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# TEXAS AGRICULTURAL EXPERIMENT STATION

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

BULLETIN NO. 340 MAY, 1926

DIVISION OF AGRONOMY

# THE EFFECT OF SPACING ON THE YIELD OF COTTON



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***In cooperation with the School of Agriculture.

## SYNOPSIS

In 1914, the Division of Agronomy, Texas Agricultural Experiment Station, began the experiments here reported to determine the optimum spacing of cotton under the conditions prevailing in different parts of the State, and also to determine the effect of deferred or late thinning on the yield of cotton. The field work in these experiments was done at the Main Station, College Station, and at the substations at Beeville, Troup, Angleton, Temple, Spur, Lubbock, Pecos, Nacogdoches, and Chillicothe. This Bulletin reports the results of this work up to the present time.

Statistical methods were used in analyzing and interpreting the data obtained in the experiments. The use of these methods makes it possible to reach more definite conclusions than would have been possible otherwise.

The highest yields in general resulted from the close and medium spacing, 6 to 21 inches, in the different parts of the State, except in eastern Texas, where comparatively wide spacing, 27 to 36 inches, gave the best results. Twelve inches was found to be the optimum spacing at Angleton, Lubbock, and Spur; 9 to 12 inches at College Station; 21 inches at Beeville and Temple; 27 inches at Nacogdoches; and 30 inches at Troup and Chillicothe.

These results show that the cotton plant has the ability to adjust itself to produce satisfactory yields within a comparatively wide range of spacing.

Thinning cotton at the usual time of thinning produced larger yields in general than late or deferred thinning.

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BULLETIN NO. 340 MAY, 1926

# THE EFFECT OF SPACING ON THE YIELD OF COTTON

E. B. REYNOLDS

Field experiments to determine the optimum spacing of cotton plants under various conditions have been conducted by experiment stations in the cotton-growing states since 1887. The Division of Agronomy, Texas Agricultural Experiment Station, began experiments on the spacing of cotton on a rather elaborate scale in 1914 at the substations at Angleton, Beeville, Chillicothe, Lubbock, Nacogdoches, Pecos, Spur, Temple, Troup, and at the Main Station, College Station. The only previous work on the spacing of cotton in Texas was done by Pittuck (85) in 1897, Pittuck and McHenry (86) in 1898, and Welborn (123) in 1908. Pittuck and McHenry used four spacings, 3 feet by 2 feet, 4 feet by 2 feet, 4 feet by 3 feet, and 5 feet by 3 feet, with five varieties of cotton. The spacing of 3 feet by 2 feet made the largest yield, but the work was not conducted long enough to reach definite conclusions. Welborn employed rows 3½ feet apart, with the plants spaced 12, 15, 18, and 24 inches apart in the row. The spacings of 12, 15, and 18 inches made the larger yields. Spacing experiments with cotton in other states were not conducted long enough, in most cases, to reach definite conclusions as to the optimum spacing. In Georgia, however, Redding and Kimbrough (104) in summarizing seventeen years' work on cotton culture stated that "On a land capable of a yield of ¾ to 1½ bales per acre the rows should be 3½ to 4 feet wide and the plants 12 to 18 inches apart in the drills, the narrower rows and the closer spacing for the less productive soil." Stubbs (114) and Lee (55, 56, 57, 58, 59) also obtained results in Louisiana which indicated rather definitely that spacing 2 stalks every 12 or 16 inches in ordinary rows made the best yields. For these reasons it was deemed necessary to establish experiments to determine the optimum spacing of cotton under conditions in Texas.

The soil and climatic conditions in Texas are widely different from those in the cotton-growing states east of the Mississippi River. In those states there is a heavier rainfall with perhaps a more favorable distribution than there is in Texas. There is a great variation in the precipitation of the different parts of the state. For instance, within the cotton-growing areas of the state, Nacogdoches in East Texas has an average rainfall of approximately 51 inches, while Lubbock in North-

west Texas has about 20 inches. The rainfall is erratic both as to amount and distribution. In some years it is excessive, while in others it is light. This erratic rainfall sometimes produces conditions which are unfavorable for the germination of cotton seed, particularly in rainy periods of the planting season, which is usually in April and May.

The cotton plant has the ability to adapt itself to a comparatively great variation in rainfall. While cotton is not generally considered as especially drouth-resistant, it is really one of the most drouth-resistant or drouth-evasive plants grown in Texas. This is probably due to the fact that it is not a determinate type of plant. That is, it blooms and puts on fruit during a comparatively long part of its growing period, rather than during a short period, as do corn and soybeans. This is important for the reason that if sufficient moisture is not available at the time the plant usually requires its maximum amount of water, it can wait and use the water when it becomes available, provided, of course, the moisture is provided within a reasonable time and not too late in the season for the bolls to mature before frost.

It is rather difficult to conduct accurate spacing experiments with cotton under wide range of conditions for several reasons. In the first place, the seasonal conditions may not be favorable for germination, resulting in a poor stand; second, even where good stands are obtained in wet seasons sore-shin, or damping off, and insects may partially destroy the stand; and third, it is not always possible to maintain a perfect stand through the entire season.

Cotton is the most important fiber plant in the world and one of the most important crops in the United States. It is the most valuable crop in Texas, having a value twice as great as the value of all the grain and hay crops in Texas combined. On account of the world's demand for cotton, the increase in values of lands on which cotton is grown, and the increasing cost of labor in producing the crop, it is imperative that methods be devised to grow cotton cheaper. It is probable that improvement of the cultural practices in cotton production has not received attention commensurate with the importance of the crop.

## REVIEW OF LITERATURE

Field experiments to determine the most satisfactory spacing of cotton under various conditions have been conducted by experiment station workers since 1887.

The North Carolina Agricultural Experiment Station (77) conducted field experiments on the spacing of cotton in 1887. Four spacings were used, 3 feet by 9 inches, 3 feet by 2 feet, 3 feet by 3 feet, and 4 feet by 4 feet. The spacing of 3 feet by 9 inches produced the largest yield, and it was stated that the spacing of 3 feet by 2 feet was considered half a stand and 3 feet by 3 feet as one-third of a stand.

McBryde (62) in South Carolina conducted experiments on the spacing of cotton at two different farms in 1888, in 1889, and in 1890. He used rows $3\frac{1}{2}$, 4, and $4\frac{1}{2}$ feet apart, with the plants spaced $2\frac{1}{2}$, 3, $3\frac{1}{2}$,

and 4 feet apart in the rows. From this work he stated, "It does not appear that varying the distances between hills, within the limits mentioned, materially affected the results. At both farms close planting gave about the same results as wide."

In Alabama, W. H. Newman (73), J. S. Newman (74), and J. S. Newman and Clayton (75, 76) conducted field experiments on the spacing of cotton in 1888, 1889, 1890, and 1891. The results secured from these experiments, however, were not conclusive. Later, Duggar (32, 33, 34) in Alabama conducted similar experiments. He concluded from his work and from all previous work done in Alabama that spacing the plants 12 to 18 inches apart in ordinary rows was safer than wider spacing.

Stubbs (114) in 1888, Lee (55, 56, 57, 58, 59) from 1889 to 1893, inclusive, and Barrow (16) conducted field experiments on the spacing of cotton in Louisiana. Stubbs and Lee employed rows of ordinary width, 4 feet in 1888, and 3½ feet in the other years, and spaced the plants 8, 12, 16, 20, and 24 inches apart with 1 and 2 stalks to the hill. Their results show that spacing 12 to 16 inches with 2 stalks to the hill produced the largest yield.

Redding and his associates in Georgia conducted a large number of experiments on cotton culture, including spacing, from 1890 to 1906. In summarizing the results on the spacing of cotton, Redding and Kimbrough (104) in 1906 stated: "The experiments that have been made indicate unmistakably that the cotton plants should be thinned to one in a place; and that the rows should be narrow and the plants wider so as to be more nearly equidistant. Of course on very thin land requiring a very thick stand, the rows cannot be economically, with reference to expense of planting and cultivating, closer than 30 to 36 inches, and the plants may then be not farther apart than 10 to 12 inches. On a land capable of a yield of ¾ to 1½ bales per acre the rows should be 3½ to 4 feet wide and the plants 12 to 18 inches apart in the drills, the narrower rows and the closer spacing for the less productive soil. In high latitudes the spacing should be closer than in the heart of the cotton belt."

Pittuck (85) and Pittuck and McHenry (86) conducted distance experiments at the Texas Station with cotton in 1897 and 1898. They used four distances, 3 feet by 2 feet, 4 feet by 2 feet, 4 feet by 3 feet, and 5 feet by 3 feet, with five varieties of cotton. As an average of all the varieties the spacing of 3 feet by 2 feet made the largest yield. In 1908, Welborn (123) at the Texas Station conducted a spacing test with cotton. He used rows 3½ feet apart, with the plants spaced 12, 15, 18, and 24 inches apart in the rows. The spacing of 12, 15, and 18 inches made the larger yields.

Several investigators worked on the problem in Mississippi previous to 1914. Among these were Ferris (36), Fox (42, 43), Ricks, Ewing, and Walker (105), and Walker (121). In these experiments spacing the plants 9 to 24 inches apart in the row gave the best results.

## OBJECT OF THE EXPERIMENT

A review of the literature shows that results of investigations on the spacing of cotton previous to 1914 were not conclusive, except perhaps in Georgia. Experiments covering only three years' work in Texas were reported. Since soil and climatic conditions in Texas are quite different from those in the cotton-growing states east of the Mississippi River, it was considered advisable to conduct experiments on this phase of cotton culture under conditions prevailing in Texas. Accordingly, in 1914 rather comprehensive investigations were begun in the different parts of the State to study the effect of spacing on the yield and other characters of the cotton plant. The objects of the investigations were to determine:

1. What effect varying degrees of environment, as represented by rate and distribution of seed and time of thinning, has on the development of the cotton plant and its characters.
2. The effect of different spacings of plants in the row on yield, quality, and market value of cotton.
3. The effect of deferred (late) thinning on yield.

This Bulletin is a report of the effect of time of thinning and rate of thinning (spacing) on yield.

## METHOD OF CONDUCTING THE EXPERIMENT

The field work included 12 different spacings, namely, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, and 36 inches, in rows 3 feet apart. At some of the stations 2 and 3 stalks were left to the hill. Two series of plats were used, both of which were thinned to the above distances. In one series, the plants were thinned at the usual time of thinning (chopping) cotton, which, in general, is done when the plants have four to six leaves, and is here called normal thinning. In the other series of plats, the cotton plants were not thinned until they were about 6 inches high; this is termed deferred thinning. Deferred thinning was done at only four stations, College Station, Angleton, Beeville, and Chillicothe.

In all cases the rate of thinning work with cotton was conducted on acres 8 rods by 20 rods, or 132 feet by 330 feet, except at Substation No. 12, Chillicothe. An acre of these dimensions is the standard acre of the field-platting system of the Texas Agricultural Experiment Station. The acre is divided into 16 plats. Each plat consists of 7 rows 3 feet wide and 132 feet long. One row on each side of the plat is used as a border, or guard row, and is not harvested as part of the plat. The area harvested on each plat consists of five rows 132 feet long, or 1/22 acre.

The cotton in these tests usually was planted at the optimum time of planting cotton at each substation. That method of preparing the land, of planting, and of cultivation which has been found best at the stations was used. A heavy rate of seeding was used in order to obtain a good stand.

The plants were given a preliminary thinning 10 days or two weeks after emergence, leaving about 25 plants more than the number desired on each plat. About 10 days later the plants remaining were thinned to the desired stand by actual count. If deferred, or late, thinning was desired, preliminary thinning was done when the plants were about 6 inches high, and the final thinning to the distances desired was made 10 days later.

In thinning the plants to the desired distances, a cord, pole, or tape, with the proper distances indicated, was placed along the row, and a plant was left as near as possible to the desired mark. It was not possible to get a plant exactly at each mark but in all cases the desired number of plants was secured on each plat.

All possible care was used in cultivating the cotton in the spacing tests to retain and realize the stand desired on each plat. But despite this care, a few plants were destroyed or died from various causes. For this reason it was considered necessary to make an actual count of the plants on each plat at the time of picking. Frequently it was found by this count that the desired stand had not been obtained and the plat had to be placed in another spacing. For instance, a plat on which the plants were thinned to 9 inches, showed by actual count at picking to have an average distance of 12 inches between plants, which was grouped *with the 12-inch instead of the 9-inch spacing.* This is the principal reason why all of the spacings were not obtained every year.

## METHOD OF ANALYZING THE DATA

At practically all of the substations where spacing work with cotton was conducted, all of the spacings were not secured every year of the test, owing to the fact that a recount of the plants was made at the time of picking, which changed some of the spacings, as stated in the preceding paragraph. For this reason the average yield of each spacing could not be obtained for the entire period. It is obvious, therefore, that a true basis of comparing the average yields of lint of the several spacings is not possible by using the averages for the entire period. This fact made it necessary to compute averages of each of the several spacings for the years they were obtained in order to study them on a comparable basis. For instance, if the test was carried for five years and all of the spacings were obtained four years of the five, the average yield of each spacing was obtained for the four years; and another set of averages was made for the spacings which were obtained for the five years. This gives a comparable basis for studying the average yields of the different rates of thinning for the years they were secured. But it does not afford an equitable basis for comparing the average yield of each spacing for the duration of the test with the average yields of the other spacings where some of the spacings were not obtained each year of the test.

In order to secure a fair comparison of the average yields of all rates of thinning for the duration of the test at any station, even though all

spacings were not obtained every year of the test, the yields of lint cotton were calculated to percentages of the average yield of all the spacings. The method of computing the average relative yields is explained as follows: The sum of the yields of all the spacings secured in any year is divided by the number of spacings. The results obtained represent the average yields of all the spacings, or 100 per cent, or the possibilities of production under the conditions. This figure divided into the yield of each spacing and the results multiplied by 100 gives the relative yield, expressed on a percentage basis. The relative yield of each rate of thinning obtained in this manner is then averaged for the years it appears in the test, regardless of the number of years, except when less than two. In this way it is possible to compare the yields of all the rates of thinning for the duration of the test without giving undue weight to large or small yields in any particular year when some of the spacings do not occur.

In most cases a second degree parabolic curve was fitted by the method of least squares to the average relative yields and in two instances to the average actual yields of lint cotton as an additional aid in the interpretation of the data. The equation[1] $Y=a+bx+cx^2$, was used in fitting the curve to the data. The index of correlation, which is an abstract measure of the closeness of agreement between the observed yields and the fitted curve, was computed. On account of the small number of observations to which each curve was fitted, the index of correlation will, in all cases, have a slightly higher value than it would have had if the curve had been fitted to a large number of similar observations. Mills says, "The index of correlation may be looked upon as a measure of the adequacy of a curve of a given type to describe the relationship between two variables."

While the uses of least squares and of relative yields are not intended to supersede entirely the average actual yields it is believed that these methods are valuable in interpreting the data and in reaching more definite conclusions than would be possible from the average actual yields alone.

## RESULTS SECURED WITH NORMAL THINNING

Spacing work with cotton thinned at the usual or normal time of thinning was conducted at the Main Station, College Station, and at the substations at Beeville, Troup, Angleton, Temple, Spur, Lubbock, Pecos, Nacogdoches, and Chillicothe. As the work was conducted at widely separated points and under different conditions, the data secured at the several stations are reported separately. The conditions at each station as regards elevation, average yearly rainfall, and character of soil are given. This information will give the reader a fairly good general idea of the region surrounding each substation.

[1]Mills, F. C., *Statistical Methods*, Henry Holt and Company, New York, 1924. The methods used in fitting the curve to the data and in computing the standard error, $Sy$, and the index of correlation are given on pages 432-441.

## Results at College Station

College Station is located in Brazos County in the east central part of Texas. The elevation is about 370 feet. According to the weather records of the Texas Agricultural Experiment Station cooperating with the Weather Bureau, U. S. Department of Agriculture, the average annual rainfall at College Station for 36 years, 1890 to 1925, inclusive, is 38.21 inches. The amount of rainfall varies greatly from year to year, and there are times when crops suffer from drouth. The soil on the Experiment Station farm is a light gray fine sandy loam with a gray or mottled gray impervious subsoil. It is classified as Lufkin fine sandy loam by the Bureau of Soils, U. S. Department of Agriculture. The surface drainage of this soil is good to excessive, but the drainage through the soil is poor on account of the heavy impervious subsoil.

The thinning, or spacing, work with cotton was conducted at College Station in 1914, 1915, 1916, 1917, and 1919, the results of which appear in Tables 1, 2, 3, and 4. Two series of plats were used in these experiments, one of which contained 1 stalk to the hill and the other, 2 stalks to the hill.

TABLE 1.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at the Main Station, College Station, Texas, 1914, 1915, 1916, 1917, and 1919.

One stalk to the hill.

| Spacing, inches between plants | 1914 | 1915 | 1916 | 1917 | 1919 | Average yield for 1915-1919 inclusive | | Average yield for 1914-1919 inclusive | | Average all years tested | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | 214.50 | 363.68 | 41.93 | 184.59 | 201.17 | 3 | ..... | ..... | 201.17 | 7 | 4 |
| 6 | ..... | 191.00 | 339.29 | 54.64 | 236.84 | 205.44 | 1 | ..... | ..... | 205.44 | 5 | 4 |
| 9 | 291.19 | 234.69 | 338.02 | 58.77 | 168.09 | 199.89 | 4 | 218.15 | 2 | 218.15 | 2 | 5 |
| 12 | 330.13 | 229.73 | 318.19 | 66.96 | 175.82 | 197.67 | 5 | 224.16 | 1 | 224.16 | 1 | 5 |
| 15 | 272.45 | 217.98 | 278.94 | 60.63 | 181.84 | 184.84 | 8 | 202.36 | 5 | 202.36 | 6 | 5 |
| 18 | 255.19 | 253.98 | 286.34 | 77.00 | 130.97 | 187.07 | 7 | 200.69 | 6 | 200.69 | 8 | 5 |
| 21 | 269.33 | 235.37 | 252.07 | 55.68 | 161.56 | 176.17 | 10 | 194.80 | 7 | 194.80 | 9 | 5 |
| 24 | 252.89 | 347.67 | 256.76 | 60.71 | 154.68 | 204.95 | 2 | 214.54 | 3 | 214.54 | 3 | 5 |
| 27 | 245.49 | 284.12 | 233.91 | 64.61 | 123.06 | 176.42 | 9 | 190.23 | 8 | 190.23 | 10 | 5 |
| 30 | 275.28 | 304.93 | 251.74 | 61.18 | 140.76 | 189.65 | 6 | 206.77 | 4 | 206.77 | 4 | 5 |
| 33 | 238.52 | 248.63 | 283.25 | 63.06 | 78.02 | 168.24 | 11 | 182.29 | 9 | 182.29 | 11 | 5 |
| 36 | 239.29 | 231.99 | 256.95 | 56.37 | 105.79 | 162.77 | 12 | 178.07 | 10 | 178.07 | 12 | 5 |

The yields secured in the series with 1 stalk to the hill appear in Table 1. In 1914 the largest yield, 330 pounds of lint to the acre, was obtained from the 12-inch spacing, but apparently the rate of thinning had no consistent effect on yield. In 1915, a favorable year for cotton production, the largest yields were obtained from the spacings ranging from 18 to 30 inches. The year 1916 was favorable for cotton production on account of the amount and distribution of rainfall. The largest yields resulted from the closer spacings, 3 to 15 inches. In 1917, which was a dry year with only 17.53 inches of rain-

fall, the spacings ranging from 15 to 36 inches, produced the best yields. In 1919 the excessive rainfall, 57 inches, was not conducive to large yields. The closer spacings made the best yields.

Average yields for the 4 years, 1915, 1916, 1917, and 1919, show that the spacing of 6 inches made the highest yield, but apparently there were no significant differences between the yield of this spacing and the yields of the 3-inch, 9-inch, and 12-inch spacings. The spacing of 12 inches made the highest average yield, 224 pounds of lint to the acre, for the entire period of the experiment. The yields of lint in Table 1 were converted to relative yields, expressed in percentages, as explained on page 9. These relative yields are given in Table 2. On this basis of comparison the 6-inch and 12-inch spacings produced the most satisfactory yields.

TABLE 2.

Relative yields of lint cotton secured in spacing experiments with cotton at Main Station, College Station, Texas, 1914, 1915, 1916, 1917, and 1919.

