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B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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DIVISION OF AGRONOMY

THE EFFECT OF SPACING AND TIME OF THINNING ON THE YIELD, GROWTH, AND FRUITING CHARACTERISTICS OF THE COTTON PLANT IN 1925

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†As of June 1, 1927.
*On Leave.
**Dean, School of Veterinary Medicine.
***In cooperation with U. S. Department of Agriculture.
****In cooperation with the School of Agriculture.

SYNOPSIS

This Bulletin reports the results of work conducted in 1925 at the Main Station Farm, College Station, Texas, to determine the effect of spacing and of time of thinning on the yield, growth, and fruiting characteristics of cotton, and may be regarded as a companion to Bulletin 340, "The Effect of Spacing on the Yield of Cotton."

Late thinning in this test, had the effect of stunting the cotton plants, in general causing them to produce fewer branches, particularly vegetative branches, shorter vegetative and fruiting branches, to produce their first branches higher from the ground, and to have smaller plants both in height and diameter, than plants thinned at the normal or usual time of thinning. In short, late thinning, in this experiment, either prevented or retarded the development of both vegetative and fruiting branches, as compared with normal thinning.

Cotton thinned at the usual, or normal time, produced blooms and open bolls earlier and also produced an earlier crop and larger yields than the late-thinned cotton. The close and medium spacings, from 9 to 18 inches, produced the earliest crop. In general, the size of bolls increased as the distance between plants was increased.

These results show there were no advantages gained by late thinning. If, however, cotton must be thinned late through uncontrollable circumstances, the results indicate that it would be better to leave more plants to the row than is normally the practice. More stunted plants can be left on an acre without crowding than can plants which grow normally. These results are in agreement with those reported in Bulletin 340 of this Station.

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THE EFFECT OF SPACING AND TIME OF THINNING ON THE YIELD, GROWTH, AND FRUITING CHARACTERISTICS OF THE COTTON PLANT IN 1925

R. H. STANSEL

The work reported in this Bulletin was conducted to obtain more information on the effect of spacing and of time of thinning on the growth and fruiting characteristics of the cotton plant and the relation of these characters to yield.

Experiments on the spacing of cotton have been conducted by the experiment stations in the cotton-growing states from about the time of their establishment. The effect of spacing on yield of cotton has been pretty thoroughly worked out and the consensus of opinion seems to be that medium to close spacing, 6 to 21 inches, gives the best results, the optimum spacing being dependent upon the soil and climatic conditions and also upon the variety of cotton grown. A more recent innovation has been that of a combination of late thinning and close spacing known as "single-stalk" cotton culture. Certain workers seem to have obtained results which support this method, while many other investigators, working on this phase of cotton culture, have found no advantage in this method.

REVIEW OF LITERATURE

In 1911, Cook of the United States Department of Agriculture published a paper (12) on dimorphic branches in tropical crop plants. He states: "Definite dimorphism of branches exists in at least five important tropical plants—cotton, coffee, cacao, the Central American rubber tree (Castilla), and the banana. Each normal plant produces two kinds of branches, with regular differences of form and function.

"The factor of branch dimorphism must be taken into account in the scientific study of the structure and habits of all these plants, as well as in the breeding and adaptation of varieties. Systems of cultivation and pruning must be planned with reference to the habit of branching."

Later, in 1912, Cook (14) advanced the theory that the vegetative branches of cotton could be restricted by crowding the plants in the row during early growth. He states: "If the plants are thinned too early, so that the lower joints are exposed before there is enough foliage to keep them shaded, the vegetative branches are likely to be put forth at each joint and even from the axils of the cotyledons or seed leaves. But if the plants are allowed to stand closer together or are thinned gradually they may not produce any vegetative branches."

In discussing the advantages to be gained from late thinning, Cook

(15) states: "The essential feature of the new system is late or more gradual thinning. This makes it possible to leave more plants in the rows than is now customary, and yet injurious crowding is avoided through suppression of the vegetative branches.

"The control or suppression of the vegetative branches also permits an earlier development of fruiting branches and leads to the production of an earlier crop. In regions where the period of crop production is limited, either by short seasons or by the presence of the boll weevil, increased earliness is a means of securing larger yields."

Cook (16, 17, 18, 20) gives additional discussion of this new system. In perfecting this new system of cotton culture which Cook (19) now calls "single-stalk cotton culture," he states: "By taking account of the specialized habits of branching, it is possible to exercise a much more effective control of the development of the plants, so as to secure earlier crops, larger yields, and greater protection against injury by the boll weevil."

Hastings (24) working at San Antonio, Texas, obtained no differences in yield from cotton in varying widths of rows where the number of plants per acre remained the same and where part were thinned early and part late. He attributes the lack of difference in yield to the extreme boll weevil infestation.

Meade (28), also working at San Antonio, Texas, compared normal-thinned Acala cotton spaced two feet apart in the row with late-thinned Acala cotton spaced six to eight inches apart in the row. The close-spaced late-thinned cotton gave better results than wide-spaced normal-thinned cotton. These results are shown in the following table:

Characters Studied	Close-spaced, Late-thinned	Wide-spaced, Normal-thinned
Average number vegetative branches per 25 plants	.48 to .56	1.56 to 1.72
40-day bloom count per row	23,189	12,574
Number bolls matured per row	2,108	848
Weight of 5-lock bolls in grams	5.64	6.2
Yield per acre, pounds seed cotton	1,071	484

Meade obtained similar results in a test where he used alternating four-row blocks, but the difference in yield obtained from the use of the two methods was not as great as in single alternate rows. Since there was less difference in yield of the two methods when four-row blocks were used, it would appear that some factor other than time and rate of thinning was involved. It is probable that where rows of close-spaced plants are adjacent to rows of wide-spaced plants, the plants on the close-spaced rows utilized plant-food material and moisture from the wide-spaced rows; hence, the plants on the close-spaced rows gave the larger yield. This influence is called "border effect." In other

tests where early- and late-thinned plants were spaced alike, no differences in yield were secured. These results further indicate that the higher yield of the close-spaced late-thinned cotton reported above were partly due to differences in spacing and partly to border effect.

Letteer (25, 26), also working at San Antonio, found that the wide-spaced early-thinned plants yielded better than the late-thinned close-spaced plants. He attributes this difference to the adverse climatic conditions of the two years, although he states the yields in 1917 were satisfactory.

At San Antonio in the years 1914, 1915, 1916, 1917, late-thinned close-spaced cotton gave larger yields in only one year out of the four, and in this year only part of the tests gave these results. Since the work in this year, 1915, is open to serious criticism of having several variables involved, there seems to be little evidence that late-thinned close-spaced cotton gives better yields in the locality in which the tests were conducted.

Garrett (21) and Hester (23) at the North Louisiana Station found that early thinning as usually practiced gave better results than single-stalk cotton culture.

Ayres (1, 2) gives results from a test comparing late- and early-thinned cotton in 6- and 12-inch spacings in Arkansas. The yields are given in pounds of seed cotton per acre. Each year the highest yield was made by the early-thinned cotton, which also gave the most cotton at the first picking.

Spacing	Time of Thinning	Yield, 1917	Yield, 1918	Average
6-Inch	Late	1290	1032	1161
6-inch	Early	1495	981	1238
12-inch	Late	1422	937	1179
12-inch	Early	1500	1103	1301

McClelland (27) reports several years' work in Georgia, comparing early- and late-thinned cotton. However, in each case about twice as many plants were left in the late-thinned plats as in the early-thinned ones. His results are as follows:

Pounds of Seed Cotton Per Acre.

Year	1914	1916	1917	1917	1918	Average
Variety	Durango	Sunbeam	Lewis No. 63	Sunbeam	Sunbeam	
Early chopping	766	1850	1390	1585	1109	1340
Late chopping	638	1878	1265	1521	1041	1248

Blair (6), in Arizona, compared upland cotton with Pima and Yuma varieties. He concluded that the varieties of upland cotton showed a

gain in yield from late thinning, while Yuma and Pima varieties showed a loss from this practice.

Cardon (11) reports experiments with the "single-stalk cotton culture" in Louisiana, Arkansas, and North Carolina, carried on by farmers in various localities. Nearly all of the farmers reported slight increases in yield due to late thinning and close spacing. Three out of nine in Louisiana obtained results in favor of early, or normal thinning. In all cases the gain was negligible. This work is open to the serious criticism that two variables, rate and time of thinning, are involved. The difference in yield might have been due to differences in the rate of spacing. The early-thinned plants were left 18 to 30 inches apart in the row and the late-thinned ones 6 to 10 inches.

Ayres (4) at the Delta Branch Station in Mississippi compared early- and late-thinned cotton of the same spacing. The early-thinned cotton outyielded the late-thinned by 32.4 per cent in the total crop and 89 per cent at the first picking.

Brown (9), in summarizing work conducted in Mississippi from 1916 to 1919, inclusive, found no evidence indicating greater productiveness of late-thinned as compared with early-thinned cotton of the same spacing, and arrived at the following conclusions: "Since there seems to be no experimental evidence to show that increased yields are to be secured through delayed thinning and since there is evidence from three different experiment stations to show that late thinning most frequently results in lower yields, it seems that the Single-Stalk Method of Cotton Culture is of very doubtful value. We believe that cotton plants should be thinned as early as it is safe to do so—that is, as soon as the danger of losing a stand from cold weather, damping off fungi, etc., has passed, and before the plants are stunted by undue crowding."

Hall and Armstrong (22) report work at Florence, South Carolina, comparing early and delayed thinning in 1923 and 1924. The plants were spaced 12 inches apart in the row and the late thinning was done at the appearance of the first squares. Their results are given in pounds of seed cotton per acre.

	Yield, 1923	Yield, 1924	Average Yield
Early thinning	733	670	702
Late thinning	607	548	578

From these results, they conclude that it is not profitable to delay thinning much beyond the stage at which cotton is regularly chopped.

