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(In cooperation with Bureau of Agricultural Engineering,
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Association; and the Joint Committee on Fertilizer Application)

MACHINE PLACEMENT OF FERTILIZER FOR COTTON



AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

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TEXAS AGRICULTURAL EXPERIMENT STATION

MACHINE PLACEMENT IN
ENTRANCE FOR COTTON

THE AGRICULTURAL EXPERIMENT STATION OF THE TEXAS AGRICULTURAL MECHANICAL COLLEGE

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Agricultural & Mechanical College of Texas

College Station, Texas

The placement of fertilizer in relation to the cottonseed at the time of planting has a profound influence on the germination of the seed. If the fertilizer is placed too near, germination is delayed and the total number of seedlings obtained will be considerably reduced.

Experiments were made at Bryan, Temple, College Station, and Nacogdoches from 1932 to 1935 to determine the effect on germination and yield when fertilizer is placed under the seed in narrow and wide bands at different depths, when applied at different depths and distances to the side of the seed, when some of the fertilizer is applied in the furrow with the seed, and when fertilizer is applied at different rates per acre and different places in relation to the seed.

The results show that of all placements of fertilizer the best germination of cottonseed and the highest yields were obtained when the fertilizer was placed to the sides and below the seed level. The location of the fertilizer in relation to the seed affected germination more than it did yield. When the fertilizer was placed within one inch of the seed, germination was injured, as it was too close.

More plants were obtained where one-fourth of the fertilizer was applied in the surface soil over the seed and the balance 2.5 inches to each side and 2 inches below the seed level, but a higher yield was obtained where one-eighth of the fertilizer was applied with the seed and the balance 3.5 inches to each side and 2 inches below the seed level.

When results of applying fertilizer in both wide and narrow bands directly under the seed were compared, the three-inch depth gave the highest number of seedlings for both width bands, but the two-inch depth gave the highest yield for the narrow bands and the one-inch depth for the wide bands.

For 250-, 500-, and 750-pound rates the 500-pound rate applied in bands 2.5 inches to each side and 2 inches below the seed level gave the largest number of plants, but the 750-pound rate applied 3.5 inches to each side and 2 inches below the seed level gave the highest yield.

No significant difference in yield was obtained where all of the fertilizer was placed on one side of the seed or where it was divided and equal amounts placed on each side of the seed. The highest yield of 326 pounds of lint per acre was obtained for the one-side placement, as compared with 312 pounds for the placement to each side.

When compared with the two unfertilized checks, which yielded 239 and 257 pounds of lint per acre, the results show a significant increase from the use of fertilizer for both the one-side and the each-side placements when all four locations are considered. Better response from the use of fertilizer was obtained at College Station and Nacogdoches than at Bryan in the Brazos River Bottoms, and at Temple.

Disturbing the soil at any depth under the seed without applying fertilizer reduced the final stand of plants as compared with the stand obtained where the soil was undisturbed for a distance of 2.5 and 3.5 inches to each side of the row and no fertilizer applied.

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MACHINE PLACEMENT OF FERTILIZER FOR COTTON

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**Texas Agricultural Experiment Station in cooperation with
Bureau of Agricultural Engineering, U. S. Department of Agriculture;
the National Fertilizer Association; and the Joint Committee
on Fertilizer Application.**

The poor stands obtained and slow germination of cottonseed have often been attributed to poor seed or some other similar factor, while in fact they may have been due to improper placement when applying the fertilizer. Fertilizer attachments on many cotton planters distribute the fertilizer in such a way that a large percentage of it is either in direct contact with the cottonseed or close enough to injure them.

Consequently, to determine the best placement of fertilizer for obtaining the most rapid emergence and the highest percentage of germination of cottonseed, numerous tests were conducted with the fertilizer applied at various positions in relation to the seed. Data were collected on both the emergence of seedlings and the yield.

These tests were conducted for a five-year period, beginning in 1931 and ending in 1935. Tests were planted at both College Station and Temple in 1931, but on account of the poor stands obtained, the data for that year are not included in this report.

In Texas it is the common practice to apply most of the fertilizer

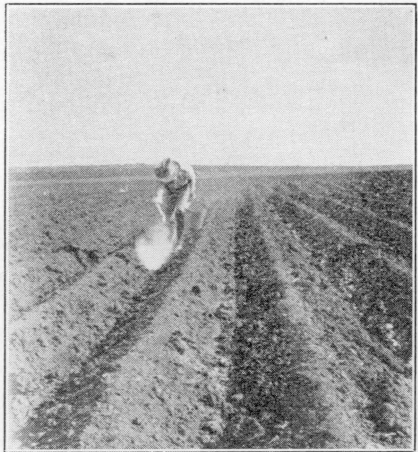


Figure 1. Distributing fertilizer by hand in lister furrow. Land is relisted to form ridges over fertilizer and so fertilizer will be under the seed.

*Credit is due G. A. Cumings of the Bureau of Agricultural Engineering, U. S. Department of Agriculture, for designing the experimental machine used and for his suggestions and coordination of the tests in Texas with the tests in other states; to W. H. Redit of the Bureau of Agricultural Engineering and A. L. Sharp, formerly of the Bureau of Agricultural Engineering, for their assistance in planting the tests; to H. R. Smalley of the National Fertilizer Association for his assistance in planning the work and cooperation by furnishing the fertilizer used; to George Chance of Bryan and Bob Haney of Nacogdoches for their cooperation in the tests that were conducted on their farms; and to Henry Dunlavy, Superintendent of Substation No. 5 until January 1937, for assistance in collecting the data at Temple.

either before planting or at the time of planting. A small amount may be applied as a side dressing later in the season.

When the fertilizer is applied before planting, two methods are used: first, the fertilizer is distributed by hand in the furrow, as shown in

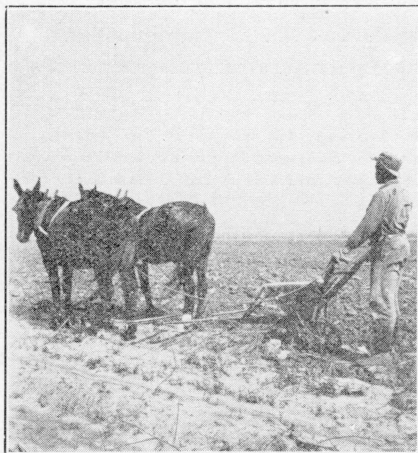


Figure 2. Placing fertilizer in ridges with vibrator type distributor. Seed are planted later.

the third method places the fertilizer in a position where it may injure and delay germination of the seed.

Figure 1, and the seed bed formed over the fertilizer; second, the ridge for the seed bed is thrown up either by a middlebreaker or by a turning plow and the fertilizer placed in the ridge by a walking fertilizer distributor, as shown in Figure 2. To apply fertilizer at the time of planting a special fertilizer attachment is mounted on the planter. Figure 3 shows a one-row riding planter equipped with a fertilizer attachment. This type of attachment usually distributes the fertilizer either ahead or to the side of the seed-furrow opener and, as a consequence, the fertilizer is mixed in the surface soil over the seed.

The first two methods call for much extra time and labor, while

REVIEW OF LITERATURE

Among the first investigations by Lee (3) of the North Louisiana Experiment Station was a test started in 1888 and continued until 1892 to determine the effects of different modes of applying fertilizer. He found that better yields were obtained when fertilizer was applied at a depth of from two to three inches under the seed. He also found that fertilizer applied shallow and as a top dressing interfered with the germination of cottonseed.

Redding (8) and Lee (3) found that when cottonseed meal was applied in direct contact with the seed, germination was impaired.

Musgrave and Coe (5) found that direct contact of fertilizer with the seed or below the seed injured germination more than applications at the side of the seed row and at the same level as the seed.

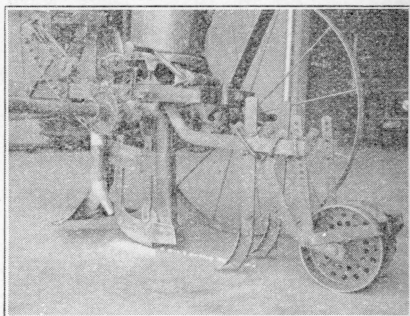


Figure 3. One-row riding planter equipped with fertilizer attachment; illustrating point where fertilizer is usually placed in relation to sweep, seed furrow opener, and covering shovels.

Cumings (1 and 2) found that fertilizer applied at shallow depths near the seed either below or at short distances to the side caused injury to germination.

The Joint Committee on Fertilizer Application (7) published results of a canvass among fertilizer manufacturers showing complaints made by farmers who used equipment that placed the fertilizer near the seed and caused injury to germination.

Cumings (1) reported in 1931 that experiments conducted at South Carolina made the greatest yields of cotton with fertilizer placed closest to the seed without encountering injury to germination.

McBryde (4) in 1891 and 1892 found that moderate amounts of fertilizer were more effective when used in the drill than when broadcast.

Experiments conducted by Musgrave and Coe (6) indicated that the position to the side of the seed appeared to be an ideal location for the most effective results from the use of any fertilizer material.

SCOPE OF EXPERIMENTS

Machine placement of fertilizers with cotton in Texas was studied at four locations: Bryan in the Brazos River bottoms on Yahola clay, Temple on Houston black clay, College Station on Lufkin fine sandy loam, and Nacogdoches on Norfolk sandy loam. These experiments covered a period of four years, 1932 to 1935, at Bryan, College Station, and Nacogdoches. At Temple the experiments were conducted during the three years from 1932 to 1934.

Soil Types

The surface soil of Yahola clay is a dark chocolate-red or reddish-brown, calcareous silty clay. The subsoil is, on the whole, lighter in texture than the surface material. The surface soil is plastic when wet and has a tendency to clod and crust when too rapid drying takes place. After rains on freshly worked soil a thick, hard crust forms, making it difficult for cotton seedlings to emerge. Each year there was sufficient rainfall after the test was planted to form a hard crust on the surface of the soil. The machine placement of fertilizers with cotton was conducted for the first three years on the heavy Yahola clay, but in 1935 the test was on a soil having a higher percentage of sand.

Houston black clay is black, very dark gray, or dark brown heavy clay. The subsoil is a yellowish-gray, greenish-yellow, or greenish-brown clay. In some areas both the topsoil and subsoil are highly calcareous. The surface soil is very plastic and tenacious when wet, but upon drying assumes an ashy color and crumbles to a desirable tilth if cultivated when moisture conditions are suitable. Rains cause a crust to form on the surface, but upon drying the crust cracks and crumbles sufficiently to permit the emergence of cotton seedlings.

Lufkin fine sandy loam is a grayish-brown or gray, rather compact, fine sandy loam underlain by a highly plastic and impervious clay subsoil. It has a smooth soapy feel and is sticky when wet but very hard and

tough when dry. The soil has very slow underdrainage, and on smooth flat areas it remains wet for long periods. As a result, the soil warms up slowly in the spring. When dry it is rather difficult to work, and after rains a hard crust forms on the surface, making it difficult for cotton seedlings to emerge.

The Norfolk soils are gray on the surface with a yellow subsurface color. The topsoil layers are friable or loose and merge below either with yellow friable sandy clay or loose very sandy material. The soils and subsoils are readily penetrated by water, and both surface and underdrainage are good. Even on the sandy loam a hard crust forms after rains, making the emergence of seedlings difficult.

Fertilizers

The fertilizer used in the machine placement studies with cotton was a 4-12-4 mixture purchased by the National Fertilizer Association on the local market and was typical of that used in farm practice. In 1932 and 1933 double strength fertilizer mixtures were used in the rate studies.

Table 1. Number of cottonseed planted in 50 feet of row

Location	1932	1933	1934	1935
Bryan	1550	667	857	600
Temple	625	582	500	
College Station	682	667	750	789
Nacogdoches	682	612	682	667

Table 2. Planting depth and spacing of cottonseed

Location	1932		1933		1934		1935	
	Planting depth in in.	Seed spacing in in.	Planting depth in in.	Seed spacing in in.	Planting depth in in.	Seed spacing in in.	Planting depth in in.	Seed spacing in in.
Bryan	1.5-2	.46	2.5	.9	1-1.5	.7	2	1
Temple	2.5-3	.96	3-3.5	1.03	2.5-3	1.2		
College Station	1-1.5	.88	1.5-2	.9	1.25-1.5	.8	1.75	.76
Nacogdoches	1	.88	.5-1	.98	.75-1	.8	1.5	.9

The amount used was equivalent to 250, 500, and 750 pounds of ordinary strength 4-12-4 fertilizer. At the time of distribution the fertilizer was in good physical condition and drilled well.

Seed

An effort was made at each location to plant varieties of cotton that produced well. At Bryan in the Brazos River bottoms Missdel cotton was used for the four years, and at Temple Qualla cotton was used for

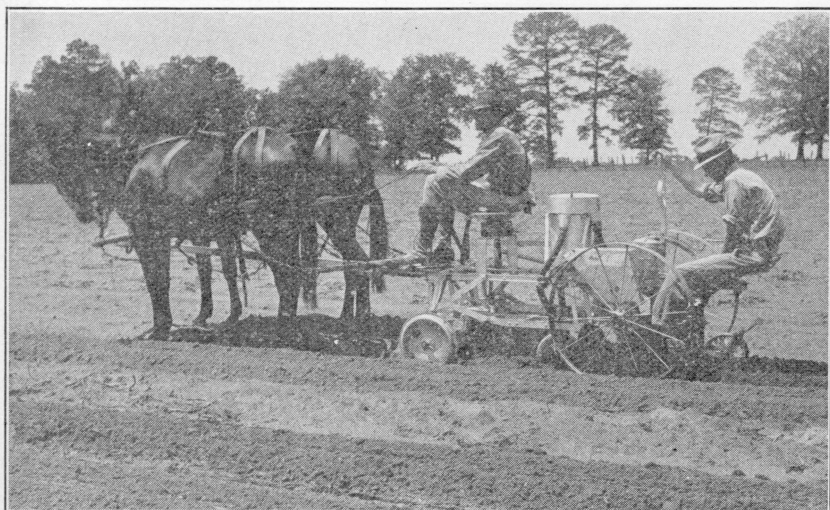


Figure 4. Side view of special combination planter and fertilizer distributor, built under the general specifications of the Bureau of Agricultural Engineering of the U. S. Department of Agriculture for fertilizer placement experiments with cotton in Texas. Note that the driver can give full attention to the team and adds weight to front of planter, while the man in the rear is free to watch operation of various planter parts and adds weight to rear of machine.

the three years. The Startex variety was used each year at College Station. At Nacogdoches Lone Star was used in 1932 and 1933, Acala in 1934, and Startex in 1935. At all locations ordinary gin-run fuzzy seed were used each year except in 1932, when mechanically delinted seed were used at Bryan. Each year at each location the cottonseed were treated with Ceresan at the rate of three ounces per bushel of seed. Table 1 shows the calculated number of seed planted at each location each year. Table 2 shows the depth and spacing at which the seed were planted.

