92 SEPTEMBER 1962

Planting Equipment and Practices for Cotton

On The High Plains

THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
TEXAS AGRICULTURAL EXPERIMENT STATION
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

IN COOPERATION WITH THE U. S. DEPARTMENT OF AGRICULTURE

Summary and Recommendations

Equipment development and planting practice tests for cotton were conducted on the High Plains over a 13-year period. Equipment studied included the planting row profile, seed-furrow openers, seed-firming wheel and covering devices. Planting practices, such as depth of lister furrow, depth of covering over seed, time of planting, rate of seed and type of seed, were studied. All studies were initially conducted on fine sandy loam soils at Substation No. 8, Lubbock, Texas. Later equipment tests were made on loamy fine sand in Terry county and on clay loam soils in Swisher and Hale counties during the last 5 years of the study.

The planting furrow or lister furrow should be deep enough to reach moisture adequate to germinate seed and insure seedling emergence. Deep-furrow plantings slowed emergence and frequently resulted in thinner stands when precipitation occurred before and during the emergence period. The plateau-planter profile prevented the silting-over of the seed row by heavy washing rains, which was experienced frequently with lister-planter profiles. The use of the plateau planter has reduced the necessity for replantings and has given the highest seedling emergence and best stands. Planting high on the bed gave the second highest emergence and stands.

A chisel-furrow opener, ¾ inch wide and shielded adequately and shaped to drop the seed to the bottom of the seed furrow, gave excellent results on the three soil types. A modified stub runner worked equally well on clay loam soil. Poorer emergence was experienced with the conventional stub runner, and the wear on the knife edge was severe in sandy soils. The seed-furrow opener should be set to cut a trench deep enough into the firm soil behind the lister bottom to permit the covering of seed with 2 inches of soil.

The use of a 1 x 10-inch rubber-tired wheel to firm the seed into moist soil at the bottom of the seed furrow resulted in faster emergence and better stands under drying conditions. Small scrapers attached to the sides of the seed-firming wheel eliminated excessive buildup of sticky soil on the side of the wheel.

Covering devices that place a 2-inch deep loose soil cover over the seed are recommended. Short fishtail drags attached at the seed-firming wheel axle were satisfactory in friable soils. A harrow-type device covered well, but caught crop residue, which interfered with proper covering.

Soil covering the seed should not be pressed on the surface in loamy fine sand and fine sandy loam soils; however, surface pressing on clay loam soils results in faster emergence and better stands. The rubber-flap press wheel mounted on a planter did not build up with sticky soil when used for pressing simultaneously with planting. Seed should be covered to a depth of 1½ to 2 inches.

Delinted seed produced earlier emergence and better stands. Delinted seed also were easier to handle and meter, and they caused fewer stoppages in the seed tube and the narrow seed-furrow openers.

Seeding rates of 20 pounds of chemically delinted seed per acre were adequate to give good emergence and stands for top yields, high harvesting efficiency and good weed control. A population of less than 20,000 plants per acre reduced yields and harvesting efficiencies. Yields decreased progressively as populations increased over 50,000 plants per acre.

Cotton may be planted successfully after the minimum soil temperature at an 8-inch depth averages 60° F. or above for the 10 days preceding planting. Plantings after this temperature occurred had higher emergence percentage and a shorter emergence period. This guide permits plantings when favorable weather prevails earlier than is normally recommended by date alone.

Contents

Summary and Recommendations 2
Introduction 3
Seedbed Preparation 5
Planting Equipment 5
- Preparation of Planter 5
- Planting Row Profile 5
- Seed-furrow Openers 8
- Seed-firming Wheel 9
- Covering of Seed 10
  - Depth of Covering 10
  - Covering Devices 11
  - Pressing of Soil Cover 11

Planting Practices 12
- Rate of Seeding 12
- Type of Seed 12
- Time of Planting 12

Acknowledgments 13
References 13

Planting Equipment and Practices for Cotton on the High Plains

E. R. Holekamp, E. B. Hudspeth, R. F. Colwick and L. L. Ray*

PLANTING COTTON TO A UNIFORM STAND is of primary importance for high yields, high harvesting efficiency and good weed control. A cotton stand of uniform spacing with a desirable number of plants per acre is the goal of every mechanized farm. Thin and skippy stands reduce yields and increase mechanical harvesting losses and stoppages caused by large branchy plants (2, 19). Such stands permit the growth of weeds, which necessitates control practices to prevent the occurrence of grass and weed trash in mechanically harvested cotton (4, 6). Planting cotton in deep lister furrows increased cotton losses with mechanical strippers (8) and pickers (17) because more bolls were close to the ground.

The establishment of a desirable cotton stand depends on cultural practices, weather, soil moisture, soil temperature, disease, seed vigor and many factors other than the planting operation itself (16). The planting operation, therefore, should be executed with care, precision and the best known techniques. This bulletin presents and summarizes the results of investigations in the Texas High Plains on planting equipment and on practices to improve cotton stands and to minimize replantings. Planting to a stand also reduces operating costs such as seed, thinning and early weed control.

Among weather hazards confronting the establishment and maintenance of cotton stands in the High Plains are heavy rains and hail, drying hot winds, blowing soil covering the cotton seedlings, unseasonally low temperatures. Each of these conditions must be considered in order to obtain satisfactory stands and to reduce replantings. Replantings, especially in late May and June (1) delay the crop and decrease yield, thereby decreasing farm income.

A summary and analysis of rainfall at Lubbock, Texas (5) show that precipitation during the cotton-planting period reaches a peak in the latter part of May, with an overall average precipitation of 2.76 inches for May. The frequency of rain is high; more than four rains for May can be expected for 4 out of 5 years (5). A brief rainfall expectation summary for May (8) from a 41-year record at Lubbock follows:

67.8 percent of the time at least one rain of ½ inch or more.

44.0 percent of the time at least two rains of ½ inch or more.

32.9 percent of the time at least three rains of ½ inch or more.

9.9 percent of the time at least four rains of ½ inch or more.

3.2 percent of the time at least five rains of ½ inch or more.

These data show that the chances of ½-inch rainfall or more after planting and before emergence in May are high; therefore, the hazards of rains crusting the soil and retarding cotton seedling emergence should be considered. Allowances also should be made for the other extreme—no precipitation with hot dry winds—which results in the need to protect seedlings from injury by blowing sand. For many years the latter consideration had more influence on planting practices than the former. Cotton was planted in deep lister furrows to "get down to moisture" and to protect the young seedlings from blowing sand.

