	3694			

*No significant differences.

Supplementary Test

1	3 Seeds per foot. No thinning.	13.24	13.67	3620	44721	4791	49512	3.1
2	6-8 Seeds per foot. Long-handled hoe. Early	16.51	13.55	4474	25496	174	25670	11.6

Notes on Windsor, Colorado Test

Main Test

Tool Settings:

- Treatments 1 & 11 - Hand block and thin
" 2 & 12 - Long-handled hoe
" 3 & 13 - Dixie. Setting on 10 inch centers leaving 2 inch block and 8 inch cut.
" 4 & 14 - Cross thin with knives. Cut 7 inches and block 1 3/4 inches with 8 3/4 inch centers.
" 5 & 15 - Cross block, long-handled hoe trim. Centers at 12 inches with 3 inch block and 9 inch cut.
" 6 & 16 - Cross-block, cross-cultivate, hoe trim. Same tools as for 5 & 15. Cross-cultivation with long curved shank duck feet having 4 inch spades.
" 7 & 17 - Mechanical thin-narrow tools. Used harrow with weights placed on top. Covered plot twice.

General Remarks:

Plots planted on April 1 but soil moisture insufficient to bring up beets for several weeks. When water became available plots were irrigated up. Germination was very good. Early thinning was done on June 10 with very good laborers. Delayed thinning on June 22 with another group of laborers not as efficient as the first used. Delayed thinning date found beets very large and hence difficult to work by hand. No benefit gained by cross-cultivation and the delayed trimming following cultivations was time consuming.

Supplementary Test

The following table shows number of beets on pre-thinning stand counts:

Treatment	Beets Per A.	% Singles
1	100362 (a)	51.1
2	177767	40.9 (b)

- (a) Even though no thinning was done, less than one half this number of beets are accounted for in number of beets harvested.
(b) Per cent singles after this treatment was long-handled hoed was 83%.

Table 4. Mechanical Thinning Test 1946, Longmont, Colorado (Great Western Sugar Co.)

		Main Test				Unmar- ketable			
		Marketable							
Treat.		Tons		Pounds	No.	No.	Total	Hand Labor	
No.	Treatment	Beets	%	Sugar	Beets	Beets	Beets	Man Hrs.	
		Per A.	Sucrose	Per A.	Per A.	Per A.	Per A.	Per Acre	
1	Hand block and thin. Early	19.61	12.02	4714	22480	22	22502	24.7	
2	Long-handled hoe. No trim. Early	19.36	12.92	5003	26689	65	26754	16.2	
3	Dixie thinning. No trim. Early	18.50	12.50	4625	23369	44	23413	14.1	
4	Cross thin with knives. Early	17.68	12.38	4378	25317	153	25470	11.6	
5	Cross-block, long-handled hoe trim. Early	17.61	12.15	4279	22193	87	22280	15.3	
6	Cross-block, cross-cultivate, long-handled hoe trim. Early	17.74	12.23	4339	23095	65	23160	10.8	
7	Mechanical thin-narrow tools. Early	17.81	12.20	4346	24441	131	24572	10.6	
11	Hand Block and thin. Delayed	18.97	12.98	4925	22977	0	22977	19.9	
12	Long-handled hoe. No trim. Delayed	18.10	12.52	4532	28780	109	28889	15.3	
13	Dixie thinning. No trim. Delayed	17.25	12.12	4181	23487	87	23574	16.2	
14	Cross thin with knives. Delayed	17.97	12.53	4503	23526	65	23591	12.8	
15	Cross-block, long-handled hoe trim. Delayed	18.38	12.35	4540	21605	109	21714	13.7	
16	Cross-block, cross-cultivate, long handled hoe trim. Delayed	16.95	12.03	4078	19579	65	19644	12.6	
17	Mechanical thin-narrow tools. Delayed	17.12	12.33	4222	29120	218	29338	13.8	
General Mean		18.07	12.38	4474	24047	87			
CV (%)		6.48	5.32	8.38	10.33				
Sm in % of General Mean		2.64	2.17	3.42	4.08				
LSD 5% point		1.35	*	432	2770				
LSD 1% point		1.79	*	574	3681				

* No significant differences.