PLACEMENT MACHINE

In studying the effect of the placement of fertilizer it is necessary that the relative positions of fertilizer and seed be accurately controlled. The amount of fertilizer and the quantity of seed distributed, width of fertilizer bands, depth and compactness of soil over the seed, general level of the final seed bed, and other seed bed conditions must be uniform throughout the experiment. A machine designed by the Bureau of



Figure 5. Rear view of special planter and fertilizer distributor, showing how top of ridge on seed bed is knocked off and how seed bed is left after all operations have been performed.

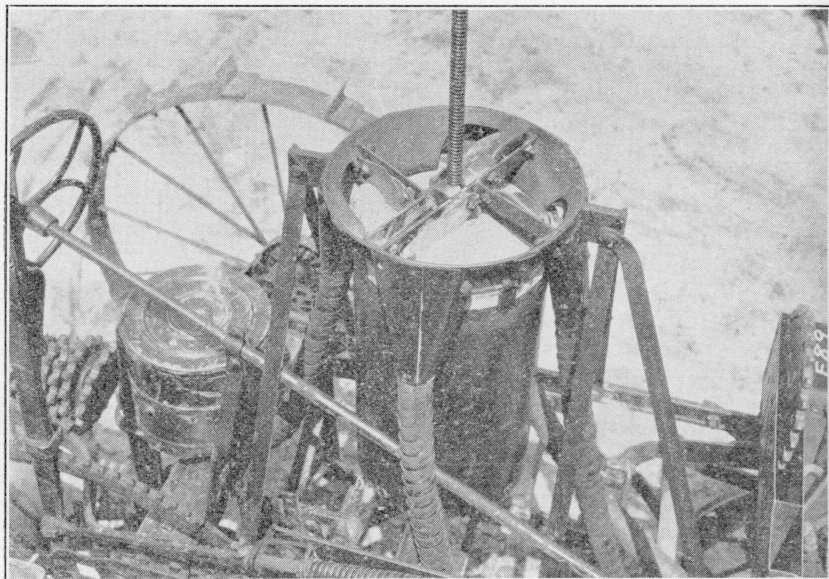
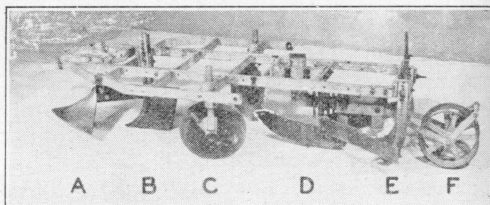


Figure 6. Top-delivery hopper showing arrangement for delivering fertilizer to as many as four spouts simultaneously.

Agricultural Engineering of the U. S. Department of Agriculture was used in the fertilizer placement studies in Texas (Figures 4 and 5). It was designed to meet the varied requirements of the tests under different farm practices and soil conditions and to plant and distribute the cottonseed and fertilizer on ridges. It has numerous attachments and adjustments so that the placement of fertilizer in relation to the seed can be accurately controlled. The machine is of the four-wheel type, which permits rigid construction and arrangement of attachments for accurate relative placements of fertilizer and seed. It was drawn by two mules.



The cotton-dropping device is of the cell-drop type, having the hopper mounted to the rear of the fertilizer hopper and in front of the operator's seat. Provision is made for changing the rate of seed distribution to suit the soil type and conditions.

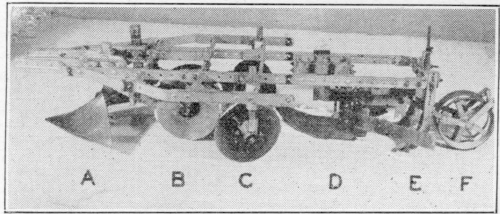
Figure 7. Subframe of distributor equipped to place a band of fertilizer under the seed: A, sweep to knock off top of seed bed; B, shovel to open fertilizer furrow; C, bedding disks; D, seed shoe or furrow opener; E, covering shovels; F, press wheel.

The fertilizer-dispensing mechanism is of the top-delivery rotating-cylinder type, as shown in Figure 6. The hopper is equipped with three delivery openings and tubes. The tubes are flexible and their length such that fertilizer can be directed to any point about the seed. Fertilizer

can be delivered through one or more tubes simultaneously and in varying proportions. The fertilizer is distributed to the various tubes by blades scraping over the surface of the fertilizer as the hopper containing it rotates. As the hopper rotates, a threaded rod through the center raises the bottom of the hopper and slowly lifts the fertilizer. Consequently, an accurate amount of fertilizer is delivered uniformly to each tube, which conveys it to the soil.

All the soil-working tools are mounted on a subframe (Figures 7 and 8) which can be raised or lowered without change of inclination or the general relationship of the various tools. At the front of the subframe is a standard on which a large sweep is mounted to remove the surface soil from the seed bed or ridge. Just to the rear of this sweep are

mounted the fertilizer openers, which may consist either of shovels for placing the fertilizer under the seed or disks for placing it to the side of the seed. On each side and slightly to the rear of the fertilizer opening tools are bedding disks to reshape the seed bed and fill up the furrows formed by the fertilizer opening tools. In the center and under the rear axle a curved



runner seed furrow opener is placed to open the furrow for the seed. To the rear of the furrow opener are placed shovels and a press wheel for covering and compacting the soil over the seed.

Figure 8. Subframe of distributor equipped to place bands of fertilizer either to one or both sides and below the seed level: A, sweep to knock off top of seed bed; B, pair of single disks to open furrows for fertilizer; C, bedding disks; D, seed shoe or furrow opener; E, covering shovels; F, press wheel.

As all of these soil-working tools are mounted on a subframe, they are raised and lowered together without changing their relative positions. Any one of the units can be adjusted independently in order to meet various seed bed conditions. For example, the shovels for placing the fertilizer under the seed (Figure 7) can be adjusted to place it in bands at depths of one, two, three, or four inches. Shields are attached to each side of the shovel to prevent soil from falling back into the furrow and to hold the lower end of the fertilizer tubes. A narrow shovel 1.75 inches in width and a wide shovel 3.5 inches in width are used in placing the fertilizer under the seed. When the fertilizer is mixed with the soil, extra small mixing shovels follow in the furrows behind the fertilizer furrow openers.

For placements to the side of the seed (Figure 8) a pair of single disks are used to open the furrows for the fertilizer. The fertilizer tubes are attached at the rear of the disks to direct the fertilizer to the bottom of the furrow. These disks are ordinary grain drill furrow-opener disks with the boot attached. The lower end of the flexible fertilizer tube is inserted in the top of the boot, thus permitting the fertilizer to flow directly through the boot to the bottom of the furrow made by the disk.

The disks are adjustable both laterally and vertically for obtaining various side placements.

When fertilizer is placed part with the seed and the balance at other points, three fertilizer distributing tubes are used simultaneously. Two



Figure 9. Cotton seedlings breaking through soil crust at Nacogdoches on April 29, 1935: A, row where fertilizer was applied 1.5 inches to one side and 2 inches below seed level; B, fertilizer applied 3.5 inches to one side and 2 inches below seed level.

of the tubes place the fertilizer either under or to the sides of the seed, and the other dispenses fertilizer in the furrow with the cottonseed.

It is understood, of course, that a practical improved machine for the farmer would not require many of the adjustments and special features of this machine, which was designed for experimental purposes. Attachments for planters are being placed on the market which place the fertilizer to the side and below the seed level.

SEASONAL CONDITIONS AND RAINFALL

The amount of moisture in the soil at the time cottonseed are planted and the rainfall directly following the planting of the seed often have considerable effect on the germination and emergence of cottonseed and seedlings. From a study of Table 3 it can be seen that in most cases light to heavy rains fell within a few days after the tests were planted.

This condition occurred each year at Bryan in the Brazos River bottoms, causing a hard crust to form on the surface of the soil which prevented the emergence of seedlings from many seed that germinated. This, of course, caused the percentage of germination to be rather low for the years 1932, 1933, and 1934. In 1935, however, rain was frequent enough to keep the soil sufficiently damp for seedlings to break through readily. In 1935 a rotary hoe was run over the seed bed just as the seedlings were beginning to emerge freely. As a consequence, a higher percentage of emergence was secured than during the three previous years.

On the black clay soils at Temple light rains fell soon after planting, but the soil crust cracked sufficiently to permit most seedlings to emerge.

At College Station on the Lufkin fine sandy loam rainfall was sufficient each year to cause a hard crust to form on the surface. This crust prevented many seedlings from emerging from seed that had germinated. When the rain fell at the time the young seedlings were in the "crook," there was a tendency for the soil crust to form around them and cement

them in so tightly that they could not break through. In 1933 a spiked-tooth harrow was dragged over the test to break the hard crust and permit the emergence of seedlings. In 1935 frequent and continuous rains kept the soil moist enough for most seedlings to emerge.

At Nacogdoches rain fell each year, except in 1934, within one or two days after planting; consequently a thick hard crust formed over the seed that kept many seedlings from emerging. Figure 9 shows seedlings bursting through the hard crust. In 1934 there was ample moisture at the time of planting for good germination of cottonseed, but very few seeds germinated where the soil was disturbed under the seed. Where the soil was disturbed to the sides of the seed in placing the fertilizer, the cottonseed germinated and a good stand of plants was obtained in from 7 to 10 days. It was observed that where the soil was disturbed 1.5 inches to the sides of the seed, germination was not as rapid as for the 2.5- and 3.5-inch distances. On the tests with placements under the seed, a stand of plants was not obtained until rain supplied moisture. Disturbing the soil under the seed at the time of planting left it loose and, as a result, the soil dried rapidly and to a depth that moisture was not sufficient to cause germination of the cottonseed. In planting the tests for the side placements the soil was not disturbed under the seed, which were deposited on a firm moist soil that did not dry out. Consequently the cottonseed germinated and seedlings emerged without delay.

EXPERIMENTAL PLATS

The experimental plats at each location comprised about two acres of land that were divided into six blocks of about equal size and shape. All placements of fertilizer were systematically arranged in each block. Each plat, or placement test, consisted of a single row, usually about 125 feet in length. Each placement was repeated in each of the six blocks, or each placement was repeated six times. The row spacing varied according to the farm practice at each location. At College Station and Temple the row spacing was 36 inches. At Bryan in the Brazos River bottoms and at Nacogdoches the spacings ranged from 39 to 41 inches between the rows. Records were taken from 100 feet of row, which was divided into two sections. Therefore in making the germination counts and calculating the yields, 12 sets of notes were secured, and these were added and the averages taken.

In the preparation of the seed bed, ridges were prepared according to the general practice of cotton farmers in the greater portion of the state. After the tests were planted the seed were slightly above the general elevation of the soil. This permitted excess water during rains to drain into the depressions between the rows and prevented water from standing in the row and drowning out young seedlings.

In 1932 and 1933 three unfertilized checks were planted, but in 1934 and 1935 only two checks were planted, one for the placements under the seed and one for the placements to the sides of the seed. One of the checks had the soil stirred 1.75 inches wide and two inches under the seed, and thus served for a check for the placements under the seed. In another check the soil was left undisturbed for a distance of 3.5

Table 3. Rainfall, planting dates, and dates on which germination counts were made at the various locations where fertilizer placement tests were conducted in Texas, 1932-1935

Date	Bryan				Temple			College Station				Nacogdoches			
	1932	1933	1934	1935	1932	1933	1934	1932	1933	1934	1935	1932	1933	1934	1935
April 10											.22				.92
11															.01
12															
13	P								.18				.98		
14						.11	.05		.62				.77		
15															
16										.02	P			.04	
17				P					P						
18		P	P	.39					.05					.81	
19			.55	.79			.90		.28		1.29	P		.38	2.53
20						.50			.88	P			1.06		.40
21	*												P		
22								.06							
23					.02			.65				.01		P	P
24					.76	.12			.02*		*	.27	.02	2.32†	
25		*	*	.08*		.01	P		P			.27	.41	.14	
26	**			.35			.02		**		.54**		.63		3.21
27				**					.41		*	*	*	.02	.05
28		**			1.78							1.40	.02		*
29					.05	.03		1.40			.05	.23	.02		*
30								.21	**			.09	.83	.01*	.26
May 1			**										.23**		**
2				1.88			.04*				2.30	**			.84
3				.58			.03				.69***			**	.06
4				2.00		1.01	*	*	1.07		.54		2.05		.13
5				.05			**				2.30			.70	8.25
6								.02							
7				***				**		***					
8		***			.02					***					
9			.04***		.55					.06		.38	***	.55	
10			.15	.10	1.55		.36	1.98		.07		.03		.45	.13***
11							.02								.67
12			.18							.07					.01
13															.11
14				.70						.02		***			.18
15					.73			.20				.05		.04	.06
16											1.30				2.36
17					1.90			.99					1.57		.06
18	***			1.25			***	***					.05		
19				1.20									1.52		2.73
													1.27		1.41
													.02		.91
													.02		

Date	Bryan				Temple			College Station				Nacogdoches			
	1932	1933	1934	1935	1932	1933	1934	1932	1933	1934	1935	1932	1933	1934	1935
21									.27						
22															
23															
24					P	.24	.66			.11			.29	.05	
25					.31	1.95	.05						4.02	.24	
26									.26				.02	.01	
27															
28															
29						.60			.17		.22		2.00		.27
30				.50	*										.80
June 1											.07				
2									.03						
3					**										.38
4														.78	
5											.09				
6							P								
7															1.34
8															
9						.74			.63						
10					1.03				.90						
11															.01
12							*			.23		.05	.46		
13												.15			.02
14						.19			.07			.05			.03
15							**					.31			.03
16															
17					***										
18								.10							.55
19										.02					
20													.16		
21												.46			
22							***								1.61
23				.30		.08					.70	.04			
24					.79				.23			.09			
25					.21				.58			.34			
26					.12							.06			
27													.04		
28										.01			.01		
29				.15					.26						
30									.07						

P—Date test was planted.
*First germination count.

**Second germination count

***Last germination count

†Rain not effective on test.

inches to each side of the row. A third check, which was used only during the first two years, had the soil stirred three inches under the seed as though mixing the fertilizer with the soil.