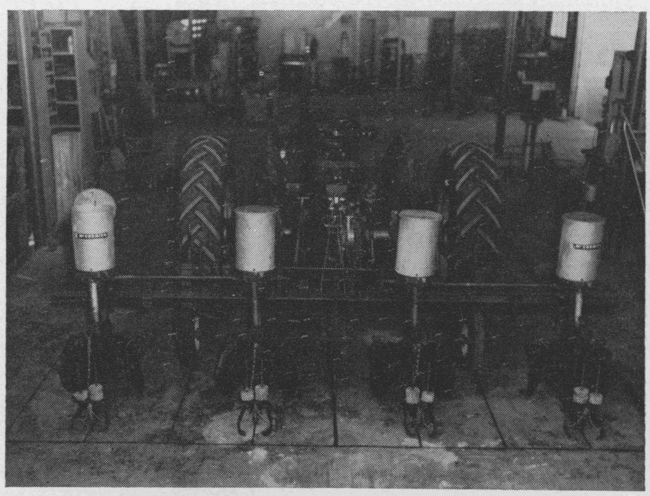

Figure 1. Line diagram adjustment of planter equipment. Lines are drawn at 20 or 19-inch centers on the concrete to represent the rows and the middles for 40 and 38-inch row widths, respectively. These narrow lines can then be used to adjust the planter so that share point, seed-furrow opener, seed-firming wheel and covering devices are centered on the row. This same diagram can be used to set listers and cultivators.

***Respectively, agricultural engineers, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Substation No. 8, Lubbock, Texas; leader, Cotton Mechanization Investigations, AERD, ARS, USDA, State College, Mississippi; and assistant agronomist, Substation No. 8, Lubbock, Texas.**

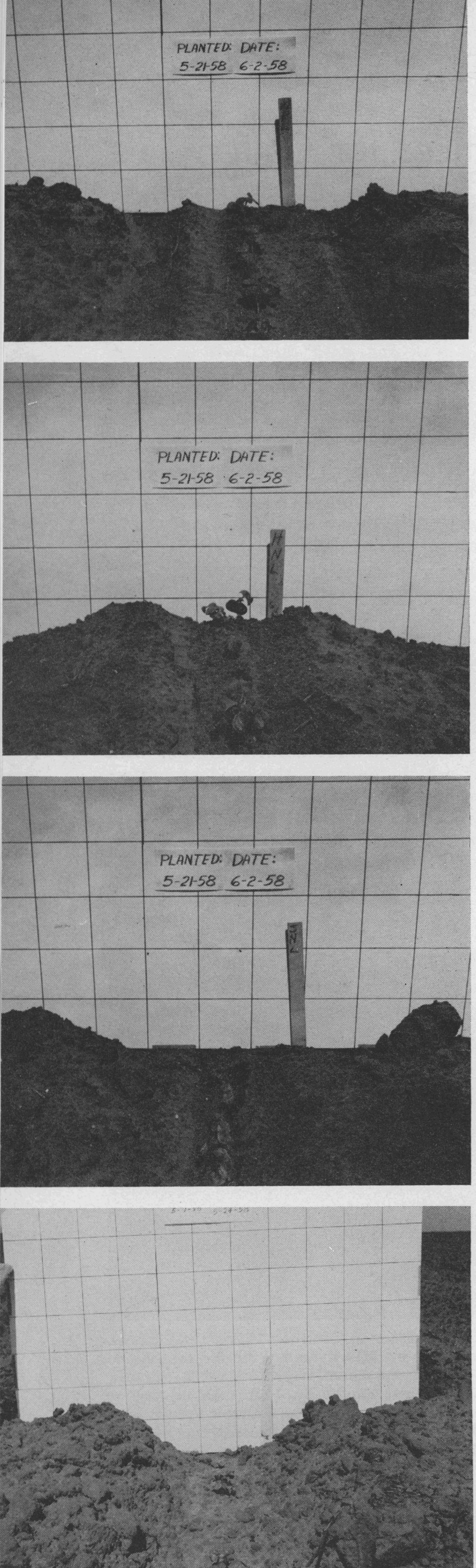

Figure 2. Typical row profiles obtained in tests from top to bottom, plateau planter, high or flat planting, wide, shallow furrow and deep lister furrow.

Figure 3. Plateau-profile planter consisted of modified lister bottom, disks on each side to cut furrows 2 to 3 inches deep and to leave a raised bed 10 inches wide at the top, narrow-shielded chisel seed-furrow opener, seed-firming wheel and short fishtail drags to cover seed.

Figure 4. Lister planter for flat and shallow-furrow plantings. Note extension of shares to widen furrow and weed control area. Planter was equipped with narrow-shielded chisel seed-furrow opener, seed-firming wheel and harrow-type covering device.

Figure 5. Typical lister planter for deep-furrow planting consisting of lister bottom, narrow-shielded chisel seed-furrow opener, seed-firming wheel and short fishtail drags to cover seed.

Many of these weather hazards were considered and observed in the development of new equipment and practices during 1949-61. The research developments were initiated, developed and tested on irrigated fine sandy loam soils at the Lubbock station. Improved developments and practices were further tested on loamy fine sand and clay loam soils during 1957-61.

Seedbed Preparation

A weed-free seedbed, good soil moisture and good tilth are important for successful cotton plantings. General recommendations for management of crop residues and seedbed preparation are presented by Jones *et al.* (12). The final preparation should leave the land in good tilth, free of competing weeds and uniform for proper gaging of planting depths. Listed land should be prepared precisely on either 40 or 38-inch centers with uniform bed heights, side slopes and furrow contour. The use of a line diagram (4) to set lister and preplanting weed control equipment is just as important as its use for adjusting planting equipment.