One stalk to the hill.

| Spacing, inches between plants | 1914 | 1915 | 1916 | 1917 | 1919 | Average | | Number years tested |
|---|---|---|---|---|---|---|---|---|
| | 266.97 pounds =100% | 249.55 pounds =100% | 288.26 pounds =100% | 60.13 pounds =100% | 153.50 pounds =100% | % | Rank | |
| | % | % | % | % | % | | | |
| 3 | ..... | 86 | 126 | 70 | 120 | 100 | 8 | 4 |
| 6 | ..... | 77 | 118 | 91 | 154 | 110 | 2 | 4 |
| 9 | 109 | 94 | 117 | 98 | 109 | 105 | 3 | 5 |
| 12 | 124 | 92 | 110 | 111 | 115 | 110 | 1 | 5 |
| 15 | 102 | 87 | 97 | 101 | 118 | 101 | 7 | 5 |
| 18 | 96 | 102 | 99 | 128 | 85 | 102 | 5 | 5 |
| 21 | 101 | 94 | 87 | 93 | 105 | 96 | 9 | 5 |
| 24 | 95 | 139 | 89 | 101 | 101 | 105 | 4 | 5 |
| 27 | 92 | 114 | 81 | 107 | 80 | 95 | 10 | 5 |
| 30 | 103 | 122 | 87 | 102 | 92 | 101 | 6 | 5 |
| 33 | 89 | 100 | 98 | 105 | 51 | 89 | 11 | 5 |
| 36 | 90 | 93 | 89 | 94 | 69 | 87 | 12 | 5 |

The yields obtained in the series with 2 stalks to the hill are reported in Table 3. In general, the results of this series are similar to those secured in the series with 1 stalk to the hill, but the yields appear to be more erratic, as shown in Table 4, which gives the relative yields of lint.

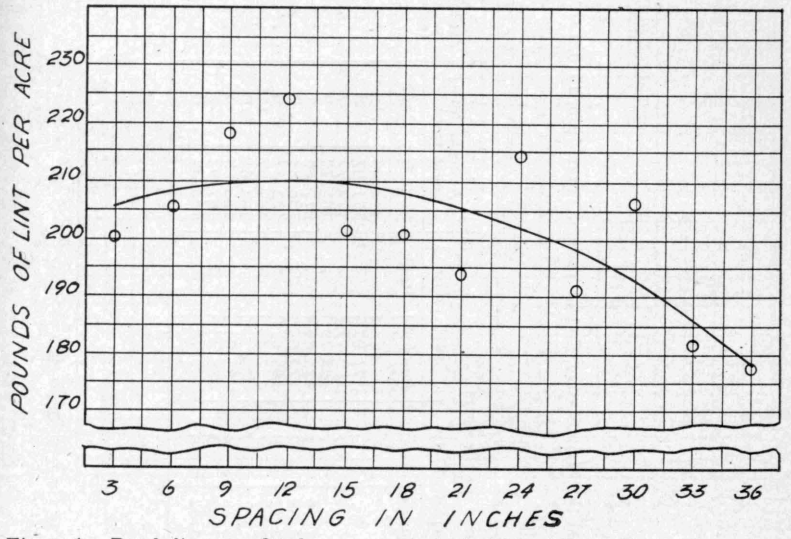


Figure 1. Parabolic curve fitted to average actual yields of lint cotton in the series with one stalk to the hill at College Station.

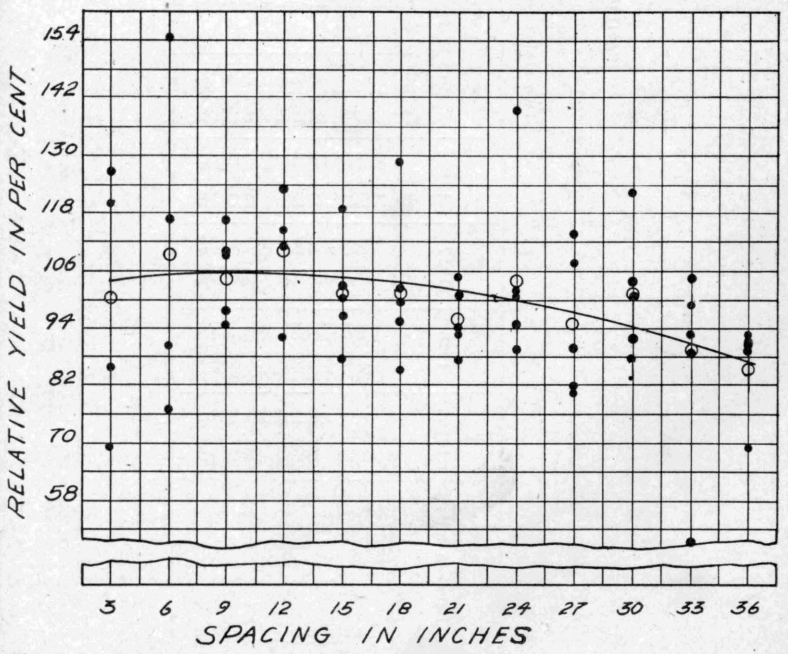


Figure 2. Relative yields of lint cotton (dots) in the series with one stalk to the hill at College Station and parabolic curve fitted to their averages (circles).

TABLE 3.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at the Main Station, College Station, Texas, 1915, 1916, 1917, and 1919.

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1916 | 1917 | 1919 | Average yield for the years | | | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1915-17-19 | | 1915-16-17-19 | | 1916-17-19 | | | | |
| | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | ..... | ..... | 114.99 | ..... | ..... | ..... | ..... | ..... | ..... | 114.99 | 12 | 1 |
| 6 | ..... | 347.88 | 34.53 | 133.52 | ..... | ..... | ..... | ..... | 171.97 | 4 | 171.97 | 8 | 3 |
| 9 | ..... | 370.92 | 35.04 | 112.35 | ..... | ..... | ..... | ..... | 172.77 | 3 | 172.77 | 7 | 3 |
| 12 | ..... | 346.83 | 41.93 | 108.62 | ..... | ..... | ..... | ..... | 165.79 | 6 | 165.79 | 9 | 3 |
| 15 | 333.26 | 354.42 | 61.18 | 119.80 | 171.41 | 1 | 217.16 | 1 | 178.46 | 2 | 217.16 | 1 | 4 |
| 18 | 250.41 | 325.88 | 91.08 | 120.16 | 153.88 | 6 | 196.88 | 2 | 179.04 | 1 | 196.88 | 2 | 4 |
| 21 | 231.05 | 298.73 | 68.39 | 130.51 | 143.31 | 7 | 182.17 | 6 | 165.87 | 5 | 182.17 | 6 | 4 |
| 24 | 209.43 | 279.81 | 79.04 | 83.60 | 124.02 | 8 | 162.97 | 7 | 147.48 | 9 | 162.97 | 11 | 4 |
| 27 | 268.65 | ..... | 81.79 | 140.49 | 163.64 | 3 | ..... | ..... | ..... | ..... | 163.64 | 10 | 3 |
| 30 | 277.23 | 264.33 | 83.51 | 117.28 | 159.34 | 5 | 185.58 | 4 | 155.04 | 8 | 185.58 | 4 | 4 |
| 33 | 255.68 | 269.50 | 93.83 | 132.67 | 160.72 | 4 | 187.92 | 3 | 165.33 | 7 | 187.92 | 3 | 4 |
| 36 | 310.95 | 238.92 | 81.79 | 101.64 | 164.79 | 2 | 183.32 | 5 | 140.78 | 10 | 183.32 | 5 | 4 |

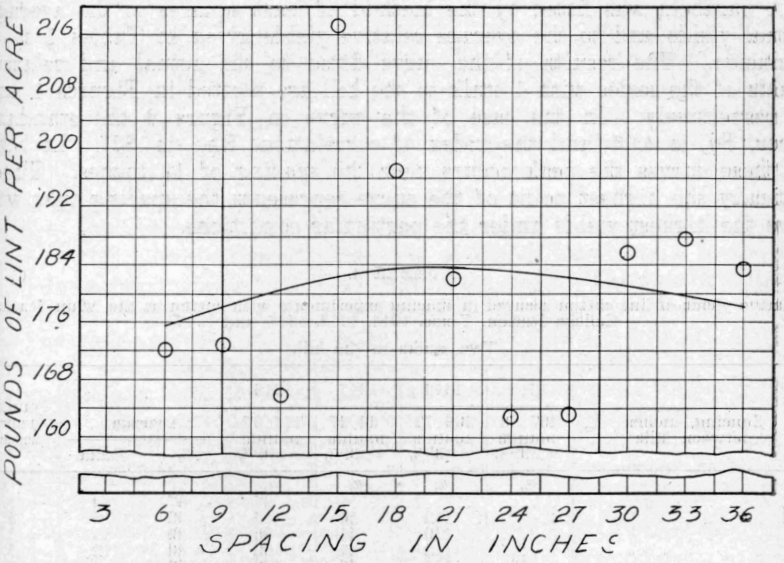


Figure 3. Parabolic curve fitted to the average actual yields (circles) of lint cotton in the series with two stalks to the hill at College Station.

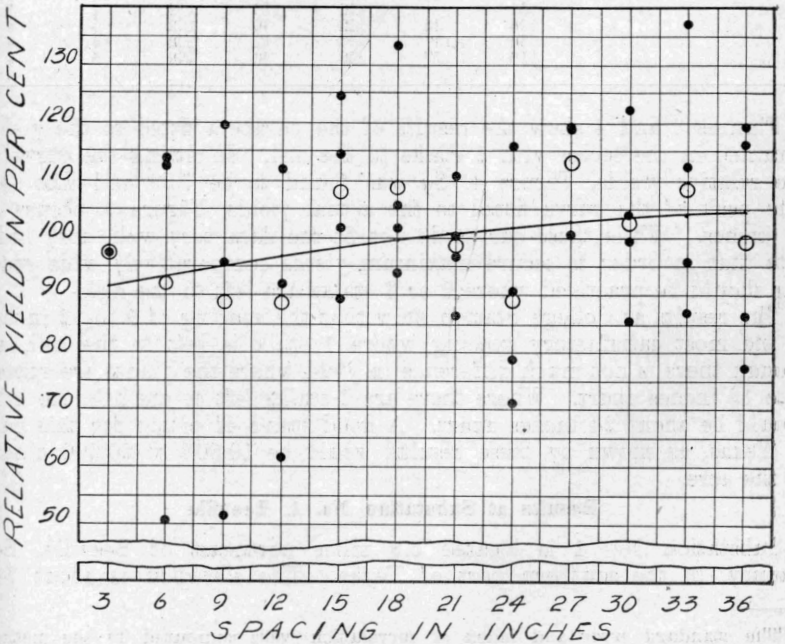


Figure 4. Relative yields of lint cotton (dots) obtained in the series with two stalks to the hill at College Station and parabolic curve fitted to their averages (circles).

A parabola was fitted by the method of least squares to the average actual yields and to the average relative yields given in Tables 1 to 4, inclusive. The results of the curve fitted to the actual and relative yields of the series with 1 stalk to the hill are plotted in Figures 1 and 2, respectively. In the case of the curve in Figure 2 the standard error, S*y*, is 4.05, and the index of correlation, Rho, is .82[1]. In both of these curves the peak occurs near the spacing of 12 inches. Theoretically the highest point of the curve represents the spacing that will give the highest yields under the particular conditions.

TABLE 4.

Relative yields of lint cotton secured in spacing experiments with cotton at the Main Station, College Station, Texas, 1915, 1916, 1917, and 1919.

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1916 | 1917 | 1919 | Average | | Number years tested |
|---|---|---|---|---|---|---|---|
| | 267.08 pounds =100% | 309.72 pounds =100% | 68.37 pounds =100% | 117.97 pounds =100% | % | Rank | |
| | % | % | % | % | | | |
| 3 | ..... | ..... | ..... | 97 | 97 | 8 | 1 |
| 6 | ..... | 112 | 50 | 113 | 92 | 9 | 3 |
| 9 | ..... | 120 | 51 | 95 | 89 | 11 | 3 |
| 12 | ..... | 112 | 61 | 92 | 88 | 12 | 3 |
| 15 | 125 | 114 | 89 | 102 | 108 | 4 | 4 |
| 18 | 94 | 105 | 133 | 102 | 108 | 2 | 4 |
| 21 | 87 | 96 | 100 | 111 | 98 | 7 | 4 |
| 24 | 78 | 90 | 116 | 71 | 89 | 10 | 4 |
| 27 | 101 | ..... | 120 | 119 | 113 | 1 | 3 |
| 30 | 104 | 85 | 122 | 99 | 102 | 5 | 4 |
| 33 | 96 | 87 | 137 | 112 | 108 | 3 | 4 |
| 36 | 116 | 77 | 120 | 86 | 100 | 6 | 4 |

Figures 3 and 4 show the results of the parabola fitted to the yields obtained in the series with 2 stalks to the hill. In fitting the curve to the relative yields, Figure 4, S*y* was found to be 7.29 and Rho .48. The peak of the curve fitted to the actual yields, Figure 3, occurs at 21 inches. While these curves do not fit the data very well, they indicate that in order to secure maximum yields comparatively wide spacing should be practiced where 2 or 3 stalks are left to the hill.

The results at College Station show that the spacing of 9 to 12 inches is the most satisfactory spacing where 1 stalk is left to the hill, although there is not much difference in yield where the plants are spaced 6 to 18 inches apart. Where there are 2 stalks left to the hill, the hills should be about 24 inches apart. A good stand of cotton for this part of Texas, as shown by these results, would be 10,000 to 20,000 plants to the acre.

### Results at Substation No. 1, Beeville

Substation No. 1 is located 5.6 miles northeast of Beeville, Bee County, in the southern part of Texas. The elevation is about 240

[1]The standard error and index of correlation were computed by the method given by Mills, *Statistical Methods*, pages 436-441.

feet above sea level. According to the weather records kept by the substation, the average yearly rainfall for the 30 years, 1896-1925, inclusive, was 29.03 inches. The soils on the substation farm belong to the Victoria series and are representative of the soils in the surrounding region. Victoria loam is the principal soil type on the farm. This soil is naturally productive and is fairly easy to cultivate. The topography is rolling enough to afford good drainage.

Spacing experiments with cotton have been conducted at Beeville since 1915. Two series of plats, one of which has 1 stalk to the hill, and the other 2 stalks to the hill have been used. The results obtained are given in Tables 5, 6, 7, and 8.

The yields secured in the series with 1 stalk to the hill are given in Table 5. In 1915 good yields were obtained, averaging a little more than half a bale to the acre, although the total rainfall was only 14.60 inches. The previous year, however, had 45.50 inches of rain. The 6-inch spacing produced the highest yield, 340 pounds of lint cotton, and the 33-inch spacing the lowest yield, 266 pounds of lint to the acre. The test was not conducted in 1916. The rainfall in 1916 was 18.50 inches. The cotton crop was practically a failure in 1917, since only 9.40 inches of rainfall were recorded.

In 1918 the yields were small, averaging 111 pounds of lint to the acre. There was too much rain in May, and practically no effective rainfall in July and August. The total rainfall for the year, however, was 30.83 inches. The 30-inch spacing made the highest yield, 145 pounds of lint, and the 3-inch spacing the lowest yield, 64 pounds of lint, to the acre.

Apparently the amount and distribution of rainfall were not conducive to large yields in 1919. There was a total precipitation of 48.76 inches. May, June, and July had 6.17, 3.93, and 5.69 inches, respectively. The largest yields resulted from medium to wide spacing and the smallest yields from the thickest spacings. Large yields were obtained in 1920, but apparently the spacing had little influence on yield. Low yields were obtained in 1922 and 1923. In 1922 the spacings ranging from 15 to 30 inches made the best yields.

In 1924 the 21-inch spacing made the largest yield, 211 pounds of lint to the acre. Fairly large yields were obtained in 1925. The average yield of all the spacings was 260 pounds of lint to the acre. The highest yield, 271 pounds of lint, was produced on the plats with the plants 18 inches apart. It appears, however, that spacing within the limits obtained had no appreciable influence on yield.

TABLE 5.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 1, Beeville, Texas, 1915, 1917, 1918, 1919, 1920, 1922, 1923, 1924, 1925.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1917 | 1918 | 1919 | 1920 | 1922 | 1923 | 1924 | 1925 | Average for | | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 1915-20-22-23-24-25 | All years tested | | |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank | |
| 3 | ..... | ..... | 64.38 | 60.06 | 323.78 | ..... | ..... | ..... | ..... | ..... | 149.40 | 9 | 3 |
| 6 | 340.34 | 85.31 | ..... | 84.70 | 275.00 | 45.81 | ..... | 171.18 | ..... | ..... | 167.05 | 8 | 6 |
| 9 | 320.32 | 132.06 | 110.55 | 73.69 | 372.32 | 73.55 | ..... | ..... | ..... | ..... | 180.38 | 6 | 6 |
| 12 | 326.98 | 81.41 | 102.82 | 140.78 | 391.95 | 79.02 | 170.50 | 209.04 | 248.86 | 237.72 | 194.59 | 2 | 9 |
| 15 | 273.58 | ..... | 121.82 | 142.54 | 355.74 | 97.76 | 155.83 | 167.96 | 256.77 | 217.94 | 196.50 | 1 | 8 |
| 18 | 273.58 | 70.70 | 128.16 | ..... | 279.51 | 98.77 | 176.00 | 199.60 | 271.04 | 216.41 | 187.17 | 5 | 8 |
| 21 | 266.92 | 99.73 | ..... | 103.49 | 330.97 | 89.27 | 169.46 | 211.75 | 257.00 | 220.89 | 191.07 | 4 | 8 |
| 24 | 266.92 | 96.22 | 114.64 | ..... | 272.18 | 93.81 | 71.50 | 178.75 | 267.65 | 191.80 | 170.20 | 7 | 8 |
| 27 | 270.27 | 83.75 | ..... | 108.88 | 374.11 | 110.93 | ..... | 201.07 | ..... | ..... | 191.50 | 3 | 6 |
| 30 | ..... | 49.47 | 145.29 | 121.06 | ..... | 104.06 | ..... | ..... | ..... | ..... | 104.97 | 11 | 4 |
| 33 | 266.88 | 79.08 | ..... | ..... | ..... | 78.87 | ..... | ..... | ..... | ..... | 141.61 | 10 | 3 |
| 36 | ..... | ..... | 101.41 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 101.41 | 12 | 1 |

TABLE 6.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 1, Beeville, Texas, 1915, 1917, 1918, 1919, 1920, 1922 1923, 1924, 1925.

One stalk to the hill.

| Spacing, inches between plants. | 1915 | 1917 | 1918 | 1919 | 1920 | 1922 | 1923 | 1924 | 1925 | Average | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 289.53 pounds =100% | 86.41 pounds =100% | 111.13 pounds =100% | 104.40 pounds =100% | 330.61 pounds =100% | 87.18 pounds =100% | 148.65 pounds =100% | 191.33 pounds =100% | 260.26 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | % | % | % | | | |
| 3 | ..... | ..... | 58 | 58 | 98 | ..... | ..... | ..... | ..... | 71 | 12 | 3 |
| 6 | 118 | 99 | ..... | 81 | 83 | 53 | ..... | 89 | ..... | 87 | 11 | 6 |
| 9 | 111 | 153 | 99 | 71 | 113 | 84 | ..... | ..... | ..... | 105 | 5 | 6 |
| 12 | 113 | 94 | 93 | 135 | 119 | 91 | 115 | 109 | 96 | 107 | 1 | 9 |
| 15 | 94 | ..... | 110 | 137 | 108 | 112 | 105 | 88 | 99 | 107 | 2 | 8 |
| 18 | 94 | 82 | 115 | ..... | 85 | 113 | 118 | 104 | 104 | 102 | 7 | 8 |
| 21 | 92 | 115 | ..... | 99 | 100 | 102 | 114 | 111 | 99 | 104 | 6 | 8 |
| 24 | 92 | 111 | 103 | ..... | 82 | 108 | 48 | 93 | 103 | 92 | 8 | 8 |
| 27 | 93 | 97 | ..... | 104 | 113 | 127 | ..... | 105 | ..... | 106 | 3 | 6 |
| 30 | ..... | 57 | 131 | 116 | ..... | 119 | ..... | ..... | ..... | 106 | 4 | 4 |
| 33 | 92 | 92 | ..... | ..... | ..... | 90 | ..... | ..... | ..... | 91 | 9 | 3 |
| 36 | ..... | ..... | 91 | ..... | ..... | ..... | ..... | ..... | ..... | 91 | 10 | 1 |

All of the spacings in the series with 1 stalk to the hill were not secured each year of the test. Nine of the 12 spacings were obtained in 1915, 1917, and 1920; 8, in 1918 and 1919; 10 in 1922; 7 in 1924; and 5 in 1923 and 1925. For this reason it is not possible to compare the average actual yields of all the spacings for the period on a fair basis. For the 6 years, 1915, 1920, 1922, 1923, 1924, and 1925, the 12-inch spacing made the highest average actual yield, 237 pounds of lint cotton. When compared on the basis of relative yields (Table 6), the 12-inch spacing also produced the highest average yield for the 9 years of the test.