In order to get an indication of delay in the germination of the cottonseed resulting from the effects of the placements, three germination

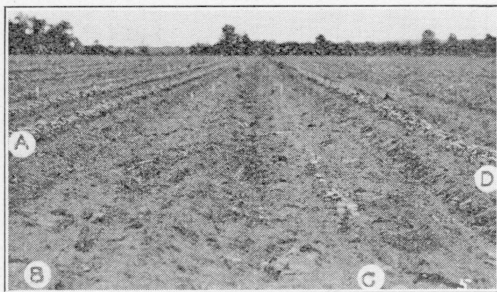


Figure 10. Growth of cotton plants 22 days after planting where fertilizer was applied under the seed: A and D, guards, fertilizer applied to sides and below seed level; B, fertilizer applied 1 inch under seed; C, fertilizer applied 2 inches under seed.

counts were made. The first count was made soon after the first seedlings began to appear above the ground, and the second count followed three or four days later, depending upon the number of new plants appearing as affected by conditions prevailing. The third, or last count was not made until just before the time for thinning the cotton. The average interval of time elapsing between planting and the first count was 7 days, between planting and the second count 11 days, and between planting and the last count 21 days.

EFFECT OF FERTILIZER PLACEMENT ON GERMINATION OF COTTONSEED

In these studies tests were planted with the fertilizer placed under the seed at various depths or at different distances to the sides of the seed and one, two, and three inches below the seed level. Tests were planted with part of the fertilizer placed with the seed and the balance at various locations in relation to the seed. Other tests were planted with the fertilizer applied at 250, 500, and 750 pounds per acre and placed at different points in relation to the seed. Fertilizer was placed under the seed in both narrow and wide bands, one, two, and three inches under the seed.

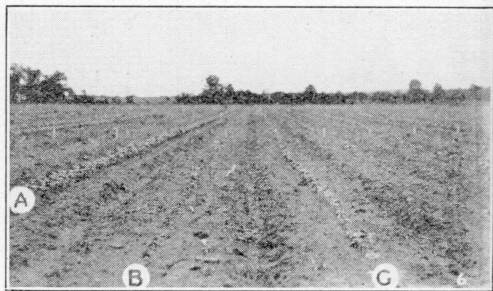


Figure 11. Growth of cotton plants 22 days after planting where fertilizer was applied under seed: A, guard, fertilizer applied to sides and below seed level; B, fertilizer applied 3 inches under seed; C, unfertilized check—soil disturbed 2 inches under seed.

Effect of Placing the Fertilizer under the Seed

It was observed in the clay soils that where the fertilizer was placed at a depth of one or two inches under the seed, the soil flowed back into the furrow and covered the fertilizer with sufficient soil to keep the seed

Table 4. Percentage of cottonseed germinating and seedling emergence when 4-12-4 fertilizer was applied at the rate of 500 pounds per acre under the seed

Fertilizer Placement	Per Cent of Cottonseed Germinating in 50 Feet of Row																				General average
	Bryan					Temple				College Station					Nacogdoches						
	Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam						
	1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.		
<i>Band 1.75 inches wide</i>																					
1 inch under seed.....	34	30	27	79	42	69	50	61	60	82	18	44	76	55	65	12	61	77	54	53	
2 inches under seed.....	38	30	23	46	34	62	76	87	75	54	24	56	77	53	54	10	56	62	46	52	
3 inches under seed.....	42	30	19	82	43	55	83	87	75	62	34	65	81	60	71	15	84	82	63	60	
Unfertilized check*.....	49	28	30	84	48	86	88	88	87	70	27	67	74	60	60	60	13	82	74	57	
<i>Band 3.5 inches wide</i>																					
1 inch under seed.....	40	31	.....	.....	36	76	58	.....	67	76	16	.....	.....	46	84	44	.....	.....	64	53
2 inches under seed.....	34	28	.....	.....	31	79	76	.....	78	67	26	.....	.....	46	74	57	.....	.....	66	55
3 inches under seed.....	28	34	.....	.....	31	68	84	.....	76	66	33	.....	.....	50	81	55	.....	.....	68	56
Unfertilized check†.....	45	20	.....	.....	32	63	83	.....	73	62	29	.....	.....	46	82	50	.....	.....	66	54

*Soil stirred 1.75 inches wide and 2 inches under seed.

†Soil stirred 3.5 inches wide and 2 inches under seed.

a uniform distance above the fertilizer. When a furrow was opened to a depth of three inches, there was a tendency for large balls or chunks of clay to be thrown out, sometimes leaving a hole or pocket in which the

soil did not flow back into and fill up before the seed were deposited. This was especially noticeable with the 3.5-inch width shovel, both at Temple and Bryan. This condition evidently prevented the seed from being placed at uniform distances above the fertilizer and perhaps kept them from being covered to uniform depths.

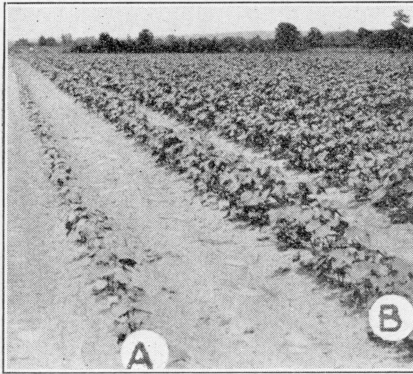


Figure 12. Difference in growth of unfertilized and fertilized cotton plants at Nacogdoches on June 23, 1932: A, unfertilized check where soil was disturbed 2 inches under seed; B, fertilizer applied 1 inch under seed.

the depressions and hindered the germination and emergence of some seed and seedlings.

Percentage of Emergence:* Where fertilizer was placed in a narrow band 1.75 inches wide and one, two, and three inches under the seed, the three-inch depth gave an average emergence of 60 per cent, the highest for all locations. The unfertilized check gave an average emergence of 63 per cent (Table 4).

Fertilizer placed in bands 3.5 inches wide and one, two, and three inches under the seed gave general emergence averages of 53, 55, and 56 per cent, respectively, and the unfertilized check gave 54 per cent for all locations. The one-inch depth at Bryan and the two-inch depth at Temple gave slightly higher percentages than did the three-inch depth. The average for the four locations, however, was in favor of the three-inch depth (Table 4).



Figure 13. Showing difference in growth of fertilized and unfertilized cotton plants at Nacogdoches on July 24, 1935: A, fertilizer applied 3 inches under seed; B, unfertilized check—soil disturbed 2 inches under seed; C, fertilizer applied 1.5 inches to one side and 2 inches below seed level.

*The percentage of emergence was obtained by dividing the number of seed planted into the total number of seedlings that emerged.

There were no significant differences in the percentages of emergence for the narrow and wide bands of fertilizer placed under the seed.

Rate of Emergence: A study of Table 5 shows that where the fertilizer was placed in either narrow or wide bands and one inch under the seed, germination was delayed and seedlings did not emerge as rapidly as where the fertilizer was placed two and three inches deep (Figures 10 and 11). Figures 12 and 13 show the difference in growth of cotton plants on fertilized and unfertilized rows where the fertilizer was placed under the seed and the soil disturbed under the seed but no fertilizer applied.

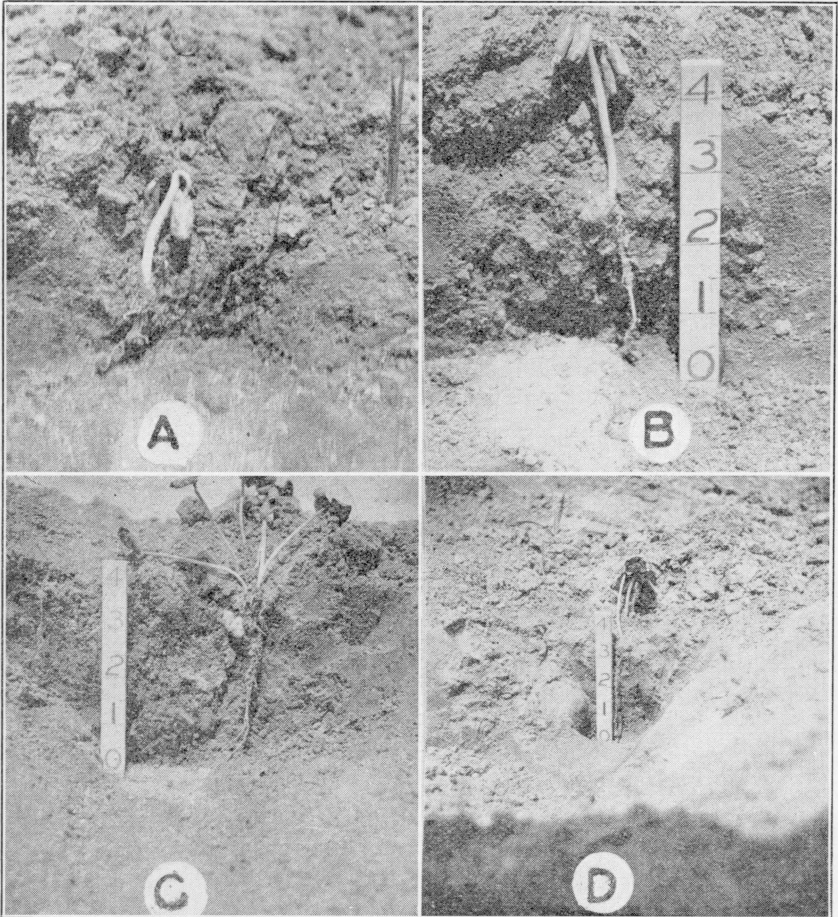


Figure 14. Showing difference in growth of young cotton seedlings 7 days after planting where the fertilizer was placed 1, 2, and 3 inches under the seed and on check where no fertilizer was applied: A, 1 inch under the seed; B, 2 inches under the seed; C, 3 inches under seed; D, unfertilized check where the soil was disturbed 2 inches under the seed.

Table 5. Effect on the germination of cottonseed when 4-12-4 fertilizer was applied under the seed at the rate of 500 pounds per acre in narrow and wide bands

Fertilizer Placement	Germination counts	Seedlings emerging in 50 feet of row																			
		Bryan					Temple				College Station					Nacogdoches					
		Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam					
		1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.	
<i>Band 1.75 inches wide</i> 1 inch under seed	first.....	0	2	18	10	8	253	57	5	105	367	8	13	1	97	1	1	1	13	4	
	second...	466	89	214	188	239	317	214	126	219	522	81	185	223	253	2	95	5	4	58	
	last.....	520	203	233	474	358	434	288	305	342	559	121	331	602	403	442	72	416	511	360	
2 inches under seed.....	first.....	5	7	14	19	11	252	113	20	128	271	16	24	4	79	219	0	7	6	58	
	second...	633	127	191	204	289	288	355	317	320	365	85	379	338	292	365	26	28	268	172	
	last.....	594	203	200	277	365	390	442	434	422	371	162	424	610	392	368	64	383	410	309	
3 inches under seed.....	first.....	7	10	13	28	14	229	345	48	207	373	28	87	10	125	19	2	4	46	18	
	second...	609	145	165	244	291	233	438	348	340	389	150	485	389	353	374	98	9	295	194	
	last.....	643	198	163	491	374	341	482	433	419	421	229	490	642	446	482	94	575	544	424	
Unfertilized check*.....	first.....	18	4	52	38	28	374	399	61	278	300	18	125	7	113	19	4	210	60	73	
	second...	702	108	226	238	318	387	490	388	422	433	105	487	313	335	345	77	309	327	265	
	last.....	754	188	231	503	419	539	510	442	497	481	181	501	586	437	409	80	559	495	386	
<i>Band 3.5 inches wide</i> 1 inch under seed.....	first.....	4	2	.....	.....	3	310	95	.....	203	308	4	.....	.....	156	1	3	.....	.....	2
	second...	641	120	.....	.....	381	396	285	.....	341	502	54	.....	.....	278	51	59	.....	.....	55
	last.....	613	208	.....	.....	411	473	337	.....	405	521	105	.....	.....	313	574	267	.....	.....	421
2 inches under seed.....	first.....	4	4	.....	.....	4	331	228	.....	280	268	16	.....	.....	142	4	70	.....	.....	37
	second...	516	137	.....	.....	326	362	410	.....	386	456	116	.....	.....	286	316	327	.....	.....	322
	last.....	522	190	.....	.....	356	495	444	.....	470	458	175	.....	.....	317	501	349	.....	.....	425
3 inches under seed.....	first.....	2	24	.....	.....	13	169	296	.....	233	271	31	.....	.....	151	4	130	.....	.....	67
	second...	449	176	.....	.....	312	190	510	.....	350	445	165	.....	.....	305	222	338	.....	.....	280
	last.....	440	227	.....	.....	334	427	490	.....	459	452	223	.....	.....	338	551	334	.....	.....	443
Unfertilized check†	first.....	32	5	.....	.....	18	168	337	.....	252	259	13	.....	.....	136	2	123	.....	.....	62
	second...	685	75	.....	.....	380	184	498	.....	341	416	97	.....	.....	256	142	374	.....	.....	238
	last.....	693	132	.....	.....	412	392	485	.....	438	426	194	.....	.....	310	556	306	.....	.....	431

*Soil stirred 1.75 inches wide and 2 inches under seed.

†Soil stirred 3.5 inches wide and 2 inches under seed.

It was observed that in many cases the cottonseed sprouted and sent out a short root, which immediately came in contact with the band of fertilizer one inch under the seed, and apparently the salt solution in the fertilizer band was so concentrated that it checked the growth of the root and the emergence of the seedling (A. Figure 14). Where the fertilizer was placed at depths of two or three inches under the seed, a longer length of time was allowed

for the growth and development of the root system, during which period the concentration of the soluble salts was probably reduced somewhat by diffusion and movement with the soil moisture, and the plant seemed to have a greater resistance to the shock of the fertilizer salts and emerged somewhat quicker than where the fertilizer was placed one inch under the seed (B and C, Figure 14). Observations show that where the roots of the cotton plant entered the band of fertilizer two and three inches under the seed, the tip of the root was often injured.

Where the root penetrated and passed through the band of fertilizer, it appeared smaller and slightly discolored at the band of fertilizer. In examining the root system of mature plants on the placements under the seed it was found that many of the plants did not have long tap roots. This may have been due to injury to the roots at the point where they came in contact with the band of fertilizer when placed directly under the seed.

Total Emergence: The data in Tables 5 and 6 show that as the depth of the fertilizer was increased, the total average number of seedlings emerging increased. The differences, however, were not as pronounced for the placements in wide bands under the seed as for the narrow bands (Figure 15). Fertilizer placed in a band 1.75 inches wide and one, two, and three inches under the seed gave an average of 366, 372, and 416 seedlings, respectively, for a four-year period at all locations. An average of 435 seedlings was obtained on the unfertilized check.

A band of fertilizer 3.5 inches wide placed one, two, and three inches deep under the seed during a period of two years gave an average of 388, 392, and 394 seedlings, respectively. The unfertilized check gave 398 seedlings. A comparison of these results may be seen graphically in Figure 15.