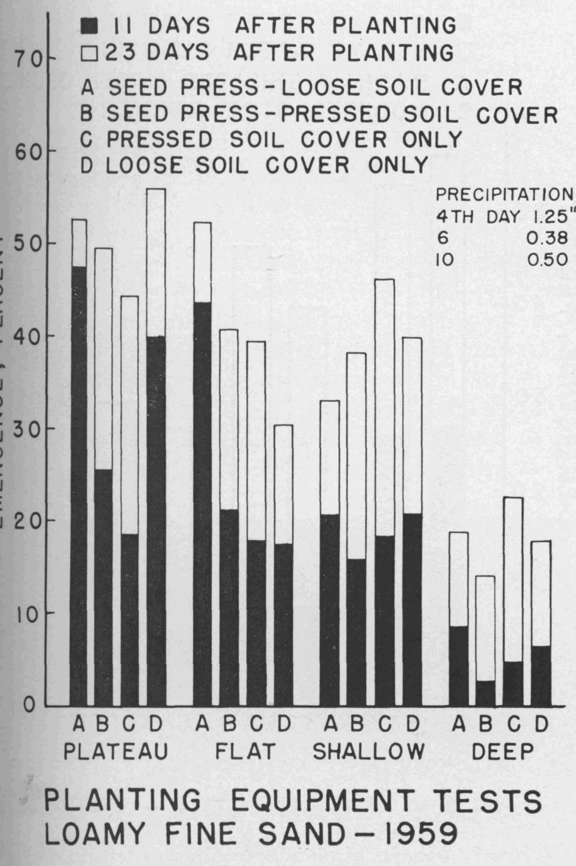

Figure 6. Results of planting equipment tests on loamy fine sand in Terry county for 1959. The stands obtained are expressed as the percent of seed planted to produce cotton seedlings. Because of the unfavorable response with pressing the covering soil and not using the seed-firming wheel, only plantings employing the seed-firming wheel and a loose soil covering 2 inches deep over the seed were used in 1960-61. The 1959-61 mean total emergence for combination "A" were 46.8, 48.1, 38.0 and 32.1 percent emergence, respectively, for the plateau, flat, shallow and deep-planting row profiles.

Planting Equipment

PREPARATION OF PLANTER

The mechanical condition of a planter is important for making precise plantings that will produce good stands. Before each planting season, the planter should be thoroughly checked, worn parts replaced, bolts tightened and shares and seed furrow openers sharpened. The row spacing should be set accurately at either 38 or 40 inches for best weed control and efficient mechanical harvesting. Spacing can be set easily with a line diagram on a concrete floor (4) which can be used later for adjusting the cultivator and the harvesting machine, Figure 1. The bottoms of lister-type planters should be straight, equally spaced and parallel so that furrows and beds will be uniform. The seed-furrow opener must be placed on a line through the center of the lister and parallel to the direction of travel. Precise adjustment of the planter row width permits closer cultivation for better weed control because extra widths between sweeps nearest the row are not required for irregularly spaced rows.

PLANTING ROW PROFILE

Deep-furrow lister planting had been the common practice in the High Plains area until the development of the shallow-furrow planter attachment by Hudspeth (8, 10). Since then the trend has been toward shallower furrows with some flat-planting practices. Early tests on irrigated land have shown that lister furrows only 4 to 5 inches deep were superior to planting furrows 6 to 8 inches deep. There

TABLE 1. COMPARISON OF PLATEAU AND WIDE SHALLOW FURROW PROFILE PLANTINGS DURING THE 1958 PLANTING SEASON, FINE SANDY LOAM SOIL

Date of planting	Planting profile	Time for initial emergence	Precipitation during initial emergence period	Plant emergence	
				Initial count	Second count 10 days after initial
		Days	Inches	Percent	Percent
April 21	Plateau	10	0	20.4	28.2
	Shallow	10	0	22.4	28.2
May 1	Plateau	8	2.05	42.2[1]	53.6[1]
	Shallow	10	2.05	17.9	31.7
May 20	Plateau	5	0	59.8	64.7
	Shallow	5	0	51.9	44.6
May 26	Plateau	5	0.25	52.1	54.8
	Shallow	5	0.25	43.1	48.5
June 2	Plateau	5	0	55.3[2]	55.6[2]
	Shallow	5	0	42.8	42.3

[1]Significantly higher at 1% level for this date.
[2]Significantly higher at 5% level for this date.

were fewer losses of stands due to silting-in from heavy rains with the wide, shallow-furrow plantings than with the deep-furrow plantings.

Additional planting row profiles were tested during the 1957-61 period on three soil types: loamy fine sand in Terry county; fine sandy loam in Lubbock county; and clay loams in Swisher and Hale counties to further evaluate their adaptability. The profiles tested were: (1) plateau or "W" profile developed by the Oklahoma Agricultural Experiment Station (13); (2) planting high on the bed; (3) wide, shallow lister furrow, 2 to 4 inches deep; and (4) deep lister furrow, 6 to 8 inches deep. The deep lister furrow was tested only in the loamy fine sand of Terry county. These profiles are illustrated in Figure 2, and planter equipment used are shown in Figures 3, 4 and 5. The results for loamy fine sand are presented in Figure 6; fine sandy loam, in Figure 7, and clay loam, in Figure 8. Other planter components, such as the use of seed-firming wheel and the type of soil covering, also were evaluated in these tests during the first and second years. These are discussed under the sections on seed-firming wheel and covering of seed.

The deeper planting row profiles generally reduced total emergence, Figures 6 and 8. This trend was particularly noticeable when rain followed 1958-59 plantings in loamy fine sand, Figure 6, and all years in the clay loam soils, Figure 8. This was partially caused by the heavier silting over of the seed row. Generally, a delayed emergence also occurred with the deeper plantings. Usually the seed was covered with 1½ to 2 inches of soil. With the deeper planting furrows, wetter and less friable soil made it more difficult to cover the seed properly.