Supplementary Test

1	3 Seeds per foot. Not thinned.	19.11	10.15	3879	19174	52	19226	8.6
2	6-8 Seeds per foot. Long-handled hoe trim. Early	19.40	10.51	4078	21000	52	21052	16.3
3	3 Seeds per foot. Not thinned.	20.14	12.54	5051	18102	0	18102	8.6
4	6-8 Seeds per foot. Long-handled hoe trim. Delayed.	19.39	13.05	5061	24794	44	24838	15.4

Notes on Longmont, Colorado Test

Main Test

Tool Settings:

- Treatments 1 & 11 - Hand block and thin
" 2 & 12 - Long-handled hoe
" 3 & 13 - Dixie. Setting made for 10 inch centers with a 6 inch cut and 4 inch block.
" 4 & 14 - Cross thin. Duck feet set to cut 6 inches and leave 4 inches.
" 5 & 15 - Same tools & settings as 4 & 14. Long-handled hoe trim.
" 6 & 16 - Cross-block, cross-cultivate, long-handled hoe trim. Same tools and setting as for 4 & 14. Cross cultivated once with bull tongues before using long-handled hoe.
" 7 & 17 - Mechanical thinning-narrow tools. Used bull tongues on cultivator bar making a $1\frac{1}{2}$ inch cut and leaving $2\frac{1}{2}$ inches.

General Remarks:

The initial stand on all treatments was rather thin which no doubt made for smaller differences between early and delayed thinning. The thinning was done in the four and eight leaf stage. The two dates differed by only 9 days. The same labor was used for each thinning.

Supplementary Test

A very good stand of beets was obtained from the 3 seeds per foot seeding rate. The following table shows the number of beets per acre based on pre-thinning stand counts:

<u>Treatment</u>	<u>Beets Per A.</u>	<u>% Singles</u>
1	22456	73.2
2	44410	67.8
3	22338	77.3
4	44863	75.6

Table 5. Mechanical Thinning Test 1946, Torrington, Wyoming (Holly Sugar Co.)

Main Test

Treat. No.	Treatment	Marketable				Unmar- ketable		Hand Labor Man Hrs. Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.	Total Beets Per A.	
1	Hand block and thin. Early	8.51	13.78	2307	20453	79	20532	21.0
2	Long-handled hoe. No trim. Early	8.20	13.98	2286	25265	1247	26512	17.9
3	Dixie thinning. No trim. Early	6.83	13.58	1846	26912	3901	30813	11.5
4	Cross thin with knives. Early	7.50	13.25	1983	20750	1168	21918	11.7
5	Cross-block, long-handled hoe trim. Early	7.50	13.95	2107	14870	237	15107	16.8
6	Cross-block, cross-cultivate, long-handled hoe trim. Early	7.64	13.12	2006	14810	178	14988	18.5
7	Mechanical thin-narrow tools. Early	6.18	14.21	1752	24532	2376	26908	12.1
11	Hand block and thin. Delayed	7.14	13.65	1946	16690	673	17363	19.6
12	Long-handled hoe. No trim. Delayed	8.56	13.59	2332	19245	534	19779	25.9
13	Dixie thinning. No trim. Delayed	6.84	13.85	1906	28928	4831	33759	11.5
14	Cross thin with knives. Delayed	5.91	13.34	1571	24077	2534	26611	11.7
15	Cross-block, long-handled hoe trim. Delayed	6.23	13.51	1676	14236	297	14533	31.9
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	7.05	13.30	1882	14315	199	14514	32.3
17	Mechanical thin-narrow tools. Delayed	7.47	13.95	2081	26651	2178	28829	14.0
General Mean		7.25	13.65	1977	20838	1460		
CV (%)		15.64	4.04	16.15	15.45			
Sm in % of General Mean		6.39	1.65	4.08	6.31			
LSD 5% point		1.31	.64	367	3712			
LSD 1% point		1.74	.85	490	4934			

Notes on Torrington, Wyoming Test

Main Test

Tool Settings:

- Treatments 1 & 11 - Hand block and thin
" 2 & 12 - Long-handled hoe
" 3 & 13 - Dixie
" 4 & 14 - Cross thin with knives. Used Planet Jr. knives on $8\frac{1}{2}$ inch centers making $1\frac{1}{2}$ inch blocks and 7 inch cuts.
" 5 & 15 - Cross-block, long-handled hoe trim. Used Planet Jr. knives on $9\frac{1}{2}$ inch centers making $2\frac{1}{2}$ inch blocks and 7 inch cuts.
" 6 & 16 - Cross-block, cross-cultivate, long-handled hoe trim. Same knife setting as in 5 & 15.
" 7 & 17 - Mechanical thinning with narrow tools. Spring tooth alfalfa renovator was used. This machine had to be used a second time in order to reduce populations so they were somewhat comparable with hand block and then treatment populations.