If the results obtained for the narrow band in 1932 and 1933 only are compared with the results for the wide band for the same two years,

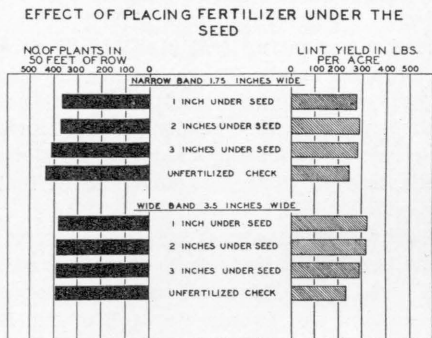


Figure 15. Averages for the four locations show that where fertilizer was placed in narrow bands 1, 2, and 3 inches under the seed, the 3-inch depth gave the highest number of plants and the 2-inch depth gave the highest yield. Fertilizer applied in wide bands 1, 2, and 3 inches under the seed showed there was a slight increase in the total number of plants obtained as the depth of application was increased. The yield, however, was in direct reverse order. The unfertilized checks in each case gave slightly larger number of plants but a lower yield than when fertilizer was applied.

the same general differences exist in the average number of seedlings as are shown for the four-year period for the narrow band. For these years the narrow band gave averages of 318, 324, and 361 seedlings for the one-, two-, and three-inch depths, respectively. The unfertilized check gave an average of 392 seedlings.

Effect of Soil Type: The data in Table 4 indicate generally that as the depth the fertilizer was placed below the seed increased, the number of seed germinating and seedlings emerging increased for both the narrow and wide bands. These results, however, fluctuated for the different soil types and climatic conditions that prevailed each year. The unfertilized checks gave more seedlings than any of the fertilizer placements under the seed, indicating that the fertilizer so placed caused early injurious effects even though removed three inches from the seed.

The percentages of cottonseed germinating and seedlings emerging are the best indications as to the effect of the soil, because a different number of seed were planted each year at each location. From Table 4 it is seen that the Yahola clay soil of the Brazos River bottom gave a comparatively low percentage of emergence. This, however, may have been largely due to the heavy crust that formed over the seed each year. The highest average for emergence was secured for the placements under the seed at Temple on the Houston black clay. There were few differences for the sandy Lufkin and Norfolk soils at College Station and Nacogdoches for narrow bands. Where a wide band of fertilizer was applied under the seed, a higher percentage of emergence was secured on the Norfolk than on the Lufkin soil.

Effect of Placing the Fertilizer to the Sides of the Seed

Tests were conducted at Bryan, Temple, College Station, and Nacogdoches to determine the effect of placing fertilizer at different depths to the sides and below the seed level. These comprised two tests with the fertilizer placed 1.5 and 3.5 inches to one side and two inches below the seed level. Bands of fertilizer were placed 1.5, 2.5 and 3.5 inches to each side and at depths of one, two, and three inches below the seed level. Unfertilized checks were planted with the soil undisturbed for distances of 2.5 and 3.5 inches to each side (Tables 7, 8, and 9). A graphic comparison of the number of plants secured for the various placements to the side of the seed is shown in Figure 16.

Percentage of Emergence: When the fertilizer furrow opening disks were set to place the fertilizer 1.5 inches to each side of the seed, it was observed that the band of soil between the furrows was slightly disturbed and loosened, especially at the deeper tests, and sufficiently to prevent the seed from being deposited on a firm compact soil. Where the disks were set for placing the fertilizer 2.5 and 3.5 inches either to one side or to each side of the row, the band of soil between the furrows was wide enough that it was not loosened in opening the furrows for the fertilizer (Figure 17).

Table 6. Summary of average germination of cottonseed when 4-12-4 fertilizer was applied under the seed at the rate of 500 pounds per acre in narrow and wide bands

Fertilizer Placement	Germination counts	Average number of seedlings emerging in 50 ft. of row				
		Bryan	Temple	College Station	Nacogdoches	General average
		Yahola clay	Houston black clay	Lufkin fine sandy loam	Norfolk sandy loam	
<i>Band 1.75 inches wide</i>						
1 inch under seed.....	first.....	8	105	97	4	54
	second.....	123	219	253	58	163
	last.....	358	342	403	360	366
2 inches under seed.....	first.....	11	128	79	4	56
	second.....	289	320	292	172	268
	last.....	368	422	392	306	372
3 inches under seed.....	first.....	14	207	125	18	91
	second.....	291	340	353	194	294
	last.....	374	419	446	424	416
Unfertilized check*.....	first.....	28	278	113	73	123
	second.....	318	422	335	265	335
	last.....	419	497	437	386	435
<i>Band 3.5 inches wide</i>						
1 inch under seed.....	first.....	3	203	156	2	91
	second.....	381	341	278	55	264
	last.....	411	405	313	421	388
2 inches under seed.....	first.....	4	280	142	37	116
	second.....	326	386	286	322	330
	last.....	356	470	317	425	392
3 inches under seed.....	first.....	13	233	151	67	116
	second.....	312	350	305	280	312
	last.....	334	459	338	443	394
Unfertilized check†.....	first.....	18	252	136	62	117
	second.....	380	341	256	238	304
	last.....	412	438	310	431	398

*Soil stirred 1.75 inches wide, 2 inches under seed.

†Soil stirred 3.5 inches wide, 2 inches under seed.

There was no difference in the percentage of emergence where the fertilizer was placed 1.5 and 3.5 inches to *one* side and two inches below the seed level.

The results in Table 7 show that where the fertilizer was placed in bands 1.5 inches to each side at all locations except Temple, the placement two inches below the seed level gave the highest average percentage of emergence. The general averages for the placements one, two, and three inches below the seed level were 60, 66, and 60 per cent, respectively (Table 7).

Where the fertilizer was placed in bands 2.5 inches to each side and one, two, and three inches below the seed level, the two-inch placement gave the highest average percentage of germination at all locations except Bryan, where the one-inch depth was highest (Table 7). The general averages for the placements one, two, and three inches below the seed level were 83, 85, and 76 per cent, respectively. The check where the soil was undisturbed for 2.5 inches to the sides gave a general average of 81 per cent emergence.

Table 7. Percentage of cottonseed germinating when 4-12-4 fertilizer was applied at the rate of 500 pounds per acre to the sides of the seed

Fertilizer Placement	Per cent of cottonseed germinating in 50 feet of row																				General average
	Bryan					Temple				College Station					Nacogdoches						
	Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam						
	1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.		
Band 1.5" to ONE side, 2" below seed level	47	29	83	53	82	100	91	37	62	81	60	52	98	79	76	70					
Band 3.5" to ONE side, 2" below seed level	51	33	81	55	79	94	86	35	63	78	59	51	97	87	78	70					
<i>Bands 1.5 inches to EACH side</i>																					
1 inch below seed level	41	50		46	90	85	88	69	36		52	56	53		54	60					
2 inches below seed level	37	46	21	88	81	83	94	86	73	37	64	81	61	59	56	77	79	68			
3 inches below seed level	43	42		42	73	81	78	75	40		58	69	60		64						
<i>Bands 2.5 inches to EACH side</i>																					
1 inches below seed level			36	101	68			94	94			65	74	70			107	93	100	83	
2 inches below seed level			28	88	58			101	101			70	79	74			112	100	106	85	
3 inches below seed level			4	93	48			92	92			57	84	70			104	88	96	76	
Unfertilized check*			27	88	58			91	91			64	77	70			94	113	104	81	
<i>Bands 3.5 inches to EACH side</i>																					
1 inch below seed level	44	52		48	66	88	77	70	39		80	54	32	36		34					
2 inches below seed level	39	54	32	89	54	76	83	92	84	68	37	60	61	41	45	89	79	64	66		
3 inches below seed level	34	49		42	76	81	78	76	38		57	46	58		52	57					
Unfertilized check†	57	58		58	66	87	76	70	40		55	39	38		38						

*Soil undisturbed under seed for 2.5 inches to each side and 2 inches below the seed level.

†Soil undisturbed under seed for 3.5 inches to each side and 2 inches below the seed level.

Fertilizer placed in bands 3.5 inches to each side and one, two, and three inches below the seed level gave the highest percentage of emergence for the two-inch depth at all locations (Table 7). The general averages for the one-, two-, and three-inch depths were 53, 66, and 57 per cent, respectively (Table 7). The check where the soil was undisturbed

for 3.5 inches to the sides and to a depth of two inches below the seed level showed a general average of 57 per cent emergence.

Rate of Emergence: Fertilizer placed either on one side or on each side of the seed did not delay germination as much as where the fertilizer was placed under the seed. Tables 8 and 9 show, however, that fertilizer placed only one inch below the seed level retarded germination more than where the fertilizer was placed two and three inches below the seed level. Where heavy rains occurred soon after planting, the effect of the fertilizer on the germination of cottonseed was not so severe.

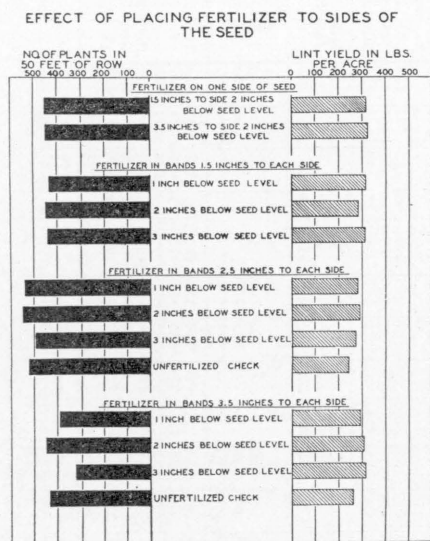


Figure 16. Graph showing comparison of both the total number of plants and the yields obtained at the four locations where fertilizer was applied to one side and to both sides of the seed. The highest number of plants was obtained where the fertilizer was applied 2.5 inches to each side and 2 inches below the seed level. The highest general average yield was secured where the fertilizer was placed 3.5 inches to one side and 2 inches below the seed level.

Where the fertilizer was placed in bands 1.5 inches to each side and one, two, and three inches below the seed level, the two-inch depth gave the highest general average number of seedlings emerging. The general averages for the three depths were 430, 446, and 437, respectively (Table 9). Table 8 shows, however, that at both Bryan and Temple the one-inch depth gave the highest average number of seedlings emerging, while at College Station and Nacogdoches the two-inch depth gave the highest number of seedlings emerging.

Where the fertilizer was placed in bands 2.5 inches to each side and one, two, and three inches below the seed level, the two-inch depth gave the highest general average number of plants emerging—536, 545, and 488, respectively (Table 9). As in the case of the placement 1.5 inches to each side, the placement 2.5 inches to each side and one inch below the seed level at Bryan and Temple gave the highest average number of plants, but at College Station and Nacogdoches the two-inch depth gave

Total Emergence: The data in Table 8 do not show any significant differences in the final number of plants emerging where the fertilizer was placed in bands 1.5 and 3.5 inches to one side and two inches below the seed level (Figure 18).

Table 8. Effect on the germination of cottonseed when 4-12-4 fertilizer was applied to the side of the seed at the rate of 500 pounds per acre

Fertilizer Placement	Germination counts	Seedlings emerging in 50 feet of row																		
		Bryan					Temple				College Station					Nacogdoches				
		Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam				
		1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.
<i>All on one side of the seed</i> Band 1.5" to ONE side, 2" below seed level	first.....		51	97	88	79	...	297	65	181	...	52	131	96	93	...	78	175	217	159
	second.....	250	242	332	275	...	458	396	427	...	170	435	471	359	...	361	267	463	364	
	last.....	315	249	500	355	...	480	498	489	...	250	463	639	451	...	315	668	525	503	
Band 3.5" to ONE side, 2" below seed level	first.....		58	128	151	112	...	345	77	211	...	35	120	67	74	...	166	193	224	194
	second.....	300	302	376	326	...	416	421	419	...	144	448	416	336	...	339	287	464	363	
	last.....	341	286	488	372	...	459	469	464	...	232	470	615	439	...	311	660	581	517	
<i>Bands 1.5 inches to EACH side</i> 1 inch below seed level.....	first.....	3	33	...	...	18	437	365	...	401	304	68	...	...	186	48	80	...	64	
	second.....	691	334	...	...	482	409	466	...	438	446	184	...	...	315	328	345	...	337	
	last.....	632	334	...	...	483	566	493	...	530	472	238	...	...	355	383	322	...	353	
2 inches below seed level.....	first.....	3	37	54	127	55	368	336	63	255	295	53	186	61	148	33	111	52	195	96
	second.....	616	259	166	361	351	448	459	381	429	387	190	437	451	366	345	337	89	450	305
	last.....	574	309	177	530	398	508	484	470	487	429	245	482	643	450	401	340	524	530	449
3 inches below seed level.....	first.....	1	68	...	...	35	350	310	...	330	354	81	...	...	218	25	215	...	121	
	second.....	625	255	...	...	440	329	458	...	394	450	213	...	...	332	334	364	...	349	
	last.....	665	277	...	...	471	455	474	...	465	513	268	...	...	391	470	369	...	420	
<i>Bands 2.5 inches to EACH side</i> 1 inch below seed level.....	first.....			112	147	130	...	...	162	162	...	...	85	62	74	...	...	282	179	231
	second.....			308	387	348	...	...	423	423	...	...	453	268	411	...	...	459	513	486
	last.....			309	606	458	...	...	471	471	...	...	489	588	539	...	...	733	622	678
2 inches below seed level.....	first.....			93	220	157	...	...	154	154	...	...	184	81	133	...	...	360	227	294
	second.....			228	421	325	...	...	400	400	...	...	491	431	461	...	...	572	585	579
	last.....			242	528	385	...	...	505	505	...	...	528	621	515	...	...	761	666	714
3 inches below seed level.....	first.....			6	162	84	...	...	159	159	...	...	200	103	152	...	...	296	284	290
	second.....			33	296	215	...	...	407	407	...	...	406	477	442	...	...	475	503	489
	last.....			38	559	299	...	...	458	458	...	...	431	665	548	...	...	709	588	649
Unfertilized check*.....	first.....			74	172	123	...	...	137	137	...	...	171	92	132	...	...	319	305	312
	second.....			215	381	298	...	...	353	353	...	...	461	440	451	...	...	469	626	548
	last.....			235	530	383	...	...	455	455	...	...	483	605	544	...	...	644	753	699

*Soil undisturbed under seed for 2.5 inches to each side and 2 inches below the seed level.

Table 8. Effect on the germination of cottonseed when 4-12-4 fertilizer was applied to the side of the seed at the rate of 500-pounds per acre—Continued.