Reynolds (29) in Texas has reported the results of experiments on the spacing of cotton conducted at Angleton, Beeville, Chillicothe, and College Station, Texas, over a period of nine years from 1916 to 1924, inclusive. In these experiments, normal and late-thinning were compared in 12 rates of thinning varying from 3 to 36 inches in three-inch

intervals. The results secured from this rather exhaustive study show in general that normal thinning produced larger yields than late or deferred thining.

OBJECT OF EXPERIMENT

The present work was undertaken to obtain more evidence as to the effect of time of thinning on cotton plants spaced the same distance apart in the row in relation to vegetative growth and fruiting characteristics, as well as to the yield. Accordingly, a study of the following characters in cotton plants was made, using in the experiment, twelve different spacings in which normal and late thinning were involved:

A. Vegetative growth
   1. Height of plant
   2. Number of nodes in plant
   3. Diameter of stalk
   4. Number and length of vegetative and fruiting branches
   5. Height of first branch from the ground

B. Fruiting characteristics
   1. Daily bloom count
   2. Date of first open boll
   3. Number and size of bolls
   4. Amount of shedding
   5. Earliness

C. Yield and character of lint

PLAN OF EXPERIMENT

The work reported in this Bulletin was conducted in 1925. Two acres on the Main Station farm at College Station, Texas, were devoted to this experiment. The soil, Lufkin fine sandy loam, was fertilized with a mixture of 200 pounds of 16 per cent acid phosphate and 100 pounds of cottonseed meal to the acre.

Twelve spacings were used in which the plants were left 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, and 36 inches apart in the row. Each appeared six times in both the normal- and the late-thinned plats. Each plat consisted of three 3-foot rows 64 feet long. The center row was the test row and the outside rows were used as guard or border rows. Several feet were left on each end of the row as border spaces to eliminate border effect, which was noticable in most cases. This cotton was planted on May 1, 1925.

DEFINITIONS OF TERMS

Thinning

The cotton plants were thinned by pulling up the plants by hand. A plaster lath marked off at the proper distances was used in thinning the plants to the stand desired.

Normal Thinning: The term normal thinning as used in this Bulletin has reference to cotton thinned at the usual chopping time as practiced by most farmers in the thinning of their cotton, which usually is done when the plants have four to six leaves.

Late Thinning: In this series of plats thinning was delayed until the plants were about six inches high and squares were forming, which was 28 days later than the thinning of the normal-thinned cotton.

The plats to be thinned at the normal time received their preliminary thinning on May 18. Two plants were left to the hill in the wider spacings, while in the 3-, 6-, and 9-inch spacings a few more plants than were required for a perfect stand were left. This was done to take care of any loss of plants through dying and at the same time to prevent the effects of late thinning. The final thinning on these plats was given on June 3. A considerable number of plants had died, especially in the closer-spaced rows, due to the unusually dry weather.

The late-thinned plats were thinned to the required stand at the first thinning on June 16. The three-inch-spaced rows required very little thinning, as many of the plants had died previously to thinning. Consequently, there could be very little effect from late, or deferred, thinning in the plats of this spacing.

The stand was not as uniform as was desired, since a few plants continued to emerge for several weeks. At the final thinning a number of very small plants which were apparently only a few days old were pulled. This late emergence of many plants, together with the death of many others, partly accounts for some of the discrepancies in the stand obtained as shown by the count of plants taken on September 16 after five pickings had been made. The discrepancies were in no case great and it was thought better not to regroup the plats, as no changes would be made in the plats spaced less than 18 inches, and the changes in the plats spaced more than 18 inches were not significant. Most of the discrepancies occurred in the 30-, 33-, and 36-inch spacings, where one or two plants would make considerable differences in stand.

Seed Used

The cotton seed used in this test was home-grown seed of the Startex variety, Texas Station No. 7000, a strain of Lone Star, originated at this Station. It is a high-yielding strain, well adapted to this locality. The seed was culled mass-selected stock seed and was very uniform.

SEASONAL CONDITIONS

The crop season of 1925 was abnormally dry. The daily precipitation is shown in Table 1. The year 1924 had also been very dry and there was little reserve moisture in the soil available in 1925. The crop was started on the showers during the latter part of April and practically the entire first crop of cotton was made from the rain of 1.44 inches on June 20 and the rain of .43 inch on July 10. May and the

first half of June were very dry and the cotton suffered considerably, grew very little, and, before the rain of June 20 came, the plants wilted during the middle of the day. The rain of August 26 and the rains in September caused renewed growth of the plants and, consequently, a top crop was set, many of the bolls setting after the middle of September. The excessive rains in October were too late to be of benefit to the cotton crop. The abnormal growing season should be borne in mind when one examines the results secured in this test.

Table 1.—Daily Precipitation in Inches at Main Station Farm, College Station, Texas, 1925.

Day	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1				.75				.11	.06	.32		
2								.10			.01	
3	T*										.28	
4											.72	
5							.05				1.95	
6											.31	
7	T										1.13	
8	.07	.05				.01						.04
9	.75											
10	.15				.02	.02	.43	.19		.02		
11	.15					.02	.01				.50	
12						T			.74	3.20		
13			.03	T					.58	3.19		.26
14		T	.14					.07		1.36		
15	.19						.11			.56		.44
16	.17		.14							.47		.07
17	.17		.02			.07						
18	.04										.61	.07
19											.27	.02
20						1.44						
21						.11						
22		.40										
23				T				.18		.03		
24				.01					.87	.57		
25								.05	.12	.38		
26				T				1.84		.50	.04	
27	T			.05								
28		.17		.30								
29			.05	.25								
30				.61		T			.65	.86		.09
31	.03						.52			.16		
Total	1.72	0.62	0.38	1.95	0.02	1.67	1.12	2.54	3.02	11.62	5.82	0.99

*Trace.
Total for the year, 31.47 inches.

DATA ON VEGETATIVE GROWTH

All plant measurements were taken on the test rows. A section of 20 consecutive plants, which appeared to be representative of the row as a whole, was selected for these measurements. In the wider spacings this included the majority of the plants, while in the case of the closer spacings only a small proportion was represented. It is believed that the measurements were representative for each test row.

All measurements except those on height of stalk were taken from September 1 to September 16. The height of the stalk at the first picking was taken on August 8, and the height at the last picking on January 9, 1926. All measurements were made in centimeters.

In each case the average for the 20 plants on each test row was secured and the average of the six repetitions was secured for each of the 24 tests, each average representing the measurements of 120 plants. In measuring the branches, averages were taken of the 20 plants as a group and not as individuals. Thus the total number of branches on the 20 plants was divided into the total length of all the branches on the 20 plants to get the average length. In this way all the plants on a row were treated as a group and not individually, as this was thought to be a better way of visualizing the actual conditions within the row.

Number of Nodes

The increase in the number of nodes above ground seemed to keep pace pretty closely with the increase in the spacing of the plants in both the normal- and late-thinned cotton, the plants of the wider-spaced cotton having a larger number of nodes. (Table 2.) There was greater variation, however, in the late-thinned than in the normal-thinned cotton. These differences appear to be of little significance.

Table 2.—The effect of spacing and time of thinning on the number of nodes.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	11.7	13.8	14.7	16.3	16.5	16.7	17.9	18.1	18.4	18.7	18.8	19.6
Late	13.0	14.6	14.9	16.2	16.1	17.2	17.7	17.1	17.4	18.2	17.8	18.6

Diameter of Stalk

Apparently there is a high correlation between the diameter of the stalk and the spacing, the wider spacing giving plants with stalks of a greater diameter, as shown in Table 3. A comparison of the normal- and late-thinned cotton shows that the former had larger stalks in the 12-inch and wider-spaced cotton, while the latter had larger stalks in the 3-, 6-, and 9-inch spacings. The difference in favor of the late-thinned cotton in these closer spacings is small and is probably of little significance.

Table 3.—The effect of spacing and time of thinning on the diameter of the stalk, measurements in centimeters.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	.395	.491	.538	.625	.674	.709	.739	.764	.814	.837	.830	.883
Late	.412	.508	.553	.592	.610	.666	.659	.683	.691	.703	.720	.732

Branches

The branches of the cotton plant are usually classified as fruiting and vegetative branches. The fruiting branches bear the fruit directly

on the branch while the vegetative branches bear the fruit on sub-branches, which may be short or long, depending on the variety and growing conditions.

At the time the plants were measured it was found that a number of the branches were devoid of fruit or sub-branches or even leaves in many cases. These were often merely stubs and it was impossible to determine whether they were vegetative or fruiting branches. The majority were probably fruiting branches but it would not be a fair criterion of the proportion of the vegetative and fruiting branches to include these doubtful branches under either of these two classifications. If these branches were disregarded it would mean the elimination of a majority of the branches on many of the plants. It was thought best to include these branches under the classification of "doubtful branches." Only the branches on the main stalk are included in the measurements and they were measured to the nearest half centimeter in length.

Number of Branches: The total number of branches, and the number of vegetative, fruiting, and doubtful branches are given in Table 4. There is a positive correlation between the total number of branches and the rate of thinning, the same holding true for the number of vegetative and of fruiting branches. Spacing produced less variation in the number of doubtful branches than in the number of vegetative or of fruiting branches. In the 3-, 6-, and 9-inch spacings the majority of branches were classed as doubtful.

Table 4.—The effect of spacing and of time of thinning on the number of branches per plant.