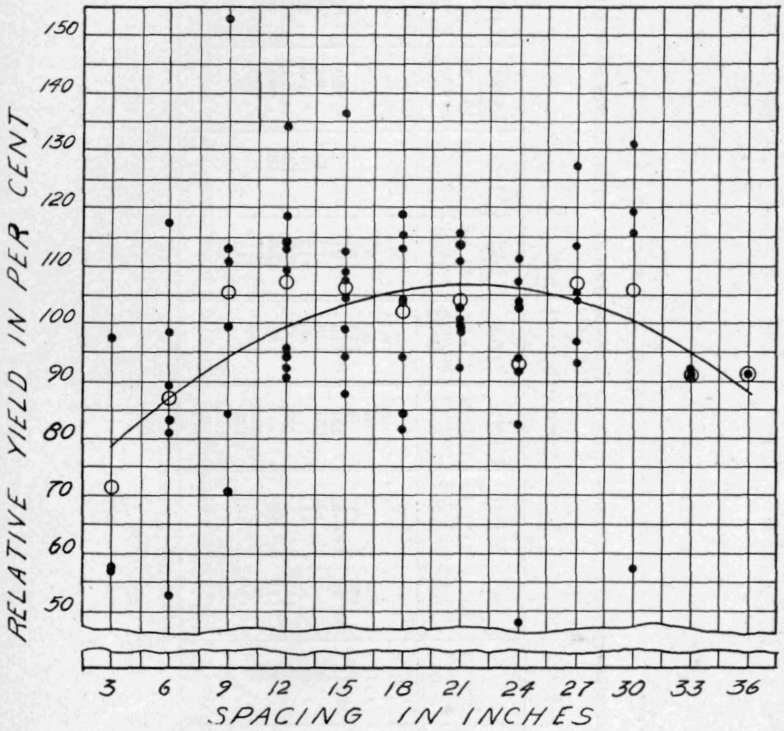


Figure 5. Relative yields of lint cotton (dots) in the series with one stalk to the hill at Beeville and parabolic curve fitted to their averages (circles).

Table 7 reports the yields of lint obtained in the series with 2 stalks to the hill at Beeville. All of the spacings were not obtained every year. In fact, they appeared rather irregularly. For this reason it was necessary to make averages for groups of years in which spacings occurred to study the yields of the several spacings on a comparable basis. For the 3 years, 1919, 1920, and 1922, the 24-inch spacing made the largest average yield, followed in order of yield by the 30-inch, 15-inch,

TABLE 7.

Acre yield in pounds of lint cotton secured with spacing experiments with cotton at Substation No. 1, Beeville, Texas, 1915, 1917, 1918, 1919, 1920, 1922, and 1923.

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1917 | 1918 | 1919 | 1920 | 1922 | 1923 | Average for the years | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1919-20-22 | | 1918-19 | | | | |
| | | | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | ..... | 106.44 | 55.04 | ..... | ..... | ..... | ..... | ..... | 80.74 | 8 | 80.74 | 12 | 2 |
| 6 | ..... | ..... | 106.33 | 95.86 | 300.00 | 55.28 | ..... | 150.38 | 8 | 101.09 | 7 | 139.36 | 11 | 4 |
| 9 | ..... | ..... | ..... | 104.58 | 296.04 | 58.78 | 144.37 | 153.13 | 7 | ..... | ..... | 150.94 | 10 | 4 |
| 12 | 293.62 | 53.36 | 197.54 | 80.28 | 430.00 | 65.29 | 168.43 | 191.85 | 6 | 138.91 | 1 | 184.07 | 7 | 7 |
| 15 | ..... | 82.58 | 125.37 | 103.96 | 463.12 | 71.90 | 190.20 | 212.99 | 3 | 114.66 | 5 | 172.85 | 8 | 6 |
| 18 | 266.92 | 81.71 | 142.39 | ..... | 570.68 | 85.93 | 176.45 | ..... | ..... | ..... | ..... | 220.68 | 2 | 6 |
| 21 | 275.81 | 83.75 | 169.40 | 105.64 | 437.61 | 81.58 | ..... | 208.27 | 4 | 137.52 | 2 | 192.29 | 5 | 6 |
| 24 | 253.56 | ..... | 145.78 | 87.70 | 607.81 | 92.81 | ..... | 262.77 | 1 | 116.74 | 4 | 237.53 | 1 | 5 |
| 27 | 253.56 | 76.94 | 162.43 | 97.14 | 490.75 | ..... | ..... | ..... | ..... | 129.78 | 3 | 216.16 | 3 | 5 |
| 30 | 253.56 | 92.93 | 165.02 | 50.69 | 497.70 | 91.56 | ..... | 213.31 | 2 | 107.85 | 6 | 191.91 | 6 | 6 |
| 33 | 242.45 | 73.63 | 228.88 | ..... | ..... | 73.43 | ..... | ..... | ..... | ..... | ..... | 154.59 | 9 | 4 |
| 36 | 200.20 | ..... | ..... | 82.34 | 431.75 | 86.01 | ..... | 200.03 | 5 | ..... | ..... | 200.07 | 4 | 4 |

and 21-inch spacings. The 24-inch spacing also made the highest average yield for all years tested. When the yields are considered on the basis of the relative yields, as given in Table 8, the 24-inch spacing again made the highest average yield.

TABLE 8.

**Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 1, Beeville, Texas, 1915, 1917, 1918, 1919, 1920, 1922, 1923.**

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1917 | 1918 | 1919 | 1920 | 1922 | 1923 | Average | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|---|
| | 254.96 pounds =100% | 77.84 pounds =100% | 154.95 pounds =100% | 86.32 pounds =100% | 452.54 pounds =100% | 76.25 pounds =100% | 169.86 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | % | | | |
| 3 | ..... | ..... | 69 | 64 | ..... | ..... | ..... | 66 | 12 | 2 |
| 6 | ..... | ..... | 69 | 111 | 66 | 72 | ..... | 80 | 11 | 4 |
| 9 | ..... | ..... | ..... | 121 | 65 | 77 | 85 | 87 | 10 | 4 |
| 12 | 115 | 69 | 127 | 93 | 95 | 86 | 99 | 98 | 8 | 7 |
| 15 | ..... | 106 | 81 | 120 | 102 | 94 | 112 | 102 | 6 | 6 |
| 18 | 105 | 105 | 92 | ..... | 126 | 113 | 104 | 108 | 4 | 6 |
| 21 | 108 | 108 | 109 | 122 | 97 | 107 | ..... | 108 | 2 | 6 |
| 24 | 99 | ..... | 94 | 102 | 134 | 122 | ..... | 110 | 1 | 5 |
| 27 | 99 | 99 | 105 | 113 | 108 | ..... | ..... | 105 | 5 | 5 |
| 30 | 99 | 119 | 106 | 59 | 110 | 120 | ..... | 102 | 7 | 6 |
| 33 | 95 | 95 | 148 | ..... | ..... | 96 | ..... | 108 | 3 | 4 |
| 36 | 79 | ..... | ..... | 95 | 95 | 113 | ..... | 96 | 9 | 4 |

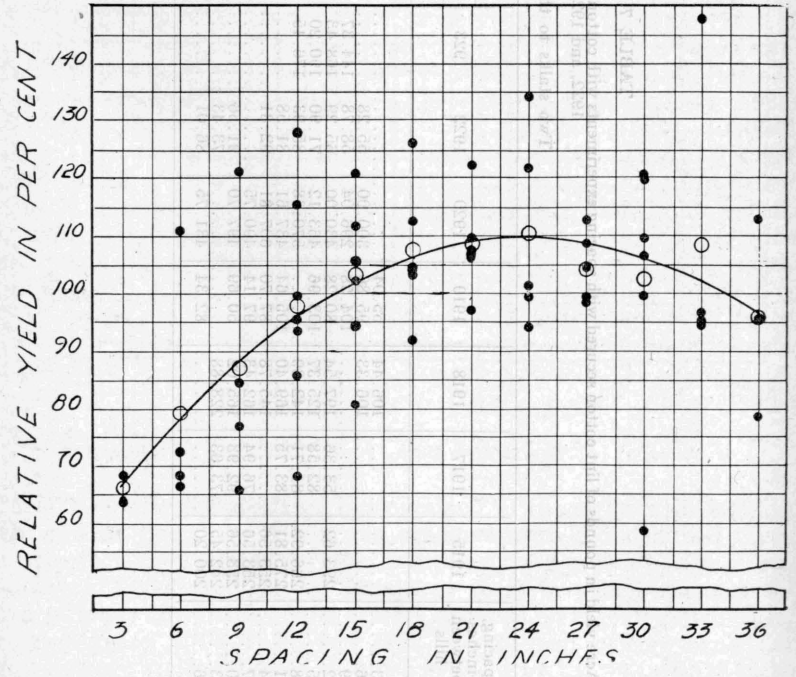


Figure 6. Relative yields of lint cotton (dots) in the series with two stalks to the hill at Beeville and parabolic curve fitted to their averages (circles).

By using the method of least squares, a parabola was fitted to the average relative yields in Tables 6 and 8 (Figures 5 and 6). In the case of Figure 5, S*y* was 6.47 and Rho was .79, while in Figure 6, S*y* was 2.62 and Rho was .97. In both cases the peak of the curve occurs near 21 inches. Considered on the basis of these curves, the spacings ranging from 15 to 27 inches, inclusive, have made the most satisfactory yields. These distances are recommended under the condition in the region of Beeville. With such spacings, there would be about 6,500 to 12,000 plants to the acre. While this range in spacing is rather wide, it appears that the cotton plant can adjust itself to produce satisfactory yields within this range of spacing.

### Results at Substation No. 2, Troup

Substation No. 2 is located at Troup, Smith County, in northeastern Texas. The altitude is 467 feet. The average annual rainfall for the 21 years, 1905 to 1925, inclusive, was 42.48 inches. The rainfall is well distributed throughout the year. The soil on the substation farm is a gray sandy loam, classed by the Bureau of Soils, U. S. Department of Agriculture, as Susquehanna fine sandy loam. This soil is representative of large areas in northeastern Texas.

Spacing work with cotton was carried on at Troup only 3 years, 1915, 1917, and 1918. Two series of plats were included in the experiment, one with 1 stalk to the hill, the other with 2 stalks to the hill, at the various distances. Cotton of the Mebane variety, Texas Station No. 804, was used in the experiment. The results obtained are reported in Tables 9, 10, 11, and 12.

Table 9 gives the yield in pounds of lint to the acre secured in the series with 1 stalk to the hill. Only five spacings, 9, 15, 18, 21, and 27 inches were obtained each of the three years. Of these the 27-inch spacing produced the largest average yield of lint for the period, followed in order of yield by the 21-inch spacing. It will be observed that the largest yields each year were produced by the medium or wide spacings, although 1915 was a wet year and 1917 and 1918 were dry years. The yields of lint in Table 9 were converted into relative yields, which are given in Table 10. When compared in this manner, the 27-inch spacing produced the highest average yield.

TABLE 9.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 2, Troup, Texas, 1915, 1917, 1918.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1917 | 1918 | Average acre yield in pounds of lint for the years | | | | | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1915-17-18 | | 1917-1918 | | 1915-1917 | | 1915-1918 | | | | |
| | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | 174.14 | | | | | | | | | | | 174.14 | 11 | 1 |
| 6 | | 188.24 | 143.49 | | | 165.86 | 6 | | | | | 165.86 | 12 | 2 |
| 9 | 226.38 | 170.93 | 183.86 | 193.72 | 3 | 177.39 | 4 | 198.65 | 4 | 205.12 | 6 | 193.72 | 8 | 3 |
| 12 | | 189.47 | 199.32 | | | 194.39 | 3 | | | | | 194.39 | 7 | 2 |
| 15 | 258.14 | 111.71 | 198.77 | 189.54 | 4 | 155.24 | 7 | 184.92 | 5 | 228.45 | 3 | 189.54 | 9 | 3 |
| 18 | 203.48 | 164.17 | 183.04 | 183.56 | 5 | 173.60 | 5 | 183.82 | 6 | 193.26 | 7 | 183.56 | 10 | 3 |
| 21 | 225.36 | 192.87 | 210.21 | 209.48 | 2 | 201.54 | 2 | 209.11 | 3 | 217.78 | 5 | 209.48 | 5 | 3 |
| 24 | 221.26 | | 219.06 | | | | | | | 220.16 | 4 | 220.16 | 4 | 2 |
| 27 | 278.63 | 244.41 | 229.57 | 250.87 | 1 | 236.99 | 1 | 261.52 | 1 | 254.10 | 1 | 250.87 | 1 | 3 |
| 30 | 264.28 | | 237.16 | | | | | | | 250.72 | 2 | 250.72 | 2 | 2 |
| 33 | 270.43 | 169.93 | | | | | | 220.18 | 2 | | | 220.18 | 3 | 2 |
| 36 | | | 202.73 | | | | | | | | | 202.73 | 6 | 1 |

TABLE 10.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 2, Troup, Texas, 1915, 1917, 1918.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1917 | 1918 | Average | | No. years tested |
|---|---|---|---|---|---|---|
| | 235.78 pounds =100% | 178.96 pounds =100% | 200.72 pounds =100% | % | Rank | |
| | % | % | % | | | |
| 3 | 74 | ..... | ..... | 74 | 12 | 1 |
| 6 | ..... | 105 | 71 | 88 | 11 | 2 |
| 9 | 96 | 96 | 92 | 95 | 8 | 3 |
| 12 | ..... | 106 | 99 | 102 | 5 | 2 |
| 15 | 109 | 62 | 99 | 90 | 9 | 3 |
| 18 | 86 | 92 | 91 | 90 | 10 | 3 |
| 21 | 96 | 108 | 105 | 103 | 4 | 3 |
| 24 | 94 | ..... | 109 | 102 | 6 | 2 |
| 27 | 118 | 137 | 114 | 123 | 1 | 3 |
| 30 | 112 | ..... | 118 | 115 | 2 | 2 |
| 33 | 115 | 95 | ..... | 105 | 3 | 2 |
| 36 | ..... | ..... | 101 | 101 | 7 | 1 |

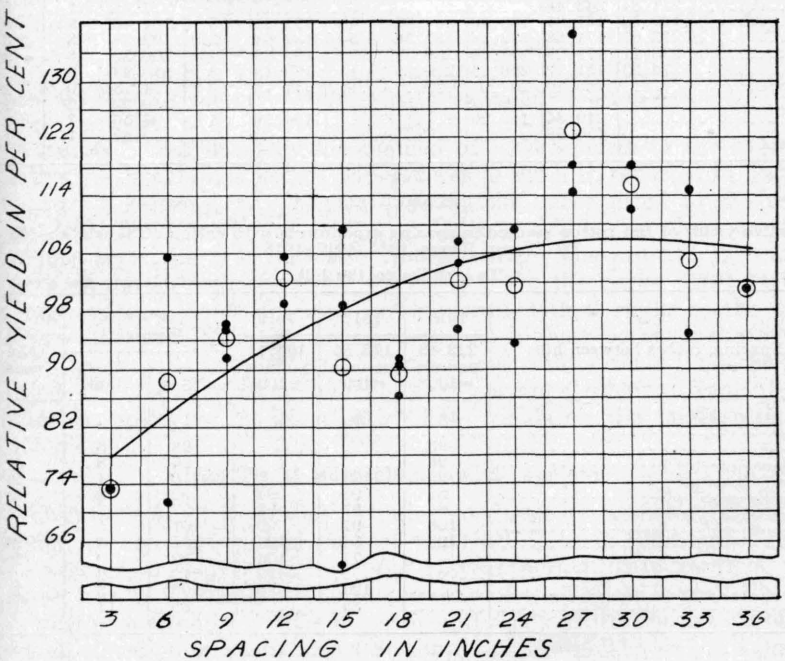


Figure 7. Relative yields of lint cotton (dots) in the series with one stalk to the hill at Troup and parabolic curve fitted to their averages (circles).

The results obtained in the series containing 2 stalks to the hill are given in Tables 11 and 12. Only four spacings, 15, 18, 21, and 24 inches, were obtained each year. Of these, the 24-inch spacing pro-

duced the highest average yield for the three years. The yield decreased as the distance between the plants decreased. For the 2 years, 1917 and 1918, the 33-inch spacing gave the highest, and the 27-inch the lowest average yield. When compared on the basis of average relative yield for all years tested, Table 12, the spacing of 12 inches produced the highest, and the 36-inch spacing the lowest, yield for the three years.

TABLE 11.

**Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 2, Troup, Texas, 1915, 1917, 1918.**

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1917 | 1918 | Average acre yield for the years | | | | Average all years tested | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1915–17–18 | | 1917–18 | | | | |
| | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 6 | 218.51 | ..... | ..... | ..... | ..... | ..... | ..... | 218.51 | 3 | 1 |
| 9 | 213.58 | ..... | ..... | ..... | ..... | ..... | ..... | 213.58 | 4 | 1 |
| 12 | 211.84 | 243.48 | ..... | ..... | ..... | ..... | ..... | 227.66 | 1 | 2 |
| 15 | 192.58 | 167.87 | 183.86 | 181.43 | 4 | 175.86 | 5 | 181.43 | 9 | 3 |
| 18 | 213.07 | 171.58 | 192.44 | 192.36 | 3 | 182.01 | 3 | 192.36 | 8 | 3 |
| 21 | 236.11 | 171.27 | 193.60 | 200.32 | 2 | 182.43 | 2 | 200.32 | 6 | 3 |
| 24 | 274.53 | 151.52 | 206.75 | 210.93 | 1 | 179.13 | 4 | 210.93 | 5 | 3 |
| 27 | ..... | 136.40 | 207.07 | ..... | ..... | 171.73 | 6 | 171.73 | 10 | 2 |
| 30 | ..... | ..... | 219.92 | ..... | ..... | ..... | ..... | 219.92 | 2 | 1 |
| 33 | ..... | 219.84 | 169.29 | ..... | ..... | 194.56 | 1 | 194.56 | 7 | 2 |
| 36 | ..... | 150.59 | ..... | ..... | ..... | ..... | ..... | 150.59 | 11 | 1 |

TABLE 12.

**Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 2, Troup, Texas, 1915, 1917, 1918.**

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1917 | 1918 | Average | | No. year |
|---|---|---|---|---|---|---|
| | 222.88 pounds =100% | 176.56 pounds =100% | 196.13 pounds =100% | % | Rank | |
| | % | % | % | | | |
| 3 | ..... | ..... | ..... | ..... | ..... | ..... |
| 6 | 98 | ..... | ..... | 98 | 6 | 1 |
| 9 | 96 | ..... | ..... | 96 | 8 | 1 |
| 12 | 95 | 138 | ..... | 116 | 1 | 2 |
| 15 | 86 | 95 | 94 | 92 | 9 | 3 |
| 18 | 96 | 97 | 98 | 97 | 7 | 3 |
| 21 | 106 | 97 | 99 | 101 | 5 | 3 |
| 24 | 123 | 86 | 105 | 105 | 4 | 3 |
| 27 | ..... | 77 | 106 | 92 | 10 | 2 |
| 30 | ..... | ..... | 112 | 112 | 2 | 1 |
| 33 | ..... | 125 | 86 | 106 | 3 | 2 |
| 36 | ..... | 85 | ..... | 85 | 11 | 1 |

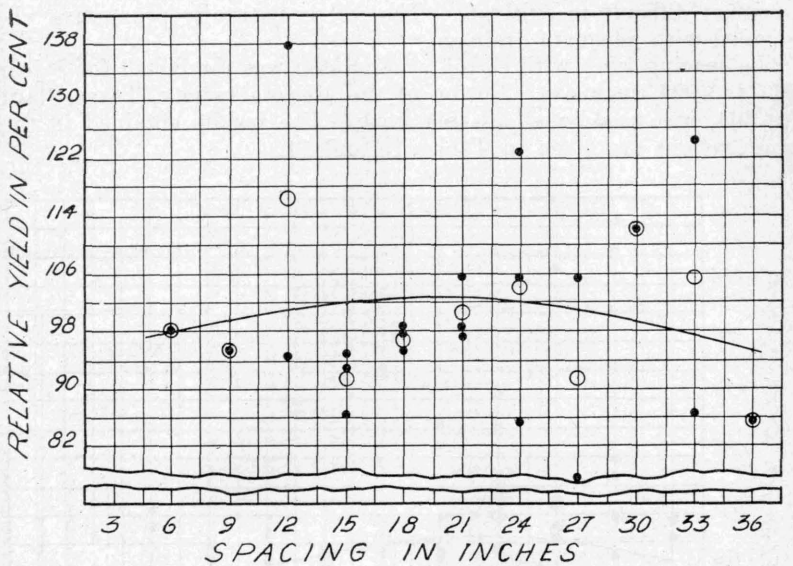


Figure 8. Relative yields of lint cotton (dots) in the series with two stalks to the hill at Troup and parabolic curve fitted to their averages (circles).

A parabola was fitted by the method of least squares to the average relative yields obtained with 1 and 2 stalks to the hill, reported in Tables 10 and 12, respectively. Figure 7 shows the curve fitted to the relative yields from the series with 1 stalk to the hill. In this case the standard error, S*y*, was 7.61 and Rho was .78. The peak of the curve occurs at the 30-inch spacing. Figure 8 gives the curve fitted to the average relative yields obtained in the series with 2 stalks to the hill. S*y* was 8.58 and Rho .47. In this case the highest point of the curve occurs at the 18-inch spacing. While these results should not be regarded as conclusive, they indicate that spacings ranging from 18 to 36 inches, will give the most satisfactory yields on the sandy soils of the region.

**Results at Substation No. 3, Angleton**

Substation No. 3 is located 3½ miles northeast of Angleton, Brazoria County, in the east central part of the Gulf Coastal Plains of Texas. The average annual rainfall for the 12-year period, 1914 to 1925, inclusive, was 47.76 inches. The topography of the region is prevailingly flat with poor drainage. The experimental fields of the substation farm have an elevation of about 22.5 feet above sea level. The soil is a dark-brown to black clay with a dark-gray or gray subsoil. It is classed as Victoria clay by the Bureau of Soils, U. S. Department of Agriculture. This soil is perhaps the most extensive soil type in the Gulf Coastal Plains of Texas. It is rather stiff and intractable in nature and is

somewhat difficult to cultivate. The soil is naturally productive when provided with adequate drainage.