The overall performance of the plateau-planting profile was satisfactory on the three soil types. This profile was developed to reduce replantings necessitated by silting-over from heavy rains (13). The profile's capability was clearly demonstrated in the May 1, 1958, planting which was followed by a 2-inch rain on May 7, Table 1. The heavy rain silted over

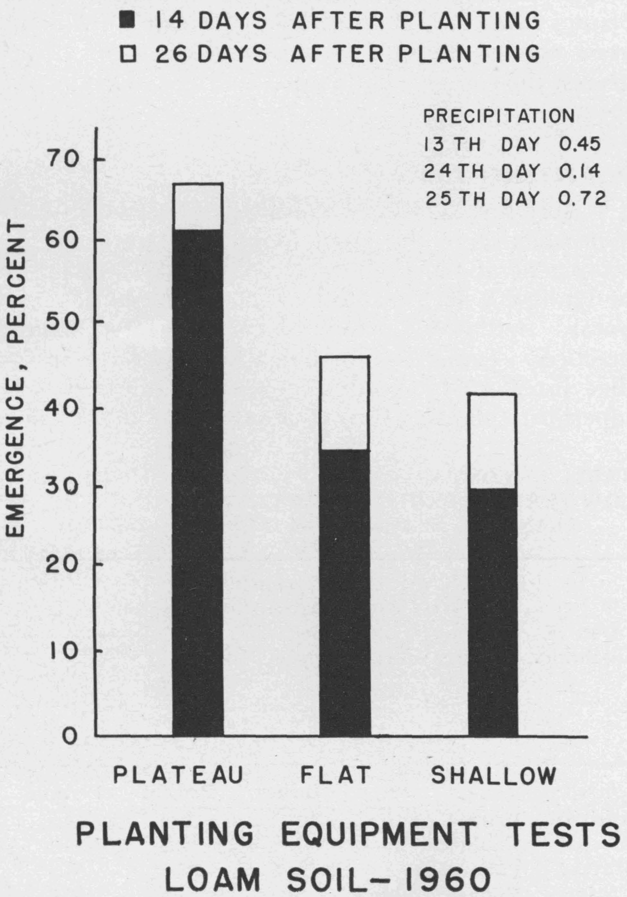

Figure 7. Typical results of planting equipment tests in fine sandy loam soils in Lubbock county for 1960. The stands obtained are expressed as the percent of seed planted to produce cotton seedlings. Because of the very unfavorable response with pressing the covering soil in 1958, its use was discontinued in 1959 and only the combination using the seed-firming wheel and loose soil cover was continued in 1960. The 3-year averages of the final combinations were 63.4, 58.0 and 59.1 percent emergence for the plateau, flat and shallow profiles, respectively.

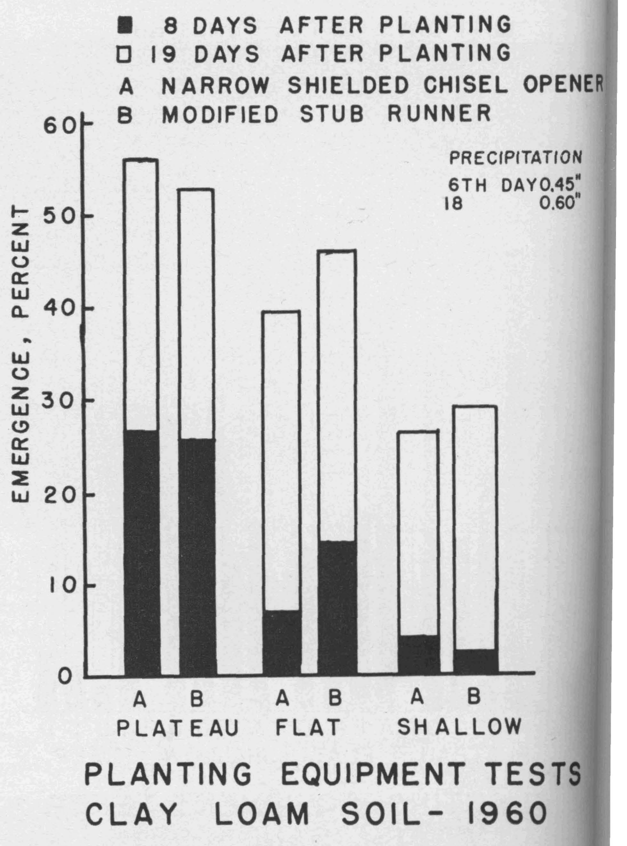

Figure 8. Results of planting equipment tests in clay loam soils in Swisher and Hale counties for 1960. The stands obtained are expressed as the percent of seed planted to produce cotton seedlings. Because of the favorable response to both the seed-firming wheel and pressing of the cover soil during 1957-59, only these combinations were continued in 1960 with a comparison of seed-furrow openers. The 1958-60 averages for combinations employing the narrow-shielded chisel opener, seed-firming wheel and pressed soil cover were 53.3, 43.3 and 35.3 percent emergence for the plateau, flat and wide shallow furrow profiles, respectively.

Figure 9. A comparison of lister furrow and plateau profile plantings after a 3-inch rain on June 2, 1959. The plantings on left were made with a lister planter on May 29, and seedling cotton was covered with silt; note only several cotyledons are showing in furrow. This planting had to be replanted. Right, cotton planted with plateau planter, May 29. Silt washed into the side furrows and the seedlings were not silted over. Photos were taken at Substation No. 8.

the seed row, creating a crusting condition at the critical period of emergence. Seedling emergence for the plateau planting was almost double that for the shallow-furrow planting; both plantings were made on May 1. The protection of seedlings from silting-over is further illustrated in Figure 9.

The absence of precipitation plus drying winds and soil blowing did not cause failure of plantings in these tests. Several plantings during 1960-61 when little or no precipitation occurred and hot dry weather prevailed during the emergence period gave satisfactory stands. This indicates that the problems of soil drying and soil blowing are not increased by the plateau profile. The plateau-profile plantings were significantly better than either the flat or shallow furrow on the loam soil. This was due, in part to shallow seed covering caused by the collapse of gage wheels and by difficulties in adjusting the linkage which attaches the planter to the tractor while planting the flat and shallow profiles. The sand-holding ability of the plateau profile under blowing conditions was good, Figure 10. The furrows on both sides of the seed row held large quantities of loose sand just as they do when heavy rains occur.

The best cotton seedling emergence was obtained with the plateau profile on the three soil types. The next best stands were obtained with flat or high plantings and poorest emergence was obtained with the deep furrow profile. The general trend of delayed and reduced seedling emergence occurred as the depth of lister furrow increased; therefore, the listing furrow should not be deeper than necessary to reach adequate moisture for good germination and emergence.

Difficulties in maintaining straight rows occurred with the use of the plateau planter. The disks must

Figure 10. Left, sand deposited in the plateau-profile plantings; right, the deep lister furrow plantings. Notice the covering of seedlings in the deep furrow. The sand was moved from the left for both plantings. The plateau plantings were adjacent to an unplanted field and held considerable sand deposits with minimum of seedling covering. The deep furrow row was the thirteenth row in from the unplanted field. Both photos were taken 22 days after planting in Terry county, May 1960.