<i>Bands 3.5 inches to EACH side</i>																				
1 inch below seed level.....	first.....	2	31	.....	.....	17	376	412	.....	394	305	46	.....	.....	176	67	81	.....	.....	74
	second...	681	296	.....	.....	489	349	501	.....	425	416	176	.....	.....	296	243	233	.....	.....	238
	last.....	680	344	.....	.....	512	410	515	.....	463	475	259	.....	.....	367	216	218	.....	.....	217
2 inches below seed level.....	first.....	0	63	113	161	85	377	378	82	279	318	47	130	58	138	82	148	243	196	167
	second...	685	289	261	353	397	371	488	401	420	427	167	448	402	361	293	292	259	450	349
	last.....	606	360	277	532	444	474	484	460	473	467	244	449	633	448	280	273	610	530	423
3 inches below seed level.....	first.....	0	73	.....	.....	37	342	367	.....	355	347	66	.....	.....	207	76	199	.....	.....	138
	second...	542	278	.....	.....	410	356	424	.....	390	456	198	.....	.....	327	312	358	.....	.....	335
	last.....	519	326	.....	.....	423	474	474	.....	474	516	257	.....	.....	387	315	357	.....	.....	236
Unfertilized check†	first.....	8	.....	.....	.....	42	304	389	.....	347	322	64	.....	.....	193	81	135	.....	.....	108
	second...	830	.....	.....	.....	584	275	486	.....	381	445	196	.....	.....	321	287	255	.....	.....	271
	last.....	880	.....	.....	.....	635	413	505	.....	459	479	266	.....	.....	373	268	234	.....	.....	251

†Soil undisturbed under seed for 3.5 inches to each side and 2 inches below the seed level.

the highest average number of seedlings emerging. The check where the soil was undisturbed for 2.5 inches to each side gave a general average of 520 seedlings (Table 9).

Where fertilizer was placed 3.5 inches to each side and one, two, and three inches below the seed level, the two-inch depth gave a higher general average (447 seedlings) than the one- and three-inch depths (390 and 380 seedlings, respectively), as shown in Table 9. At Bryan the one-inch depth gave a higher average number of seedlings, and at Temple the three-inch depth gave the highest average number of seedlings. At College Station and Nacogdoches the two-inch depth gave the highest average number of emerged seedlings (Table 8). For the check where the soil was undisturbed for 3.5 inches to each side the general average number of seedlings emerging was 430 (Table 9).

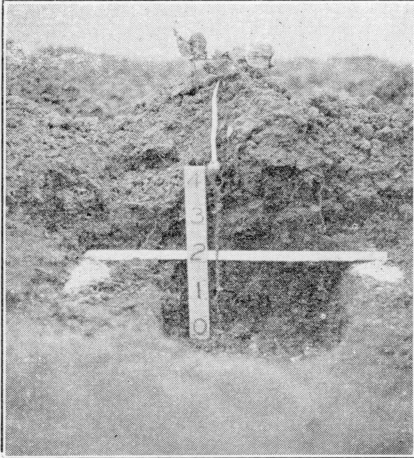


Figure 17. Showing growth of young cotton seedlings 7 days after planting where fertilizer was applied in bands 3.5 inches to each side and 2 inches below the seed level.

two inches below the seed level. The tests for the placements 2.5 inches to each side were conducted for the two years 1934 and 1935, and the tests 1.5 and 3.5 inches to each side were conducted in 1932 and 1933. An analysis of the data in Table 8, which gives two placements run consecutively for the four years, shows that a higher average number of plants was obtained in 1934 and 1935 than in 1932 and 1933. It cannot be safely said, therefore, that the placement 2.5 inches to each side and two inches below the seed level would have averaged higher for a four-year period. The data, however, collected in 1934 and 1935 at Bryan, College Station, and Nacogdoches for the 1.5-, 2.5-, and 3.5-inch placements show that the average number of plants was 481, 558, and 505, respectively.

Effect of Soil Type: From Table 7 it is seen that a lower average percentage of emergence was obtained on the Yahola clay than on the Houston black clay. Better germination was obtained on the sandy Norfolk soil at Nacogdoches than on the Lufkin fine sandy loam at College Station. The poor drainage, slow warming, and plastic qualities of the Lufkin soils appeared to reduce the percentage of germination of cottonseed. The Yahola clay with its heavy soil crust appeared to have

a greater retarding effect on the emergence of cotton seedlings than the Houston clay and the sandy Lufkin and Norfolk soils.

Effect of Placing Part of Fertilizer in Furrow with Seed

Tests were conducted at all locations to determine the effect of germination when part of the fertilizer was placed in the furrow with the cottonseed. Tests were also conducted with the fertilizer placed either in the soil above the seed or mixed in the soil under the seed. The two

Table 9. Summary of average germination of cottonseed when 4-12-4 fertilizer was applied to one and to both sides of the seed at the rate of 500 pounds per acre

Fertilizer Placement	Germination counts	Seedlings emerging in 50 ft. of row				
		Bryan	Temple	College Station	Nacogdoches	General average
		Yahola clay	Houston black clay	Lufkin fine sandy loam	Norfolk sandy loam	
<i>All fertilizer on one side of seed</i>						
1.5" to one side, 2" below seed level..	first.....	79	181	93	157	128
	second....	275	427	359	364	356
	last.....	355	489	451	503	450
3.5" to one side, 2" below seed level..	first.....	112	211	74	194	148
	second....	326	419	336	363	361
	last.....	372	464	439	517	448
<i>Fertilizer applied to each side of seed</i>						
1.5" to each side, 1" below seed level.	first.....	18	401	186	64	167
	second....	482	438	315	337	393
	last.....	483	530	355	353	430
1.5" to each side, 2" below seed level.	first.....	55	255	148	96	138
	second....	351	429	366	305	363
	last.....	398	487	450	449	446
1.5" to each side, 3" below seed level.	first.....	35	330	218	121	176
	second....	440	394	332	349	379
	last.....	471	465	391	420	437
2.5" to each side, 1" below seed level.	first.....	130	162	74	231	149
	second....	348	423	411	486	417
	last.....	458	471	539	678	536
2.5" to each side, 2" below seed level.	first.....	157	154	133	294	184
	second....	325	400	461	579	441
	last.....	385	505	575	714	545
2.5" to each side, 3" below seed level.	first.....	84	159	152	290	171
	second....	215	407	442	489	388
	last.....	299	458	548	649	488
Unfertilized check*.....	first.....	123	137	132	312	176
	second....	298	353	451	548	412
	last.....	383	455	544	699	520
3.5" to each side, 1" below seed level.	first.....	17	394	176	74	165
	second....	489	425	296	238	362
	last.....	512	463	367	217	390
3.5" to each side, 2" below seed level.	first....	85	279	138	167	167
	second....	397	420	361	349	382
	last.....	444	473	448	423	447
3.5" to each side, 3" below seed level.	first.....	37	355	207	138	184
	second....	410	390	327	335	366
	last.....	423	474	387	236	380
Unfertilized check†	first.....	42	347	193	108	172
	second....	584	381	321	271	453
	last.....	635	459	373	251	430

*Soil undisturbed under seed for 2.5 inches to each side and 2 inches below the seed level.

†Soil undisturbed under seed for 3.5 inches to each side and 2 inches below the seed level.

latter tests were conducted for a period of four years. The other tests were carried on for a period of two years, some during the years 1932 and 1933 and others during 1934 and 1935. The tests conducted during each of these years are shown in Tables 10 and 11. The effect of these placements are shown graphically in Figure 19.

Percentage of Emergence: Two tests were conducted where one-sixteenth and one-fourth of the fertilizer were placed in the surface soil over the seed and the balance 2.5 inches to each side and two inches



Figure 18. Showing difference in emergence of cotton seedlings: A, fertilizer applied 3.5 inches to one side and 2 inches below seed level. Note large number of seedlings; B, fertilizer applied 1.5 inches to one side and 2 inches below seed level. Only a few seedlings had emerged.

below the seed level. These tests were conducted during the years 1934 and 1935. Table 10 shows that there were no significant differences in the percentages of seedlings emerging.

Two tests were conducted in 1932 and 1933 where one-sixteenth and one-eighth of the fertilizer was applied with the seed and the balance 3.5 inches to each side and two inches below the seed level. There were no significant differences in the percentages of germination (Table 10). The general average percentages of emergence for these placements were somewhat lower than where the fertilizer was placed in partial contact with the seed and 2.5 inches to each side and two inches below the seed level. This may be attributed to the climatic differences during the years 1932 and 1933 as compared with the years 1934 and 1935. It appears that a better germination of seed was secured during the latter two years.

Fertilizer placed one-sixteenth with the seed and the balance in bands 1.75 inches wide and three inches under the seed gave a slightly lower

Table 10. Percentage of cottonseed germinating when part of the fertilizer (4-12-4) was applied in the furrow with the seed at the rate of 500 pounds per acre

Fertilizer Placement	Per cent of cottonseed germinating in 50 feet of row																			Gen. Ave.
	Bryan					Temple				College Station					Nacogdoches					
	Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam					
	1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.	
<i>In partial contact with seed</i>																				
Bands 2 inches below seed level																				
$\frac{1}{8}$ to $\frac{1}{4}$ with seed, balance 2.5" to each side			19	94	56			87	87			55	87	71			116	91	104	
$\frac{1}{4}$ in surface soil, over seed, bal. 2.5" to each side			21	89	55			99	99			51	83	67			111	97	104	
$\frac{1}{8}$ with seed, balance 3.5" to each side	38	48			43	83	84		84	71	37			54	67	36			52	
$\frac{1}{8}$ with seed, balance 3.5" to each side	44	48			46	88	84		84	72	31			52	71	36			54	
Bands 3 inches below seed level																				
$\frac{1}{8}$ with seed, bal. in band 1.75" wide under seed	44	33			38	76	73		74	66	20			43	85	19			52	
All in soil above seed	47	18	36	90	48	66	67	93	75	67	20	68	81	59	47	19	89	91	52	
All mixed with soil to a depth of 3" under seed	42	22	18	85	42	57	74	86	72	72	24	64	82	60	77	72	58	83	70	

Table 11. Effect on the germination of cottonseed when part of the fertilizer (4-12-4) was applied in the furrow with the seed at the rate of 500 pounds per acre

Fertilizer Placement	Germination counts	Seedlings emerging in 50 feet of row																			
		Bryan					Temple				College Station					Nacogdoches					
		Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam					
		1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.	
<i>In partial contact</i> Bands 2 inches below seed level $\frac{1}{8}$ to $\frac{1}{2}$ with seed, bal. 2.5" to each side	first.....			59	81	70				68	68			44	1	22			60	66	63
	second...			151	346	248				370	370			386	312	349			261	373	317
	last.....			163	562	362				456	456			416	688	552			794	604	699
$\frac{1}{4}$ in surface soil over seed, balance 2.5" to each side.....	first.....			78	142	110				164	164			117	106	112			331	248	290
	second...			170	382	276				426	426			385	460	422			525	505	515
	last.....			179	535	357				493	493			384	658	521			755	650	702
$\frac{1}{8}$ with seed, balance 3.5" to each side..	first.....	0	21			11	392	259		325	332	29			131	15	72			44	
	second...	586	284			435	421	424		422	468	157			312	276	262			269	
	last.....	588	322			456	516	487		502	487	246			367	457	223			340	
$\frac{1}{8}$ with seed, balance 3.5" to each side..	first.....	0	27			14	388	162		275	332	16			174	1	47			24	
	second...	644	280			462	425	384		404	479	142			310	187	289			238	
	last.....	676	319			498	553	488		521	494	206			350	485	220			352	
Bands 3 inches below seed level $\frac{1}{8}$ with seed, balance in bands 1.75" wide under seed.....	first.....	7	10			8	245	308		276	248	5			127	6	20			13	
	second...	708	154			431	301	394		348	414	75			244	265	244			254	
	last.....	686	223			454	478	425		301	453	135			294	578	118			348	
All in soil above seed.....	first.....	6	10	69	80	41	348	350	148	282	320	4	122	53	125	14	1	50	203	67	
	second...	619	92	308	285	326	352	401	404	386	436	58	492	400	447	148	102	81	548	220	
	last.....	736	122	311	538	427	414	392	463	423	455	134	510	643	436	322	114	610	604	262	
All mixed with soil to a depth of 3 inches under seed.....	first.....	11	7	10	21	12	201	296	38	178	276	9	78	8	93	1	159	17	62	60	
	second...	599	96	149	249	274	238	440	358	345	454	100	448	380	346	134	461	49	457	275	
	last.....	650	144	156	512	366	358	433	428	406	488	159	484	647	444	524	443	398	553	479	

general average percentage of emergence than the placements discussed above (Table 10).

Placing all of the fertilizer in the soil above the seed did not give quite as high a general average percentage of emergence as did the placement where all of the fertilizer was mixed with the soil three inches under the seed (Table 10).

Tests conducted in 1931 and 1932 but not reported showed that placing the fertilizer in direct contact with the seed considerably reduced the percentage of germination and emergence, and the results obtained indicated that this placement was very injurious to the germination of cottonseed. It appears that a small amount of fertilizer can be placed in direct contact with the seed without materially affecting germination, but a large quantity will seriously injure the germination of cottonseed and result in poor stands.

Rate of Emergence: From Table 11 it appears that placing one-fourth of the fertilizer in the surface soil over the seed gave a more rapid emergence than placing one-sixteenth to one-eighth of the fertilizer with

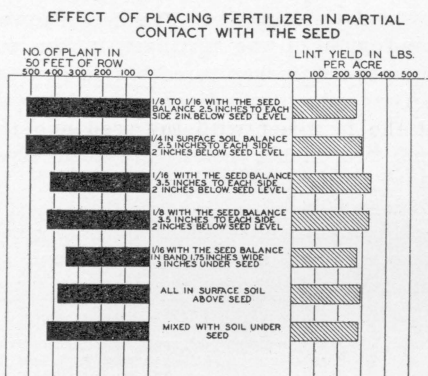


Figure 19. Comparison of total emergence and yields at the four locations where fertilizer was placed part with the seed and the balance at different places in relation to the seed.



Figure 20. Effect of placing part of the fertilizer in the soil with the seed on growth of cotton plants: A, 1/8 to 1/16 fertilizer with seed, balance 1.5 inches to each side and 2 inches below seed level; B, 1/4 of fertilizer in surface soil, balance 2.5 inches to each side and 2 inches below seed level.

the seed and the balance to the sides and below the level of the seed (Figure 20). Mixing the fertilizer under the seed to a depth of three inches delayed germination and emergence more than applying it in the surface soil above the seed.

Total Germination: The data shown in Table 11 indicate that placing one-fourth of the fertilizer in the surface soil over the seed and the balance 2.5 inches to each side and two inches below the seed level did not retard germination as much as placing one-sixteenth to one-eighth of the fertilizer with the seed and the balance 2.5 inches to each side and two inches below the seed level. The differences in final stand obtained were not significant.