Spacing Inches	Number of Branches Per Plant							
	Total		Vegetative Branches		Fruiting Branches		Doubtful Branches	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
3	2.96	3.66	0.00	0.00	0.80	1.22	2.16	2.44
6	5.12	5.80	0.05	0.06	1.86	2.63	3.21	3.11
9	6.45	6.76	0.16	0.16	2.38	2.96	3.91	3.64
12	8.54	7.98	0.39	0.31	3.71	3.91	4.44	3.76
15	9.45	8.56	0.43	0.16	4.34	4.28	4.68	4.12
18	9.72	8.96	0.51	0.31	4.85	4.61	4.33	4.04
21	11.32	9.73	0.75	0.21	5.43	5.51	5.14	4.01
24	11.04	9.41	0.71	0.26	5.37	5.06	4.96	4.09
27	11.77	9.61	0.81	0.22	6.05	5.68	4.91	3.71
30	12.16	10.24	0.89	0.31	6.52	5.64	4.75	4.29
33	11.64	10.11	0.80	0.41	6.50	5.71	4.34	3.99
36	12.21	10.83	1.15	0.32	6.76	6.50	4.30	4.01

The late-thinned cotton had more branches than the normal-thinned cotton, from the 3- to the 9-inch spacing, inclusive. The number of vegetative branches, however, is approximately the same in each case. From the 12-inch to the 36-inch spacing the normal-thinned cotton has more branches than the late-thinned cotton. This is strikingly noticeable in the case of vegetative branches.

Length of Branches: The data on length of branches are given in Table 5. As a whole, the wider spacings had longer branches than the narrower spacings and the normal-thinned plants had longer branches than the late-thinned plants. The variation in the length of the vegetative branches is probably due to the small number present.

Table 5.—The effect of spacing and of time of thinning on the length of branches.

Spacing, Inches	Length of Branches in Centimeters					
	Vegetative Branches		Fruiting Branches		Doubtful Branches	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.
3	0.0	0.0	1.7	2.4	1.7	1.7
6	7.6	7.5	2.5	2.8	2.4	2.3
9	10.6	12.2	3.0	3.3	2.9	2.7
12	10.5	9.9	3.8	3.6	3.3	2.9
15	14.7	9.1	4.5	4.0	3.9	2.7
18	12.9	12.7	5.0	4.1	4.3	3.0
21	12.0	14.1	5.8	4.4	4.5	3.4
24	13.3	11.7	6.1	4.6	4.7	3.4
27	16.1	10.9	6.9	4.7	5.1	3.3
30	15.4	14.1	7.3	5.1	5.7	3.8
33	15.3	14.3	6.8	4.8	5.4	3.6
36	16.6	14.9	7.6	5.8	5.5	4.7

Height of First Branch from the Ground: There was considerable variation in the average height of the first branch from the ground, as shown in Table 6. However, the data show quite conclusively that the closer-spaced plants bear the first branch a greater distance from the ground than the wider-spaced plants. This holds true both for the normal and the late thinnings.

Table 6.—Effect of spacing and of time of thinning on the height of first branch from surface of ground.

Spacing, Inches	Height from Ground of							
	First Branch of Any Kind		First Vegetative Branch		First Fruiting Branch		First Doubtful Branch	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.
3	11.8	12.5	.....	.....	14.7	17.3	11.9	12.5
6	11.0	12.2	9.8	11.1	14.8	15.8	12.0	12.8
9	10.3	10.3	8.5	8.5	14.1	14.5	11.6	11.6
12	9.7	10.0	10.9	12.2	14.3	14.6	11.7	10.9
15	8.1	8.7	7.5	8.3	13.5	13.7	10.4	9.9
18	8.2	9.5	9.0	10.8	13.2	14.5	10.3	10.7
21	7.9	8.7	10.2	7.7	14.3	13.4	8.9	9.4
24	8.3	9.7	9.2	9.2	13.6	14.8	10.1	11.1
27	7.4	9.2	8.5	10.1	13.4	13.4	9.8	10.8
30	7.4	8.8	9.3	9.6	13.4	14.2	10.2	10.1
33	8.2	8.3	9.2	10.3	13.3	13.1	11.4	9.5
36	8.8	8.4	9.9	9.1	15.3	14.4	11.7	9.4

The average height of the first vegetative branch from the ground was quite variable and might have been due to the small number present. In the case of the height of the first fruiting branches there

was little difference in any of the spacings in the plats thinned at the normal time. In the late-thinned cotton, the 3- and 6-inch spacings bore their first fruiting branches farther from the ground than the wider-spaced cotton. This difference is apparently significant. The first doubtful branch seemed to be at a height from the ground intermediate between the first fruiting branch and the first branch of any kind.

Height of Stalk

At First Picking: Table 7 gives data on the height of stalk at the first picking. There was considerable difference in the height of the stalk in the various spacings and also in the normal and late thinnings. There was a progressive increase in height of plants as the distance between the plants increased, which was, however, not so marked in the late-thinned cotton, there being little difference in the spacings wider than 18 inches. However, in the normal-thinned cotton the increase was rather regular throughout.

Table 7.—The effect of spacing and time of thinning on the height of stalk at first picking, measurements in centimeters.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	14.6	17.7	21.4	24.8	26.2	27.7	29.7	29.2	31.8	31.7	30.8	33.2
Late	16.3	19.1	19.7	20.7	20.5	21.4	21.3	22.4	21.9	22.9	22.9	22.9

The late-thinned cotton was somewhat taller than the normal-thinned cotton in the 3- and 6-inch spacings, but the latter was considerably taller in all the other spacings, the difference in some cases amounting to 50 per cent.

Table 8.—The effect of spacing and time of thinning on the height of stalk at last picking. Measurements in centimeters.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	21.9	26.4	31.2	33.6	37.6	36.8	39.4	39.2	43.4	42.0	42.9	47.8
Late	25.5	26.1	31.5	33.1	33.2	35.1	35.7	36.2	36.8	37.5	35.9	41.3

At Last Picking: Table 8 reports data on height of stalk at last picking. As in the height of the stalk at the first picking, the height of the stalk at the last picking increased as the distance between the plants increased. However, the plants made considerable growth between the first and the last pickings. The late-thinned cotton grew more in proportion to the height at the time of the first picking than did the normal-thinned cotton. This seems to indicate that the late thinning stunted the plants to a certain extent and they did not recover until the rains began late in the season. They never reached the height of the normal-thinned cotton except in the 3-, 6-, and 9-inch spacings, where the late-thinned plants already had the advantage.

FRUITING CHARACTERISTICS

Date of First Bloom

The first bloom opened on June 18. The number of days after June 17 that the first bloom opened on each test row was taken as the date of first bloom for that row. Table 9 shows the average number of days after June 17 that the first bloom opened for each rate of thinning.

Table 9.—The effect of spacing and time of thinning on the date of first bloom. Measured in days from June 17.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	4.8	6.0	6.6	5.3	4.6	6.1	5.5	6.6	6.3	6.0	5.1	7.0
Late	6.0	6.6	6.1	7.3	6.3	6.8	9.3	6.5	8.6	7.6	7.1	8.0

The spacings showed little uniformity in the date of the first bloom with the exception of the late thinning, where the spacings from three to nine inches seemed to bloom a little earlier than the wider spacings.

A comparison of the normal and late thinnings shows that the normal-thinned cotton bloomed earlier in almost every case than the late-thinned cotton.

Daily Bloom Count

The blooms were counted daily on all the test rows from the date of the first bloom, which occurred on June 18, until September 18, a period of 93 consecutive days. The counts were made in the morning after the blooms had opened but before they had become pink in color.

The daily bloom counts are given in graphic form in Figures 1 to 13, inclusive. The average cumulative bloom counts on the test rows by periods are given in Table 10. It is noticeable that the closer spacings gave a larger bloom count than the wider spacings. In general, the number of blooms decreased as the distance between the plants increased, and in the late thinning there were no exceptions to this.

Table 10.—The effect of spacing and of time of thinning on the number of blooms produced during different periods.

Spacing, Inches	Number of Blooms Produced from June 18 to							
	July 1		July 16		August 16		September 18	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
3	74	72	334	344	537	583	674	748
6	63	52	312	278	495	497	617	630
9	73	44	333	212	477	406	589	521
12	77	38	318	176	493	374	637	494
15	64	33	288	128	423	297	550	396
18	60	27	286	119	432	279	560	379
21	42	19	234	96	389	239	498	331
24	33	16	193	85	363	229	456	311
27	36	15	214	76	384	215	483	309
30	35	13	187	69	366	203	453	295
33	23	16	144	80	310	207	393	289
36	24	11	148	63	329	190	411	280

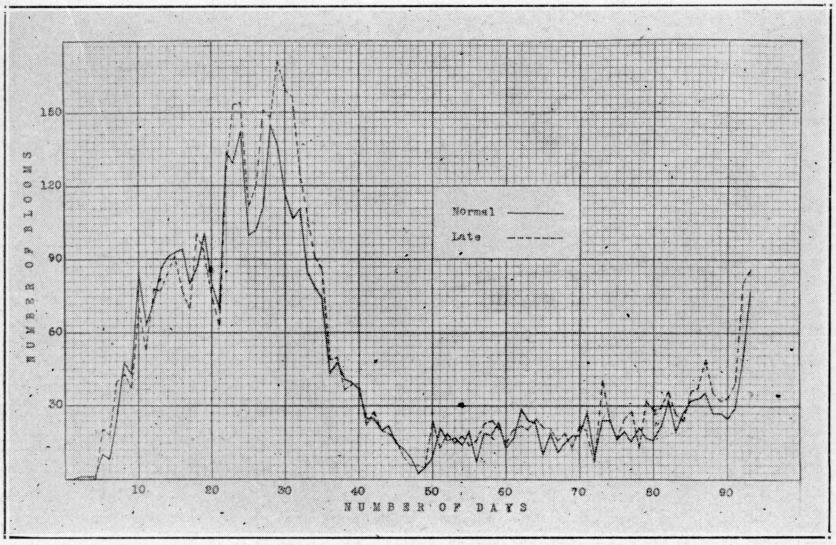

Fig. 1.—Number of blooms counted daily in 3-inch spacing of normal- and of late-thinned cotton