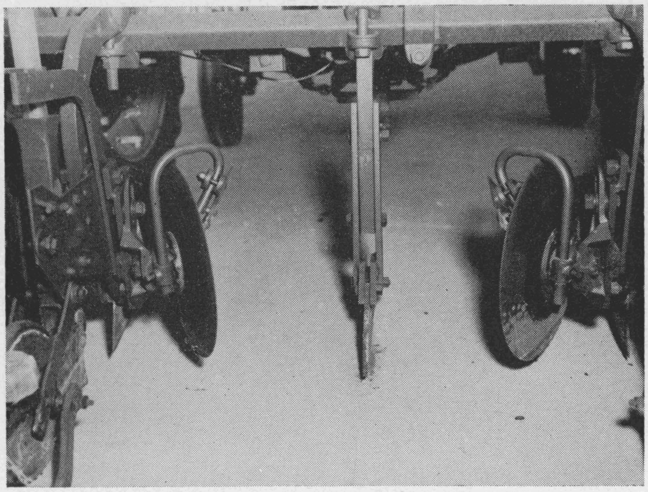

Figure 11. Stabilizer on plateau planter to minimize side draft of planter caused by deeper cutting of disks in uneven beds or occasionally driving off the center of beds.

be carefully adjusted for depth and angle to avoid unequal sidedraft. A stabilizer, Figure 11, helps to overcome sidedraft caused by the occasional drift off the center of the beds.

SEED-FURROW OPENERS

The type of seed-furrow opener used on the lister or plateau-type planters should be selected for resistance to wear in the abrasive sandy soils. In addition, the opener must be adequately shielded to hold the furrow open so the seed will drop to the bottom of the seed furrow.

The narrow-shielded chisel opener, Figure 14, developed by Hudspeth (8, 10) produced better stands than the wide, shovel openers found on conventional planters of the past. A 4-year average of results for tests on this development shows that 10 percent more

TABLE 2. COMPARISON OF NARROW CHISEL SEED-FURROW OPENER WITH SEED-FIRMING WHEEL AND STANDARD LISTER PLANTER WITH SHOVEL OPENER ON FINE SANDY LOAM SOIL

Year	Emergence of cotton seedling: Conventional lister planter with shovel opener and drag covering	Emergence of cotton seedling: Narrow-shielded chisel opener with seed-firming wheel and drag covering
	– – – – Percent	– – – –
1950	87.8	91.2
1951	50.6	62.7
1952	44.6	50.8
1953	41.5	62.4[1]
Average	56.1	66.8

[1]Significantly higher at 1% level for 1953.

of the seed germinated and produced seedlings when the narrow-shielded chisel was used, Table 2. Another advantage of the narrow-shielded chisel opener is the decrease in the width of the seed row, Figure 12, which is desirable for subsequent mechanized cultural practices.

A comparison of seed-furrow openers in clay loam soil demonstrated that the narrow-shielded chisel and the modified stub runner resulted in about equally good cotton emergence, which was distinctly better than that of the standard stub-runner opener, Table 3. The stub runner is modified by the addition of a steel wedge behind the knife edge to spread and firm the bottom of the furrow into a "V," Figure 13. This modification works equally well on the curved runner opener.

The results of the tests over the years have shown that the use of the narrow-shielded chisel seed-furrow opener gave better stands than other types and has

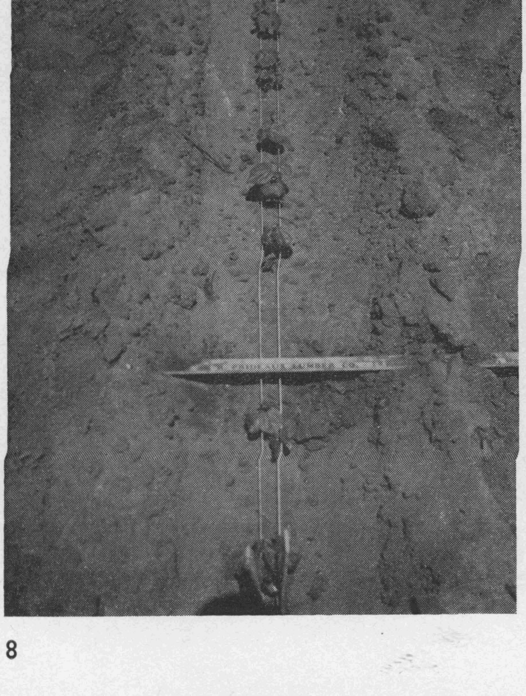

Figure 12. The narrow-shielded chisel opener produced a narrower drill row of cotton (left) than *the shovel type opener.* The narrow drill is only 1½ inches wide and is more desirable for other mechanical operation than the wider row 2½ inches wide.

TABLE 3. COTTON EMERGENCE AS AFFECTED BY TYPE OF SEED-FURROW OPENER ON CLAY LOAM SOILS. TESTS CONDUCTED WITH SEED-PRESS WHEEL

Seed-furrow opener	Seed to produce cotton seedlings			
	1959 tests		1960 tests	
	7 days after planting	17 days after planting	8 days after planting	19 days after planting
	– – – – –	Percent	– – – – –	
Narrow-shielded chisel	19.4	41.4	12.9	40.9
Modified stub runner	19.9	43.2	14.2	42.3
Stub runner	17.0	37.8[1]		

[1]Significantly lower at 5% level.

had excellent wearing qualities in sandy and sandy loam soils. The use of a modified stub-runner opener gave as good to slightly better stands than the chisel opener in clay loam soils. The use of a knife or root slicer on the underside of the lister share of the lister-type planter has been useful in cutting previous crop residues and trash and in reducing the lodging of trash on the chisel opener.

SEED-FIRMING WHEEL

The development and use of the 1 x 10-inch rubber seed-firming wheel to press seed into moist soil before covering came early in planting equipment modifications by Hudspeth (10), and its use has been widely accepted. The use of the seed-firming wheel gave faster emergence and usually a more dependable stand in years when no precipitation occurred.