A comparison of the results obtained where one-sixteenth of the fertilizer was applied with the seed and the balance 3.5 inches to each side and two inches below the seed level, with the placement where one-eighth

Table 12. Summary of average germination of cottonseed when part of the fertilizer (4-12-4) was applied in the furrow with the seed at the rate of 500 pounds per acre

Fertilizer Placement	Germination counts	Seedlings emerging in 50 ft. of row				
		Bryan	Temple	College Station	Nacogdoches	General average
$\frac{1}{8}$ to $\frac{1}{4}$ with seed, balance in bands 2.5" to each side and 2" below seed level.	first.....	70	68	22	63	56
	second...	248	370	349	317	321
	last.....	362	456	552	699	517
$\frac{1}{4}$ in surface soil over seed, balance in bands 2.5" to each side and 2" below seed level.	first.....	110	164	112	290	169
	second...	276	426	422	515	410
	last.....	357	493	521	702	518
$\frac{1}{8}$ with seed, balance in bands 3.5" to each side and 2" below seed level.	first.....	11	325	131	44	128
	second...	435	422	312	269	360
	last.....	456	502	367	340	416
$\frac{1}{8}$ with seed, balance in bands 3.5" to each side and 2" below seed level.	first.....	14	275	174	24	122
	second...	462	404	310	238	354
	last.....	498	521	350	352	430
$\frac{1}{8}$ with seed, balance in bands 1.75" wide and 3" under the seed.	first.....	8	276	127	13	106
	second...	431	348	244	254	319
	last.....	454	301	294	348	349
All in surface soil above seed.	first.....	41	282	125	67	129
	second...	326	386	447	220	345
	last.....	427	423	436	262	387
Mixed with soil to a depth of 3" below seed level.	first.....	12	178	93	60	86
	second...	274	345	346	275	310
	last.....	366	406	444	497	428

of the fertilizer was applied with the seed and the balance 3.5 inches to each side and two inches below the seed level, does not show any significant differences in the earliness of germination or final stand obtained (Table 11).

The general averages for the final stands for all locations for the three placements where part of the fertilizer was applied with the seed and the balance in narrow bands under the seed, all the fertilizer in the soil above

the seed, and all of the fertilizer mixed with the soil under the seed to a depth of three inches were 349, 387, and 428 plants, respectively (Table 12).

Effect of Soil Type: The data in Table 10 show two tests conducted during 1934 and 1935, three tests conducted in 1932 and 1933, and two tests conducted during all four years. By taking any set of these tests it can be found that lower percentages of emergence were obtained on the Yahola clay than on the Houston black clay soils. Of the four soil types, the Houston black clay gave the highest percentage of germination for all placements with two exceptions where fertilizer was placed in partial contact and either above or below the seed.

As a general rule, the sandy Norfolk soil gave a higher percentage of emergence of cotton seedlings than did the Lufkin soil.

Effect of Applying Fertilizer at Different Rates and Placements

To determine the effect of applying different rates of fertilizer at different placements, tests were conducted with three different rates of

fertilizer applied at five different places in relation to the seed. The rates and placements are shown in Tables 13, 14, and 15. Figures 21 and 22 show the difference in growth of cotton plants where no fertilizer was applied and where 250 and 750 pounds of fertilizer were applied.

Percentage of Emergence: When fertilizer was applied at 250, 500, and 750 pounds per acre in bands 1.75 inches wide and three inches under the seed, the heavy rate gave a slightly lower percentage of emergence for all locations (Table 13).

When these three rates of fertilizer were applied in bands 1.5, 2.5, and 3.5 inches to each side and two inches below the seed level, no significant differences in the general average percentages of emergence were obtained. Of the three rates and three placements the highest general average percentage was secured for the 500-pound rate with the fertilizer placed in bands 2.5 inches to each side and two inches below the seed level.

When fertilizer applied at the three rates was mixed with the soil under the seed, the 500-pound rate gave a slightly higher percentage of



Figure 21. Comparing effect of rates of fertilizer application on growth of cotton plants at Nacogdoches on July 24, 1935: A, plants where 750 pounds of fertilizer was applied in a band 1.75 inches wide, 3 inches under seed; B, plants where fertilizer was applied in bands 2.5 inches to each side and 2 inches below seed level; C, unfertilized check where soil was undisturbed 2.5 inches to each side.

Table 13. Percentage of cottonseed germinating when 4-12-4 fertilizer was applied at different rates and placements

Fertilizer Placement	Per cent of cottonseed germinating in 50 feet of row																				Gen. Ave.
	Bryan					Temple					College Station					Nacogdoches					
	Yahola clay					Houston black clay					Lufkin fine sandy loam					Norfolk sandy loam					
	1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.		
250 pounds per acre																					
Band 1.75" wide, 3" under seed.....	50	22	16	80	42	68	80	86	78	68	23	63	80	58	64	44	97	82	72	62	
Band 1.5" to each side, 2" below seed level.....			23	90	57			104	104			70	81	76			93	76	84	80	
Band 2.5" to each side, 2" below seed level.....			30	85	58			98	98			63	80	72			53	95	74	76	
Band 3.5" to each side, 2" below seed level.....	56	32			44	80	87		84	69	38			54	53	33				43	
Mixed with soil to a depth of 3" under seed.....	53	20			36	68	81		74	65	37			51	81	64				72	
500 pounds per acre																					
Band 1.75" wide, 3" under seed.....	51	23	19	82	44	83	65	97	78	60	21	65	81	57	64	38	84	82	67	62	
Band 1.5" to each side, 2" below seed level.....			21	88	54			94	94			64	81	72			77	79	78	74	
Band 2.5" to each side, 2" below seed level.....			28	88	58			101	101			70	79	74			112	100	106	85	
Band 3.5" to each side, 2" below seed level.....	58	37	32	87	54	89	84	92	85	71	38	60	80	62	48	37	89	79	63	66	
Mixed with soil to a depth of 3" under seed.....	41	11	18	85	39	63	78	86	76	66	29	64	82	60	78	60	58	83	70	61	
750 pounds per acre																					
Band 1.75" wide, 3" under seed.....	48	16	15	78	39	74	41	91	69	56	23	64	82	56	63	37	58	78	59	56	
Band 1.5" to each side, 2" below seed level.....			19	86	52			89	89			56	84	70			69	94	82	73	
Band 2.5" to each side, 2" below seed level.....			18	82	50			96	96			64	80	72			73	95	84	76	
Band 3.5" to each side, 2" below seed level.....	59	40			50	79	91		85	72	40			56	46	38				42	
Mixed with soil to a depth of 3" under seed.....	42	15			28	72	74		73	71	26			48	80	59				70	

emergence than the 250- and 750-pound rates (Table 13). For all three rates the highest average percentage of germination was obtained where the fertilizer was placed in bands 2.5 inches to each side and two inches below the seed level. The lowest average percentage germination for all three rates was for the placement where the fertilizer was mixed with the soil under the seed.

Rate of Emergence: Tables 14 and 15 show that of the various placements of fertilizer applied at the rates of 250 and 750 pounds per acre, the placement in bands 3.5 inches to each side and two inches below the seed level gave the most rapid emergence. At the 500-pound rate, fertilizer placed in bands 2.5 inches to each side and two inches below the seed level gave the most rapid emergence.

At each of the three rates, fertilizer applied either in bands 1.75 inches wide and three inches under the seed or mixed with the soil under the seed to a depth of three inches delayed germination and emergence much below that obtained for the side applications.

Of the side applications the placement 1.5 inches to each side and two inches below the seed level gave the lowest rate of germination and emergence.

Total Germination: The data in Table 15 show that for the three rates and the various placements the narrow band 1.75 inches wide at three inches under the seed retarded germination more than any of the placements at all rates. The final stand obtained for the narrow band three inches under the seed was lower than for the side placements at all rates.

The data show that where the fertilizer was applied 1.5, 2.5, and 3.5 inches to each side and two inches below the seed level, the highest number of seedlings emerged for each of the three rates where the fertilizer was placed in bands 2.5 inches to each side, except for the placement 1.5 inches to each side at the 250-pound rate, which averaged five plants more.

The 500-pound rate and the placement of fertilizer 2.5 inches to each side and two inches below the seed level gave the highest average number of plants for the three rates and placements.



Figure 22. Comparing growth of fertilized and unfertilized cotton plants at Nacogdoches on July 24, 1935: A, unfertilized check where soil was undisturbed 2.5 inches to each side and 2 inches below seed level; B, fertilizer applied at the rate of 250 pounds per acre 1.5 inches to each side and 2 inches below seed level.

Table 14. Number of seedlings emerged when 4-12-4 fertilizer was applied at different rates and placements

Fertilizer Placement	Germination counts	Seedlings emerging in 50 feet of row																				
		Bryan					Temple				College Station					Nacogdoches						
		Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam						
		1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.		
<i>250 pounds per acre</i>																						
Band 1.75" wide, 3" under seed		first	267	4	8	32	78	321	188	57	189	334	10	80	10	108	14	44	34	71	41	
		second	800	96	131	241	317	367	438	384	394	446	85	456	361	337	257	309	65	347	245	
		last	774	148	139	477	384	427	465	430	440	464	151	471	633	430	436	267	664	545	478	
Band 1.5" to each side, 2" below seed level		first	.....	.....	72	117	94	.....	.....	168	168	.....	.....	176	120	148	.....	.....	280	97	188
		second	.....	.....	193	371	282	.....	.....	422	422	.....	.....	486	477	481	.....	.....	465	452	458
		last	.....	.....	194	541	368	.....	.....	519	519	.....	.....	523	642	582	.....	.....	633	504	568
Band 2.5" to each side, 2" below seed level		first	.....	.....	90	218	154	.....	.....	145	145	.....	.....	140	113	126	.....	.....	246	245	246
		second	.....	.....	249	412	331	.....	.....	402	402	.....	.....	450	465	457	.....	.....	399	501	450
		last	.....	.....	254	511	382	.....	.....	488	488	.....	.....	470	630	550	.....	.....	359	631	595
Band 3.5" to each side, 2" below seed level		first	.....	.....	.....	76	378	417	.....	397	321	25	.....	.....	173	33	48	.....	.....	40	.....
		second	850	151	.....	500	346	466	.....	406	430	159	.....	.....	294	266	204	.....	.....	235	.....
		last	865	216	.....	540	502	507	.....	505	471	256	.....	.....	363	362	202	.....	.....	282	.....
Mixed with soil to a depth of 3" under seed		first	.....	.....	.....	14	151	266	.....	208	238	29	.....	.....	134	1	145	.....	.....	73	.....
		second	608	94	.....	351	174	495	.....	335	416	152	.....	.....	284	120	423	.....	.....	271	.....
		last	829	132	.....	480	422	471	.....	446	446	245	.....	.....	346	550	391	.....	.....	470	.....
<i>500 pounds per acre</i>																						
Band 1.75" wide, 3" under seed		first	135	8	12	28	46	310	75	48	144	292	12	86	10	100	27	43	4	46	30	
		second	612	112	165	244	283	411	318	348	359	382	100	485	389	339	315	270	9	295	222	
		last	795	156	163	491	401	517	377	433	442	407	138	490	642	419	434	231	575	544	446	
Band 1.5" to each side, 2" below seed level		first	.....	.....	54	127	91	.....	.....	63	63	.....	.....	186	61	124	.....	.....	52	195	124
		second	.....	.....	166	361	264	.....	.....	381	381	.....	.....	437	451	444	.....	.....	89	450	268
		last	.....	.....	177	530	354	.....	.....	470	470	.....	.....	482	643	562	.....	.....	524	530	527
Band 2.5" to each side, 2" below seed level		first	.....	.....	93	220	157	.....	.....	154	154	.....	.....	184	81	132	.....	.....	360	227	294
		second	.....	.....	228	421	324	.....	.....	400	400	.....	.....	491	431	461	.....	.....	572	585	578
		last	.....	.....	242	528	385	.....	.....	505	505	.....	.....	528	621	574	.....	.....	761	666	714
Band 3.5" to each side, 2" below seed level		first	76	29	113	161	95	421	369	82	291	340	24	130	58	138	46	39	243	196	131	
		second	808	185	261	353	402	429	481	401	437	439	150	448	402	360	302	260	359	450	443	
		last	904	247	277	532	490	558	489	460	502	486	255	448	633	456	328	224	610	530	423	
Mixed with soil to a depth of 3" under seed		first	2	10	21	11	142	202	38	127	258	28	78	8	94	3	86	17	62	42
		second	675	46	149	249	280	197	433	358	329	411	137	448	380	344	121	388	49	457	254	
		last	637	73	156	512	344	391	456	428	425	452	196	484	647	445	532	368	398	553	463	

Table 14. Number of seedlings emerged when 4-12-4 fertilizer was applied at different rates and placements
—Continued

Fertilizer Placement	Germination counts	Seedlings emerging in 50 feet of rows																		
		Bryan					Temple				College Station					Nacogdoches				
		Yahola clay					Houston black clay				Lufkin fine sandy loam					Norfolk sandy loam				
		1932	1933	1934	1935	Ave.	1932	1933	1934	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.
<i>750 pounds per acre</i> Band 1.75" wide, 3" under seed.....	first.....	65	2	9	40	29	272	16	43	110	272	8	97	12	97	3	59	17	43	30
	second...	630	59	118	257	267	362	169	354	295	366	84	494	367	328	217	265	32	372	222
	last.....	751	104	131	465	363	462	240	456	386	383	153	480	644	415	432	227	393	519	393
Band 1.5" to each side, 2" below seed level	first.....	.....	.....	27	99	63	.....	.....	149	149	.....	.....	138	70	104	.....	.....	198	260	229
	second...	.....	.....	145	327	236	.....	.....	397	397	.....	.....	383	489	436	.....	.....	298	488	393
	last.....	.....	.....	165	514	339	.....	.....	447	447	.....	.....	419	659	539	.....	.....	472	625	548
Band 2.5" to each side, 2" below seed level	first.....	.....	.....	46	134	90	.....	.....	145	145	.....	.....	167	84	126	.....	.....	165	250	208
	second...	.....	.....	142	369	255	.....	.....	437	437	.....	.....	436	456	446	.....	.....	292	517	404
	last.....	.....	.....	155	491	323	.....	.....	480	480	.....	.....	479	632	555	.....	.....	498	634	566
Band 3.5" to each side, 2" below seed level	first.....	43	41	.....	.....	42	379	355	.....	367	346	20	.....	.....	183	55	78	.....	.....	67
	second...	796	220	.....	.....	508	366	482	.....	424	460	154	.....	.....	307	297	278	.....	.....	287
	last.....	919	266	.....	.....	592	496	529	.....	513	494	264	.....	.....	379	312	236	.....	.....	274
Mixed with soil to a depth 3" under seed...	first.....	44	3	.....	.....	24	146	149	.....	148	318	15	.....	.....	166	0	85	.....	.....	43
	second...	706	62	.....	.....	384	208	393	.....	300	472	119	.....	.....	295	72	321	.....	.....	196
	last.....	646	97	.....	.....	372	450	433	.....	442	484	173	.....	.....	329	544	360	.....	.....	452

Where 250, 500, and 750 pounds of fertilizer per acre were mixed with the soil under the seed, a slightly larger number of plants was obtained at the 250-pound rate at all locations. The lowest number secured was for the 750-pound rate.