General Remarks:

Excellent Mexican laborers were used. These laborers were not experienced in using the long handle hoe. The early thinning was made a little on the late side making the delayed thinning quite late when beets were well in the 8 - leaf stage. It took laborers longer to long handle hoe following cross-blocking in the delayed stage than just straight long handle hoe.

Table 6. Mechanical Thinning Test 1946, Saginaw, Michigan (Michigan Sugar Co.)

Treat. No.	Treatment	Main Test				Unmar- ketable		
		Marketable		Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.	Total Beets Per A.	Hand Labor Man Hrs. Per Acre
		Tons Beets Per A.	% Sucrose					
11	Hand block and thin. Delayed	10.47	18.40	3396	19333	6380	25713	18.8
12	Long-handled hoe. No trim. Delayed	10.39	18.18	3357	18173	7347	25520	20.1
13	Soucci thinning. No trim. Delayed	8.69	17.77	2761	17787	11020	28807	16.0
14	Cross thin with knives. Delayed	8.51	17.98	2723	17400	11793	29193	12.8
15	Cross-block, long-handled hoe trim. Delayed	10.67	18.27	3376	16820	4640	21460	18.8
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	7.33	17.78	2299	15467	11777	27244	22.7
17	Mechanical thinning.	6.82	17.88	2166	16240	18753	34993	14.8
General Mean		8.98	18.04	2873	17317	10247		
CV (%)		10.32	1.60	10.94	9.04			
Sm in % of General Mean		4.42	.65	4.67	3.69			
LSD 5% point		1.15	.34	371	1846			
LSD 1% point		1.54	.46	489	2486			

Table 7. Mechanical Thinning Test 1946, King City, California (Spreckels Sugar Co.)

Main Test

Treat. No.	Treatment	Marketable				Unmar- ketable	Total Beets Per A.	Hand Labor Man Hrs. Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.		
1.	Hand block and thin. Early	22.71	18.4	8280	29800	2048	31848	Information
2	Long-handled hoe. No trim. Early	25.08	17.9	8970	38339	3703	42042	
3	Dixie thinning. No trim. Early	20.76	17.8	7280	35296	6666	41962	
4	Dixie, Long-handled hoe trim. Early	21.70	17.7	7680	25639	1590	27229	
5	Dixie, hand trim. Early	20.66	17.6	7160	23286	1743	25029	
11	Hand block and thin. Delayed	22.64	18.6	8400	28297	1786	30083	not
12	Long-handled hoe. No trim. Delayed	24.92	18.4	8740	40495	5751	46246	
13	Dixie thinning. No trim. Delayed	21.89	18.4	8000	39559	8648	48207	
14	Dixie, long-handled hoe trim. Delayed	20.46	18.2	7480	30431	2527	32958	Available
15	Dixie, hand trim. Delayed	21.09	18.3	7680	23765	1329	25094	
General Mean		22.19	18.1	7960	31491	3579		
CV (%)		20.08	4.19	19.53	16.39			
Sm in % of General Mean		8.20	1.71	7.97	6.69			
LSD 5% point		5.18	.88	1807	6002			
LSD 1% point		6.92	1.18	2414	8016			

Supplementary Test

1	3 Seeds per foot.	19.47	18.2	7060	22960	2890	25850
2	6-8 Seeds per foot, long-handled hoe trim. Early	23.39	18.4	8620	25705	2309	28014
3	3 Seeds per foot.	18.38	18.8	6860	22393	3529	25922
4	6-8 Seeds per foot, long-handled hoe trim. Delayed	24.84	18.6	9260	25617	3224	28841

Notes on King City, California Test

Main Test

Tool Settings:

- Treatments 1 & 11 - Hand block and thin
" 2 & 12 - Long-handled hoe
" 3 & 13 - Dixie. Set for 6 inch centers leaving 2 inch blocks
and 4 inch cuts.
" 4 & 14 - Dixie followed by long-handle hoe. Same setting as in
3 & 13.
" 5 & 15 - Dixie followed by hand trim. Same setting as in 3 & 13.

General Remarks:

Time data sheets arrived too late to permit making the proper records hence man hours per acre is omitted. It was noted, however, that labor both by use of long-handled hoe and hand work was able to move along more rapidly following a Dixie than when no Dixie was used.

These plots were placed on beds which did permit cross the row tools. Rows were spaced at 14 inches on the beds and 26 inches between beds. Three subsequent hoeings were made and 5 subsequent cultivations.