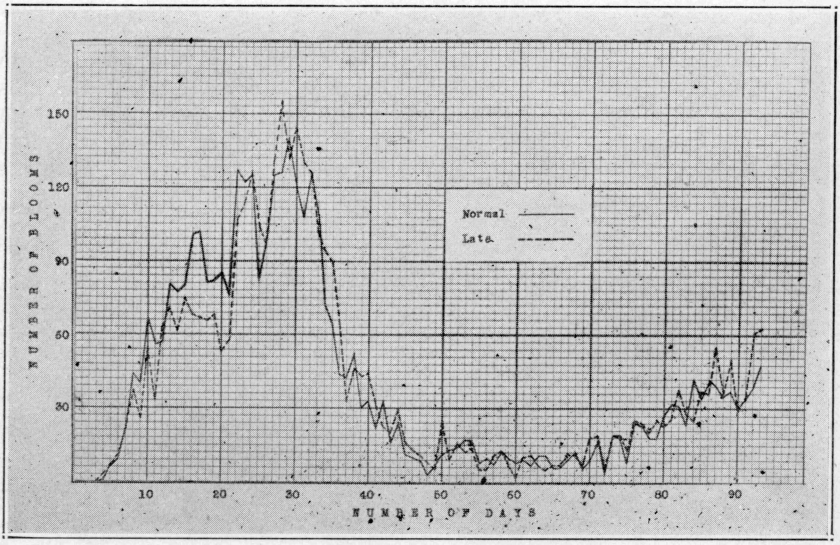

Fig. 2.—Number of blooms counted daily in 6-inch spacing of normal- and of late-thinned cotton

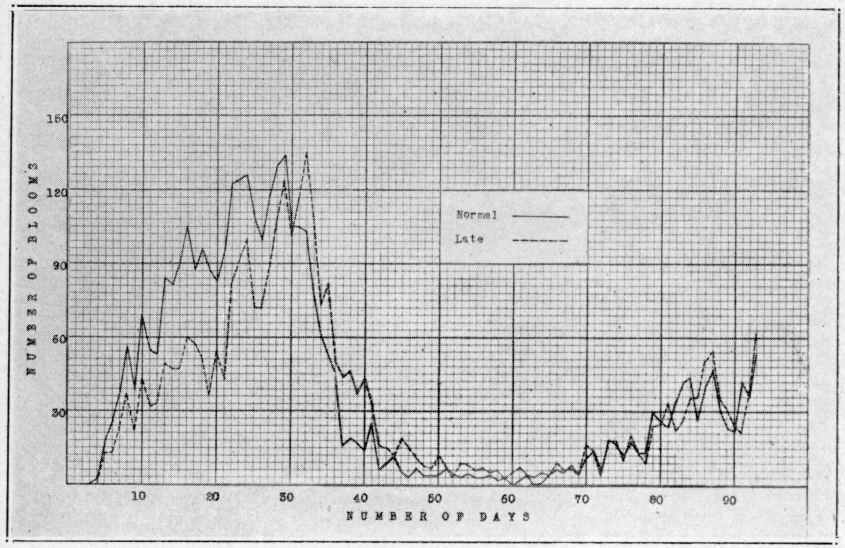

Fig. 3.—Number of blooms counted daily in 9-inch spacing of normal- and of late-thinned cotton

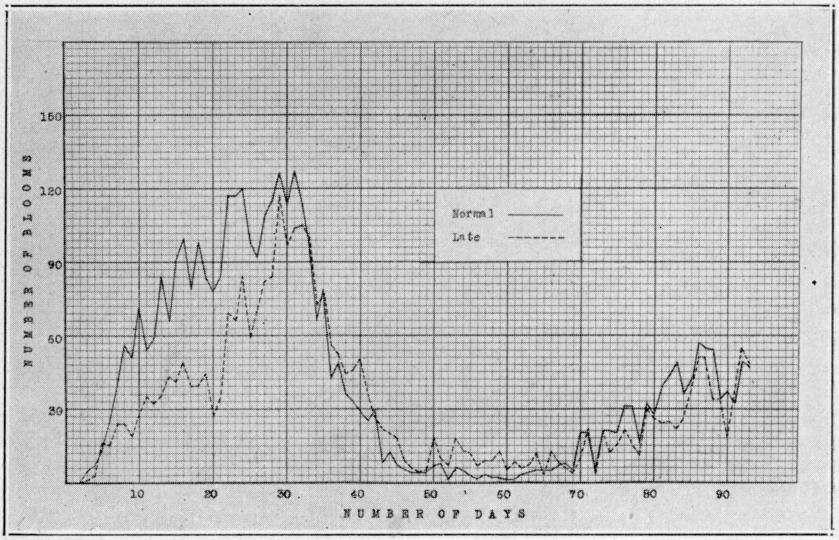

Fig. 4.—Number of blooms counted daily in 12-inch spacing of normal- and of late-thinned cotton

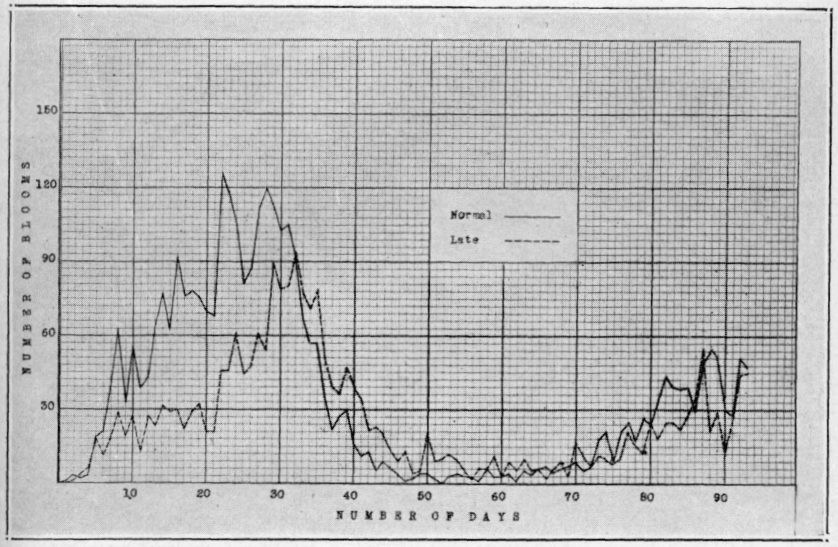

Fig. 5.—Number of blooms counted daily in 15-inch spacing of normal- and of late-thinned cotton

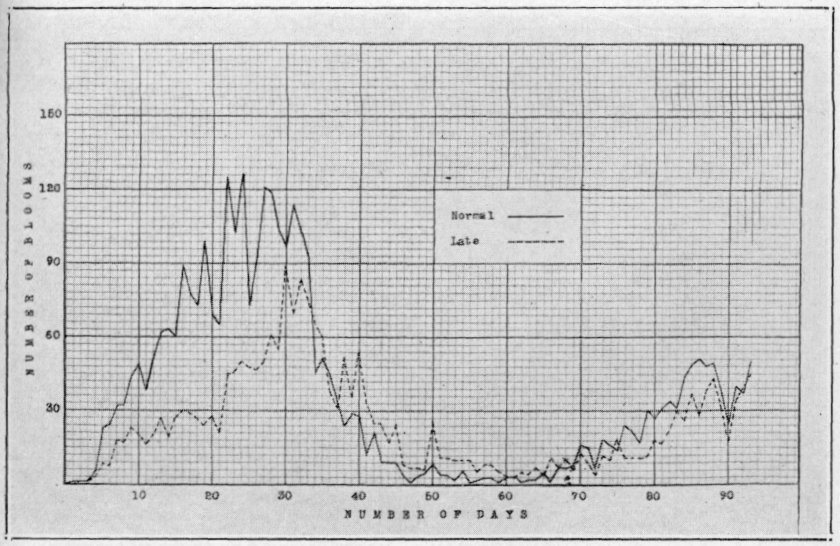

Fig. 6.—Number of blooms counted daily in 18-inch spacing of normal- and of late-thinned cotton

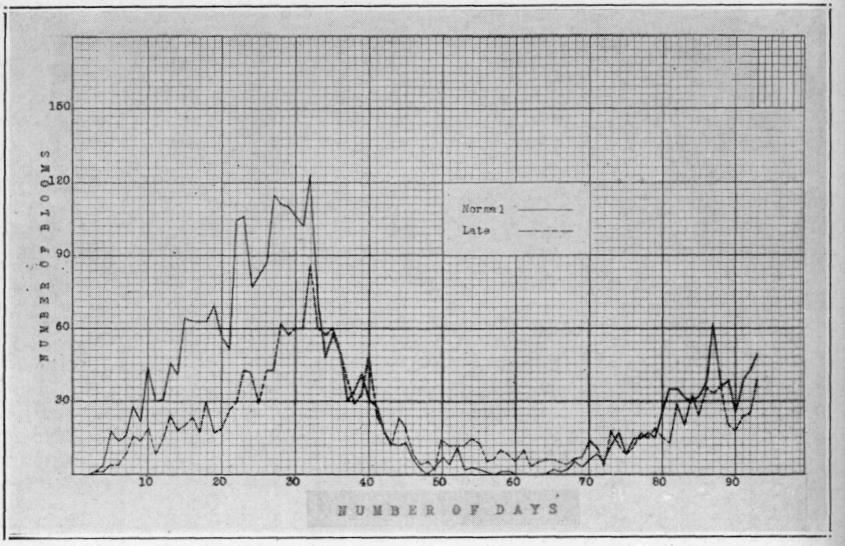

Fig. 7.—Number of blooms counted daily in 21-inch spacing of normal- and of late-thinned cotton