The spacing work with cotton at Angleton was conducted for 8 years, 1917 to 1924, inclusive. Cotton of the Mebane variety, Texas Station No. 804, was used in all of this work. The results obtained in these investigations are given in Tables 13 and 14.

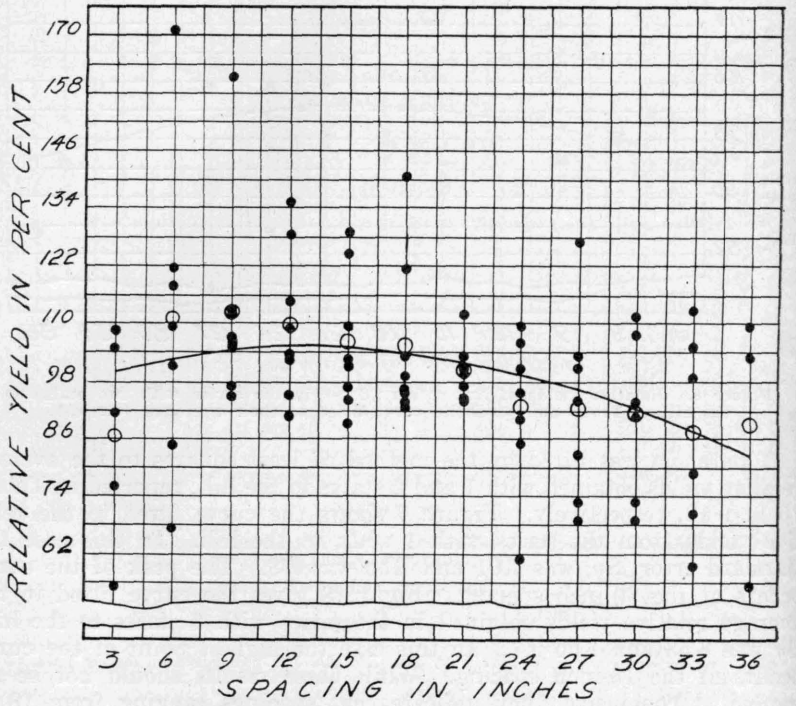


Figure 9. Relative yields of lint cotton (dots) at Angleton and parabolic curve fitted to their averages (circles).

The yields in pounds of lint to the acre are given in Table 13. Only four rates of thinning, 9, 12, 15, and 18 inches, were secured every year of the test. The average yields of these spacings were practically identical for the 8 years, 1917 to 1924, inclusive. For the 5 years, 1918, 1921, 1922, 1923, and 1924, the 6-inch spacing produced the highest, and the 3-inch spacing the lowest, average yield. The 12-inch spacing made the highest average yield, 224 pounds of lint to the acre, for the 6 years, 1917, 1919, 1920, 1922, 1923, and 1924, although the yields of the 9-inch, 15-inch, and 18-inch spacings were about as large. It appears that the character of the season did not have much influence on the relative rank in yield of the different spacings. For instance, 1917 and 1918 were dry years and the spacings ranging from 3 to 18

TABLE 13.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 3, Angleton, Texas, 1917 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | Average yield for the years | | | | | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 1917-24 incl. | 1918-21-22-23-24 | 1917-19-20-22-23-24 | | 1922-23-24 | | |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | 282.38 | ..... | ..... | 40.81 | 134.68 | 43.16 | 294.03 | ..... | 159.01 | ..... | .... | 157.29 | 12 | 5 |
| 6 | 299.20 | 330.40 | ..... | 396.08 | 51.31 | 151.64 | 67.89 | 323.84 | ..... | 185.01 | ..... | .... | 181.12 | 8 | 7 |
| 9 | 290.40 | 284.21 | 138.77 | 358.13 | 84.59 | 171.22 | 64.30 | 311.30 | 212.86 | 183.12 | 222.35 | 2 | 182.27 | 4 | 8 |
| 12 | 313.13 | 293.02 | 165.88 | 319.80 | 77.59 | 163.94 | 50.92 | 330.35 | 214.32 | 183.16 | 224.00 | 1 | 181.73 | 6 | 8 |
| 15 | 297.00 | 276.11 | 158.02 | 325.62 | 94.49 | 160.07 | 40.92 | 301.13 | 206.67 | 174.54 | 213.79 | 4 | 167.37 | 11 | 8 |
| 18 | 333.85 | 250.25 | 127.20 | 323.83 | 106.85 | 178.26 | 38.30 | 297.08 | 206.95 | 174.14 | 216.42 | 3 | 171.21 | 10 | 8 |
| 21 | 266.20 | 269.30 | 137.20 | 346.36 | ..... | 168.43 | 37.66 | 319.99 | ..... | ..... | 212.64 | 5 | 175.36 | 9 | 7 |
| 24 | 289.85 | 230.17 | 118.38 | 302.39 | ..... | 196.83 | 24.15 | 322.43 | ..... | ..... | 209.00 | 6 | 181.13 | 7 | 7 |
| 27 | 187.00 | 223.15 | 88.81 | 337.98 | ..... | 227.94 | 37.20 | 330.02 | ..... | ..... | 201.49 | 8 | 198.38 | 1 | 7 |
| 30 | 248.60 | ..... | 89.12 | 315.30 | ..... | 199.05 | 27.08 | 343.53 | ..... | ..... | 203.78 | 7 | 189.88 | 2 | 6 |
| 33 | 214.50 | ..... | 82.30 | 331.14 | ..... | 201.98 | 23.60 | 334.55 | ..... | ..... | 198.01 | 9 | 186.71 | 3 | 6 |
| 36 | ..... | ..... | ..... | ..... | ..... | 195.27 | 21.80 | 328.94 | ..... | ..... | ..... | .... | 182.00 | 5 | 3 |

TABLE 14.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 3, Angleton, Texas, 1917 to 1924, inclusive.

One stalk to the hill..

| Spacing, inches between plants | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | Average | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 273.97 pounds =100% | 270.99 pounds =100% | 122.85 pounds =100% | 335.66 pounds =100% | 75.94 pounds =100% | 179.10 pounds =100% | 39.74 pounds =100% | 319.76 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | % | % | | | |
| 3 | ..... | 104 | ..... | ..... | 54 | 75 | 109 | 92 | 87 | 12 | 5 |
| 6 | 109 | 122 | ..... | 118 | 68 | 85 | 171 | 101 | 111 | 2 | 7 |
| 9 | 106 | 105 | 113 | 107 | 111 | 96 | 162 | 97 | 112 | 1 | 8 |
| 12 | 114 | 108 | 135 | 95 | 102 | 92 | 128 | 103 | 110 | 3 | 8 |
| 15 | 108 | 102 | 129 | 97 | 124 | 89 | 103 | 94 | 106 | 4 | 8 |
| 18 | 122 | 92 | 104 | 96 | 141 | 100 | 96 | 93 | 106 | 5 | 8 |
| 21 | 97 | 99 | 112 | 103 | ..... | 94 | 95 | 100 | 100 | 6 | 7 |
| 24 | 106 | 85 | 96 | 90 | ..... | 110 | 61 | 101 | 93 | 7 | 7 |
| 27 | 68 | 82 | 72 | 101 | ..... | 127 | 94 | 103 | 92 | 8 | 7 |
| 30 | 91 | ..... | 73 | 94 | ..... | 111 | 68 | 107 | 91 | 9 | 6 |
| 33 | 78 | ..... | 70 | 99 | ..... | 113 | 59 | 105 | 87 | 11 | 6 |
| 36 | ..... | ..... | ..... | ..... | ..... | 109 | 55 | 103 | 89 | 10 | 3 |

inches made the best yields, while in 1919 and 1920, both of which were years of heavy rainfall, similar results were obtained. In 1922 the yields increased roughly as the distance between plants increased up to 27 inches. In 1923 the largest yields were obtained from the closer spacings, while in 1924, which was a favorable year for cotton production, good yields were obtained throughout the range of spacing.

The yields of lint in Table 13 were converted to relative yields, which are reported in Table 14. When compared on the basis of relative yields, the spacing of 9 inches made the highest average yield for the entire period of the experiment. Apparently there were no significant differences between the average relative yield of the 9-inch spacing and the average relative yields of the 6-inch, 12-inch, 15-inch, and 18-inch spacings.

A parabola was fitted by the method of least squares to the average relative yields in Table 14, the results of which are plotted in Figure 9. The standard error, $Sy$, was 6.17 and the index of correlation, Rho, was .74. The peak of the curve occurs at the 12-inch spacing, which is in agreement with the average actual yields. These results show that in the humid part of the Gulf Coastal plains of Texas the plants should be spaced about 12 inches apart in rows of ordinary width, or in such a manner as to allow about 15,000 plants to the acre. The distance between plants, however, may vary from 6 to 18 inches, making it possible to have 10,000 to 29,000 plants to the acre, without significant decrease in yield.

### Results at Substation No. 5, Temple

Substation No. 5 is located 5 miles west of Temple, Bell County, in the blackland belt of Texas. The altitude is 740 feet. The average yearly rainfall at the substation for the 13 years, 1913 to 1924, inclusive, was 35.99 inches. The average annual precipitation at the city of Temple for the 36 years, 1890 to 1925, inclusive, was 33.76 inches according to the records of the U. S. Weather Bureau. The soils on the substation farm are dark-brown to black clays belonging to the Simmons and Abilene series. Both of these are good cotton soils.

The spacing work with cotton was conducted at Temple from 1915 to 1921, inclusive, yields being secured every year. Two series of plats have been carried, one with 1 stalk to the hill, the other with 2 stalks to the hill, at the various distances. Lone Star cotton, Texas Station No. 1383, was used in these tests from 1915 to 1919, inclusive, and Belton cotton in 1920 and 1921. Tables 15, 16, 17, and 18 give the results obtained.

The yields of lint cotton secured in the series with 1 stalk to the hill appear in Table 15. In 1915, about the average amount of rainfall, 34.26 inches, occurred at Temple. The largest yield was produced by the 6-inch spacing, but in general the wider spacings, 21 to 33 inches, made larger yields than closer spacing. There were 26.27 inches of rainfall in 1916, which was well distributed during the growing season,

TABLE 15.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 5, Temple, Texas, 1915 to 1921, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | Average yield for the years | | | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1915-1921 inclusive | | 1915-17-19-20-21 | | 1915-17-18-19-20-21 | | | | |
| | | | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | 113.43 | ..... | 163.89 | ..... | 237.05 | 696.02 | 225.75 | ..... | ..... | 287.22 | 12 | ..... | ..... | 287.22 | 9 | 5 |
| 6 | 284.62 | ..... | 162.36 | ..... | 219.26 | 619.66 | 207.39 | ..... | ..... | 298.65 | 10 | ..... | ..... | 298.65 | 4 | 5 |
| 9 | 196.96 | ..... | 153.86 | ..... | 258.19 | 599.78 | 283.63 | ..... | ..... | 298.48 | 11 | ..... | ..... | 298.48 | 5 | 5 |
| 12 | 193.87 | 385.94 | 143.08 | 70.21 | 243.24 | 744.70 | 254.85 | 290.84 | 5 | 315.94 | 8 | 274.99 | 8 | 290.84 | 7 | 7 |
| 15 | 196.96 | 326.89 | 162.86 | 79.77 | 205.08 | 747.97 | 267.41 | 283.84 | 7 | 316.05 | 7 | 276.67 | 7 | 283.84 | 11 | 7 |
| 18 | 185.62 | 408.88 | 176.62 | 77.62 | 235.43 | 799.99 | 287.20 | 310.19 | 1 | 336.97 | 4 | 293.74 | 4 | 310.19 | 1 | 7 |
| 21 | 212.43 | ..... | 177.67 | 77.87 | 184.85 | 807.93 | 263.84 | ..... | ..... | 329.34 | 6 | 287.43 | 6 | 287.43 | 8 | 6 |
| 24 | 243.37 | 325.87 | 187.11 | 90.30 | 234.09 | 771.93 | 250.71 | 300.48 | 3 | 337.44 | 3 | 296.25 | 3 | 300.48 | 3 | 7 |
| 27 | 226.87 | 240.27 | 159.35 | 76.33 | 264.77 | 779.44 | 243.60 | 284.37 | 6 | 334.80 | 5 | 291.72 | 5 | 284.37 | 10 | 7 |
| 30 | 246.46 | 264.00 | 150.17 | 68.22 | 235.12 | 825.88 | 266.73 | 293.79 | 4 | 344.87 | 2 | 298.76 | 2 | 293.79 | 6 | 7 |
| 33 | 232.03 | 266.06 | 146.09 | 94.27 | 218.88 | 919.95 | 262.09 | 305.62 | 2 | 355.80 | 1 | 312.21 | 1 | 305.62 | 2 | 7 |
| 36 | 168.09 | 167.06 | 168.91 | 80.65 | 199.41 | 774.67 | 235.74 | 256.36 | 8 | 309.36 | 9 | 271.24 | 9 | 256.36 | 12 | 7 |

and fairly large yields were produced. The largest yield, 408 pounds of lint to the acre, resulted from the 18-inch spacing.

The season of 1917 was unusually dry; only 20.75 inches of rainfall were reported, although it was well distributed in May, June, July, and August. Medium spacing of the plants gave best results. In 1918, 29.36 inches of rainfall were recorded at the substation. This was not well distributed, since no rain fell in July and only .07 inches in August. As a result, very low yields were secured. By referring to the yields obtained in 1918, Table 15, one will see that there was no appreciable effect of spacing on yield.

In 1919, 47.45 inches of rain occurred. Fairly good yields were obtained. Apparently, the rate of thinning did not have much influence on yield, since relative yields above the average occurred throughout the range of spacing. The season of 1920, with 44.73 inches of rainfall, was unusually favorable for cotton production in the blackland belt of Texas. The lowest yield was 599 pounds of lint to the acre from the 9-inch spacing, and the highest yield, 920 pounds, from the 33-inch spacing. The spacings, 18 to 36 inches, produced larger yields than the closer spacings. In 1921, the yields obtained were smaller than the average for the 7-year period. It appears that the rate of thinning had no consistent relation to the yields obtained, although the two closest spacings made the lowest yields.

Only eight of the twelve rates of thinning were obtained every year of the test. Of these eight, the spacing of 18 inches made the highest average yield, 310 pounds of lint to the acre. All of the spacings were obtained in each of the five years, 1915, 1917, 1919, 1920, and 1921. During this period the spacing of 33 inches made the highest average yield, and in general the yield declined as the distance between plants increased or decreased from 33 inches. The high average yield of the 33-inch spacing was due to the exceptionally high yield of 920 pounds of lint of this spacing in 1920.

TABLE 16.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 5 Temple, Texas, 1915 to 1921, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | Average | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|---|
| | 208.39 pounds =100% | 298.12 pounds =100% | 162.66 pounds =100% | 79.47 pounds =100% | 227.94 pounds =100% | 757.32 pounds =100% | 254.08 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | % | | | |
| 3 | 54 | ..... | 101 | ..... | 104 | 92 | 89 | 88 | 12 | 5 |
| 6 | 137 | ..... | 100 | ..... | 96 | 82 | 82 | 99 | 9 | 5 |
| 9 | 95 | ..... | 95 | ..... | 113 | 79 | 112 | 99 | 10 | 5 |
| 12 | 93 | 129 | 88 | 88 | 107 | 98 | 100 | 100 | 4 | 7 |
| 15 | 95 | 110 | 100 | 100 | 90 | 99 | 105 | 100 | 7 | 7 |
| 18 | 89 | 137 | 109 | 98 | 103 | 106 | 113 | 108 | 2 | 7 |
| 21 | 102 | ..... | 109 | 98 | 81 | 107 | 104 | 100 | 6 | 6 |
| 24 | 117 | 109 | 115 | 114 | 103 | 102 | 99 | 108 | 1 | 7 |
| 27 | 109 | 81 | 98 | 96 | 116 | 103 | 96 | 100 | 8 | 7 |
| 30 | 118 | 89 | 92 | 86 | 103 | 109 | 105 | 100 | 5 | 7 |
| 33 | 111 | 89 | 90 | 119 | 96 | 121 | 103 | 104 | 3 | 7 |
| 36 | 81 | 56 | 104 | 101 | 87 | 102 | 93 | 89 | 11 | 7 |

The actual yields of lint reported in Table 15 were converted into relative yields, which are given in Table 16. The 24-inch spacing produced the highest average relative yield for the seven years of the test, although the yield of the 18-inch spacing was about as large.

The yield of the series with 2 stalks to the hill appear in Table 17. In 1915, the largest yields were produced in the spacings ranging from 9 to 24 inches, while in 1916 the wider spacings gave the best results. The largest yields in 1917 were produced by the closer spacings. In both 1919 and 1920 the spacings ranging from 15 to 33 inches gave the largest yields.

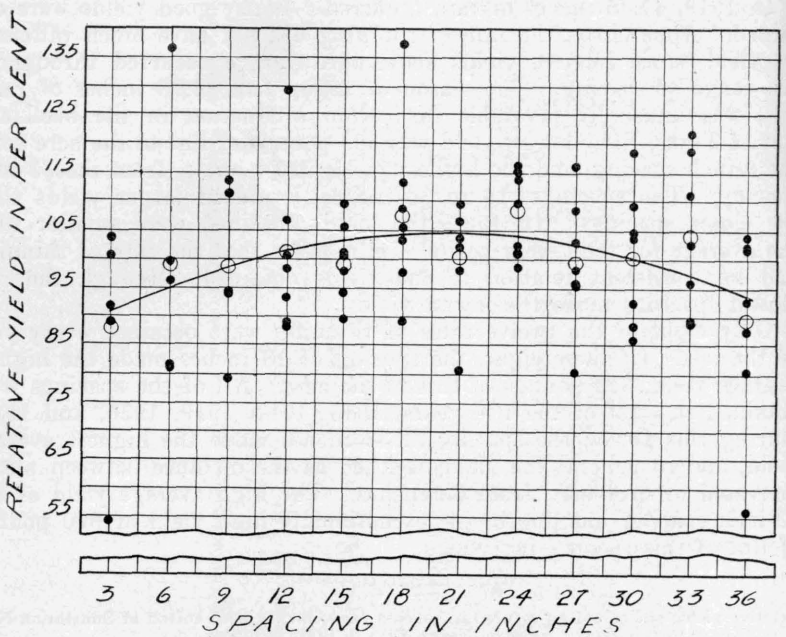


Figure 10. Relative yields of lint cotton (dots) in the series with one stalk to the hill at Temple and parabolic curve fitted to their averages (circles).

For the entire period of the test, 1915-1920, inclusive, nine rates of thinning with 2 stalks to the hill occurred each year. Of these, the 30-inch spacing made the highest average yield, 329 pounds of lint to the acre, followed in order of yield by the 21-inch, 27-inch, and 18-inch spacings. The yields of lint were converted to relative yields, which appear in Table 18. When compared on the basis of relative yields, the 18-inch and 21-inch spacings made the highest yields.

TABLE 17.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 5, Temple, Texas, 1915 to 1920, inclusive.

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | Average yield for the years | | | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1915-1920, inclusive | | 1917-19-20 | | 1915-16-17-19-20 | | | | |
| | | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | 210.37 | 149.14 | ..... | 180.98 | 706.66 | ..... | ..... | 345.59 | 12 | ..... | ..... | 311.78 | 9 | 4 |
| 6 | ..... | ..... | 196.35 | ..... | 206.12 | 662.92 | ..... | ..... | 355.13 | 11 | ..... | ..... | 355.13 | 1 | 3 |
| 9 | 221.71 | 250.59 | 209.03 | ..... | 321.75 | 708.25 | ..... | ..... | 413.01 | 9 | 342.26 | 10 | 342.26 | 2 | 5 |
| 12 | 234.09 | 264.51 | 181.65 | 68.13 | 322.25 | 748.91 | 303.25 | 8 | 417.60 | 8 | 350.28 | 8 | 303.25 | 11 | 6 |
| 15 | 235.12 | 296.99 | 201.42 | 73.22 | 354.62 | 736.43 | 316.30 | 6 | 430.82 | 2 | 364.91 | 5 | 316.30 | 8 | 6 |
| 18 | 225.84 | 366.09 | 189.20 | 68.96 | 401.28 | 670.26 | 320.27 | 4 | 420.24 | 7 | 370.53 | 4 | 320.27 | 6 | 6 |
| 21 | 232.03 | 382.84 | 141.06 | 72.02 | 450.39 | 683.93 | 327.04 | 2 | 425.12 | 3 | 378.05 | 2 | 327.04 | 4 | 6 |
| 24 | 220.68 | 387.75 | 122.75 | 81.37 | 413.65 | 592.87 | 303.17 | 9 | 376.42 | 10 | 347.54 | 9 | 303.17 | 12 | 6 |
| 27 | 200.06 | 408.37 | 145.68 | 56.36 | 401.54 | 724.82 | 322.80 | 3 | 424.01 | 4 | 376.09 | 3 | 322.80 | 5 | 6 |
| 30 | 176.34 | 377.43 | 115.13 | 60.53 | 441.88 | 808.10 | 329.90 | 1 | 455.03 | 1 | 383.77 | 1 | 329.90 | 3 | 6 |
| 33 | 177.37 | 375.37 | 82.06 | 76.91 | 409.53 | 779.49 | 316.78 | 5 | 423.69 | 5 | 364.76 | 6 | 316.78 | 7 | 6 |
| 36 | 191.81 | 342.37 | 84.26 | 66.45 | 311.82 | 868.34 | 310.84 | 7 | 421.47 | 6 | 359.72 | 7 | 310.84 | 10 | 6 |

TABLE 18

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 5, Temple, Texas, 1915 to 1920, inclusive.