Supplementary Test

Paired comparisons were conducted on a field not adjacent to the main test. There were 2 subsequent hoeings and 3 subsequent cultivations.

Table 8. Mechanical Thinning Test 1946, Twin Falls, Idaho (Amalgamated Sugar Co.)

		Main Test				Unmar- ketable			
		Marketable		Pounds	No.	No.	Total	Hand Labor	
Treat.		Tons	%	Sugar	Beets	Beets	Beets	Man	Hrs.
No.	Treatment	Per A.	Sucrose	Per A.	Per A.	Per A.	Per A.	Per Acre	
1	Hand block and thin. Early	21.35	17.57	7500	20673	1070	21743	19.1	
2	Long-handled hoe. No Trim. Early	22.42	17.67	7920	22107	1579	23686	17.0	
3	Dixie thinning. No trim. Early	20.41	17.95	7340	32307	4701	37008	11.3	
4	Cross thin with knives. Early	20.06	17.37	6960	28115	3248	31363	10.7	
5	Cross-block, long-handled hoe trim. Early	20.30	16.98	6900	16153	944	17097	16.3	
6	Cross-block, cross-cultivate, long-handled hoe trim. Early	19.30	16.55	6400	15355	1143	16498	14.8	
7	Mechanical thin-narrow tools. Early	19.17	17.37	6660	22071	2396	24467	10.9	
11	Hand block and thin. Delayed	20.63	16.80	6920	19257	1434	20691	18.8	
12	Long-handled hoe. No trim. Delayed	21.76	17.48	7620	24049	1578	25627	15.6	
13	Dixie thinning. No trim. Delayed	19.87	17.35	6900	26444	3013	29457	11.5	
14	Cross thin with knives. Delayed	20.49	17.78	7280	28314	2850	31164	10.7	
15	Cross-block, long-handled hoe trim. Delayed	19.87	17.03	6760	16934	1324	18258	14.1	
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	20.45	17.25	7060	16299	943	17242	13.1	
17	Mechanical thin-narrow tools. Delayed	20.12	17.53	7060	27189	1815	29004	11.3	
General Mean		20.44	17.33	7091	22518	1989			
CV (%)		6.82	2.88	7.48	10.40				
Sm in % of General Mean		2.78	1.18	3.05	4.25				
LSD 5% point		1.61	.58	611	2701				
LSD 1% point		2.13	.76	813	3590				

Supplementary Test

1	3 Seeds per foot.	15.45	17.3	5340	47807		47807	28.3
2	6-8 Seeds per foot. Long-handled hoe. Early	16.50	16.8	5560	18658		18658	22.6

Notes on Twin Falls, Idaho Test

Main Test

Tool Settings:

- | | | |
|------------|--------|---|
| Treatments | 1 & 11 | - Hand block and thin on 14 inch centers |
| " | 2 & 12 | - Long-handled hoe on 14 inch centers |
| " | 3 & 13 | - Dixie. Set on 9 inch centers with a 3 inch block and 6 inch cut. |
| " | 4 & 14 | - Cross thinning. Used John Deere knives set on 12 inch centers. Left a 4 inch block. |
| " | 5 & 15 | - Cross-block, long-handled hoe trim. Same tools and settings as with 4 & 14. |
| " | 6 & 16 | - Cross-block, cross-cultivate, long-handled hoe trim. Same tools and settings as with 4 & 14. |
| " | 7 & 17 | - Mechanical thin-narrow tools. Used Self Weeder with 3 inch diamond points. Set to make a 1 inch block and 3 inch cut. |

General Remarks:

Used Mexican laborers rated as good. Had one subsequent hoeing.

Supplemental Test

Made one subsequent hoeing on long-handled hoe thinned plots and 2 weed hoeings on unthinned plots which were seeded at the rate of 3 seeds per foot.

Table 9. Mechanical Thinning Test 1946, St. Louis, Michigan (Lake Shore Sugar Co.)