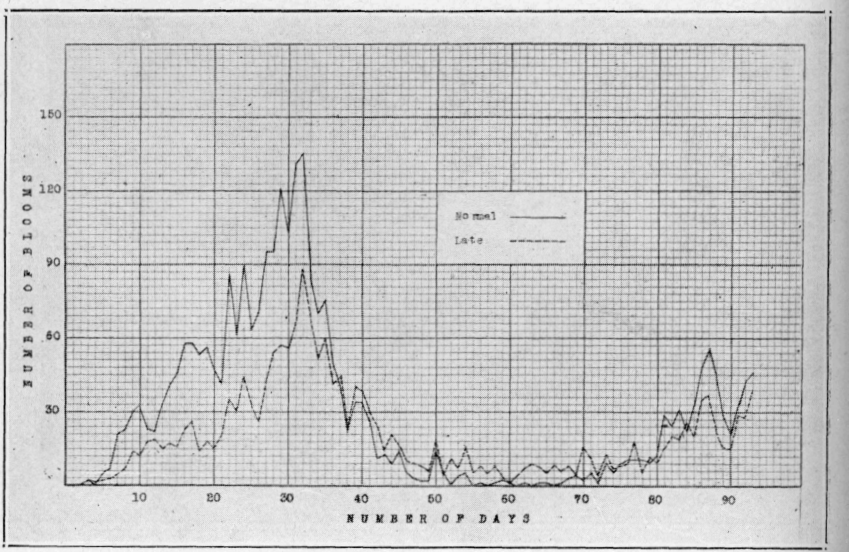

Fig. 8.—Number of blooms counted daily in 24-inch spacing of normal- and of late-thinned cotton

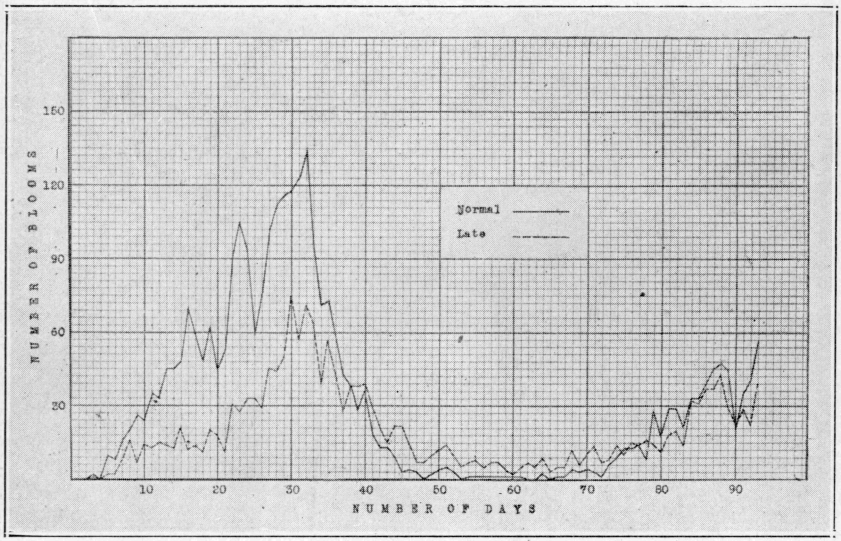

Fig. 9.—Number of blooms counted daily in 27-inch spacing of normal- and of late-thinned cotton

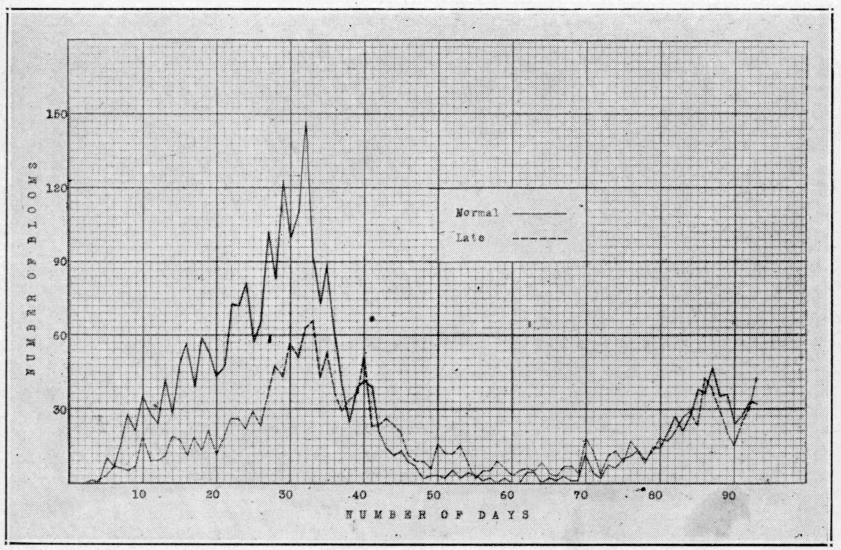

Fig. 10.–Number of blooms counted daily in 30-inch spacing of normal- and of late-thinned cotton

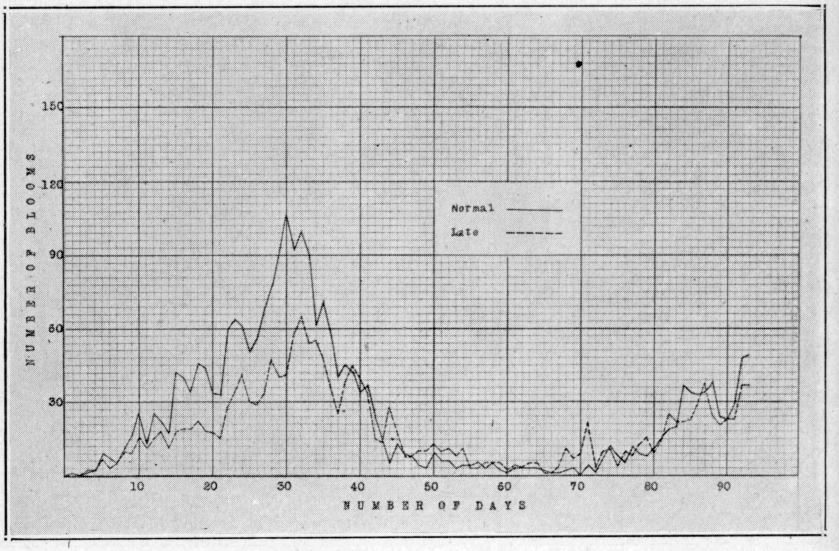

Fig. 11.–Number of blooms counted daily in 33-inch spacing of normal- and of late-thinned cotton

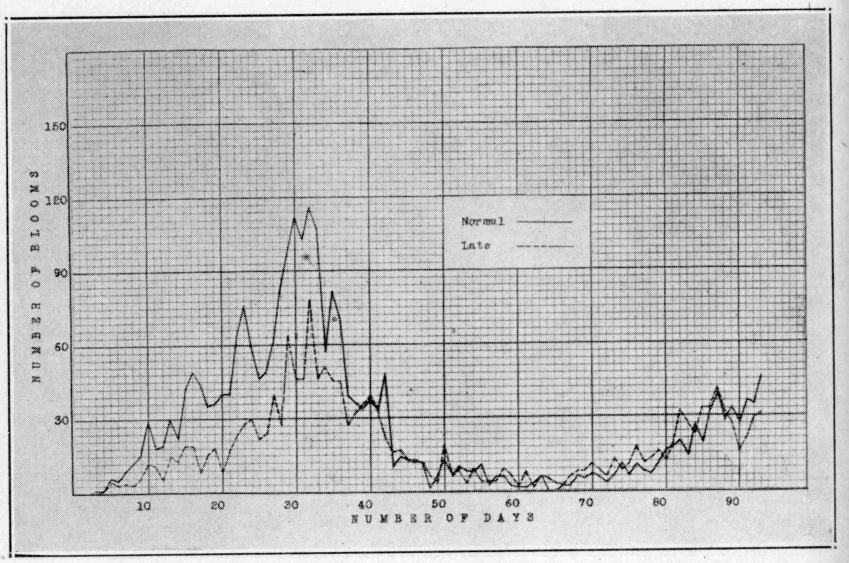

Fig. 12.–Number of blooms counted daily in 36-inch spacing of normal- and of late-thinned cotto n

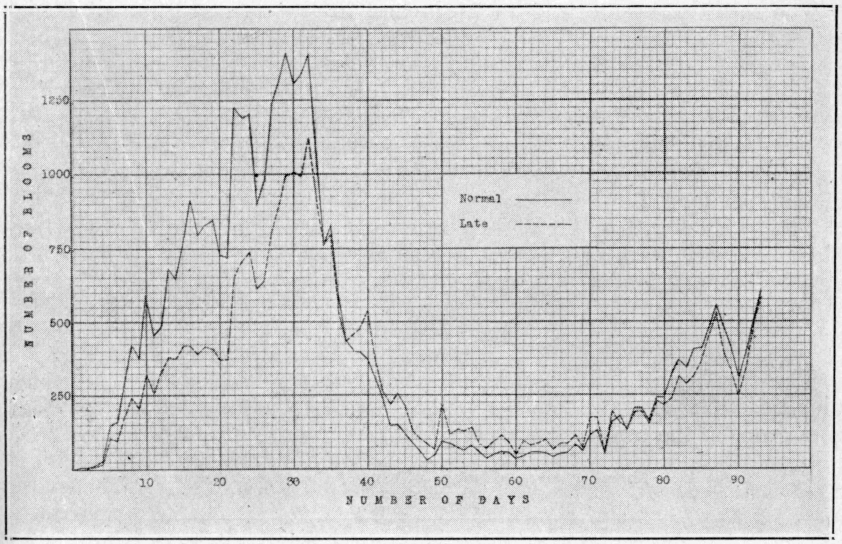

Fig. 13.—Total number of blooms counted daily in all the spacings of normal- and of late-thinned cotton.

In the 3- and 6-inch spacings the normal-thinned cotton produced more blooms during the first three weeks of blooming than did the late-thinned cotton, but afterwards the latter gained a lead which it retained as long as the blooms were counted. In all the other spacings the normal-thinned cotton gave a higher bloom count than did the late-thinned cotton.