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | Average | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|
| | 211.50 pounds =100% | 339.97 pounds =100% | 151.48 pounds =100% | 69.33 pounds =100% | 351.32 pounds =100% | 724.24 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | | | |
| 3 | ..... | 63 | 98 | ..... | 52 | 98 | 78 | 12 | 4 |
| 6 | ..... | ..... | 130 | ..... | 59 | 92 | 94 | 10 | 3 |
| 9 | 105 | 75 | 138 | ..... | 92 | 98 | 102 | 5 | 5 |
| 12 | 111 | 79 | 120 | 98 | 92 | 103 | 100 | 7 | 6 |
| 15 | 111 | 89 | 133 | 106 | 101 | 102 | 107 | 3 | 6 |
| 18 | 107 | 110 | 125 | 99 | 114 | 93 | 108 | 1 | 6 |
| 21 | 110 | 115 | 93 | 104 | 128 | 94 | 107 | 2 | 6 |
| 24 | 104 | 116 | 81 | 117 | 118 | 82 | 103 | 4 | 6 |
| 27 | 95 | 123 | 96 | 81 | 114 | 100 | 102 | 6 | 6 |
| 30 | 83 | 113 | 76 | 87 | 126 | 112 | 100 | 8 | 6 |
| 33 | 84 | 113 | 54 | 111 | 117 | 108 | 98 | 9 | 6 |
| 36 | 91 | 103 | 56 | 96 | 89 | 120 | 92 | 11 | 6 |

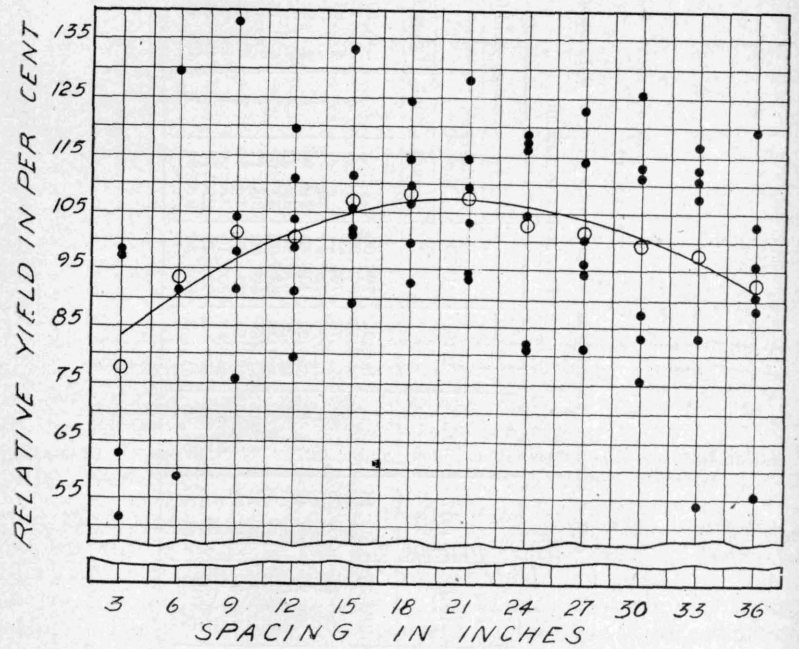


Figure 11. Relative yields of lint cotton (dots) in the series with two stalks to the hill at Temple and parabolic curve fitted to their averages (circles).

A parabola was fitted by the method of least squares to the average relative yields obtained with 1 and 2 stalks to the hill. Figure 10 shows the curve fitted to the relative yields obtained in the series containing 1 stalk to the hill. $Sy$ was 3.65 and Rho .77. In plotting the curve in

Figure 11, S*y* was found to be 2.73 and Rho .93. In each case the peak of the curve occurs at 21 inches. These results show that in actual farm practice the cotton plants should be left about 21 inches apart under the conditions in that part of Texas, although the distance between plants may vary from 12 inches to 30 inches without reducing the yield to any considerable extent. This range in spacing would require 6,000 to 15,000 plants to the acre.

**Results at Substation No. 7, Spur**

Substation No. 7 is located at Spur, Dickens County, in the northwestern part of the State, in the Permian Red Beds region. The elevation is 2,200 feet above sea level. The average annual precipitation for the 12 years, 1914 to 1925, inclusive, was 21.66 inches. The rainfall is fairly well distributed during the growing season, although there are times when the crops suffer from drouth. This is a sub-humid region and the cotton crop usually does not have an excess of moisture.

The spacing experiments with cotton at Spur have been conducted on Abilene clay loam and Miles clay loam soils. The Abilene clay loam is dark chocolate-brown in color with a dark-brown clay subsoil. The Miles clay loam is dark chocolate-red in color with a heavier and somewhat darker subsoil. These soils are naturally productive and are representative of the soils in that section of the Red Beds region.

Spacing experiments with cotton have been conducted at Spur since 1914. Mebane cotton, Texas Station No. 804, has been used in all of this work. In 1916 and in 1920 the cotton in the experiment was destroyed by hail, and as the work was not conducted in 1918, these three years are not included in the averages.

Table 19 gives the yield of lint obtained. Unusually large yields were secured in 1914, which were no doubt due to the exceptionally favorable season, since 34.13 inches of rainfall were recorded during the year. The spacing of 15 inches made the highest yield, 620 pounds of lint to the acre. The lowest yield, 282 pounds, resulted from the 36-inch spacing. Inspection of Table 19, however, seems to show that the yield had no consistent relation to spacing. In 1915, also a favorable year for cotton production, the largest yields were obtained from the spacings varying from 6 to 21 inches, but apparently the spacing had no consistent effect on yield.

The crop season of 1917 was dry, with a total of 11.91 inches of precipitation for the year. The spacings ranging from 6 to 12 inches made decidedly the larger yields. In a general way the yields decreased as the spacing increased from 9 to 36 inches.

Yields of all the spacings in 1919 were considerably higher than the average for the entire period of the test. The spacings within the limits obtained appear to have had no appreciable influence on yield, although the highest yield, 393 pounds of lint, was obtained from the 24-inch spacing, and the lowest yield, 284 pounds of lint, from the 36-inch spacing.

TABLE 19.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 7, Spur, Texas, 1914 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1914 | 1915 | 1917 | 1919 | 1921 | 1922 | 1923 | 1924 | Average for the years | | | | | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 1915-17-19-23-24 | 1915-17-19 | | 1914-17-19 | 1922-23-24 | All years tested | |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank | Pounds | Pounds | Pounds | |
| 3... | ..... | ..... | ..... | ..... | ..... | 199.40 | 59.40 | 151.80 | ..... | ..... | ..... | ..... | 136.86 | 136.86 | 3 |
| 6... | 559.70 | 339.38 | 244.03 | 329.89 | ..... | 152.33 | 63.80 | 171.60 | 229.74 | 304.43 | 4 | 377.87 | 129.24 | 265.81 | 7 |
| 9... | 516.66 | 317.24 | 336.16 | 334.18 | 287.38 | 173.55 | 77.00 | 173.80 | 247.67 | 329.19 | 1 | 395.66 | 141.45 | 276.99 | 8 |
| 12... | ..... | 308.33 | 280.31 | 366.96 | ..... | 154.00 | 81.40 | 170.50 | 241.50 | 318.53 | 2 | ..... | 135.30 | 226.91 | 6 |
| 15... | 620.46 | 312.10 | 188.49 | 381.81 | 237.94 | 188.70 | 74.80 | 162.80 | 224.00 | 294.13 | 5 | 396.92 | 142.10 | 270.88 | 8 |
| 18... | 531.53 | 339.68 | 199.94 | 380.60 | 264.84 | 197.25 | 70.40 | 151.80 | 228.48 | 306.74 | 3 | 370.69 | 139.81 | 267.00 | 8 |
| 21... | 582.92 | 314.50 | 186.56 | 378.18 | 238.34 | ..... | 66.00 | 158.40 | 220.72 | 293.08 | 6 | 382.55 | ..... | 274.98 | 7 |
| 24... | 556.85 | 293.02 | 151.68 | 393.14 | ..... | 178.35 | 59.40 | 173.80 | 214.20 | 279.28 | 7 | 367.22 | 137.18 | 258.03 | 7 |
| 27... | 520.07 | 296.34 | 145.04 | 366.08 | ..... | 163.58 | ..... | ..... | ..... | 269.15 | 8 | 343.73 | ..... | 298.22 | 5 |
| 30... | ..... | 273.22 | 138.30 | 367.18 | 210.71 | ..... | ..... | ..... | ..... | 259.56 | 9 | ..... | ..... | 245.35 | 4 |
| 33... | 530.92 | 309.77 | 147.35 | 312.18 | ..... | 169.80 | ..... | ..... | ..... | 256.43 | 10 | 330.15 | ..... | 294.00 | 5 |
| 36... | 282.57 | ..... | 105.53 | 284.46 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 224.18 | ..... | 224.18 | 3 |

The year 1921 was a normal year for cotton production. The average yield of all the spacings was 247 pounds of lint to the acre. The closest spacing obtained, 9 inches, produced the highest yield, 287 pounds of lint to the acre; while the widest spacing, 30 inches, made the smallest yield, 210 pounds to the acre.

In 1922, the 3-inch spacing made the largest yield but the 6-inch, 15-inch, 18-inch, and 24-inch spacings made yields which indicate that the distance between plants had very little influence on yield. The low yield in 1923 was due largely to the unfavorable distribution of rainfall during the growing season. The 12-inch spacing produced the largest yield, 81 pounds of lint to the acre. The yields diminished as the distance increased or decreased from 12 inches. The yields in 1924 were below the average. The rainfall for the year was 11.16 inches or about one-half of the normal rainfall. The spacing evidently did not have much, if any, effect on yield.

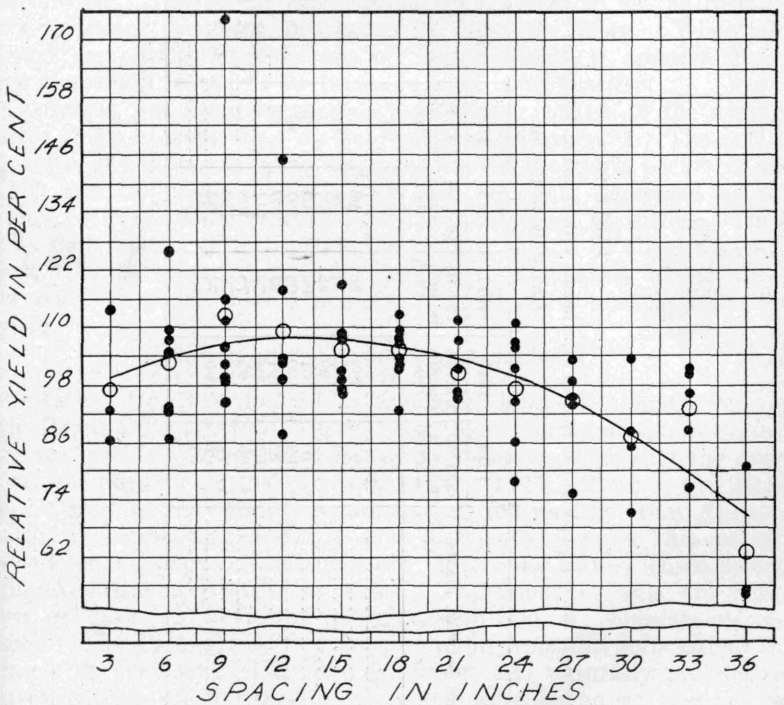


Figure 12. Relative yields of lint cotton (dots) at Spur and parabolic curve fitted to their averages (circles).

All of the twelve spacings were not obtained during any year of the test. In 1917 and 1919, however, only the 3-inch spacing was missing. The 9-inch, 15-inch, and the 18-inch spacings were the only spacings which occurred every year of the test. The average yields for the eight

TABLE 20.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 7, Spur, Texas, 1914 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants. | 1914 | 1915 | 1917 | 1919 | 1921 | 1922 | 1923 | 1924 | Average | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 522.40 pounds =100% | 310.35 pounds =100% | 193.03 pounds =100% | 354.06 pounds =100% | 247.84 pounds =100% | 175.21 pounds =100% | 69.02 pounds =100% | 164.31 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | % | % | | | |
| 3 | ..... | ..... | ..... | ..... | ..... | 114 | 86 | 92 | 97 | 8 | 3 |
| 6 | 107 | 109 | 126 | 93 | ..... | 87 | 92 | 104 | 103 | 5 | 7 |
| 9 | 99 | 102 | 174 | 94 | 116 | 99 | 112 | 106 | 113 | 1 | 8 |
| 12 | ..... | 99 | 145 | 104 | ..... | 88 | 118 | 104 | 110 | 2 | 6 |
| 15 | 119 | 101 | 98 | 108 | 96 | 108 | 108 | 99 | 104 | 4 | 8 |
| 18 | 102 | 109 | 104 | 107 | 107 | 113 | 102 | 92 | 104 | 3 | 8 |
| 21 | 112 | 101 | 97 | 107 | 96 | ..... | 96 | 96 | 101 | 6 | 7 |
| 24 | 107 | 94 | 79 | 111 | ..... | 102 | 86 | 106 | 98 | 7 | 7 |
| 27 | 100 | 95 | 75 | 103 | ..... | 93 | ..... | ..... | 93 | 9 | 5 |
| 30 | ..... | 88 | 72 | 104 | 85 | ..... | ..... | ..... | 87 | 11 | 4 |
| 33 | 102 | 100 | 76 | 88 | ..... | 97 | ..... | ..... | 93 | 10 | 5 |
| 36 | 54 | ..... | 55 | 80 | ..... | ..... | ..... | ..... | 63 | 12 | 3 |

years were 276, 270, and 267 pounds of lint to the acre, respectively. For the five years, 1915, 1917, 1919, 1923, and 1924, the spacing of 9 inches made the highest average yield, 247 pounds of lint to the acre. In a 3-year period, 1915, 1917, 1919, the 9-inch spacing also made the highest yield. The 3-inch spacing was obtained in 1922, 1923, and 1924, during which period it ranked fifth, with 136 pounds of lint to the acre, although there was very little difference in the yield of any of the spacings for this period. The 36-inch spacing was obtained in 1914, 1917, and 1919, during which time it made the lowest average yield, 224 pounds of lint cotton to the acre, while the 15-inch spacing produced during the same period the highest average yield, 396 pounds to the acre.

The actual yields of lint reported in Table 19 were converted into relative yields, which appear in Table 20. As an average of all years tested, regardless of the number, the 9-inch spacing made the highest relative yield. In general the relative yield decreased as the distance between plants increased or decreased from 9 inches. When the spacings are studied on the basis of relative yields, it appears that a range of spacing from 6 to 21 inches is good farm practice.

A parabola was fitted by the method of least squares to the average relative yields in Table 20. $Sy$ was 4.98 and Rho was .91. The results are shown in Figure 12. The highest point on the curve occurs at the 12-inch spacing. This curve shows that the yield decreased as the distance between plants increased or decreased from 12 inches. These results show that in farm practice the spacing should be about 12 to 15 inches, but the spacing may vary from 6 to 21 inches, which would allow 8,300 to 29,000 plants to the acre, without noticeable reduction in yield.

**Results at Substation No. 8, Lubbock**

Substation No. 8 is located at Lubbock, Lubbock County, on the High Plains of Northwest Texas. The elevation is about 3240 feet above sea level. Weather records at the substation show that the average annual rainfall for the 13 years, 1913 to 1925, inclusive, was 19.85 inches. Most of the rainfall occurs during the months from April to October, inclusive, and is fairly well distributed during this period. The soils on the experimental fields are fine sandy loams, which belong to the Amarillo and Richfield series. The Amarillo soils are dark-brown or dark-reddish-brown in color with red or chocolate-colored subsoils. The Richfield soils differ from the Amarillo soils chiefly in having a darker color. They are calcareous and naturally productive.

Investigations on the spacing of cotton were begun at Lubbock in 1913 and have been continued since that time. The yields of lint cotton obtained in this work are reported in Table 21.

The yields were rather low in 1913. The spacings of 9 and 12 inches produced 160 pounds of lint cotton to the acre. The yield became smaller as the spacing was increased. In 1914, a large yield was secured, which was probably due to the amount and favorable distribution of

## TABLE 21.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 8, Lubbock, Texas, 1913 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | Average yield for | | | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | 1916-18-19-22-23-24 | | 1916-17-18-21-22-23 | All years tested | |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank | Pounds | Pounds | |
| 3 | ..... | ..... | ..... | 297.84 | 139.87 | 92.12 | ..... | ..... | 229.68 | 155.98 | 356.62 | ..... | ..... | ..... | 212.01 | 212.01 | 6 |
| 6 | ..... | 639.67 | 362.93 | 303.55 | 156.33 | 104.50 | 501.60 | 162.25 | ..... | 199.32 | 353.47 | 147.02 | 268.24 | 1 | ..... | 293.06 | 10 |
| 9 | 160.35 | 638.42 | 348.75 | 287.44 | 114.25 | 101.75 | 417.78 | 205.56 | 275.77 | 212.08 | 350.59 | 163.74 | 255.56 | 4 | 223.64 | 273.04 | 12 |
| 12 | 160.07 | 621.01 | ..... | 270.87 | 140.38 | 171.87 | 421.52 | 159.50 | 237.82 | 218.90 | 284.79 | 150.37 | 253.05 | 6 | 220.77 | 257.91 | 11 |
| 15 | 154.45 | 627.85 | 351.40 | 253.76 | ..... | 165.00 | 411.84 | 154.68 | 279.40 | 230.78 | 322.87 | 135.34 | 253.26 | 5 | ..... | 280.67 | 11 |
| 18 | 151.58 | 638.72 | 341.27 | 220.86 | 107.15 | 165.00 | 478.94 | ..... | 249.70 | 196.68 | 299.92 | 113.60 | 245.83 | 7 | 206.55 | 269.40 | 11 |
| 21 | 137.65 | 660.63 | 321.01 | 226.90 | ..... | 178.75 | 461.78 | 149.53 | 222.86 | 263.78 | 329.20 | 120.29 | 263.45 | 2 | ..... | 279.30 | 11 |
| 24 | ..... | ..... | ..... | 240.98 | 105.09 | 165.00 | 377.96 | 143.00 | 239.14 | 234.52 | 302.19 | 147.02 | 244.61 | 8 | 214.48 | 217.21 | 9 |
| 27 | ..... | ..... | 300.13 | 189.43 | ..... | 165.00 | 459.36 | 193.88 | 197.12 | 263.78 | 316.84 | 147.02 | 256.90 | 3 | ..... | 248.06 | 9 |
| 30 | 128.99 | ..... | 301.61 | 201.58 | ..... | 191.12 | 374.22 | 160.19 | 220.22 | 221.32 | 320.38 | 143.68 | 242.05 | 9 | ..... | 226.33 | 10 |
| 33 | ..... | ..... | 272.70 | 186.94 | ..... | 165.00 | 425.70 | 159.50 | ..... | ..... | ..... | 157.05 | ..... | ..... | ..... | 227.81 | 6 |
| 36 | ..... | ..... | ..... | 119.58 | 65.45 | 169.12 | 284.46 | ..... | 205.70 | 190.30 | 297.02 | 123.64 | 197.35 | 10 | 174.52 | 181.90 | 8 |

rainfall during the growing season of cotton. The total rainfall in 1914 was 31.43 inches. The widest spacing obtained, which was 21 inches, produced the highest yield, 660 pounds of lint cotton to the acre, while the spacing of 12 inches made the lowest yield, 621 pounds of lint. A study of the yields in 1914, Table 21, shows, however, that there is no consistent relation between yield and spacing of the plants.

In 1915, the rainfall at Lubbock was 31.88 inches, and was distributed rather favorably during the active growing season. The average yield of all of the spacings was 324 pounds of lint to the acre. Six inches was the closest spacing obtained that year and it made the highest yield, 362 pounds of lint to the acre. In a general way the yield decreased roughly as the spacing increased. Similar results were secured in 1916.

Low yields resulted in 1917, probably due to the scant rainfall of 8.73 inches. The rainfall of 15.03 inches in 1916 probably was a contributing factor towards low yields in 1917. The spacings ranging from 3 to 12 inches made the largest yields but these were not satisfactory. The yield became smaller as the distance between the plants was increased from 12 to 36 inches. Low yields resulted in 1918; the average yield of all the spacings was 152 pounds of lint cotton to the acre. The lowest yields were produced on the plats with the closer spacings, 3 to 9 inches, but an examination of Table 21 shows that the yield apparently was not otherwise correlated with the distance between plants.