In tests comparing plantings with and without the seed-firming wheel, the average emergence at first count was 15.2 percent with the seed-firming wheel and 10.6 percent without the wheel on the loamy fine sand, 52.8 percent with and 48.5 percent without on fine sandy loam and 37.1 percent with and 29.2 percent without on the clay loam. These percentages demonstrated a definite trend of increased emergence before the post-planting precipitation masked the differences. For example, in 1957 on clay loam soil, the emergence was 43.4 percent in 7 days for plantings with the seed-firming wheel, compared with 20.3 percent without the firming wheel. On the sixth day of planting, 1.40 inches of precipitation occurred, and the emergence increased to 50.0 per cent of the seed

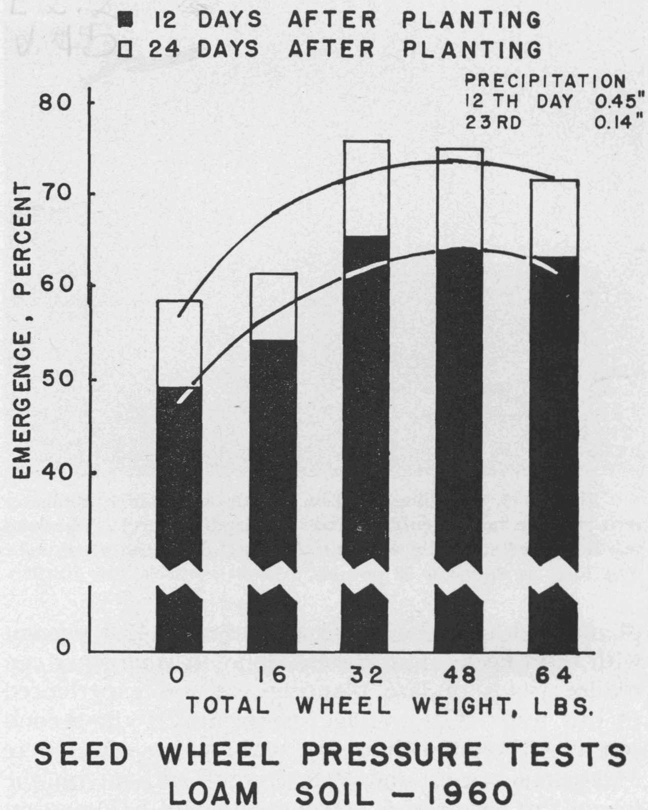

Figure 14. Results of the seed-firming wheel pressure tests for 1960.

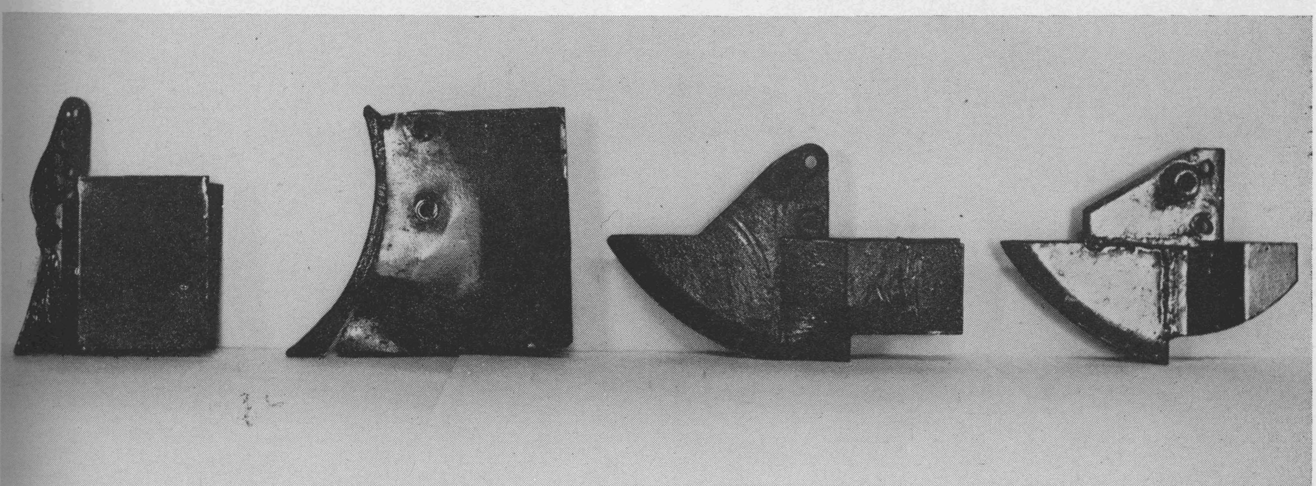

Figure 13. Comparison of seed-furrow openers, two narrow-shielded chisel openers (left), modified stub runner and, conventional stub runner (right). The stub runner was modified by welding a steel wedge behind the leading knife and extending the shields back. The chisel openers are ¾ inch wide at point, the shields extend to the point, then expand to a 1-inch width and are raised slightly at the rear. Long shields are required to insure seed reaching bottom of the seed furrow.

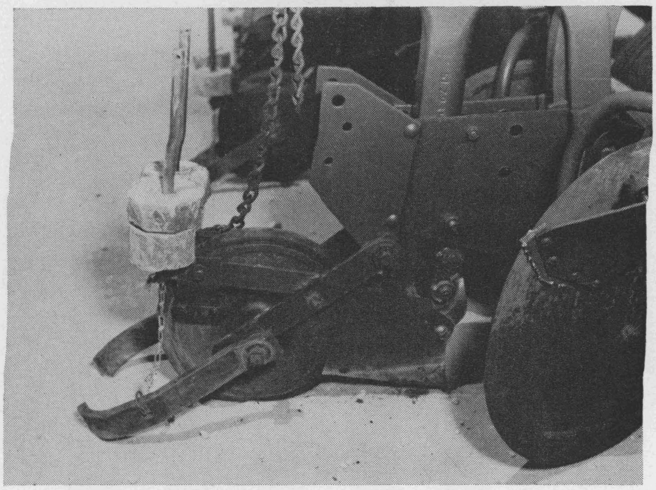

Figure 15. Loading of 1-inch wide by 10-inch diameter zero pressure hollow rubber-tired seed-firming wheel. The load was measured statically with a scale attached at the wheel axle. The load as shown is 52 pounds.

planted without the wheel and to only 45.0 percent with the wheel. This 2-week delay in emergence can reduce yields of late plantings, as was experienced in this test. The average emergence at the second counts with and without the seed-firming wheel were 34.6 percent with and 30.9 percent without on the loamy fine sand; 57.6 percent with and 54.7 percent without in the fine sandy loam; and 44.7 percent with and 48.8 percent without in the clay loam soil. These results indicate a general increase of stands using the seed-firming wheel even during wet seasons, except for the clay loam soil. The advantages of using the firming wheel under drying conditions on clay loam soils were evident.