A comparison of the total bloom count on all the test rows of the two acres shows that the late-thinned cotton produced 29,902 blooms while the normal-thinned cotton produced 38,040 blooms, an increase of 27.2 per cent.

Date of First Open Boll

The first open boll occurred on July 20, 32 days after the first bloom. The early opening, together with the character of the opening, indicated premature opening, which was probably due to the unusually dry season. The date of the first open boll is measured in days from July 19 for each test plat. The average date of first open boll of all six repetitions is given in Table 11.

Table 11.—The effect of spacing and time of thinning on the date of first open boll. Measured in days from July 19.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	11.1	8.1	8.1	9.5	7.3	7.8	8.7	10.3	8.8	9.0	10.0	10.0
Late	9.6	11.0	9.1	10.5	10.1	13.8	13.5	12.0	14.1	13.5	14.1	13.5

The medium spacings, 9 to 21 inches, in the normal-thinned cotton produced the first open boll earlier than the other spacings in either the normal- or the late-thinned cotton. In every spacing, except the 3-inch, the normal-thinned cotton produced the first open boll earlier than did the late-thinned cotton. These data indicate that normal-thinned cotton tends to produce open bolls earlier in the medium spacings, while late-thinned cotton tends to produce bolls earlier in the closer spacings.

There is a rather high correlation between the date of the first bloom and the date of the first open boll on all the plats. The coefficient of correlation for the entire 144 test rows was .9089±.0977.

Number of Bolls

The number of bolls picked on each test row was counted at each picking. The average number of bolls picked on each test row in the first crop, in the top crop, and in the total crop are given in Table 12.

Table 12.—The effect of spacing and of time of thinning on the number of bolls produced.

Spacing, Inches	Average Number of Bolls Produced on Test Rows					
	First Crop		Top Crop		Total Crop	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
3	113	117	58	79	171	196
6	119	116	70	69	189	185
9	119	105	70	65	189	170
12	129	105	72	75	201	180
15	114	80	72	76	186	156
18	112	81	81	71	193	152
21	104	74	73	73	177	147
24	96	64	61	62	157	126
27	101	67	67	74	168	141
30	99	60	71	64	170	124
33	87	62	62	58	149	120
36	92	60	71	73	163	133

In the first crop of the normal-thinned cotton the 12-inch spacing produced the largest number of bolls, the number diminishing roughly as the distance between the plants became greater or less than 12 inches. In the first crop of the late-thinned cotton the 3-inch spacing produced the largest number of bolls and in a general way the number of bolls decreased as the distance between the plants increased.

The 18-inch spacing of the normal-thinned cotton produced the largest number of bolls in the top crop, the number in general diminishing as the distance between the plants became greater or less than 18 inches. There seems to be little significant difference in the number of bolls produced in the various spacings in the top crop of the late-thinned cotton.

It is evident that the two dates of thinning induced a different behavior as regards the total number of bolls produced by the cotton

plants in the various spacings. If the total number of bolls produced by each spacing were to be plotted, the normal-thinned cotton would produce a curve with its peak at the 12-inch spacing, while in the late-thinned cotton the peak would occur at the 3-inch spacing and would gradually decrease as the distance between the plants increases.

The coefficient of correlation between the total number of blooms and the total number of bolls in the first crop for the entire 144 test rows is .8875±.0119. The coefficient of correlation is not as high as it is when the total number of blooms counted to September 18 is compared with the number of bolls picked, it being .6484±.0326. A large number of bolls was set after the counting of the blooms had ceased, which may partly account for the lower correlation in this case.

Size of Bolls

The average weight in grams of 100 well-opened bolls at the time of picking is given for each spacing for the first crop, for the top crop, and for the total crop (Table 13). Since there is a difference in number and in size of bolls in the first and top crops, the size of bolls in the total crop is not an average of the two crops but is derived by dividing the total number of bolls into their total weight.

Table 13.—Effect of spacing and of time of thinning on size of bolls.

Spacing, Inches	Weight in Grams of 100 Well-opened Bolls of					
	First Crop		Top Crop		Total Crop	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
	Grams	Grams	Grams	Grams	Grams	Grams
3	212	227	225	238	218	232
6	257	261	258	251	258	258
9	294	275	260	260	282	270
12	322	309	279	293	308	303
15	335	295	292	292	318	293
18	336	321	299	310	320	314
21	345	325	289	311	323	317
24	361	335	299	336	337	336
27	370	330	276	322	341	327
30	378	341	279	327	339	335
33	378	345	302	316	346	331
36	382	335	292	352	342	343

The size of bolls in the first crop, in the top crop, and in the total crop was very much the same in the several spacings of the late-thinned cotton. There was a greater difference in the normal-thinned cotton; the bolls being somewhat smaller in the wider spacings in the top crop as compared with those of the first crop.

In the total crop of both dates of thinning there was an increase in the size of bolls as the spacing increased. There was little difference in the size of the boll in the total crop when the dates of thinning were compared, but in the first crop the normal-thinned cotton had the larger bolls, while in the top crop the late-thinned cotton had the larger bolls.

These differences counteracted each other in the size of bolls in the total crop; so there was very little difference shown.

The bolls produced by the cotton in this test were smaller than usual, due to the exceptionally dry season. Cotton of this strain normally produces bolls weighing from 650 to 700 grams per 100 bolls, or about twice the size of the bolls produced in this experiment.

Shedding

Data on the amount of shedding are given in Table 14. There was a considerable amount of shedding of both forms and small bolls on all the plats. This was especially noticeable during the middle of July.

Table 14.—The effect of spacing and time of thinning on the per cent of blooms shed in the first crop.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	79.8	77.8	75.6	74.1	73.3	74.5	73.8	73.9	73.2	73.3	72.0	72.7
Late	80.6	77.0	74.5	72.1	73.7	71.0	69.8	72.4	69.4	71.0	70.3	69.0

The percentage of shedding of the first crop was calculated by dividing the total number of blooms counted to August 16 into the total number of bolls produced in the first crop, and then multiplying by 100. This takes into account the shedding after blooming and no attempt was made to determine the amount of shedding before blooming. However, there was a considerable amount of shedding of squares.

More blooms were produced on the closer-spaced plants and the percentage of shedding was higher than on the wider spacing. The late-thinned cotton did not produce as many blooms in the medium to wide spacings and did not shed quite as many of the blooms as did the normal-thinned cotton. However, the greater number of blooms produced by the normal-thinned cotton more than offset the difference in the percentage of shedding. This is shown clearly in the number of bolls produced (Table 12).

Earliness

The earliness is measured in this test by the per cent of the first crop produced in the first two pickings. It was obtained by dividing the yield in pounds of the first two pickings by the total yield in pounds of the first crop and then multiplying by 100. The results are given in Table 15. These data show conclusively that the normal-

Table 15.—The effect of spacing and time of thinning on earliness as indicated by per cent of first crop in the first two pickings.

Spacing, Inches	3	6	9	12	15	18	21	24	27	30	33	36
Normal	39.2	40.1	49.0	43.6	48.2	47.9	39.2	40.2	41.2	37.1	35.4	32.5
Late	39.0	39.4	37.5	30.3	26.2	23.8	22.1	20.4	20.1	18.1	23.1	19.0

thinned cotton produced a larger proportion of the first crop in the first two pickings than did the late-thinned cotton. There is not so much difference in a comparison of the 3-inch spacings of the two kinds of thinning, but the normal thinning gives a curve with the peak at the 15-inch spacing while the late thinning shows a decreasing trend from the 3-inch to the 36-inch spacing.

DATA ON YIELD

Six pickings were made of the first crop and two of the top crop. The first crop was picked on August 4, August 11, August 18, August 28, September 8, and October 2. At each picking all plats were picked on the same day. Due to unfavorable weather conditions and shortage of labor, each of the two pickings of the top crop was not completed on the same day. At the first picking of the top crop, plats 1 to 26 were picked on November 15, plats 27 to 60 were picked on November 25, plats 61 to 132 were picked on November 27, and plats 133 to 144 were picked on November 28. At the second picking, plats 1 to 48 were picked to December 11, plats 49 to 120 were picked on December 12, and plats 121 to 144 were picked on December 21.

The cotton on each row was picked and put in a separate paper bag. It was carried to the laboratory and weighed as soon as possible. In some cases several days elapsed before all the samples were weighed.

Yield of Test Rows

The average yields of the first crop, of the top crop, and of the total crop of the test rows are given in Table 16.

Table 16.—Effect of spacing and of time of thinning on yield of seed cotton on test rows.

Spacing, Inches	Average Yield Per Acre of Seed Cotton on Test Rows of					
	First Crop		Top Crop		Total Crop	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
3	122.1	135.5	66.5	93.5	188.6	229.0
6	156.6	154.1	90.0	89.0	246.6	243.1
9	179.1	148.5	92.5	87.5	271.1	236.0
12	213.1	165.1	101.0	112.0	314.1	277.1
15	198.6	121.5	105.0	111.0	303.6	232.5
18	196.1	133.0	121.5	112.0	317.6	245.0
21	184.1	122.0	108.5	112.0	292.6	234.0
24	177.1	112.0	91.0	105.5	268.1	217.5
27	192.6	115.0	101.0	121.0	293.6	236.0
30	192.1	107.5	101.0	106.5	293.1	214.0
33	164.6	107.5	96.0	98.5	260.6	206.0
36	179.1	104.5	103.5	129.5	282.6	234.0

The highest yields of the first crop of the normal-thinned cotton were made by the 12-, 15-, and 18-inch spacings, and the lowest yields were made by the 3- and 6-inch spacings. There was considerable fluctuation in the yields of the spacings greater than 21 inches. The first

crop of the late-thinned cotton yielded more in the 12-inch spacing than in any of the other spacings. The 6-, 9-, and 12-inch spacings gave the best yields, while the wider spacings gave lower yields, which were somewhat inversely proportional to the spacing. The chief differences brought out by a comparison of the yields of the first crop of the various spacings of the normal- and of the late-thinned cotton are the uniformly lower yields of the late-thinned cotton, the 3-inch spacing being the only exception, and the decided tendency for the late-thinned cotton to give its best yields in the closer spacings.