The year 1919 was favorable for cotton production at Lubbock, and as a result an average yield of about 419 pounds of lint cotton to the acre was produced in the spacing test. The 6-inch spacing made the largest yield, which was 501 pounds of lint to the acre. It would appear, however, that the spacing had no consistent influence on yield, since yields above the average for the year appeared throughout the range of spacing. Similar results were obtained in 1920.

In 1921, the rainfall was considerably below the average, there being 16.75 inches. About an average yield of cotton, however, was produced, which was probably due to the rains in June and September with a favorable maturing season and late frost. The largest yields resulted from the 9-inch and 15-inch spacings. Yields somewhat below the average for the 12-year period were obtained in 1922, which was a dry year with a rainfall of 14.59 inches. The largest yield, 263 pounds of lint to the acre, was produced by the 21-inch and 27-inch spacings. The yields decreased in general as the distance between plants increased or decreased from these spacings.

Yields considerably above the average for the 12-year period were obtained in 1923, although conditions were unfavorable for securing a stand. It was necessary to replant the cotton in the test, which was done on June 15. This gave a short season for producing cotton. The 3-inch spacing made the largest yield, 356 pounds of lint to the acre. The yields of the 6-inch and 9-inch spacings, however, were about as large, being 353 and 350 pounds of lint to the acre, respectively.

TABLE 22.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 8, Lubbock, Texas, 1913 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | Average | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 148.84 pounds =100% | 637.71 pounds =100% | 324.97 pounds =100% | 233.31 pounds =100% | 118.36 pounds =100% | 152.85 pounds =100% | 419.56 pounds =100% | 165.34 pounds =100% | 235.74 pounds =100% | 217.04 pounds =100% | 321.26 pounds =100% | 140.79 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | % | % | % | % | % | % | | | |
| 3 | ..... | ..... | ..... | 128 | 118 | 60 | ..... | ..... | 97 | 72 | 111 | ..... | 98 | 9 | 6 |
| 6 | ..... | 100 | 112 | 130 | 132 | 68 | 120 | 98 | ..... | 92 | 110 | 104 | 107 | 1 | 10 |
| 9 | 108 | 100 | 107 | 123 | 97 | 67 | 100 | 124 | 117 | 98 | 109 | 116 | 106 | 2 | 12 |
| 12 | 108 | 97 | ..... | 116 | 119 | 112 | 100 | 96 | 101 | 101 | 89 | 107 | 104 | 3 | 11 |
| 15 | 104 | 98 | 108 | 109 | ..... | 108 | 98 | 94 | 119 | 106 | 100 | 96 | 104 | 4 | 11 |
| 18 | 102 | 100 | 105 | 95 | 91 | 108 | 114 | ..... | 106 | 91 | 93 | 81 | 99 | 7 | 11 |
| 21 | 92 | 104 | 99 | 97 | ..... | 117 | 110 | 90 | 95 | 122 | 102 | 85 | 101 | 6 | 11 |
| 24 | ..... | ..... | ..... | 103 | 89 | 108 | 90 | 86 | 101 | 108 | 94 | 104 | 98 | 8 | 9 |
| 27 | ..... | ..... | 92 | 81 | ..... | 108 | 109 | 117 | 84 | 121 | 98 | 104 | 102 | 5 | 9 |
| 30 | 87 | ..... | 93 | 86 | ..... | 125 | 89 | 97 | 93 | 102 | 100 | 102 | 97 | 10 | 10 |
| 33 | ..... | ..... | 84 | 80 | ..... | 108 | 101 | 96 | ..... | ..... | ..... | 112 | 97 | 11 | 6 |
| 36 | ..... | ..... | ..... | 51 | 55 | 111 | 68 | ..... | 87 | 88 | 92 | 88 | 80 | 12 | 8 |

In 1924, low yields were produced, the average of all of the spacings was 140 pounds of lint to the acre, which was approximately 120 pounds lower than the average yield for the period of the experiment. A study of Table 21 shows that apparently the spacing had little effect on yield, since yields above the average for the year occur throughout the range of spacing.

Only one spacing, the 9-inch, occurred every year of the test. There were only two years, 1916 and 1918, in which all of the spacings occurred. The 6-inch spacing made the highest average yield, 268 pounds of lint, for the six years 1916, 1918, 1919, 1922, 1923, and 1924. It also made the largest yield for all years tested. The spacing of 36 inches made the lowest average yield in each of the period of years in which it occurred.

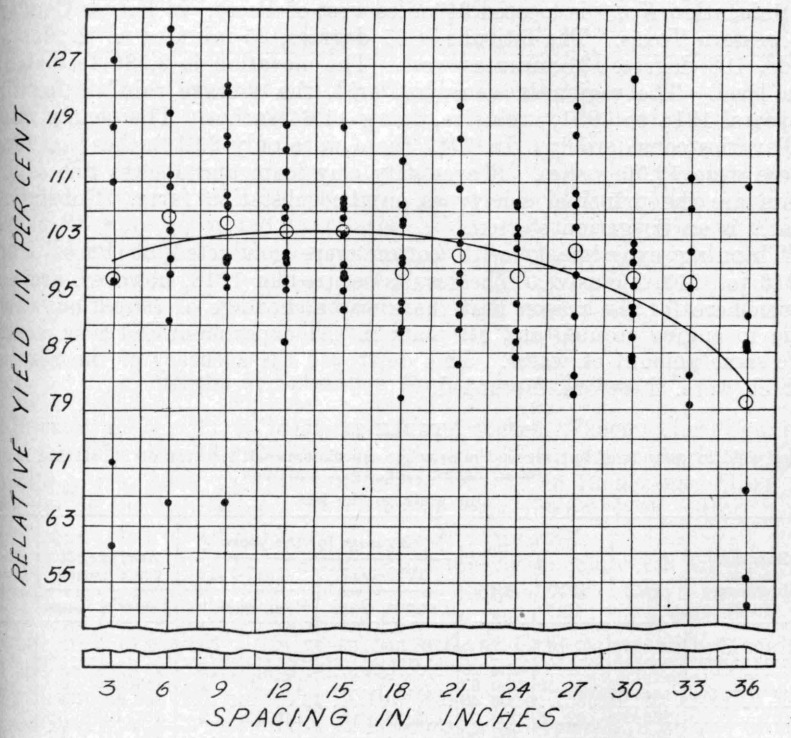


Figure 13. Relative yields of lint cotton (dots) at Lubbock and parabolic curve fitted to their averages (circles).

The yields of lint cotton reported in Table 21 were converted to relative yields, which are given in Table 22. The 6-inch spacing produced the highest average relative yield, followed in order of relative yield by the 9-inch, 12-inch, and 15-inch spacings. When considered on the

basis of relative yields these spacings would be the ones to recommend in actual farm practice.

A parabola was fitted by the method of least squares to the average relative yields, the results of which are plotted in Figure 13. S$y$ in this case was 3.65 and Rho was .83. The highest point of the curve occurs at 12 and 15 inches. The curve shows that the yield decreased as the distance increased or decreased from 12 to 15 inches. From these results it is concluded that the optimum spacing for the conditions at Lubbock would be 12 to 15 inches, but a satisfactory range of spacing in farm practice would be one of 6 to 21 inches since there is no significant decrease in yield within this range of spacing.

### Results at Substation No. 9, Pecos

Substation No. 9 is located 3½ miles west of Pecos,[1] in Reeves County, in western Texas. The latitude is 31 degrees, 25 minutes north; longitude, 103 degrees, 31 minutes west. The elevation is 2,580 feet above sea level. The region is somewhat arid, the average rainfall for the 8 years, 1914 to 1921, inclusive, being 11.64 inches. The yearly rainfall varies considerably. In 1917 there were only 2.61 inches; in 1920 there were 19.70 inches. Reeves silty clay loam and Reeves fine sandy loam are the principal soil types on the substation farm. Substation No. 9 is an irrigation station.

Thinning experiments with cotton were conducted at Pecos from 1916 to 1919, inclusive. The results secured in 1918, however, are not given here for the reason that there was a shortage of irrigation water due to engine trouble and all plats in the experiment did not receive the same amount of water. This destroyed the accuracy of the results, which were, therefore, discarded.

TABLE 23.

Acre yield in pounds of lint secured in spacing experiments with cotton at Substation No. 9, Pecos, Texas, 1916, 1917, and 1919.

One stalk to the hill.

| Spacing, inches between plants | 1916 | 1917 | 1919 | Average for the years | | | | Average all years tested | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1916-1917 | | 1917-1919 | | | | |
| | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 6 | ..... | ..... | 224.20 | ..... | ..... | ..... | ..... | 224.20 | 3 | 1 |
| 9 | ..... | 64.10 | 250.63 | ..... | ..... | 157.36 | 1 | 157.36 | 6 | 2 |
| 12 | ..... | ..... | 200.40 | ..... | ..... | ..... | ..... | 200.40 | 4 | 1 |
| 15 | 268.32 | 42.45 | 250.60 | 155.38 | 1 | 146.52 | 2 | 187.12 | 5 | 3 |
| 18 | 281.93 | ..... | 253.50 | ..... | ..... | ..... | ..... | 267.71 | 1 | 2 |
| 21 | ..... | 34.27 | 229.80 | ..... | ..... | 132.03 | 3 | 132.03 | 8 | 2 |
| 24 | 187.28 | 29.65 | ..... | 108.46 | 3 | ..... | ..... | 108.46 | 10 | 2 |
| 27 | 211.69 | 24.77 | ..... | 118.23 | 2 | ..... | ..... | 118.23 | 9 | 2 |
| 30 | 193.22 | 22.33 | 194.80 | 107.77 | 4 | 108.56 | 4 | 136.78 | 7 | 3 |
| 33 | ..... | 23.87 | ..... | ..... | ..... | ..... | ..... | 23.87 | 11 | 1 |
| 36 | ..... | ..... | 225.90 | ..... | ..... | ..... | ..... | 225.90 | 2 | 1 |

[1]The substation was removed to Balmorhea, about 35 miles from Pecos, in 1922.

TABLE 24

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 9, Pecos, Texas, 1916, 1917, and 1919.

One stalk to the hill.

| Spacing, inches between plants | 1916 | 1917 | 1919 | Average | | No. years tested |
|---|---|---|---|---|---|---|
| | 228.48 pounds =100% | 34.49 pounds =100% | 228.72 pounds =100% | % | Rank | |
| | % | % | % | | | |
| 3 | ..... | ..... | ..... | ..... | ..... | ..... |
| 6 | ..... | ..... | 98 | 98 | 6 | 1 |
| 9 | ..... | 186 | 110 | 148 | 1 | 2 |
| 12 | ..... | ..... | 88 | 88 | 7 | 1 |
| 15 | 117 | 123 | 110 | 117 | 3 | 3 |
| 18 | 123 | ..... | 111 | 117 | 2 | 2 |
| 21 | ..... | 99 | 100 | 100 | 4 | 2 |
| 24 | 82 | 86 | ..... | 84 | 8 | 2 |
| 27 | 93 | 72 | ..... | 82 | 9 | 2 |
| 30 | 85 | 65 | 85 | 78 | 10 | 3 |
| 33 | ..... | 69 | ..... | 69 | 11 | 1 |
| 36 | ..... | ..... | 99 | 99 | 5 | 1 |

The results of the test are reported in Tables 23 and 24. Only two spacings, the 15-inch and the 30-inch, appeared each of the 3 years. The spacings ranging from 9 to 21 inches gave the best yields each year. The average yields for all years tested show that the best yield resulted from the 18-inch spacing. The yields of lint cotton given in Table 23 were converted to relative yields, which are given in Table 24. When compared in this manner, the 9-inch spacing produced the highest average yield. While these results are not conclusive, they indicate that under irrigated conditions in that part of the State spacing the plants 6 to 21 inches apart will give best results.

### Results at Substation No. 11, Nacogdoches

Substation No. 11 is located at Nacogdoches, Nacogdoches County, in eastern Texas. The elevation is 292 feet. The average yearly rainfall for 23 years, 1902 to 1924, inclusive, was 50.96 inches according to records of the substation. The spacing experiments with cotton have been conducted on Orangeburg fine sandy loam soil.

Investigations on the spacing of cotton were conducted at Nacogdoches from 1915 to 1920, inclusive. The results are shown in Tables 25 to 30, inclusive. Three series of plats were used, one with 1 stalk to the hill, one with 2 stalks to the hill, and the other with 3 stalks to the hill, at the various distances.

The yields of lint obtained in the series with 1 stalk to the hill are given in Table 25. All of the 12 spacings were secured in only 2 of the 6 years, in 1915 and in 1918. For these 2 years the 30-inch spacing made the highest average yield, 258 pounds of lint to the acre, followed in order of yield by the 33-inch, 21-inch, and 27-inch spacings. For the 4-year period, 1915-1918, inclusive, the 21-inch spacing made the best average yield, 209 pounds of lint to the acre. The 30-inch, 33-inch, and 24-inch spacings followed closely in the order named.

TABLE 25.

Acre yields in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 11, Nacogdoches, Texas, 1915-1920, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | Average for the years | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1915, 1918 | | 1915-16-17-18 | | | | |
| | | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 3 | 112.94 | ..... | ..... | 171.87 | ..... | ..... | 142.40 | 12 | ..... | ..... | 142.40 | 8 | 2 |
| 6 | 148.63 | ..... | ..... | 171.87 | 10.31 | 48.12 | 160.25 | 11 | ..... | ..... | 94.73 | 12 | 4 |
| 9 | 137.54 | 107.50 | 135.37 | 192.50 | ..... | ..... | 165.02 | 10 | 143.22 | 8 | 143.22 | 7 | 4 |
| 12 | 220.00 | 110.85 | ..... | 178.75 | 17.18 | 85.93 | 199.37 | 8 | ..... | ..... | 122.54 | 11 | 5 |
| 15 | 214.80 | 110.85 | 127.58 | 185.62 | 13.75 | ..... | 200.21 | 7 | 159.71 | 7 | 130.52 | 10 | 5 |
| 18 | 238.40 | 180.44 | ..... | 165.00 | 30.07 | 103.12 | 201.70 | 6 | ..... | ..... | 143.40 | 6 | 5 |
| 21 | 310.77 | 208.82 | 160.57 | 158.12 | ..... | ..... | 234.44 | 3 | 209.57 | 1 | 209.57 | 1 | 4 |
| 24 | 275.00 | 224.31 | 106.64 | 158.12 | 17.18 | 61.87 | 216.56 | 5 | 191.01 | 4 | 140.52 | 9 | 6 |
| 27 | 291.72 | 185.62 | 92.27 | 165.00 | ..... | 82.49 | 228.36 | 4 | 183.65 | 5 | 163.42 | 2 | 5 |
| 30 | 324.63 | 180.46 | 127.02 | 192.50 | 21.48 | 96.25 | 258.56 | 1 | 206.15 | 2 | 157.05 | 4 | 6 |
| 33 | 344.03 | 154.68 | 134.21 | 158.12 | 32.65 | 92.81 | 251.07 | 2 | 197.76 | 3 | 152.75 | 5 | 6 |
| 36 | 250.49 | 173.10 | 105.45 | 116.87 | ..... | ..... | 183.68 | 9 | 161.47 | 6 | 161.47 | 3 | 4 |

Apparently the character of the season had no marked influence on the relative rank in yield of the different rates of thinning. For instance, 1915 and 1916 were average years as far as total rainfall was concerned, and the medium to wide spacings produced the largest yields. This was true also for 1917 and 1918, both of which were dry years. Similar results were obtained in 1919 and 1920, both of which had normal or more than normal precipitation.

The yields of lint in Table 25 were converted into relative yields, which are given in Table 26. On the basis of relative yield, the 21-inch spacing produced the highest average yield for the period of test. In general the spacings from 18 to 33 inches made larger yields than closer spacing.

TABLE 26

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 11, Nacogdoches, Texas, 1915 to 1920, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | Average | | No. years tested |
|---|---|---|---|---|---|---|---|---|---|
| | 239.08 pounds =100% | 163.66 pounds =100% | 123.64 pounds =100% | 167.86 pounds =100% | 20.37 pounds =100% | 81.51 pounds =100% | % | Rank | |
| | % | % | % | % | % | % | | | |
| 3 | 47 | ..... | ..... | 102 | ..... | ..... | 74 | 11 | 2 |
| 6 | 62 | ..... | ..... | 102 | 51 | 59 | 68 | 12 | 4 |
| 9 | 58 | 66 | 109 | 115 | ..... | ..... | 87 | 10 | 4 |
| 12 | 92 | 68 | ..... | 106 | 84 | 105 | 91 | 8 | 5 |
| 15 | 90 | 68 | 103 | 111 | 68 | ..... | 88 | 9 | 5 |
| 18 | 100 | 110 | ..... | 98 | 148 | 127 | 117 | 3 | 5 |
| 21 | 130 | 128 | 130 | 94 | ..... | ..... | 120 | 1 | 4 |
| 24 | 115 | 137 | 86 | 94 | 84 | 76 | 99 | 6 | 6 |
| 27 | 122 | 113 | 75 | 98 | ..... | 101 | 102 | 5 | 5 |
| 30 | 136 | 110 | 103 | 115 | 105 | 118 | 114 | 4 | 6 |
| 33 | 144 | 95 | 109 | 94 | 160 | 114 | 119 | 2 | 6 |
| 36 | 105 | 106 | 85 | 70 | ..... | ..... | 92 | 7 | 4 |

Table 27 reports the yields of lint secured in the series with 2 stalks to the hill. This series included spacings from 9 to 36 inches. All of these spacings were obtained only two years, in 1915 and 1918. For these 2 years the spacing of 27 inches made the highest average yield, 338 pounds of lint to the acre. The 21-inch, 24-inch, 30-inch, and 36-inch spacings each produced more than 300 pounds of lint to the acre as an average for the 2 years. The 9-inch spacing gave the lowest average yield, 231 pounds of lint to the acre, for the same period. Only six spacings were obtained through the three years, 1915, 1917, and 1918. Of these six, the 27-inch and 36-inch spacings produced the highest average yield, 266 pounds of lint to the acre, although the 24-inch and 30-inch spacings produced practically as large yields.

The yields of lint in Table 27 were converted into relative yields, which are given in Table 28. On this basis of comparison, the 21-inch spacing made the highest, and the 9-inch spacing the lowest, average relative yield for the duration of the experiment.

TABLE 27.

Acre yields in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 11, Nacogdoches, Texas, 1915 to 1919, inclusive.

Two stalks to the hill.

| Spacing, inches between hills | 1915 | 1916 | 1917 | 1918 | 1919 | Average for the years | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1915, 1918 | | 1915-17-18 | | | | |
| | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 9 | 297.00 | ..... | ..... | 165.00 | ..... | 231.00 | 10 | ..... | ..... | 231.00 | 3 | 2 |
| 12 | 344.03 | ..... | 130.61 | 151.25 | ..... | 247.64 | 9 | 208.63 | 5 | 208.63 | 6 | 3 |
| 15 | 352.00 | ..... | ..... | 185.62 | ..... | 268.81 | 7 | ..... | ..... | 268.81 | 1 | 2 |
| 18 | 335.72 | ..... | 93.46 | 178.75 | ..... | 257.23 | 8 | 202.64 | 6 | 202.64 | 7 | 3 |
| 21 | 371.40 | 180.46 | ..... | 261.25 | 33.22 | 316.32 | 5 | ..... | ..... | 211.58 | 4 | 4 |
| 24 | 445.54 | ..... | 103.59 | 213.12 | 34.37 | 329.33 | 2 | 254.08 | 4 | 199.15 | 9 | 4 |
| 27 | 409.86 | 134.06 | 120.95 | 268.12 | ..... | 338.99 | 1 | 266.31 | 2 | 233.24 | 2 | 4 |
| 30 | 415.40 | 144.69 | 140.20 | 220.00 | 22.33 | 317.70 | 3 | 258.53 | 3 | 188.52 | 10 | 5 |
| 33 | 352.00 | 79.92 | ..... | 199.37 | ..... | 275.68 | 6 | ..... | ..... | 210.43 | 5 | 3 |
| 36 | 448.31 | 170.15 | 165.66 | 185.62 | 34.80 | 316.96 | 4 | 266.53 | 1 | 200.90 | 8 | 5 |

TABLE 28.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 11, Nacogdoches, Texas, 1915 to 1919, inclusive.