When all rates and placements are considered as a whole, the data indicate that slightly more plants were secured for the 500-pound rate

than for the 250- or 750-pound rates. The 750-pound rate gave the fewest number of plants for the three rates and the various placements of fertilizer (Table 15).

These results are graphically shown in Figure 23.

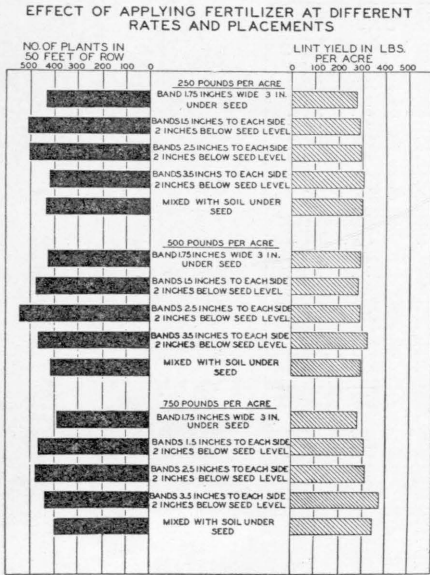


Figure 23. The largest total number of plants obtained at the four locations when fertilizer was applied at rates of 250, 500, and 750 pounds per acre was where 500 pounds was applied in bands 2.5 inches to each side and 3 inches below the seed level. The highest yield was obtained where 750 pounds was applied in bands 3.5 inches to each side and 2 inches below the seed level.

seedlings. From observation it was found that numerous seedlings were sealed up under the soil crust that could not force their way out. The high emergence obtained in 1935 resulted from the use of a rotary hoe to break up the heavy crust.

The crumbling characteristics of the Houston black clay prevented the formation of a soil crust of a sufficient hardness to hinder emergence of cotton seedlings. This factor is reflected in the high percentage of emergence obtained. This percentage was generally the highest of the four soil types, being even higher than the percentages obtained on the sandy Norfolk soil.

The Norfolk sandy loam gave higher percentages of emergence than were obtained on the Lufkin fine sandy loam. This reflects the effect of

poor drainage and the plastic and crust-forming characteristics of the Lufkin soils.

EFFECT OF FERTILIZER PLACEMENTS ON YIELD OF COTTON

The data collected in the studies of machine placement of fertilizer for cotton do not always show that the highest yield was obtained on the

Table 15. Summary of average germination of cottonseed when 4-12-4 fertilizer was applied at different rates and placements

Fertilizer Placement	Germination counts	Seedlings emerging in 50 feet of row				
		Bryan	Temple	College Station	Nacogdoches	General average
<i>250 pounds per acre</i>						
Band 1.75" wide, 3" under seed.....	first.....	78	189	108	41	104
	second...	317	394	337	245	323
	last.....	384	440	430	478	433
Band 1.5" to each side, 2" below seed level.....	first.....	94	168	148	188	150
	second...	282	422	481	458	411
	last.....	368	519	582	568	509
Band 2.5" to each side, 2" below seed level.....	first.....	154	145	126	246	168
	second...	331	402	457	550	410
	last.....	382	488	550	595	504
Band 3.5" to each side, 2" below seed level.....	first.....	76	397	173	40	172
	second...	500	406	294	235	359
	last.....	540	505	363	282	422
Mixed with soil to a depth of 3" under seed.....	first.....	14	208	134	73	107
	second...	351	335	284	271	310
	last.....	480	446	346	470	436
<i>500 pounds per acre</i>						
Band 1.75" wide, 3" under seed.....	first.....	46	144	100	30	80
	second...	283	359	339	222	301
	last.....	401	442	419	446	427
Band 1.5" to each side, 2" below seed level.....	first.....	91	63	124	124	100
	second...	264	381	444	268	339
	last.....	354	470	562	527	478
Band 2.5" to each side, 2" below seed level.....	first.....	157	154	132	294	184
	second...	324	400	461	578	441
	last.....	385	505	574	714	544
Band 3.5" to each side, 2" below seed level.....	first.....	95	291	138	131	164
	second...	402	437	360	443	410
	last.....	490	502	456	423	468
Mixed with soil to a depth of 3" under seed.....	first.....	11	127	94	42	68
	second...	280	329	344	254	302
	last.....	344	425	445	463	419
<i>750 pounds per acre</i>						
Band 1.75" wide, 3" under seed.....	first.....	29	110	97	30	66
	second...	267	295	328	222	278
	last.....	363	386	415	393	389
Band 1.5" to each side, 2" below seed level.....	first.....	63	149	104	229	136
	second...	236	397	436	393	366
	last.....	339	447	539	548	468
Band 2.5" to each side, 2" below seed level.....	first.....	90	145	126	208	142
	second...	255	437	446	404	386
	last.....	323	480	555	566	481
Band 3.5" to each side, 2" below seed level.....	first.....	42	367	183	67	165
	second...	508	424	307	287	382
	last.....	592	513	379	274	440
Mixed with soil to a depth of 3" under seed.....	first.....	24	148	166	43	95
	second...	384	300	295	196	294
	last.....	372	442	329	452	399

test where the highest percentage of germination and emergence of seedlings was obtained. This may be attributed to some extent to moisture and climatic conditions, which probably may have influenced the availability of the fertilizer to the plants.

Effect of Placing Fertilizer under the Seed

The two-inch depth gave the highest yield where the fertilizer was placed in narrow bands 1.75 inches wide and one, two, and three inches under the seed (Table 16). At College Station and Nacogdoches, however, the average yield for the four years was highest for the three-inch depth. The unfertilized check at Bryan gave a higher yield than did the fertilized test for the one- and three-inch placements under the seed. At Temple the average yield for the check was higher for the three-inch depth and slightly lower than for the one- and two-inch placements under the seed. At College Station and Nacogdoches the average yields for the one-, two-, and three-inch depths increased as the depth increased, but the differences were not significant. There was, however, a significantly lower yield for the check (Figure 15).

Tests were conducted for only two years with the fertilizer placed in wide bands 3.5 inches wide and one, two, and three inches under the seed (Table 16). At Bryan and Temple the highest yields were obtained for the one-inch depth, but at College Station and Nacogdoches the two-inch depth gave the highest yields. The two-inch depth under the seed gave the highest general average yield for all locations. At Bryan, College Station, and Nacogdoches the unfertilized checks were significantly lower than the fertilized tests, but at Temple the check yielded higher than the placements two and three inches under the seed but lower than the one-inch placement.

The general averages for the placements under the seed for all locations were lower than any of the tests for the side bands. The general average yields decreased in the same order as the fertilizer was placed deeper in the soil (Figure 15).

By comparing the yields for the narrow and wide bands, it may be seen in Tables 16 and 17 that in each test the wide band gave the highest general average for all locations. When the general averages, however, for 1932 and 1933 are compared, the data indicate that the three-inch depth for the narrow band gave higher yields than the three-inch depth for the wide band. There were no significant differences in the checks for the wide and narrow bands for the two years.

Effect of Placing Fertilizer to the Sides of the Seed

The results shown in Tables 18 and 19 for the bands 1.5 and 3.5 inches to one side and two inches below the seed level do not show any significant differences in yield for the two placements. These results are 313 pounds

Table 16. Effect on yield of cotton when 4-12-4 fertilizer was applied under the seed at the rate of 500 pounds per acre

Fertilizer Placement	Pounds of lint per acre																				Gen. Ave.
	Bryan					Temple			College Station					Nacogdoches							
	Yahola clay					Houston black clay			Lufkin fine sandy loam					Norfolk sandy loam							
	1932	1933	1934	1935	Ave.	1932	1933	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.			
<i>Band 1.75 inches wide</i>																					
1 inch under seed	238	423	169	366	299	261	343	302	342	290	171	404	302	223	157	159	281	205	277		
2 inches under seed	247	525	168	357	324	272	338	305	234	371	183	437	306	251	185	174	320	232	292		
3 inches under seed	283	472	135	351	310	245	295	270	225	415	194	413	312	255	295	138	269	239	283		
Unfertilized check*	266	424	200	366	314	267	315	291	203	250	177	436	267	92	44	207	92	109	245		
<i>Band 3.5 inches wide</i>																					
1 inch under seed	307	508	.....	.....	408	313	394	354	275	294	.....	.....	285	204	280	.....	.....	242	322
2 inches under seed	268	460	.....	.....	364	279	319	299	313	371	.....	.....	342	236	294	.....	.....	265	318
3 inches under seed	256	414	.....	.....	335	220	278	249	253	353	.....	.....	303	235	269	.....	.....	252	285
Unfertilized check†	262	330	.....	.....	296	263	366	314	188	302	.....	.....	245	94	70	.....	.....	82	234

*Soil stirred 1.75 inches wide, 2 inches under seed.

†Soil stirred 3.5 inches wide, 2 inches under seed.

of lint per acre for the placement 1.5 inches to the side and 326 pounds for the placement 3.5 inches to the side of the seed (Figure 16).

When the fertilizer was placed in bands 1.5 inches to each side and one, two, and three inches below the level of the seed, the highest general average was secured for the one-inch depth (Table 19). This, however, was only two pounds more than the general average for the three-inch depth, the yields being 312 pounds for the former and 310 pounds of lint per acre for the latter. Results from the two-inch depth were considerably lower and gave a general average of only 282 pounds of lint per acre (Figure 16).

Table 17. Summary of average acre yields of cotton when 4-12-4 fertilizer was applied under the seed at the rate of 500 pounds per acre in narrow and wide bands

Fertilizer Placement	Average number pounds of lint per acre				
	Bryan	Temple	College Station	Nacogdoches	General average
<i>Band 1.75 inches wide</i>					
1 inch under seed.....	299	302	302	205	277
2 inches under seed.....	324	305	306	233	292
3 inches under seed.....	310	270	312	239	283
Unfertilized check*	314	291	267	109	245
<i>Band 3.5 inches wide</i>					
1 inch under seed.....	408	354	285	242	322
2 inches under seed.....	364	299	342	265	318
3 inches under seed.....	335	249	303	252	285
Unfertilized check†	296	314	245	82	234

*Soil stirred 1.75 inches wide, 2 inches under seed.

†Soil stirred 3.5 inches wide, 2 inches under seed.

Fertilizer placed in bands 2.5 inches to each side and one, two, and three inches below the seed level did not show any significant differences in yield at any of the locations except Bryan, the general averages being 280, 287, and 269 pounds of lint per acre for the one-, two-, and three-inch depths, respectively. The unfertilized check at Bryan and College Station did not give significantly lower yields than the fertilized tests (Table 18). There was, however, a significantly lower yield at Nacogdoches. The average for all locations was 239 pounds of lint per acre (Figure 16).

Bands of fertilizer placed 3.5 inches to each side and one, two, and three inches below the level of the seed gave general average yields that increased as the depth of the fertilizer increased, being 293, 304, and 311 pounds, respectively (Table 19).

At Bryan the unfertilized check where the soil was undisturbed for 3.5 inches to each side gave higher yields than did any of the side placements (Table 18). At this location 389 pounds of lint per acre were secured on the unfertilized check, while the next highest yield, 367 pounds, was secured where the fertilizer was placed in bands 3.5 inches to each side and three inches below the level of the seed. At Temple the

Table 18. Effect on yield of cotton when 4-12-4 fertilizer was applied to the side of the seed at the rate of 500 pounds per acre

Fertilizer Placement	Pounds of lint per acre																				Gen. Ave.
	Bryan					Temple			College Station					Nacogdoches							
	Yahola clay					Houston black clay			Lufkin fine sandy loam					Norfolk sandy loam							
	1932	1933	1934	1935	Ave.	1932	1933	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.			
<i>All on one side of seed</i>																					
Band 1.5" to one side, 2" below seed level.....	....	443	206	379	343	....	302	302	....	321	206	432	320	....	317	257	288	287	313	
Band 3.5" to one side, 2" below seed level.....	....	481	202	370	351	....	353	353	....	356	198	428	327	....	327	235	255	272	326	
<i>Bands 1.5 inches to each side</i>																					
1 inch below seed level.....	244	495	....	....	370	284	320	293	274	352	....	....	313	210	331	....	....	....	271	312
2 inches below seed level.....	252	459	166	391	317	306	329	318	239	325	210	400	294	244	324	195	271	198	282	282	
3 inches below seed level.....	283	435	....	....	359	275	322	298	258	337	....	....	298	230	341	....	....	....	286	310
<i>Bands 2.5 inches to each side</i>																					
1 inch below seed level.....	....	....	216	385	301	....	....	....	....	....	207	416	312	....	....	191	260	226	280	280
2 inches below seed level.....	....	....	220	384	302	....	....	....	....	....	206	404	305	....	....	248	262	255	287	287
3 inches below seed level.....	....	....	91	376	234	....	....	....	....	....	211	442	327	....	....	225	267	246	269	269
Unfertilized check*.....	....	....	209	368	289	....	....	....	....	....	172	465	319	....	....	134	83	109	239	239
<i>Bands 3.5 inches to each side</i>																					
1 inch below seed level.....	204	457	....	....	331	282	291	286	231	367	....	....	299	240	270	....	....	....	255	293
2 inches below seed level.....	280	451	233	366	333	315	275	295	259	371	222	474	332	231	312	208	265	254	304	304	
3 inches below seed level.....	240	494	....	....	367	286	247	266	261	392	....	....	326	230	340	....	....	....	285	311
Unfertilized check†.....	232	545	....	....	389	341	287	314	189	300	....	....	244	94	67	....	....	....	81	257

*Soil undisturbed under seed for 2.5 inches to each side and 2 inches below the seed level.

†Soil undisturbed under seed for 3.5 inches to each side and 2 inches below the seed level.

unfertilized check where the soil was undisturbed for 3.5 inches to each side gave 314 pounds of lint per acre, while next highest yield for the fertilized tests was with the fertilizer placed 1.5 inches to each side and two inches below the seed level, or 318 pounds, which was four pounds higher than for the unfertilized check. At College Station and Nacogdoches the unfertilized check with the soil undisturbed for 3.5 inches to each side gave lower yields than did any of the fertilized tests. The general average for this unfertilized check was 257 pounds of lint per acre (Table 18).