A top crop is the exception rather than the rule in this locality. For this reason the yield of the first crop is perhaps a fairer criterion of the actual results to be expected in general than are the yields of the top crop or of the total crop. The results in the first crop may be masked by those of the top crop and the total yield may not be indicative of results to be expected in actual farm practice. However, they indicate what may be expected where a top crop is produced.

The yields of the top crop in the normal-thinned cotton show the same tendencies as are shown by the first crop, namely, lowest yield in the 3- and 6-inch spacings and highest yields centering around the 18-inch spacing. However, the higher yields seem to be in the spacings that are a little wider than those giving the higher yields in the first crop. The yields of the several spacings of the top crop in the late-thinned cotton are radically different from those of the first crop. The same general tendency exhibited by the normal-thinned cotton is shown, namely, the spacings from 12 to 21 or even 27 inches giving the larger yields. With the exception of the 33-inch spacing there is not much difference in the yields of the spacings from 12 to 36 inches. The 9-, 6-, and 3-inch spacings gave the lowest yields in the order named. There is little difference in the yields of the early- and late-thinned cotton in the top crop. What little difference there is seems to be in favor of the late thinning.

The total yield of the normal-thinned cotton gives the same comparative results as in either the first crop or top crop, which is to be expected, as the two crops show the same tendency. The total yield of the late-thinned cotton gives results similar to those of the normal thinning with the exception that the closer spacings yield somewhat better in comparison with the yields of the wider spacings, than those of the normal thinning with the same comparison. In every spacing, with the exception of the 3-inch, the normal-thinned cotton gave higher yields than the late-thinned cotton.

Yield of Plats

The average yield of the test row and of the two guard rows of the various spacings shows the same tendencies in both the normal and the late thinning (Table 17), as are shown in the total average yield of the test plats. In this case the yields show less fluctuation, which is to be expected, as a greater number of repetitions are included.

Table 17.—Effect of spacing and of time of thinning on yield of seed cotton on entire plat, including the test rows and guard rows.

Spacing, Inches	Average Yield Per Acre of Seed Cotton on							
	Test Rows		Guard A		Guard B		Average of Test and Guard Rows	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
3	188.6	229.0	230.6	289.1	206.6	207.1	208.6	241.7
6	246.6	243.1	239.6	233.1	264.1	243.1	250.1	239.8
9	271.1	236.0	267.6	217.1	287.1	243.1	275.3	232.1
12	314.1	277.1	297.6	257.1	338.1	290.1	316.6	274.8
15	303.6	232.5	292.1	233.6	303.6	244.6	299.8	236.9
18	317.6	245.0	309.6	234.6	328.6	261.1	318.6	246.9
21	292.6	234.0	289.1	212.1	301.1	214.1	294.3	220.1
24	268.1	217.5	279.1	211.6	282.6	241.1	276.6	223.4
27	293.6	236.0	276.6	189.1	266.6	218.6	278.9	214.6
30	293.1	214.0	279.6	198.6	277.6	211.1	283.4	207.9
33	260.6	206.0	255.1	176.6	315.6	237.6	276.9	206.7
36	282.6	234.0	299.6	226.6	250.6	186.1	277.6	215.6

INTERPRETATION OF DATA ON YIELD BY STUDENT'S METHOD

In order to determine the border effect, if any, on each of the two guard rows of each plat by comparing their yields with the yield of the test row and to determine the significance of the difference in yield for each successive spacing, the significance of the mean difference was calculated by means of Student's method as given by Love and Brunson in volume 16, No. 1 of the Journal of the American Society of Agronomy.

There was wide variation in the yield of the two acres. This, together with the fact that only six repetitions were used, would make the probable error of each test so high that the probable error of the difference could not be used in determining the significance of the differences in yield. In each case the successive spacings were adjacent to each other, and the difference in soil heterogeneity could not be great; so Student's method of determining the probability of the difference where the results naturally arrange themselves in pairs, as in this case, was used. The original data from all of the six repetitions were used in each case.

Border Effect as Determined by Student's Method

As already stated, each plat consisted of three rows, the middle row being the test row, and the two outside rows being used as guard or border rows. The guard rows adjacent to plats with successive closer spacings were designated as guard A, while the guard rows adjacent to plats with successive wider spacings were designated as guard B.

If there were any differences in yield between guard A and the test row, due to border effect, it would be expected that the yield of guard A would be smaller than the yield of the test row in all cases, with the exception of the 3-inch spacing which was adjacent to the 36-inch spacing. This was found to be true in the 3-inch spacing of the normal-

thinned cotton, where the yield of guard A was significantly higher than the yield of the test row (Table 18). In all the other spacings there appears to be little or no difference between the yield of guard A and the yield of the test row, as shown by the odds calculated.

Table 18.—Odds calculated by Student's method showing the significance of the difference in yield of Guard A and the test rows of the various spacing of the normal-thinned cotton.

Spacing, Inches	Greater Yield	Smaller Yield	Odds
3	Guard A	Test	19 to 1
6	Test	Guard A	1.6 to 1
9	Test	Guard A	1.7 to 1
12	Test	Guard A	3.9 to 1
15	Test	Guard A	3.8 to 1
18	Test	Guard A	2.2 to 1
21	Test	Guard A	1 to 1
24	Guard A	Test	3.8 to 1
27	Test	Guard A	8.7 to 1
30	Guard A	Test	2.5 to 1
33	Test	Guard A	1.4 to 1
36	Guard A	Test	2.8 to 1

In the late-thinned cotton there appears to be a rather significant difference between the yield of guard A and the yield of the test row (Table 19.) In the 3-inch spacing the yield of guard A is significantly greater than the yield of the test row, the odds being 234 to 1 that the difference is significant. While the yield of the test row is greater than that of guard A in all other spacings, the significance in most cases is not great. However, the fact that all the results point in the same direction certainly indicates that the difference is significant.

Table 19.—Odds calculated by Student's method showing the significance of the differences in yield of Guard A and test row of the various spacings of the late-thinned cotton.

Spacing, Inches	Greater Yield	Smaller Yield	Odds
3	Guard A	Test	234.0 to 1
6	Test	Guard A	1.7 to 1
9	Test	Guard A	14.5 to 1
12	Test	Guard A	11.0 to 1
15	Test	Guard A	1.0 to 1
18	Test	Guard A	4.0 to 1
21	Test	Guard A	10.0 to 1
24	Test	Guard A	1.5 to 1
27	Test	Guard A	60.0 to 1
30	Test	Guard A	4.0 to 1
33	Test	Guard A	16.5 to 1
36	Test	Guard A	1.5 to 1

In comparing the yields of guard B and the test row, any difference due to border effect should be in favor of guard B, since it is adjacent to the successively wider spacing in all cases except the 36-inch spacing. There appears to be some border effect in the closer spacings of the normal-thinned cotton (Table 20), the difference being in favor of guard B, as was expected. However, in the spacings above 24 inches the significant differences found seem to have little relation to border

effect with the exception of the 36-inch spacing. In this case the yield of guard B should be smaller than the yield of the test row, since it was in competition with a 3-inch-spaced row adjacent to it. The odds of 140 to 1 are certainly significant.

Table 20.—Odds calculated by Student's method showing the significance of the differences in yield of Guard B and the test row of the various spacings of the normal-thinned cotton.

Spacing, Inches	Greater Yield	Smaller Yield	Odds
3	Guard B	Test	8.5 to 1
6	Guard B	Test	48.0 to 1
9	Guard B	Test	5.4 to 1
12	Guard B	Test	10.2 to 1
15	Guard B	Test	1.0 to 1
18	Guard B	Test	4.5 to 1
21	Guard B	Test	1.8 to 1
24	Guard B	Test	5.3 to 1
27	Test	Guard B	15.0 to 1
30	Test	Guard B	38.0 to 1
33	Guard B	Test	12.0 to 1
36	Test	Guard B	140.0 to 1

There is little appreciable difference between the yield of guard B and the yield of the test row in the late-thinned cotton, as shown by the odds given in Table 21; for all the spacings with the exception of the 36-inch spacing. Here, as in the normal-thinned cotton, the odds are significant, being 208 to 1.

Table 21.—Odds calculated by Student's method showing significance of the differences in yield of Guard B and the test row of the various spacings of the late-thinned cotton.

Spacing, Inches	Greater Yield	Smaller Yield	Odds
3	Test	Guard B	24.0 to 1
6	Guard B	Test	1.0 to 1
9	Guard B	Test	3.1 to 1
12	Guard B	Test	2.8 to 1
15	Guard B	Test	3.5 to 1
18	Guard B	Test	3.0 to 1
21	Test	Guard B	5.0 to 1
24	Guard B	Test	7.5 to 1
27	Test	Guard B	3.1 to 1
30	Test	Guard B	1.8 to 1
33	Guard B	Test	34.5 to 1
36	Test	Guard B	208.0 to 1

The Significance of Differences in Yield Between the Adjacent Spacings as Determined by Student's Method

Since there was significant border effect on the yield of guard A of the 3-inch spacing and on the yield of guard B of the 36-inch spacing, the yields of these two guards were omitted in obtaining the average yield of the three rows of each plat for the purpose of calculating the significance of the difference in yield between adjacent spacings.

Table 22.—Odds calculated by Student's method showing the significance of the differences in yield of the test rows of the various spacings of the normal-thinned cotton.