The effects of varying pressures applied with the seed-firming wheel are shown in Figure 14. The tests were conducted with dead weights for the wheel, Figure 15. The actual maximum pressure per square inch was not determined readily because the zero-pressure tire flattened irregularly and increased in contact area on a flat surface as the weight was increased. These tests also showed the usefulness of *the seed firming in that the zero-pressure plantings* had the lowest percentage of emergence. The best performance was 32 pounds total weight in 1960 and 17 pounds in 1961. The curvilinear regressions calculated for each test and periodic stand count show maximum emergence for 48 and 52 pounds total weight, whereas the actual weight was 17 to 32 pounds. *A total wheel weight of 30 to 35 pounds is considered* desirable.

In moist soils, the soil stuck to the sides of the firming wheel. This difficulty was eliminated by installing scrapers on the sides of the wheel, Figure 16. Wheels equipped with these small scrapers have been used successfully for several years on numerous experimental plots and on approximately 80 acres of planting.

COVERING OF SEED

Covering of seed planted at the proper depth and with proper compactness influences the rate of emergence, earliness and the total emergence. Each of these three factors has been observed in tests during the 13-year period.

Depth of Covering

The depth at which seed is covered influences the time required for emergence and the total emergence obtained. Early results of this work were reported by Hudspeth (11).

Covering seed with more than 2 inches of soil delayed emergence and decreased the final emergence, Figure 17. Covering the seed with less than 2 inches

Figure 16. Small scrapers mounted on the side of the seed-firming wheel (left) prevent the excessive buildup of soil (right) interfering with proper operation. Such scrapers have been used on extensive acreage and observed not to interfere with operation. The scrapers are made of thin sheets of high carbon steel mounted at a 28.5 degree angle from the side of the wheel. See Figure 15 for improved scraper attachment.

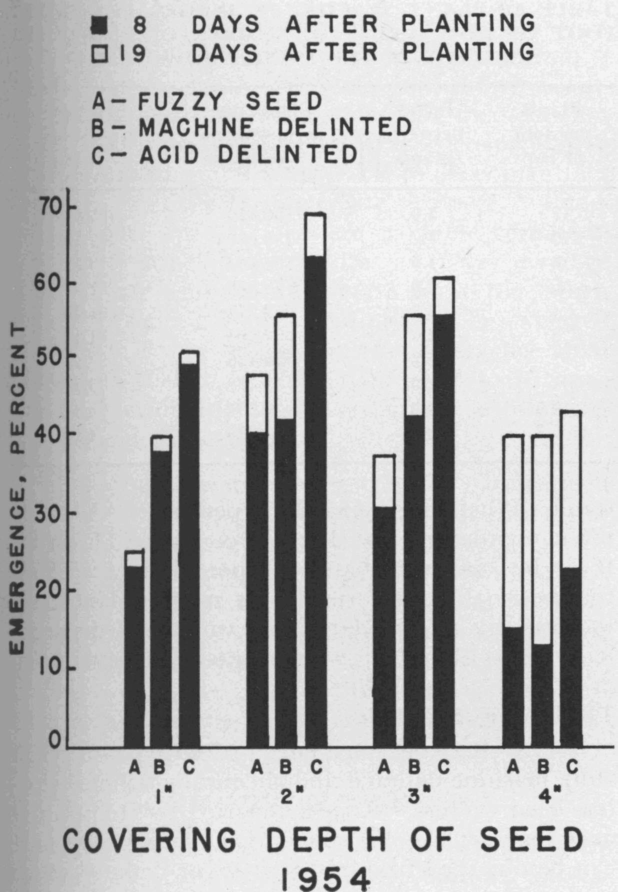

Figure 17. Depth of soil covering the seed test results. The results were consistent over the 4-year test period. Each year the early emergence for the 2-inch depth was significantly better than the 1-inch or 4-inch depths.

generally resulted in decreased emergence because of the drying of the seed and of the soil around the seed. After 1955, all test plantings were made to cover seed at a maximum depth of 2 inches and a minimum of 1½ inches. To obtain good stands, the seed-furrow openers must be set to cut a furrow of sufficient depth into the moist soil behind the lister to cover the seed with 2 inches of soil.

Covering Devices

Seed covering 2 inches deep can be obtained readily with covering devices, Figures 3, 4 and 5. The harrow drag reported by Hudspeth (10) covers the seed well and tills the soil to provide a loose soil cover, Figure 4. Its main disadvantage is that trash or old stalks and stems from the previous crop lodges in the spikes and results in poor covering.

The short drags shown in Figures 3 and 5, adaptations of the fishtail drags, are pivoted at the seed-firming wheel axle. These covering devices are self-cleaning and perform well in a friable soil. They do not, however, cover as well as desired in sticky, wet soils. No specific tests were made comparing the two covering devices, but all of the plateau plantings compared in Figures 6, 7 and 8 used this fishtail type

Figure 18. Pressing the soil covering the seed with a zero pressure tire. This pressing was found detrimental to seedling emergence on loamy fine sand and fine sandy loam soils but helpful on clay loam soils.

of covering device. The performance was acceptable under all of the conditions encountered.

Pressing of Soil Cover

Pressing the soil which covers the seed is a practice that may or may not increase emergence, depending on the type of soil encountered. Pressing the soil over the seed row with a zero-pressure rubber tire, Figure 18, caused heavy crusting; it decreased emergence on the loamy fine sand and fine sandy loam soils but increased emergence on clay loam soils. The average first-count emergence comparing the loose soil cover and the pressed soil cover were, respectively, 14.3 and 11.6 percent on the loamy fine sand, 44.8 and 20.8 on the fine sandy loam and 30.6 and 37.3 on the clay loam. These averages for the second counts were 32.3 percent for the loose soil and 33.4 percent for the pressed soil on the loamy fine sand, 55.5 and 31.6 percent on the fine sandy loam and 39.3 and 43.5 on the clay loam. Extreme crusting experienced with the pressed soil cover in the 1958 tests on fine sandy loam soil reduced emergence to two-thirds of that for the loose soil cover. The first-count emergence on the loamy fine sand indicated the same detrimental effect from pressing as was also found on the fine sandy loam. An overall increase of emergence was experienced by pressing the covering soil on clay loam soils. As the clay content of soil increases, some pressing of the soil cover becomes desirable. The division point at which this operation becomes advantageous has not been determined.