Table 19. Summary of average yield of cotton when 4-12-4 fertilizer was applied to one and to both sides of the seed at the rate of 500 pounds per acre

Fertilizer Placement	Pounds of lint per acre				
	Bryan	Temple	College Station	Nacogdoches	General average
<i>All fertilizer on one side of seed</i>					
1.5" to one side of seed, 2" below seed level.....	343	302	320	287	313
3.5" to one side of seed, 2" below seed level.....	351	353	327	272	326
<i>Fertilizer applied to each side of seed</i>					
1.5" to each side and 1" below seed level.....	370	293	313	271	312
1.5" to each side and 2" below seed level.....	317	318	294	198	282
1.5" to each side and 3" below seed level.....	359	298	298	286	310
2.5" to each side and 1" below seed level.....	301	....	312	226	280
2.5" to each side and 2" below seed level.....	302	....	305	255	287
2.5" to each side and 3" below seed level.....	234	....	327	246	269
Unfertilized check*.....	289	....	319	109	239
3.5" to each side and 1" below seed level.....	331	286	299	255	293
3.5" to each side and 2" below seed level.....	333	295	332	254	304
3.5" to each side and 3" below seed level.....	367	266	326	285	311
Unfertilized check†.....	389	314	244	81	257

*Soil undisturbed under seed for 2.5" to each side and 2" below the seed level.

†Soil undisturbed under seed for 3.5" to each side and 2" below the seed level.

Placing the fertilizer to one side of the seed gave higher general average yields than did any of the placements where the fertilizer was divided and placed to each side of the seed at various depths (Table 19).

From Tables 18 and 19 it can be seen that generally higher yields were obtained where fertilizer was placed 1.5 and 3.5 inches to each side than for the placement 2.5 inches to each side. In considering these results it must be kept in mind that the placements 2.5 inches to each side were used only in 1934 and 1935, while the 1.5- and 3.5-inch placements were used in 1932 and 1933. In the latter placements the two-inch depth was used during each of the four years. For this placement a both Bryan and Nacogdoches higher average yields were obtained for the period from 1932 to 1933 than for the period from 1934 to 1935. At College Station the reverse was true. As no yields are available for the placement 2.5 inches to each side for the years of 1932 and 1933 during the period the higher yields were obtained at Bryan and Nacogdoches the yields for these placements cannot be compared with the placement 1.5 and 3.5 inches to each side. This also explains why the general average

Table 20. Effect on yield of cotton when 4-12-4 fertilizer was applied in partial contact above and below the seed at 500 pounds per acre

Fertilizer Placement	Pounds of lint per acre																			Gen. Ave.
	Bryan					Temple			College Station					Nacogdoches						
	Yahola clay					Houston black clay			Lufkin fine sandy loam					Norfolk sandy loam						
	1932	1933	1934	1935	Ave.	1932	1933	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.		
<i>In partial contact</i>																				
Bands 2 inches below seed level																				
$\frac{1}{16}$ to $\frac{1}{8}$ with seed, balance 2.5" to each side.....																				269
$\frac{1}{4}$ in surface soil over seed, balance 2.5" to each side.....																				294
$\frac{1}{16}$ with seed, balance 3.5" to each side.....																				332
$\frac{1}{8}$ with seed, balance 3.5" to each side.....																				329
Bands 3 inches under seed																				
$\frac{1}{16}$ with seed, balance in band 1.75" wide under seed																				276
All in soil above seed.....																				292
All mixed with soil to a depth of 3" under seed.....																				287

yields are lower for the placement 2.5 inches to the sides than for the placements 1.5 and 3.5 inches to the sides.

Effect of Placing Part of Fertilizer in Furrow with Seed

The highest general average yields obtained when part of the fertilizer was placed in the furrow with the seed were for the placements where one-sixteenth and one-eighth of the fertilizer was placed with the seed and the balance 3.5 inches to each side, or 332 and 329 pounds of lint per acre, respectively (Tables 20 and 21). The general average yields for all of the other placements ranged below 300 pounds of lint per acre (Table 21). The lowest general average yield obtained was for the placement where one-sixteenth to one-eighth of the fertilizer was placed with the seed and the balance 2.5 inches to each side and two inches below the

Table 21. Summary of average acre yield of cotton when 4-12-4 fertilizer was applied at the rate of 500 pounds per acre in partial contact with the seed and mixed in soil above and below the seed

Fertilizer Placement	Average pounds of lint per acre				
	Bryan	Temple	College Station	Nacogdoches	General average
$\frac{1}{16}$ to $\frac{1}{8}$ with seed, balance in bands 2.5" to each side and 2" below seed level..	284	....	294	229	269
$\frac{1}{4}$ in surface soil over seed, balance in bands 2.5" to each side and 2" below seed level.....	295	....	314	272	294
$\frac{1}{8}$ with seed, balance in bands 3.5" to side and 2" below seed level.....	382	327	327	290	332
$\frac{1}{8}$ with seed, balance in bands 3.5" to each side and 2" below seed level.....	379	318	325	295	329
$\frac{1}{8}$ with seed, balance in band 1.75" wide and 3" under seed.....	316	265	261	264	276
All in surface soil above seed.....	319	320	299	231	292
Mixed with soil to depth of 3" under seed	284	294	303	267	287

level of the seed, or 269 pounds of lint per acre. In comparing these averages, however, it must be kept in mind that the highest average yields were for the years 1932 and 1933, and that the lowest were for the two-year period of 1934 and 1935. Climatic and moisture conditions therefore, may have influenced the average yields. The four-year average yield for the placements where all of the fertilizer was in the soil above the seed or all mixed with the soil under the seed gave 292 pounds of lint per acre for the former and 287 pounds for the latter (Figure 19).

Effect of Applying Fertilizer at Different Rates and Placements

In comparing the yields obtained where fertilizer was applied at the rates of 250, 500, and 750 pounds per acre at various placements in relation to the seed, it is found from a study of Tables 22 and 23 that as a whole, a higher general average yield was obtained for the 750-pound rate (Figure 23). In general, the yields increased as the rates of fertilizer application increased. When the various placements were considered, the

Table 22. Effect on yield of cotton when 4-12-4 fertilizer was applied at different rates and placements

Fertilizer Placement	Pounds of lint per acre																				Gen. Ave.
	Bryan					Temple			College Station					Nacogdoches							
	Yahola clay					Houston black clay			Lufkin fine sandy loam					Norfolk sandy loam							
	1932	1933	1934	1935	Ave.	1932	1933	Ave.	1932	1933	1934	1935	Ave.	1932	1933	1934	1935	Ave.			
<i>250 pounds per acre</i>																					
Band 1.75" wide, 3" under seed	261	405	133	386	296	264	355	310	243	298	209	434	296	209	272	165	213	215	279		
Band 1.5" to each side, 2" below seed level	.....	.....	204	384	294	.....	.....	.....	.....	.....	227	420	323	.....	.....	287	221	254	290
Band 2.5" to each side, 2" below seed level	.....	.....	229	393	311	.....	.....	.....	.....	.....	213	463	338	.....	.....	265	204	234	294
Band 3.5" to each side, 2" below seed level	238	494	.....	.....	366	315	348	332	256	341	.....	.....	298	191	258	.....	.....	224	305
Mixed with soil to a depth of 3" under seed	260	481	.....	.....	370	284	348	316	249	332	.....	.....	290	192	250	.....	.....	221	299
<i>500 pounds per acre</i>																					
Band 1.75" wide, 3" under seed	256	489	135	351	308	318	297	308	261	342	194	413	303	248	350	138	269	251	292		
Band 1.5" to each side, 2" below seed level	.....	.....	166	391	278	.....	.....	.....	.....	.....	210	400	305	.....	.....	195	271	263	282
Band 2.5" to each side, 2" below seed level	.....	.....	220	384	302	.....	.....	.....	.....	.....	206	404	305	.....	.....	248	262	255	287
Band 3.5" to each side, 2" below seed level	271	463	233	366	333	329	411	370	266	379	222	474	335	239	328	208	265	260	324		
Mixed with soil to a depth of 3" under seed	267	356	147	384	288	309	345	327	255	351	211	389	301	237	344	187	268	261	294		
<i>750 pounds per acre</i>																					
Band 1.75" wide, 3" under seed	273	402	132	352	290	304	237	270	255	303	199	388	286	264	315	141	382	275	280		
Band 1.5" to each side, 2" below seed level	.....	.....	197	367	282	.....	.....	.....	.....	.....	212	429	320	.....	.....	273	395	334	312
Band 2.5" to each side, 2" below seed level	.....	.....	173	361	267	.....	.....	.....	.....	.....	225	482	353	.....	.....	295	354	324	315
Band 3.5" to each side, 2" below seed level	307	527	.....	.....	417	295	365	330	281	440	.....	.....	360	308	463	.....	.....	385	373
Mixed with soil to a depth of 3" under seed	285	423	.....	.....	354	310	371	341	278	431	.....	.....	354	259	424	.....	.....	341	348

MACHINE PLACEMENT OF FERTILIZER FOR COTTON

highest yields were obtained where the fertilizer was placed 3.5 inches to each side and two inches below the level of the seed. It is significant to note that this placement gave the highest general average yield for all rates of fertilizer application.

The increase in yield for either the 500- over the 250-pound rate or the 750- over the 250-pound rate was not sufficient to consider the higher rates profitable at any of the locations except Nacogdoches.

Considering all three rates and the five placements for each as a unit, it will be seen that the average increase of the 500-pound over the 250-pound rate was only three pounds of lint per acre, but the average increase of the 750-pound over the 250-pound rate was 33 pounds of lint per acre.

The placement 3.5 inches to each side and two inches below the seed level gave the largest gain (68 pounds of lint per acre) when the fertilizer rate was increased from 250 to 750 pounds per acre. Doubling the fertilizer rate from 250 to 500 pounds per acre raised the acre yield 19 pounds, but when 750 pounds of fertilizer were applied, there was a gain of 49 pounds of lint per acre over that obtained for the 500-pound rate.

At Bryan on the Yahola clay the only significant increase in yield was obtained where fertilizer was applied at 750 pounds per acre and placed 3.5 inches to each side and two inches below the seed level.

The Houston black clay did not give any significant increase at any rate or placement.

Table 23. Summary of average acre yield of cotton when 4-12-4 fertilizer was applied at different rates and placements

Fertilizer Placement	Average pounds of lint per acre				
	Bryan	Temple	College Station	Nacogdoches	General average
<i>250 pounds per acre</i>					
Band 1.75" wide, 3" under seed	296	310	296	215	279
Band 1.5" to each side, 2" below seed level	294	....	323	254	290
Band 2.5" to each side, 2" below seed level	311	....	338	234	294
Band 3.5" to each side, 2" below seed level	366	332	298	224	305
Mixed with soil to depth of 3" under seed	370	316	290	221	299
<i>500 pounds per acre</i>					
Band 1.75" wide, 3" under seed	308	308	303	251	292
Band 1.5" to each side, 2" below seed level	278	....	305	263	282
Band 2.5" to each side, 2" below seed level	302	....	305	255	287
Band 3.5" to each side, 2" below seed level	333	370	335	260	324
Mixed with soil to depth of 3" under seed	288	327	301	261	294
<i>750 pounds per acre</i>					
Band 1.75" wide, 3" under seed	290	270	286	275	280
Band 1.5" to each side, 2" below seed level	282	....	320	334	312
Band 2.5" to each side, 2" below seed level	267	....	353	324	315
Band 3.5" to each side, 2" below seed level	417	330	360	385	373
Mixed with soil to depth of 3" under seed	354	341	354	341	348

On the Lufkin fine sandy loam significant increases were obtained at the 750-pound rate for two placements of fertilizer. These were 3.5 inches to each side, two inches below the seed level, and mixed in the soil under the seed.

At Nacogdoches significant increases were obtained for most of the placements by increasing the fertilizer rates from 250 to 500 pounds per acre. Larger gains in yield were obtained when the fertilizer rate was raised from 500 to 750 pounds per acre than by doubling the 250-pound rate. In either case profitable increases were obtained for each of the five placements.

SUMMARY AND CONCLUSIONS

Machine placement of fertilizers with cotton in Texas was studied at four locations—Bryan in the Brazos River Bottoms on Yahola clay soil, Temple on Houston black clay, College Station on Lufkin fine sandy loam, and Nacogdoches on Norfolk sandy loam. These experiments covered a period of three years at Temple, and four years at Bryan, College Station, and Nacogdoches.

A 4-12-4 fertilizer was applied at the rate of 500 pounds per acre in six placements under the seed with an unfertilized check; eleven placements to the side of the seed, including two placements to one side of the seed, with the addition of two unfertilized checks; five placements in the furrow with the seed; one placement in the soil above the seed; and one placement mixed with the soil three inches under the seed. Fertilizer was also applied at the rates of 250, 500, and 750 pounds per acre at five placements.

The results show that the earliest germination, the highest average percentage of seedlings emerging, the best final stand of plants, and the most rapid growth were obtained when the fertilizer was applied 2.5 inches to the sides and two inches below the seed level.

Fertilizer placed within one inch of the seed, materially delayed germination and emergence of seedlings, thus reducing the final stand of plants.

Placing the fertilizer in a band 3.5 inches wide, one inch under the seed, gave the highest yields on the clay soils of Bryan and Temple, but the wide band two inches under the seed at College Station and Nacogdoches gave the highest yields of all placements of fertilizer under the seed.

The highest average yield for the narrow bands was 292 pounds of lint per acre and was obtained where the fertilizer was placed two inches under the seed. The same placement for the wide bands gave the highest yields at College Station and Nacogdoches, while the one inch depth gave the highest yields at Bryan and Temple. The check for the narrow band yielded an average of 245 pounds of lint per acre, while the check for the wide bands yielded an average of 234 pounds of lint per acre.

Disturbing the soil under the seed at any depth reduced the final stand of plants as compared with stands where the soil was not disturbed.

Fertilizer applied at the rate of 500 pounds per acre, 2.5 inches to each side and two inches below the seed level, gave higher average percentages of emergence of seedlings and better final stands than did the 250- and 750-pound rates and fertilizer applied in other places in relation to the seed.

Fertilizer placed 3.5 inches to one side and two inches below the seed level gave an average yield of 326 pounds of lint per acre, which was slightly higher than that obtained for any of the placements where the fertilizer was applied to each side of the seed. Fertilizer placed 1.5 inches to each side and one inch below the seed level, yielded 312 pounds of lint per acre, which was only one pound more per acre than was obtained for the placement 3.5 inches to each side and three inches below the seed level. The unfertilized checks yielded 239 and 257 pounds of lint per acre.

The highest general average yields obtained when fertilizer was placed in the furrow with the seed were for the placements of one-sixteenth and one-eighth of the fertilizer with the seed and the balance 3.5 inches to each side, or 332 and 329 pounds of lint per acre, respectively.

When the fertilizer was applied at the rates of 250, 500, and 750 pounds per acre, the average yields were increased as the rate of fertilizer application increased. For all rates of fertilizer application the placement 3.5 inches to each side and two inches below the seed level gave the highest yield.

Considering all the placements enumerated and discussed, it appears that the best results were secured when the fertilizer was placed 2.5 inches to the sides and two or three inches below the seed level.

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