Two stalks to the hill.

| Spacing, inches, between hills | 1915 | 1916 | 1917 | 1918 | 1919 | Average | | No. years tested |
|---|---|---|---|---|---|---|---|---|
| | 377.12 pounds =100% | 141.85 pounds =100% | 125.74 pounds =100% | 202.81 pounds =100% | 31.18 pounds =100% | % | Rank | |
| | % | % | % | % | % | | | |
| 9 | 79 | ..... | ..... | 81 | ..... | 80 | 10 | 2 |
| 12 | 91 | ..... | 104 | 75 | ..... | 90 | 7 | 3 |
| 15 | 93 | ..... | ..... | 92 | ..... | 92 | 6 | 2 |
| 18 | 89 | ..... | 74 | 88 | ..... | 84 | 8 | 3 |
| 21 | 98 | 127 | ..... | 129 | 107 | 115 | 1 | 4 |
| 24 | 118 | ..... | 82 | 105 | 110 | 104 | 4 | 4 |
| 27 | 109 | 94 | 96 | 132 | ..... | 108 | 3 | 4 |
| 30 | 110 | 102 | 111 | 108 | 72 | 101 | 5 | 5 |
| 33 | 93 | 56 | ..... | 98 | ..... | 82 | 9 | 3 |
| 36 | 119 | 120 | 132 | 92 | 112 | 115 | 2 | 5 |

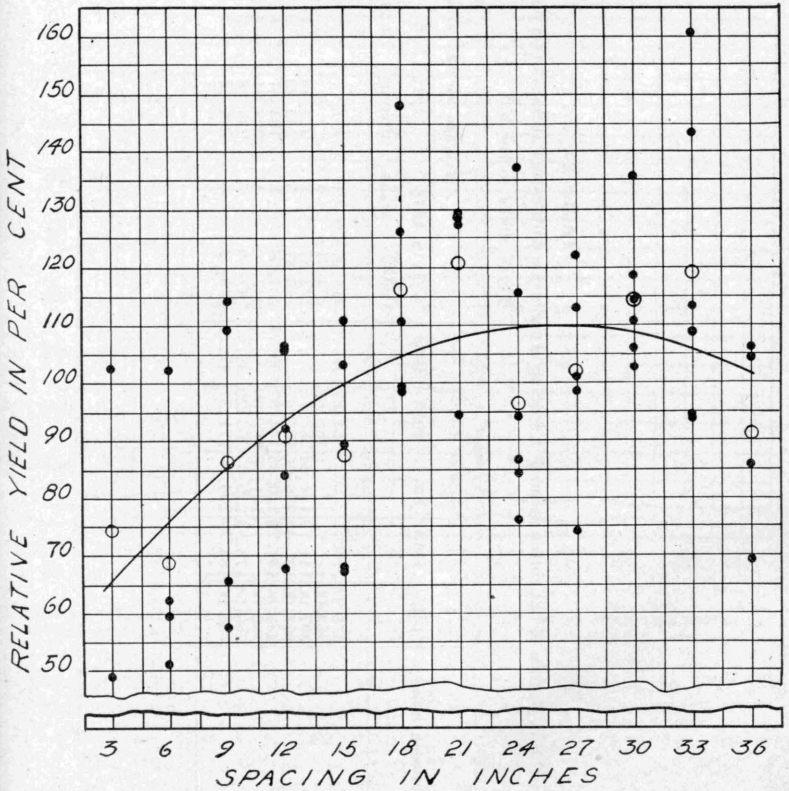


Figure 14. Relative yields of lint cotton (dots) in the series with one stalk to the hill at Nacogdoches and parabolic curve fitted to their averages (circles).

TABLE 29.

Acre yields in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 11, Nacogdoches, Texas, 1915 to 1919, inclusive.

Three stalks to the hill.

| Spacing, inches between hills | 1915 | 1916 | 1917 | 1918 | 1919 | Average for the years | | | | | | Average all years tested | | Number years tested |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1915, 1918 | | 1915-17-18 | | 1915-16-17-18 | | | | |
| | | | | | | Pounds | Rank | Pounds | Rank | Pounds | Rank | Pounds | Rank | |
| 15 | 376.14 | ..... | ..... | 254.37 | ..... | 315.25 | 1 | ..... | ..... | ..... | ..... | 315.25 | 1 | 2 |
| 18 | 363.00 | ..... | ..... | 185.62 | ..... | 274.31 | 3 | ..... | ..... | ..... | ..... | 274.31 | 2 | 2 |
| 21 | 297.00 | 141.79 | 144.64 | 288.75 | ..... | 292.87 | 2 | 243.46 | 1 | 218.04 | 3 | 218.04 | 4 | 4 |
| 24 | 308.00 | 131.48 | 236.06 | 185.62 | ..... | 246.81 | 5 | 243.22 | 2 | 215.29 | 4 | 215.29 | 5 | 4 |
| 27 | 258.80 | 141.79 | 150.38 | 144.37 | 56.71 | 201.58 | 8 | 184.51 | 6 | 173.83 | 5 | 150.41 | 8 | 5 |
| 30 | 330.00 | ..... | 191.73 | 165.00 | ..... | 247.50 | 4 | 228.91 | 4 | ..... | ..... | 228.91 | 3 | 3 |
| 33 | 269.54 | 176.59 | 230.07 | 206.25 | 39.53 | 237.89 | 7 | 235.28 | 3 | 220.61 | 1 | 184.39 | 7 | 5 |
| 36 | 308.00 | 188.20 | 206.70 | 171.87 | 47.26 | 239.93 | 6 | 228.85 | 5 | 218.68 | 2 | 184.40 | 6 | 5 |

The yields of lint obtained in the series with 3 stalks to the hill are given in Table 29. This series included spacings ranging from 15 to 36 inches. All of the spacings were secured in 1915 and 1918. The 15-inch spacing made the highest average yield, 315 pounds of lint; and the 27-inch spacing the lowest yield, 201 pounds of lint to the acre, for these 2 years. For the 3 years, 1915, 1917, and 1918, the spacings of 21 and 24 inches gave the best yields, each with 243 pounds of lint to the acre. The 27-inch spacing made the lowest average yield, 184 pounds of lint. For the 4 years, 1915 to 1918, inclusive, the highest average yield was produced by the 33-inch spacing, but the yields of the 21-inch, 24-inch, and 36-inch spacings were practically as large. The yields are so erratic that it is not possible to draw definite conclusions from them.

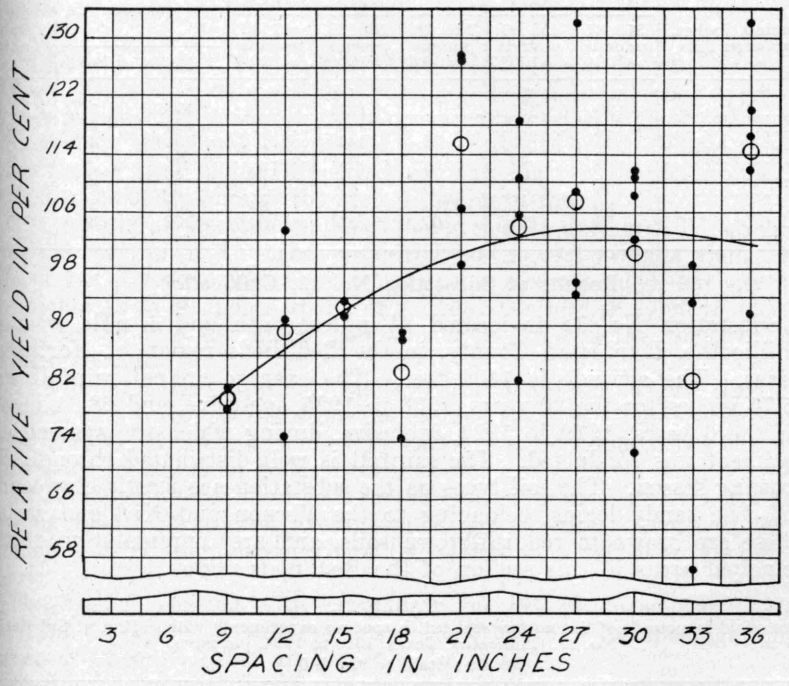


Figure 15. Relative yields of lint cotton (dots) in the series with two stalks to the hill at Nacogdoches and parabolic curve fitted to their averages (circles).

A parabola was fitted by the method of least squares to the relative yields secured in the series with 1 stalk and with 2 stalks to the hill (Figures 14 and 15). In fitting the curve, Figure 14, $Sy$ was 9.55 and Rho was .81, while in Figure 15 $Sy$ was 10.17 and Rho .58. The peak of the curve occurs at 27 and 30 inches for the series with 1 stalk and with 2 stalks to the hill, respectively. The peak represents

the optimum spacing of cotton under the conditions of the experiment. These results, studied in connection with the actual yields, show that the largest yields have been obtained from spacings ranging from 18 to 36 inches, whether there were 1 or 2 stalks to the hill. In general, however, the series with 2 stalks and 3 stalks to the hill made slightly larger yields than the series with 1 stalk to the hill. These results indicate that in the region of Nacogdoches the spacing of cotton should be about 27 to 30 inches with 2 or 3 stalks to the hill, but the spacing may vary from 18 to 36 inches without serious reduction in yield.

TABLE 30.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 11, Nacogdoches, Texas, 1915 to 1919, inclusive.

Three stalks to the hill.

| Spacing, inches, between hills | 1915 | 1916 | 1917 | 1918 | 1919 | Average | | No. years tested |
|---|---|---|---|---|---|---|---|---|
| | 313.81 pounds =100% | 155.97 pounds =100% | 193.26 pounds =100% | 200.23 pounds =100% | 47.83 pounds =100% | % | Rank | |
| | % | % | % | % | % | | | |
| 15 | 120 | ..... | ..... | 127 | ..... | 124 | 1 | 2 |
| 18 | 116 | ..... | ..... | 93 | ..... | 104 | 2 | 2 |
| 21 | 95 | 91 | 75 | 144 | ..... | 101 | 4 | 4 |
| 24 | 97 | 84 | 122 | 93 | ..... | 99 | 6 | 4 |
| 27 | 82 | 91 | 78 | 72 | 119 | 88 | 8 | 5 |
| 30 | 105 | ..... | 99 | 82 | ..... | 95 | 7 | 3 |
| 33 | 86 | 113 | 119 | 103 | 83 | 101 | 5 | 5 |
| 36 | 98 | 121 | 107 | 86 | 99 | 102 | 3 | 5 |

### *Results at Substation No. 12, Chillicothe*

Substation No. 12 is located 4½ miles south and 1 mile west of Chillicothe, Hardeman County, in the Red Beds region of Northwest Texas. The altitude is 1406 feet. The average annual rainfall was 25.74 inches for the 20 years, 1906 to 1925, inclusive, and 28.84 inches for the 6 years, 1919 to 1924, inclusive, during which the spacing experiment was conducted. The rainfall is well distributed through the growing season. The soil types on the substation are mostly clay loams and fine sandy loams, belonging to the Vernon and Kirkland series. These are brown to reddish-brown soils, and are representative of the principal areas in this section of the Red Beds region.

TABLE 31.

Acre yield in pounds of lint cotton secured in spacing experiments with cotton at Substation No. 12, Chillicothe, Texas, 1919 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1919 | 1920 | 1921 | 1922 | 1924 | Average all years tested | |
|---|---|---|---|---|---|---|---|
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank |
| 6 | 315.35 | 345.21 | 297.63 | 114.75 | 277.29 | 270.04 | 5 |
| 12 | 389.35 | 345.01 | 327.75 | 123.60 | 304.37 | 298.01 | 4 |
| 18 | 370.35 | 381.31 | 324.64 | 140.64 | 322.60 | 307.90 | 3 |
| 24 | 345.40 | 399.66 | 319.97 | 142.50 | 338.12 | 309.13 | 2 |
| 30 | 347.75 | 395.06 | 333.57 | 152.65 | 358.69 | 317.54 | 1 |

Investigations on the spacing of cotton have been conducted at Chillicothe since 1919. The spacing work included only five spacings, 6, 12, 18, 24, and 30 inches. Table 31 gives the yields of lint secured during the 5 years. The 30-inch spacing made the largest yield three years out of five, and the highest average yield, 317 pounds of lint to the acre, for the five years of the experiment. The average yield of lint increased as the spacing increased. These results show that spacing ranging from 18 to 30 inches has given the most satisfactory yields in that part of the State. This range of spacing is recommended in farm practice of the region.

**Discussion of Results**

The general conclusions of the spacing work with cotton at each substation are given here for convenience in studying the experiment as a whole.

At College Station on the gray flat lands of East Central Texas the highest yields were obtained from the 9-inch and the 12-inch spacings over a period of 5 years, although practically as large yields were obtained where the plants were spaced 6 to 18 inches apart. These results show that a good stand of cotton for this part of Texas would be 10,000 to 20,000 plants to the acre in ordinary rows.

The results at Beeville on black loam soil in southern Texas show that the spacing of 21 inches produced the highest average yield over a period of 8 years. The 21-inch spacing is recommended, but spacing the plants 12 to 30 inches apart, or a distance allowing 6,000 to 15,000 plants to the acre, has given yields about as large as the yields of the 21-inch spacing.

At Troup on the gray sandy lands of east Texas the largest yield for a period of 3 years resulted from the 30-inch spacing. The results indicate, however, that the spacing may vary from 18 to 36 inches without significant reduction in yield.

At Angleton on the black soils of the Gulf Coastal Plains the 12-inch spacing made the highest average yield for 8 years. About as large yields, however, were made where the plants were left 6 to 18 inches apart.

The 21-inch spacing with 2 stalks to the hill produced the highest yield for 6 years at Temple in the blackland belt, but the spacings ranging from 12 to 30 inches made yields almost as large.

At Spur on the red lands of northwestern Texas the 12-inch spacing produced the highest yield over a period of 8 years. The 12-inch spacing is recommended in farm practice, although the 9-inch, 15-inch, and 18-inch spacings gave about as satisfactory yields as the 12-inch spacing.

The results at Lubbock on the High Plains in northwestern Texas show that the 12-inch and the 15-inch spacings made the highest average yield for 12 years. The results indicate that the spacing may vary from 6 to 21 inches without significant decrease in yield.

The spacing work with cotton at Pecos was not conclusive, but the

results secured indicate that spacing the plants 6 to 21 inches apart will give the best yields under irrigation in western Texas.

At Nacogdoches on the red and gray sandy hill lands of eastern Texas the 27-inch spacing with 2 and 3 stalks to the hill made the highest yield over a period of 6 years. Spacing the plants 18 to 33 inches apart, however, gave yields about as large as the yield of the 27-inch spacing.

At Chillicothe on the red lands of northwestern Texas the widest spacing used, 30 inches, produced the highest average yield over a period of 5 years. The results indicate that spacing the plants 6 to 12 inches apart gives too thick a stand for maximum production under the particular conditions. These results are not in agreement with those secured at Spur, where 12 inches was the optimum spacing.

These results on the spacing of cotton agree in general with the spacing work done in other states previous to 1914 and also with subsequent work. The results obtained at Nacogdoches and at Troup, on sandy soils in East Texas, and at Chillicothe on the red lands in northwestern Texas are exceptions. At these three points it was found that the optimum spacing was 27 to 30 inches, which is considerably wider than the optimum spacing found at the other points in Texas.

The Alabama Station (34) recommends spacing the plants 12 to 18 inches apart in rows of ordinary width.

The Arkansas Station (8, 9, 10) recommends that the plants be spaced a hoe's width apart, and states that the stand should be about 15,000 plants to the acre where the land produces 1,200 pounds of seed cotton to the acre in the absence of the boll weevil.

The Georgia Station (102) found that "On a land capable of a yield of $\frac{3}{4}$ to $1\frac{1}{2}$ bales per acre the rows should be $3\frac{1}{2}$ to 4 feet wide and the plants 12 to 18 inches apart in the drills, the narrower rows and the closer spacing for the less productive soil."

The Mississippi Station recommends fairly close spacing, 6 to 12 inches. At the Delta Branch Station (11) 8 inches was found to be the optimum spacing. The Holly Springs Branch Station (7) found that rows $3\frac{1}{2}$ feet apart with 2 to 3 stalks in bunches to the foot on valley lands, and rows 3 feet apart with 3 to 4 stalks to the foot on hill land, were best for those conditions. The South Mississippi Branch Station (40) also recommends close spacing.

The North Carolina Station (84) found that spacing the plants 12 inches apart in ordinary rows gave the largest yields. It is stated (81) "Results have shown that an increased yield and earlier maturity may be expected from closer spacing than has been practiced in the past," but a definite spacing or range of spacing is not given.

The South Carolina Station (113) has found "that the earliest crop and the highest yields are apt to be obtained from spacing which will give 15,000 to 20,000 plants to the acre."

The Tennessee Station (70) from 8 years' work on cotton spacing found that spacing 6 to 18 inches in rows 3 feet apart gave the best yields.

## RESULTS SECURED WITH DEFERRED THINNING

In 1913, O. F. Cook of the United States Department of Agriculture published a paper (25) in which he advocated a new system of cotton culture. This paper sets forth the theory that the development of the vegetative branches of the cotton plant can be suppressed or restricted by crowding the plants during early growth. This method is known as "single-stalk cotton culture." In this paper Cook states: "The way to secure an early short-season crop of cotton is to thin the plants later and leave them closer together in the rows than is now customary. Neither of these policies is advisable if used alone, but they give a real advantage when properly combined. Keeping the plants closer together during the early stages of growth restricts the formation of vegetative branches and induces an early development of fruiting branches." In the same paper Cook reports that Durango cotton at Norfolk, Virginia, in 1912, in a field planting thinned in the usual manner to ordinary distances made an average yield of 909 pounds of seed cotton to the acre, while alternate rows that were thinned late and left with plants closer together yielded at a rate of 1,391 pounds, or about 53 per cent higher than the others. It is not clear from his results whether the increase in yield of the closely spaced cotton was due to the close spacing or late thinning, since there was not a check on the date of thinning or of the spacing. Cook has published other papers on this phase of cotton culture (27, 28, 29).

The Texas Agricultural Experiment Station included late or deferred thinning in the general work on the spacing of cotton which it began in 1914. The object of this work was to investigate farther the theory advanced by Cook and to determine its applicability to conditions in Texas. Results with late thinning, however, were not obtained until 1916.

The field work in comparing normal and deferred thinning of cotton consisted of two series of plats. The rate of thinning, or spacing, was the same on both series of plats. The time of thinning, however, was different, as stated below:

1. **Normal thinning.** The series was thinned at the normal or usual time of thinning cotton, which, in general, is done when the plants have four to six leaves.

2. **Deferred thinning.** This series was thinned when the plants were about 6 inches high, or at the time squares began to form.

All of the cultural methods, such as time and method of seed-bed preparation; time, method and rate of planting; varieties; and methods of cultivation, were the same for both series of plats. The only variable was the date of thinning.

Late thinning was done at four stations: Angleton, Beeville, Chillicothe, and College Station.

### Results at College Station

Table 32 gives the actual yields of lint obtained at College Station for three years, 1916, 1917, and 1919. In 1916, which was a favorable year for cotton production, thinning the cotton at the normal time produced decidedly large yields than deferred thinning. In 1917, which was an unusually dry year, the deferred thinning made the highest yields, particularly in the spacings from 6 to 18 inches, inclusive. During the season of 1919, slightly larger yields were made in the deferred thinning, the largest being obtained from the spacing of 9 inches. The 6-inch spacing gave the highest yield in the normal thinning.

As an average for the three years, 1916, 1917, and 1919, the 6-inch spacing in the normal thinning produced the highest actual yield, 210 pounds of lint to the acre. The 6-inch spacing also produced the highest yield, 203 pounds, in the late-thinned cotton. There is very little difference in the actual yields of the normal and deferred thinning where the plants are spaced 6 to 18 inches apart. Deferred thinning at greater distances, however, produced smaller average actual yields than the normal thinning. When the normal and deferred thinnings are compared on the basis of the relative yield, Table 33, the deferred thinning has a slight advantage, especially in the 6-inch, 9-inch, 12-inch, 15-inch, and 18-inch spacings. For the wider spacings the normal thinning produced significantly larger yields. These results show that plants should be thinned 6 to 18 inches apart at the usual time of thinning cotton.

TABLE 32.

Acre yield in pounds of lint cotton secured in normal and deferred thinning of cotton at the Main Station, College Station, 1916, 1917, and 1919.

One stalk to the hill.

| Spacing, inches between plants. | 1916 | | 1917 | | 1919 | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | | Deferred | |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank | Pounds | Rank |
| 3 | 363.68 | ..... | 41.93 | 37.79 | 184.59 | 79.75 | 196.73 | 2 | 58.77* | 12 |
| 6 | 339.29 | 326.39 | 54.64 | 73.54 | 236.84 | 211.06 | 210.25 | 1 | 203.66 | 1 |
| 9 | 338.02 | 258.83 | 58.77 | 84.54 | 168.09 | 248.18 | 188.29 | 3 | 197.18 | 3 |
| 12 | 318.19 | 281.18 | 66.96 | 84.54 | 175.82 | 180.81 | 186.99 | 4 | 182.17 | 5 |
| 15 | 278.94 | 288.06 | 60.63 | 96.93 | 181.84 | 206.93 | 173.80 | 5 | 197.30 | 2 |
| 18 | 286.34 | 216.20 | 77.00 | 88.33 | 130.97 | 263.65 | 164.74 | 6 | 189.39 | 4 |
| 21 | 252.07 | 206.93 | 55.68 | 39.18 | 161.56 | 139.21 | 156.43 | 8 | 128.44 | 8 |
| 24 | 256.76 | ..... | 60.71 | 40.54 | 154.68 | 80.09 | 157.38 | 7 | 60.31 | 11 |
| 27 | 233.91 | 172.21 | 64.61 | 41.25 | 123.06 | 118.93 | 140.52 | 11 | 110.79 | 10 |
| 30 | 251.74 | 247.50 | 61.18 | 39.18 | 140.76 | 147.46 | 151.22 | 9 | 144.71 | 7 |
| 33 | 283.25 | 265.01 | 63.06 | 48.79 | 78.02 | 61.87 | 141.44 | 10 | 125.22 | 9 |
| 36 | 256.95 | ..... | 56.37 | ..... | 105.79 | 176.68 | 139.70 | 12 | 176.68† | 6 |

*Average of two years. †One year only.