Main Test

Treat. No.	Treatment	Marketable			No. Beets Per A.	Unmar- ketable No. Beets Per A.	Total Beets Per A.	Hand Labor Man Hours Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.				
1	Hand block and thin. Early	12.94	20.4	4756	18059	236	18295	16.27
2	Long-handled hoe. No trim. Early	13.33	20.1	4757	20383	508	20891	16.63
3	Dixie thinning. No trim. Early	10.84	20.0	3848	19185	1089	20274	11.72
4	Cross thin with knives. Early	10.82	19.6	3785	17642	1434	19076	10.60
5	Cross-Block, long-handled hoe trim. Early	11.93	20.1	4317	17279	672	17951	9.83
6	Cross-block, cross-cultivate, long-handled hoe trim. Early	11.86	19.8	4156	16626	563	17189	8.50
7	Mechanical thin-narrow tools. Early	10.98	21.0	4128	26136	3884	30020	9.08
11	Hand block and thin. Delayed	12.85	20.3	4651	17932	300	18132	16.63
12	Long-handled hoe. No trim. Delayed	12.04	20.5	4432	19856	726	20582	14.18
13	Dixie thinning. No trim. Delayed	10.62	20.0	3813	19493	1180	20673	10.20
14	Cross thin with knives. Delayed	10.86	20.1	3914	19584	1452	21036	9.63
15	Cross-block, long-handled hoe trim. Delayed	11.20	20.0	3963	17261	745	18006	9.08
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	10.84	20.2	3939	16898	781	17679	9.27
17	Mechanical thin-narrow tools. Delayed	11.06	20.8	4143	28169	3122	31291	10.20
General Mean		11.58	20.22	4186	19607			
CV (%)		8.27	3.39	8.94	12.43			
Sm in % of General Mean		3.78	1.38	3.65	5.07			
LSD 5% point		1.11	.79	431	2809			
LSD 1% point		1.47	1.05	573	3733			

Table 10. Mechanical Thinning test 1946, Deshler, Ohio. (Great Lakes Sugar Co.)

Main Test

Treat. No.	Treatment	Marketable				Unmar- ketable	Total Beets Per A.	Hand Labor Man hours Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.		
11	Hand block and thin. Delayed	10.37	20.43	3773	26393	2515	28908	20.70
12	Long-handled hoe. No trim. Delayed	10.03	20.56	3757	25978	2351	28329	20.70
13	Dixie thinning. No trim. Delayed	9.44	19.89	3326	21839	2554	24393	20.25
14	Cross thin with knives. Delayed	10.18	19.84	3580	22156	1386	23542	19.80
15	Cross-block, long-handled hoe trim. Delayed	9.05	19.71	3130	19800	1366	21166	20.70
16	Cross-block, cross-cultivate, long-handled hoe trim. Delayed	10.66	20.58	3963	24671	1782	26453	21.15
17	Mechanical thin-narrow tools. Delayed	8.90	20.06	3232	21641	1742	23383	21.15
General Mean		9.80	20.15	3537	23211			
CV (%)		20.77	2.24	20.89	13.75			
Sm. in % General Mean		8.50	.92	8.37	7.65			
LSD 5% point		2.40	.54	855	5129			
LSD 1% point		3.23	.72	1152	6908			

Table 11. Mechanical Thinning Test 1946, Draper, Utah. (Utah-Idaho Sugar Company)

Main Test

Treat. No.	Treatment	Marketable				Unmar- ketable	Total Beets Per A.	Hand Labor Man Hours Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.	No. Beets Per A.	No. Beets Per A.		
1	Hand block and thin. Early	26.01	13.81	7172	25716			38.59
2	Long-handled hoe. No trim. Early	24.15	13.78	6652	27028			31.52
3	Dixie thinning. No trim. Early	23.53	14.30	6732	29128			24.46
4	Cross thin (8" center). Early	21.94	13.59	5918	23879			30.98
5	Cross-block, long-handled hoe trim. Early	23.85	13.92	6484	22567			28.26
6	Cross-block (12" centers). Early	22.57	13.91	6262	25978			30.43
7	Mechanical thin - narrow tools. Early	23.67	14.35	6808	29652			32.61
11	Hand block and thin. Delayed	23.91	14.14	6886	25454			35.87
12	Long-handled hoe. No trim. Delayed	23.76	14.36	6816	27028			31.52
13	Dixie thinning. No trim. Delayed	22.48	14.29	6404	27028			22.28
14	Cross thin (8" center). Delayed	21.14	13.80	5684	25191			26.63
15	Cross-block, long-handled hoe trim. Delayed	23.60	13.44	6326	23354			26.63
16	Cross-block (12" centers). Delayed	20.56	14.15	5804	25978			20.11
17	Mechanical thin - narrow tools. Delayed	21.11	13.66	5748	25191			23.91
General Mean		23.02	14.02	6408	25926			
CV (%)		7.38	5.04	8.93	8.79			
Sm in % of General Mean		4.08	2.05	3.64	3.59			
LSD 5% point		1.96	.81	659	2624			
LSD 1% point		2.60	1.08	876	3494			

Table 12. Mechanical Thinning Test 1946, Idaho Falls, Idaho. (Utah-Idaho Sugar Co.)