Greater Yield	Smaller Yield	Odds
6 inch	3 inch	314.0 to 1
9 inch	6 inch	4.0 to 1
12 inch	9 inch	28.0 to 1
12 inch	15 inch	2.5 to 1
18 inch	15 inch	3.0 to 1
18 inch	21 inch	7.7 to 1
21 inch	24 inch	4.4 to 1
27 inch	24 inch	7.4 to 1
27 inch	30 inch	1.0 to 1
30 inch	33 inch	3.0 to 1
36 inch	33 inch	5.3 to 1

In the normal thinning (Table 22), a comparison of the yields of the test rows by Student's method shows quite conclusively that spacings closer than 12 inches can be discarded as being too close. The odds that the yield of the 12-inch spacing is significantly higher than the yield of the 9-inch spacing are 28 to 1. Since the 9-inch spacing produced a larger yield than the 6-inch spacing, and the 6-inch spacing produced a larger yield than the 3-inch spacing, the above statement seems justified. The difference in yield of the 12-inch and the 15-inch spacings and of the 15-inch and the 18-inch spacings appear to be of little significance. However, there are some differences in yield of the 18-inch and of the 21-inch spacings, and of the 21-inch and the 24-inch spacings. These results show that the spacings from 12 to 18 inches gave the highest yields, with less difference in the yields of the successively wider spacings than in the successively smaller spacings. These results are in accord with previous work of this Station. (29)

Table 23.—Odds calculated by Student's method showing the significance of the differences in yield of the test rows of the various spacings of the late-thinned cotton.

Greater Yield	Smaller Yield	Odds
6 inch	3 inch	2.5 to 1
6 inch	9 inch	1.9 to 1
12 inch	9 inch	4999.0 to 1
12 inch	15 inch	55.0 to 1
18 inch	15 inch	2.0 to 1
18 inch	21 inch	1.6 to 1
21 inch	24 inch	2.0 to 1
27 inch	24 inch	4.0 to 1
27 inch	30 inch	7.0 to 1
30 inch	33 inch	2.1 to 1
36 inch	33 inch	130.0 to 1

In the late thinning a comparison of the yields of the test rows of the various spacings by Student's method shows the 12-inch spacing to be much superior to all the other spacings (Table 23). It is certainly significantly greater than the yield of any smaller spacing and probably greater than the yield of any of the wider spacings.

Table 24.—Odds calculated by Student's method showing the significance of the differences in yield of the plats of the various spacings of the normal-thinned cotton.

Greater Yield	Smaller Yield	Odds
6 inch	3 inch	490.0 to 1
9 inch	6 inch	5.7 to 1
12 inch	9 inch	36.0 to 1
12 inch	15 inch	4.5 to 1
18 inch	15 inch	5.8 to 1
18 inch	21 inch	9.0 to 1
21 inch	24 inch	8.5 to 1
27 inch	24 inch	1.1 to 1
30 inch	27 inch	2.0 to 1
30 inch	33 inch	1.5 to 1
36 inch	33 inch	7.5 to 1

Table 25.—Odds calculated by Student's method showing the significance of the differences in yields of the plats of the various spacings of late-thinned cotton.

Greater Yield	Smaller Yield	Odds
6 inch	3 inch	5.5 to 1
6 inch	9 inch	2.8 to 1
12 inch	9 inch	370.0 to 1
12 inch	15 inch	10000.0 to 1
18 inch	15 inch	3.0 to 1
18 inch	21 inch	21.0 to 1
24 inch	21 inch	1.0 to 1
24 inch	27 inch	4.0 to 1
27 inch	30 inch	3.0 to 1
30 inch	33 inch	1.0 to 1
36 inch	33 inch	30.0 to 1

Where comparisons are made between the average yield of all three rows of the plat, in both the normal- and the late-thinned cotton (Tables 24 and 25), the same results as were found in the comparison of the test rows of the various spacings are brought out even more forcibly.

PERCENTAGE OF LINT

The total amount of seed cotton produced by each test row was placed in one sack when weighed after each picking, and the total lot ginned together. The seed cotton from the two guard rows of each plat was put together and ginned. Due to the small samples in some cases and to errors in weighing and loss in ginning, there was more fluctuation in the percentage of lint than could possibly have been caused by spacing or time of thinning. Previous work (11, 28) and especially unpublished data of the Division of Agronomy of the Texas Agricultural Experiment Station, has shown that there is little effect on the percentage of lint due to rate or time of thinning, each variety remaining approximately constant in this respect. The variation in percentage of lint in this work was high and appeared to be due to chance and not to the influence of any of the variables in the test. The mean percentage of lint of the normal-thinned cotton was 29.97 and of the late-thinned cotton, 30.00. The mean of the two was $29.99 \pm .15$ per

cent with a standard deviation of 2.75±.01 per cent. The percentage of lint of the entire crop may be taken as 30 per cent, which is low for this strain of cotton.

LENGTH AND GRADE OF LINT

The length and grade of lint of each test row and of the combined lint of the two guard rows of each plat were determined by the Department of Textile Engineering, Agricultural and Mechanical College of Texas. There was little consistent difference in the length of the lint in the various rates of thinning or in the two dates of thinning. The lint from a large majority of the plats had a length of 1 1/16 inches, while a few plats had a length of 1 inch, two had a length of 15/16 inch, and three had a length of 1⅛ inches.

In order to be able to derive some average grade of lint for the six repetitions of each spacing in both normal and late thinning, a value of 1 was given to the grade middling, 2 to the grade of strict middling, 2.5 to a grade of strict middling full, and a value of 3 to a grade of good middling (Table 26). Thus, if all the lint from the plats of the 3-inch normal-thinned cotton had a grade of middling, its total value would be 6, while the grade of good middling on all six repetitions would give a value of 18. Most of the grades ranged from strict middling to good middling, only three plats giving a grade of middling, and these were all late-thinned plats.

Table 26.—Grade of lint as affected by spacing and time of thinning.

Spacing, Inches	Comparative Grade of Lint Produced on			
	Test Rows		Guard Rows	
	Normal Thinned	Late Thinned	Normal Thinned	Late Thinned
3	15.0	15.0	13.5	12.0
6	17.0	13.0	15.0	13.0
9	16.0	14.0	14.5	13.0
12	17.0	15.5	14.5	12.0
15	18.0	14.0	16.0	14.5
18	17.5	14.0	15.0	13.0
21	18.0	15.0	17.0	13.5
24	17.0	16.0	16.0	13.0
27	17.0	17.0	16.5	14.0
30	16.5	15.0	16.0	14.0
33	17.5	14.0	16.0	15.0
36	16.5	13.0	15.5	14.5

In this table the several grades of lint were assigned values as follows:

Middling	1
Strict middling	2
Strict middling full	2.5
Good middling	3

There was a consistent difference in the grade of the lint of the normal-thinned cotton as compared with that of the late-thinned cotton. This is shown in Table 26. In no case did the late-thinned cot-

ton give a higher total grade value for the various spacings than that of the normal-thinned cotton.

SUMMARY AND CONCLUSIONS

In this experiment, conducted in 1925, which was an unusually dry year, cotton plants thinned late produced less vegetative growth than plants thinned at the normal time. The late-thinned plants had shorter stalks of a smaller diameter than the normal-thinned plants. The time of thinning apparently had little effect on the number of nodes. In both dates of thinning there was a gradual increase in the height of the stalk, number of nodes, diameter of stalk, and of the number and length of vegetative and of fruiting branches as the distance between the plants increased, the rate of increase being less for the late-thinned plants than for the normal-thinned plants.

The normal-thinned wide-spaced cotton made the largest vegetative growth. The advocates of late thinning say that late thinning will cause the development of more fruiting branches nearer to the ground, at the expense of the vegetative branches. In this investigation, conducted during an unusually dry year, the results show that there were fewer fruiting branches which were borne farther from the ground in almost every case, in spite of the shorter plants of the late-thinned cotton. This would indicate that not only were the first vegetative branches aborted but the lower fruiting branches as well.

The normal-thinned cotton bloomed earlier than the late-thinned cotton. The normal-thinned cotton also produced more blooms in all of the spacings, except the 3-inch and 6-inch spacings, than the late-thinned cotton. There is nothing in the bloom count to indicate that late thinning promotes earliness. In both dates of thinning, the number of blooms decreased as the spacing increased.

The data on the first open boll afford no evidence that late thinning promotes earliness. The medium spacings, 9 to 18 inches, of the normal-thinned cotton produced an earlier crop as measured by the percentage of the first crop in the first two pickings.

The normal-thinned cotton produced a larger number of bolls in each spacing except the 3-inch, than did the late-thinned cotton. The normal-thinned cotton produced larger bolls in the first crop, while the late-thinned cotton produced larger bolls in the top crop. Late-thinned cotton produced a smaller and later crop than normal-thinned cotton.

The fact that the late-thinned cotton made a better proportionate top crop as compared with the first crop than did the normal-thinned cotton, indicates that it was able, in a measure, to overcome the setback it received early in the season, due to the competition of plants later to be removed. It lacked, to a considerable extent, the ability to overcome the lead the normal-thinned cotton had gained.

These results in general show there are no advantages to be gained in the late thinning of cotton. If, however, cotton must be thinned late, through uncontrollable circumstances, the results indicate that it

would be better to leave more plants to the row than is normally the practice. More stunted plants can be left on an acre without crowding than can plants which grow normally.

In the normal-thinned cotton there were more blooms produced by the closer-spaced plants, but there was also a greater amount of shedding. There was little difference in the number of bolls produced in the 3-, 6-, and 9-inch spacings. Spacings wider than these produced fewer bolls, the number diminishing as the spacing increased. There was a steady increase in the size of the bolls from the 3- to 36-inch spacing. As the yield depends on the number and size of the bolls, there must be some point where the diminishing number and the increasing size of the bolls will give the largest total yield. This point seems to be somewhere between the 12- and the 21-inch spacings in this test.

While it is understood that one year's test is not conclusive, and that this test was conducted under abnormal growing conditions, the indications are that cotton should be thinned at the normal time.

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