TABLE 33.

Relative yields of lint cotton secured in normal and deferred thinning of cotton at the Main Station, College Station, Texas, in 1916, 1917, and 1919.

One stalk to the hill.

| Spacing, inches between plants | 1916 | | 1917 | | 1919 | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 288.26 pounds =100% | | 60.13 pounds =100% | | 153.50 pounds =100% | | | | | |
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | | Deferred | |
| | % | % | % | % | % | % | % | Rank | % | Rank |
| 3 | 126 | ..... | 70 | 63 | 120 | 52 | 105 | 4 | 57 | 11 |
| 6 | 118 | 113 | 91 | 122 | 154 | 137 | 121 | 1 | 124 | 4 |
| 9 | 117 | 90 | 98 | 141 | 110 | 162 | 108 | 3 | 131 | 3 |
| 12 | 110 | 98 | 111 | 141 | 115 | 118 | 112 | 2 | 119 | 5 |
| 15 | 97 | 100 | 101 | 161 | 118 | 135 | 105 | 5 | 132 | 1 |
| 18 | 99 | 75 | 128 | 147 | 85 | 172 | 104 | 6 | 131 | 2 |
| 21 | 87 | 72 | 93 | 65 | 105 | 91 | 95 | 8 | 76 | 7 |
| 24 | 89 | ..... | 101 | 67 | 101 | 52 | 97 | 7 | 59 | 10 |
| 27 | 81 | 60 | 107 | 69 | 80 | 77 | 89 | 10 | 69 | 9 |
| 30 | 87 | 86 | 102 | 65 | 92 | 96 | 94 | 9 | 82 | 6 |
| 33 | 98 | 92 | 105 | 81 | 51 | 40 | 85 | 11 | 71 | 8 |
| 36 | 89 | ..... | 94 | ..... | 69 | 115 | 84 | 12 | ..... | ..... |

**Results at Substation No. 1, Beeville**

The results secured in comparing normal and deferred thinning at Beeville are given in Tables 34 and 35. Deferred thinning was conducted only 4 years, 1918, 1919, 1922, and 1923. All of the 12 spacings were not obtained in either the normal or the deferred thinning in any year of the test. In fact, the spacings occurred quite irregularly, which makes it rather difficult to reach any definite conclusion about the matter. Table 34 reports actual yields for the 4 years. In general the spacings in the normal thinning made slightly larger yields than the same spacings in the deferred thinning. In 1923, however, the 12-inch, 15-inch, and 18-inch spacings in the deferred thinning produced considerably more than the corresponding spacings of the normal thinning.

The average actual yields for the 4 years, 1918, 1919, 1922 and 1923, show that the normal thinning in general made significantly higher yields than the deferred thinning. The actual yields reported in Table 34 were converted into relative or comparative yields and are given in Table 35. When compared on this basis the cotton thinned at the normal time produced larger yields than where the thinning was deferred. While these results at Beeville cannot be stated as conclusive, they indicate that the normal thinning is superior to the deferred or late thinning. It has been shown previously in this Bulletin, page 23, that 21 inches is the optimum spacing for conditions at Beeville.

TABLE 34.

Acre yield in pounds of lint cotton secured in normal and deferred thinning of cotton at Substation No. 1, Beeville, Texas, 1918, 1919, 1922, and 1923.

| Spacing, inches between plants | 1918 | | 1919 | | 1922 | | 1923 | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | | Deferred | |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Rank | Pounds | Rank |
| 3 | 152.65 | 108.94 | 73.58 | 58.44 | ..... | ..... | ..... | ..... | 113.11 | 8 | 83.69 | 9 |
| 6 | 188.88 | 128.97 | 55.23 | 48.99 | 63.93 | 37.81 | ..... | ..... | 102.68 | 9 | 71.92 | 10 |
| 9 | 217.38 | ..... | 54.33 | 46.20 | 49.50 | 59.81 | 337.50 | 287.50 | 164.67 | 1 | 131.17 | 5 |
| 12 | 121.04 | 157.94 | 56.44 | 49.34 | 64.85 | 62.21 | 275.00 | 312.50 | 129.33 | 7 | 145.49 | 3 |
| 15 | 210.46 | 169.52 | 38.70 | ..... | 79.06 | 57.06 | 304.16 | 362.50 | 158.09 | 2 | 196.36 | 1 |
| 18 | 133.50 | 66.94 | 49.44 | 55.48 | ..... | 66.00 | 246.87 | 258.33 | 143.27 | 3 | 111.68 | 6 |
| 21 | 68.46 | 56.26 | 51.25 | ..... | ..... | ..... | 275.00 | 250.00 | 131.57 | 6 | 153.13 | 2 |
| 24 | 74.94 | 65.52 | ..... | 38.77 | 73.56 | 79.06 | 252.50 | 237.50 | 133.66 | 4 | 105.20 | 7 |
| 27 | 71.14 | ..... | 30.46 | ..... | 86.85 | 68.89 | ..... | ..... | 62.81 | 11 | 68.89 | 11 |
| 30 | ..... | 64.31 | 59.68 | 68.82 | ..... | 66.00 | ..... | 337.50 | 59.68 | 12 | 134.15 | 4 |
| 33 | 80.88 | ..... | 57.05 | ..... | 76.31 | 90.75 | 312.50 | ..... | 131.68 | 5 | 90.75 | 8 |
| 36 | ..... | ..... | ..... | ..... | 96.25 | ..... | ..... | ..... | 96.25 | 10 | ..... | ..... |

TABLE 35.

Relative yields of lint cotton secured in normal and deferred thinning of cotton at Substation No. 1, Beeville, Texas, 1918, 1919, 1922, and 1923.

| Spacing, inches between plants | 1918 | | 1919 | | 1922 | | 1923 | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 131.93 pounds =100% | | 52.62 pounds =100% | | 73.79 pounds =100% | | 286.22 pounds =100% | | Normal | | Deferred | |
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | | | | |
| | % | % | % | % | % | % | % | % | % | Rank | % | Rank |
| 3 | 116 | 83 | 140 | 111 | ..... | ..... | ..... | ..... | 128 | 1 | 97 | 3 |
| 6 | 143 | 98 | 105 | 93 | 87 | 51 | ..... | ..... | 112 | 4 | 81 | 7 |
| 9 | 165 | ..... | 103 | 88 | 67 | 81 | 118 | 100 | 113 | 2 | 90 | 5 |
| 12 | 92 | 120 | 107 | 94 | 88 | 84 | 96 | 109 | 96 | 5 | 102 | 2 |
| 15 | 160 | 128 | 74 | ..... | 107 | 77 | 106 | 127 | 112 | 3 | 111 | 1 |
| 18 | 101 | 51 | 94 | 105 | ..... | 89 | 86 | 90 | 94 | 7 | 84 | 6 |
| 21 | 52 | 43 | 97 | ..... | ..... | ..... | 96 | 87 | 82 | 8 | 65 | 9 |
| 24 | 57 | 50 | ..... | 74 | 100 | 107 | 88 | 83 | 82 | 9 | 78 | 8 |
| 27 | 54 | ..... | 58 | ..... | 118 | 93 | ..... | ..... | 77 | 10 | ..... | ..... |
| 30 | ..... | 49 | 113 | 131 | ..... | 89 | ..... | 118 | ..... | ..... | 97 | 4 |
| 33 | 61 | ..... | 108 | ..... | 103 | 123 | 109 | ..... | 95 | 6 | ..... | ..... |
| 36 | ..... | ..... | ..... | ..... | 130 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

### Results at Substation No. 3, Angleton

Deferred or late thinning of cotton was compared with normal thinning at Angleton for the 5 years, 1920 to 1924, inclusive. The results secured during this period are stated in Tables 36 and 37. During these 5 years there were only five instances in which any spacing in the deferred thinning produced larger yields than the corresponding spacing in the normal thinning. The 3-inch and 6-inch spacings in 1921, the 33-inch spacing in 1923, and the 9-inch and 15-inch spacings in 1924, in the deferred thinning made larger yields than the corresponding spacings in the normal thinning. In these five instances the larger yields of the deferred thinning are not significant.

The average actual yields for the 5 years, Table 36, show that cotton thinned at the normal time has produced larger yields than cotton thinned late. In fact, for the 3 years, 1922, 1923, and 1924, the lowest average yield in the normal thinning was about the same as the highest yield, 148 pounds of lint to the acre, of the deferred thinning. The actual yields reported in Table 36 were converted into relative yields, which are set forth in Table 37. The highest average relative yield was obtained from the 6-inch and 9-inch spacings of the normal thinning. In the deferred thinning, the 6-inch and 9-inch spacings also made the highest yields. The results at Angleton show conclusively that normal thinning has given the highest yields and that the plants should be spaced 6 to 18 inches apart in ordinary rows for maximum production.

TABLE 36.

Acre yields of lint cotton secured in normal and deferred thinning of cotton at Substation No. 3, Angleton, Texas, 1920 to 1924, inclusive.

| Spacing, inches between plants | 1920 | | 1921 | | 1922 | | 1923 | | 1924 | | Average yields for 1922-23-24 | | Average yields for All years | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds |
| 3 | ..... | ..... | 40.81 | 50.98 | 134.68 | 129.36 | 43.16 | 19.60 | 294.03 | 293.37 | 157.29 | 147.44 | 128.17 | 123.32 |
| 6 | 396.08 | 299.11 | 51.31 | 52.66 | 151.64 | 103.16 | 67.89 | 35.28 | 323.84 | 303.77 | 181.12 | 147.40 | 198.15 | 158.79 |
| 9 | 358.13 | ..... | 84.59 | 60.85 | 171.22 | 110.87 | 64.30 | 50.66 | 311.30 | 314.38 | 182.27 | 158.63 | 197.90 | 134.19 |
| 12 | 319.80 | 258.48 | 77.59 | 63.37 | 163.94 | 95.70 | 50.92 | 31.18 | 330.35 | 311.85 | 181.73 | 146.24 | 188.52 | 152.11 |
| 15 | 325.62 | 264.75 | 94.49 | 60.43 | 160.07 | 112.64 | 40.92 | 30.71 | 301.13 | 306.04 | 167.37 | 149.79 | 184.44 | 154.91 |
| 18 | 323.83 | 270.79 | 106.85 | 49.89 | 178.26 | 98.00 | 38.30 | 30.29 | 297.08 | 291.96 | 171.21 | 140.08 | 188.86 | 148.18 |
| 21 | 346.36 | 215.52 | ..... | 50.74 | 168.43 | 76.63 | 37.66 | 25.80 | 319.99 | 280.01 | 175.36 | 127.48 | 218.11 | 129.74 |
| 24 | 302.39 | 257.11 | ..... | ..... | 196.83 | 69.41 | 24.15 | 23.07 | 322.43 | 260.94 | 181.13 | 117.80 | 211.45 | 152.63 |
| 27 | 337.98 | 198.39 | ..... | ..... | 227.94 | 89.25 | 37.20 | 23.78 | 330.02 | 268.99 | 198.38 | 127.34 | 233.28 | 145.10 |
| 30 | 315.30 | 190.14 | ..... | ..... | 199.05 | 76.53 | 27.08 | 15.59 | 343.53 | 264.28 | 189.88 | 118.80 | 221.24 | 136.63 |
| 33 | 331.14 | ..... | ..... | ..... | 201.98 | 66.20 | 23.60 | 24.02 | 334.55 | 265.58 | 186.71 | 118.60 | 222.81 | 118.60 |
| 36 | ..... | ..... | ..... | ..... | 195.27 | 65.15 | 21.80 | 18.59 | 328.94 | 249.87 | 182.00 | 111.20 | 182.00 | 111.20 |
| Average | 335.66 | 244.28 | 75.94 | 55.56 | 179.10 | 91.07 | 39.74 | 27.38 | 319.76 | 284.25 | | | | |

TABLE 37.

Relative yields of lint cotton secured in normal and deferred thinning of cotton at Substation No. 3, Angleton, Texas, 1920 to 1924, inclusive.

| Spacing, inches between plants | 1920 | | 1921 | | 1922 | | 1923 | | 1924 | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 335.66 pounds =100% | | 75.94 pounds =100% | | 179.10 pounds =100% | | 39.74 pounds =100% | | 319.76 pounds =100% | | 1922-23-24 | | All years | |
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred |
| | % | % | % | % | % | % | % | % | % | % | % | % | % | % |
| 3 | ..... | ..... | 54 | 67 | 75 | 72 | 109 | 49 | 92 | 92 | 92 | 71 | 82 | 70 |
| 6 | 118 | 89 | 68 | 69 | 85 | 58 | 171 | 89 | 101 | 95 | 119 | 81 | 109 | 80 |
| 9 | 107 | ..... | 111 | 80 | 96 | 62 | 162 | 127 | 97 | 98 | 118 | 96 | 115 | 92 |
| 12 | 95 | 77 | 102 | 83 | 92 | 53 | 128 | 78 | 103 | 98 | 108 | 76 | 104 | 78 |
| 15 | 97 | 79 | 124 | 80 | 89 | 63 | 103 | 77 | 94 | 96 | 95 | 79 | 101 | 79 |
| 18 | 96 | 81 | 141 | 66 | 100 | 55 | 96 | 76 | 93 | 91 | 96 | 74 | 105 | 74 |
| 21 | 103 | 64 | ..... | 67 | 94 | 43 | 95 | 65 | 100 | 88 | 96 | 65 | 98 | 65 |
| 24 | 90 | 77 | ..... | ..... | 110 | 39 | 61 | 58 | 101 | 82 | 91 | 60 | 90 | 64 |
| 27 | 101 | 59 | ..... | ..... | 127 | 50 | 94 | 60 | 103 | 84 | 108 | 65 | 106 | 63 |
| 30 | 94 | 57 | ..... | ..... | 111 | 43 | 68 | 39 | 107 | 83 | 95 | 55 | 95 | 56 |
| 33 | 99 | ..... | ..... | ..... | 113 | 37 | 59 | 60 | 105 | 83 | 92 | 60 | 94 | 60 |
| 36 | ..... | ..... | ..... | ..... | 109 | 36 | 55 | 47 | 103 | 78 | 89 | 54 | 89 | 54 |

### Results at Substation No. 12, Chillicothe

Work in comparing normal and deferred thinning of cotton was conducted at Chillicothe in 1919, 1920, 1921, 1923, and 1924. Only five spacings, 6, 12, 18, 24, and 30 inches were used. The actual yields of lint obtained are given in Table 38. The most striking feature of the results is that in the normal thinning the average yield for the 5 years increased as the spacing increased. The 30-inch spacing of the normal thinning made a higher average yield, 317 pounds of lint to the acre, than any other treatment in the experiment. In the deferred thinning, the 18-inch spacing produced the highest average yield, 305 pounds of lint to the acre. In every spacing the normal thinning produced a higher average yield for the 5 years than the deferred thinning, except in the 12-inch spacing, where the two kinds of thinning produced equal yields.

The relative yields, obtained from the yields of lint in Table 38, are given in Table 39. The 30-inch spacing in the normal thinning made the highest average yield. The 18-inch, 24-inch, and 30-inch spacings in the normal thinning produced larger yields than any spacing in the deferred thinning. In the deferred thinning, the 18-inch spacing gave the highest average yield. This indicates that if deferred thinning is used the plants should be placed closer than if thinning is done at the normal or usual time of chopping cotton. These results show that cotton thinned at the normal time produced slightly larger yields than cotton thinned later and that spacings varying from 18 to 30 inches gave better results than closer spacing under conditions at Chillicothe.

TABLE 38.

Acre yield in pounds of lint cotton secured in normal and deferred thinning of cotton at Substation No. 12, Chillicothe, Texas, 1919 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1919 | | 1920 | | 1921 | | 1922 | | 1924 | | Average for all years tested | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Norma | Deferred | Normal | Deferred |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds |
| 6 | 315.35 | 297.00 | 345.21 | ..... | 297.63 | ..... | 114.75 | 115.70 | 277.29 | 275.27 | 270.04 | 229.32 |
| 12 | 389.35 | 354.85 | 345.01 | 390.60 | 327.75 | 312.64 | 123.60 | 133.20 | 304.37 | 300.76 | 298.01 | 298.41 |
| 18 | 370.35 | 372.10 | 381.31 | 405.84 | 324.64 | 310.31 | 140.64 | 136.80 | 322.60 | 301.73 | 307.90 | 305.35 |
| 24 | 345.40 | 316.30 | 399.66 | 361.30 | 319.97 | 305.41 | 142.50 | 142.55 | 338.12 | 304.58 | 309.13 | 286.02 |
| 30 | 347.75 | 337.20 | 395.06 | 387.13 | 333.57 | 304.07 | 152.65 | 136.15 | 358.69 | 300.15 | 317.54 | 292.94 |

TABLE 39.

Relative yields of lint cotton secured in spacing experiments with cotton at Substation No. 12, Chillicothe, Texas, 1919 to 1924, inclusive.

One stalk to the hill.

| Spacing, inches between plants | 1919 | | 1920 | | 1921 | | 1922 | | 1924 | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 353.64 pounds =100% | | 373.25 pounds =100% | | 320.71 pounds =100% | | 134.82 pounds =100% | | 320.21 pounds =100% | | | |
| | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred | Normal | Deferred |
| | % | % | % | % | % | % | % | % | % | % | % | % |
| 6 | 89 | 84 | 92 | ..... | 93 | ..... | 85 | 86 | 87 | 86 | 89 | 85 |
| 12 | 110 | 100 | 92 | 105 | 102 | 97 | 92 | 99 | 95 | 94 | 98 | 99 |
| 18 | 105 | 105 | 102 | 109 | 101 | 97 | 104 | 101 | 101 | 94 | 103 | 101 |
| 24 | 98 | 89 | 107 | 97 | 100 | 95 | 106 | 106 | 106 | 95 | 103 | 96 |
| 30 | 98 | 95 | 106 | 104 | 104 | 95 | 113 | 101 | 112 | 94 | 107 | 98 |

## Discussion of Results

The results secured in comparing normal and deferred thinning of cotton show in general that normal thinning produced larger yields than deferred thinning. These results are in accord with contemporaneous work on this phase of cotton culture. Ayres in Arkansas (9, 10) and later in Mississippi (11, 12); Brown and Ames (21) and Brown (22, 23) in Mississippi; McClelland (63) in Georgia; Garrett (45) and Hester (53) in Louisiana; and Hall and Armstrong (49) in South Carolina, who worked with normal and late thinning of cotton, during the time covered by the work in Texas, have reported results similar to those obtained at this Station. Letteer (60, 61) at San Antonio, Texas, also obtained better results with early thinning.

Cook in Virginia (25, 28), Cardon in Louisiana, Arkansas, and North Carolina (24), Blair in California (19), Meade in Texas (67), and Hastings in Texas (51) have reported results showing that late thinning of cotton gave larger yields than cotton thinned at the usual time. Usually they had two series of plats, one with plants closely spaced and thinned late, and the other with plants spaced widely and thinned early. In most cases they did not have any checks on the date of thinning or of the spacing. At that time it was not clear from their results whether the larger yields of the late-thinned cotton were due to the late thinning or to the closer spacing, since they had no check on either the date of thinning or of the spacing.

The results secured at this Station show conclusively that early-thinned cotton produced larger yields than late-thinned cotton. In comparing these results with those of Cook, Cardon, Blair, Meade, and Hastings, it appears that the larger yields they obtained from the "single-stalk" method resulted from the close spacing rather than the late thinning, since the work at this Station shows that closely spaced cotton thinned early produced larger yields than similarly spaced cotton thinned late. In studying "single-stalk cotton culture" and widely spaced cotton, Ricks and Brown in Mississippi (107) obtained larger yields with the "single-stalk" method. In the rows with wide-spaced plants there were 54.9 plants to the row and 95.6 plants to the row in the "single-stalk" rows. They were of the opinion that the larger yields of the "single-stalk" method were due to the close spacing, since previous work at the Mississippi Station covering a period of eight years had shown that close spacing had given larger yields than wide spacing.

A careful review of the literature and an analysis of the data presented on late or deferred thinning do not show any experimental evidence that late thinning of cotton increases the yield as compared with normal thinning. Present knowledge indicates that the usual or normal time of thinning as now commonly practiced is safer, and that the spacing should be that found best under the particular conditions under consideration.

## SUMMARY

In these experiments it was found that close to medium spacing, 6 to 21 inches, produced the largest yields in general in the different parts of the State, except in eastern Texas on the sandy lands, where comparatively wide spacing, 27 to 30 inches, gave the best results. Twelve inches was the optimum spacing at Angleton, Spur, and Lubbock; 9 to 12 inches at College Station; 21 inches at Beeville and Temple; 27 inches at Nacogdoches; and 30 inches at Troup and Chillicothe. A satisfactory range of spacing, in addition to the optimum spacing, is given for each substation.

These results show that the cotton plant has the ability to adjust itself to produce satisfactory yields within a comparatively wide range of spacing.

In general early-thinned cotton produced larger yields than late-thinned cotton. At Angleton and Beeville early-thinned cotton produced decidedly larger yields than late-thinned cotton. No evidence was obtained to show that late thinning of cotton is better practice than early thinning as now commonly practiced.

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The author appreciates the opportunity to use the data.

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