Main Test

Treat. No.	Treatment	Marketable			No. Beets Per A.	Unmar- ketable No. Beets Per A.	Total Beets Per A.	Hand Labor Man Hours Per Acre
		Tons Beets Per A.	% Sucrose	Pounds Sugar Per A.				
1	Hand block and thin. Early	18.56	16.34	6064	20790	238	21028	22.52
2	Long-handled hoe. No trim. Early	17.38	17.08	5938	20552	594	21146	31.13
3	Dixie thinning. No trim. Early	14.97	17.22	5144	22572	2020	24592	10.60
4	Cross thin (8" center). Early	16.55	16.71	5534	22334	2020	24354	12.58
5	Cross-block, long-handled hoe trim. Early	16.56	16.81	5568	18414	238	18652	21.19
6	Cross-block (12" center). Early	15.47	16.83	5190	20433	1663	22096	10.60
7	Mechanical thin-narrow tools. Early	14.52	16.72	4862	20790	1426	22216	11.26
11	Hand block and thin. Delayed	18.11	16.90	5472	20909	238	21147	22.52
12	Long-handled hoe. No trim. Delayed	18.11	17.04	6114	19839	475	20314	20.53
13	Dixie thinning. No trim. Delayed	14.41	17.07	4924	25067	2495	27564	10.60
14	Cross thin (8" center). Delayed	14.62	16.74	4898	20671	1901	22572	11.26
15	Cross-block, long-handled hoe trim. Delayed	15.49	16.52	5122	20790	1307	22097	11.26
16	Cross-block (12" center). Delayed	14.63	16.19	4766	21740	2614	24354	11.26
17	Mechanical thin - narrow tools. Delayed	14.12	16.63	4690	19958	2376	22334	11.92
General Mean		15.97	16.77	5354	21146	1426		
CV (%)		11.04	2.37	11.29	11.50			
Sm in % of General Mean		6.39	1.37	6.52	6.64			
LSD 5% point		2.96	.67	1014	4071			
LSD 1% point		4.00	.90	1372	5504			

Table 13, Pre-Thinning and After Thinning Stand Counts.
Plants per 100 feet

Area in Which test conducted	Ave. Pre- thinning count	Average After Thinning Counts														
		TREATMENT NUMBER														
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>	<u>17</u>	
Billings	397.0	104.1	131.8	129.8	130.5	96.3	90.6	101.8	102.6	117.5	114.8	105.6	80.6	88	87.3	
Deshler	200.6								86.3	86.0	73	65.0	75.7	79.7	96.2	
Longmont	233.4	93.8	100.5	90.7	95.7	80.5	84.3	91.7	87.3	116.1	86.5	89.5	78.1	65.0	114.5	
St. Louis	198	84.3	96.3	105.3	92.7	80.7	79.3	148.7	90.2	90.7	104.2	98.2	88.7	90.7	151.2	
Rocky Ford	589.0	104	155	260	157	150	123	237	95	151	246	152	108	102	311	
Saginaw	444.7								140.5	134	149**	153	126.1	141	167	
Torrington	359	85.6	103.8	123.1	82.1	63.1	53.5	126	80.5	74.6	152.6	118.6	63.6	61.5	128.6	
Twin Falls	299.6	93.5	96.8	140.1	131.6	75.3	62.2	89.5	95.0	107.2	103.3	125.2	77.2	73.7	116.7	
Windsor	607.8	97.0	98.5	100.5	109.5	98.8	66.5	132.0	102.5	177.3	138.5	141.5	107.3	76.0	238.3	
Draper	292.5	98.3	103.0	110.0	90.9	86.4	98.9*	113.2	95.3	103.2	102.8	96.1	88.6	98.9*	95.6	
Idaho Falls		103.8	97.7	142.5	126.7	86.7	120.3*	132.0	97.0	107.2	131.7	122.0	124.2	127.7*	122.0	
AVERAGE	362.2	96.0	109.3	133.6	113.0	90.0	79.9	130.2	97.5	115.0	125.3	115.2	92.6	86.4	148.0	

* Cross blocked with 12 inch centers - no subsequent cross cultivation.

** Thinned with Soucci

- | | |
|--|---|
| 1. Hand block and thin. Early | 11. Hand block and thin. Delayed |
| 2. Long-handled hoe. No trim. Early | 12. Long-handled hoe. No Trim. Delayed |
| 3. Dixie thinning. No trim. Early | 13. Dixie thinning. No trim. Delayed |
| 4. Cross thin with knives. Early | 14. Cross thin with knives. Delayed |
| 5. Cross block, long-handled hoe trim. Early | 15. Cross-block, long-handled hoe trim. Delayed |
| 6. Cross-block, cross cultivate, long-handled
hoe trim. Early | 16. Cross-block, cross cultivate, long-handled
hoe trim. Delayed |
| 7. Mechanical thin - narrow tools. Early | 17. Mechanical thin - Narrow tools. Delayed |

CHART NO. 1 RELATIVE YIELDS OF DIFFERENT TREATMENTS
DELAYED HAND BLOCK AND THIN IS FIGURED AS 100% AVERAGE OF
ELEVEN TESTS.

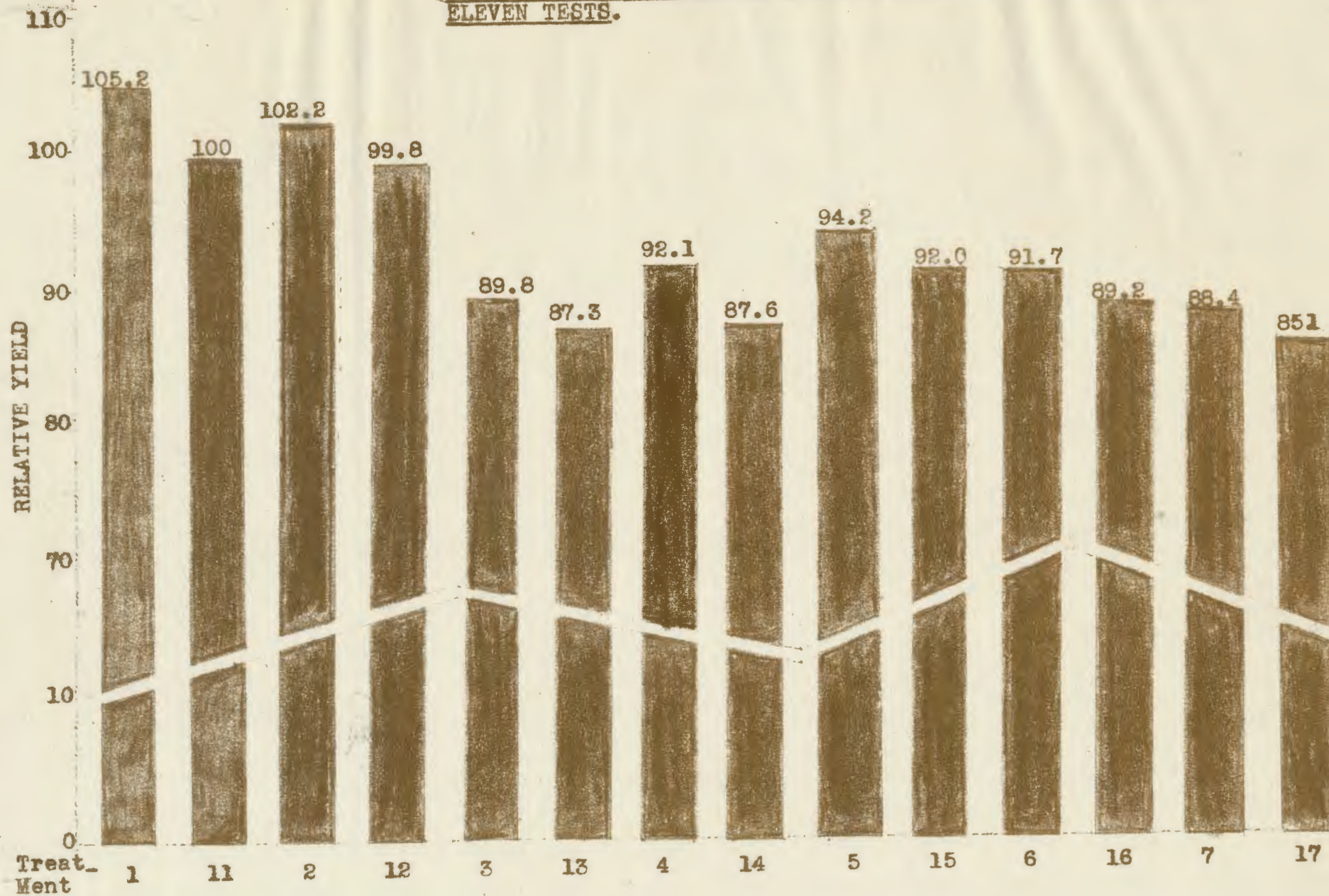


CHART NO. 2: AVERAGE NUMBER OF HOURS REQUIRED FOR THINNING AND SUBSEQUENT
HOEING AND CULTIVATION FOR EACH TREATMENT BASED ON NINE TESTS.

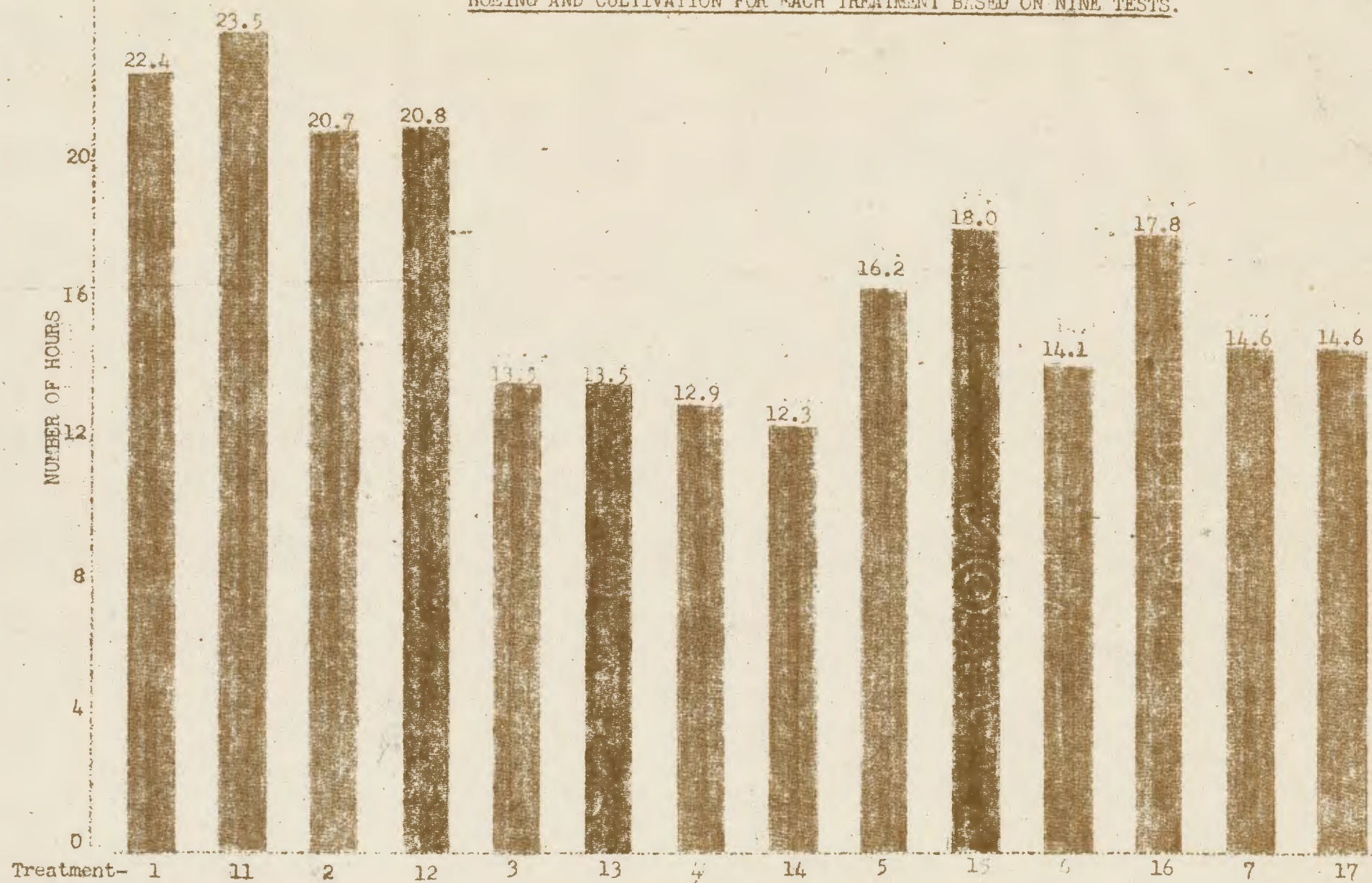


CHART NO. 3 RELATIVE TIME REQUIRED FOR THINNING, AND SUBSEQUENT HOEING AND CULTIVATION FOR EACH TREATMENT BASED ON NINE TESTS.