Pressing the soil covering the seed on clay loam soils should be done at the time of planting to reduce the number of field operations. The zero-pressure rubber tire was not practical for this operation because of excessive sticking of soil to the tire. The flap-rubber-press wheel developed by Smith and Wilkes (18) was useful in overcoming this difficulty, Figure 19. As many as 5 acres were planted with

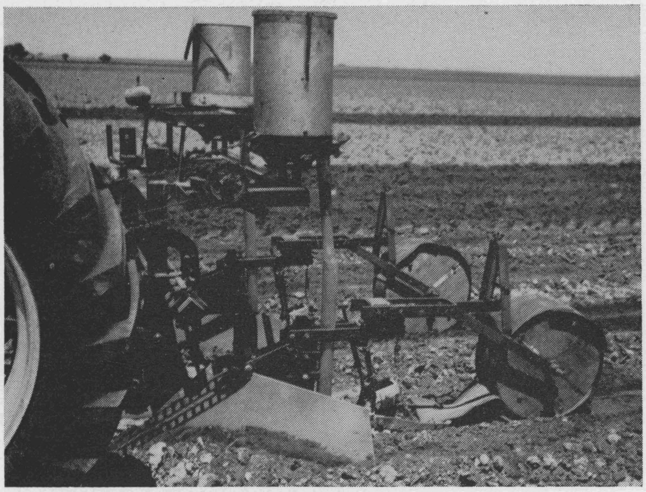

Figure 19. Pressing the soil covering the seed with rubber-flap wheel on the clay loam soils. This type of wheel permitted the pressing of covering soil while planting without sticking to the wheel.

these flap-press wheels without the buildup of soil which was previously experienced with the zero-pressure tires.

Planting Practices

RATE OF SEEDING

Plant population was studied extensively to determine maximum yields and harvesting efficiencies. This type of study for the High Plains was reported by Ray *et al.* (15). The best seeding rate for yield was determined to be from 15 to 25 pounds of seed per acre for irrigated land. These seeding rates resulted in an average plant population of 33,500 to 50,000 plants per acre or an average plant spacing of 4.7 and 3.1 inches apart, respectively, for the lower and higher seeding rates on 40-inch row widths. Table 4 summarizes plants per acre for 38 and 40-inch row widths for various plant spacings.

The conclusions from the study by Ray *et al.* (15) were: (1) "A planting rate of 15 pounds per acre will give satisfactory plant population in most years, but increasing this rate to 20 pounds per acre will give insurance against replanting in years when emergence is poor. Other factors which should be considered are seed type, seed germination, soil type and weather conditions." and (2) "Planting rates of about 20 pounds per acre should give high stripper harvesting efficiency, good yields and a minimum probability of replanting."

Seeding rates of 15 pounds per acre would plant 60,000 to 75,000 seeds per acre, and the 20-pound rate would plant 80,000 to 100,000 per acre, depending on variety or seed size. When emergence is low, or around 25 percent of seed planted, the 15-pound rate would produce 15,000 to 18,750 seedlings per acre, a thin but adequate stand; the 20-pound rate would result in 20,000 to 25,000 plants per acre, a good

TABLE 4. PLANT SPACING IN INCHES, PLANTS PER FOOT OF ROW AND THE NUMBER OF PLANTS PER ACRE FOR 40 AND 38-INCH ROW WIDTHS

Plants per foot of row	Inches between plants	Plants per acre, 40-inch rows	Plants per acre, 38-inch rows
12	1.0	156,816	165,048
10	1.2	130,680	137,540
8	1.5	104,544	110,032
6	2.0	78,408	82,524
4	3.0	52,272	55,016
3	4.0	39,204	41,262
2	6.0	26,136	27,508
1	12.0	13,068	13,754
0.5	24.0	6,534	6,877
0.3	40.0	3,920	4,126

stand. When emergence is 50 percent or higher, the plant populations are doubled or higher. From this it can be concluded that the 20-pound rate is adequate for the small seed varieties. It may be desirable to increase this rate for large seed varieties if the germination test shows a low percentage of germination.

TYPE OF SEED

The effect on emergence of seed type—fuzzy (gin run), machine delinted and chemically delinted seed—has been studied. Results reported by Hudspeth (9) and Jones *et al.* (12) stated that "satisfactory stands can be obtained from either fuzzy or delinted cotton-seed. There is a trend toward the use of delinted seed because of less seed tube stoppage, greater ease of handling, faster germination and greater uniformity of stands." The faster germination of delinted seed as related to depth of covering is shown in Figure 17. Approximately the same seeding rates are required to obtain comparable stands. Chemically delinted seed averages 5 to 6 percent more seed per pound than fuzzy seed (9).

TIME OF PLANTING

The earliest feasible plantings are desirable for maximum production on the High Plains. General recommendations have set May 10 as the ideal beginning date for planting cotton. A recently completed study (7) has shown that soil temperatures can be a valuable guide to timely cotton plantings, with due consideration of weather forecasts. The following recommendations were made from this study for using soil temperatures as a guide to timely cotton planting:

"Cotton planting should be delayed until an average minimum soil temperature of 60° F. at the 8-inch depth is reached for a 10-day period. Following soil temperature as a guide results in earlier plantings more often than following optimum planting dates. This guide should be used only to establish the earliest possible time for planting. Soil temperature is not a determining factor for late-season plantings.

"Cottonseed planted at recommended soil temperatures should not be covered with more than 2 inches of soil for quick emergence, and proper planting practices and equipment should be used for best results. Heavy soil-crusting rains are detrimental to cotton emergence and it is advisable to delay plantings when such rains are in immediate prospect. Long-range weather forecasts also are valuable considerations at planting time. With a 10-day average minimum soil temperature of 60° F. at the 8-inch depth as a planting guide, seedlings can be expected to emerge in 9 days or less, whereas emergence from plantings in colder soils may require 13 to 15 days. Thus, seed rotting will be reduced greatly by planting at proper soil temperature.

"Daily soil temperatures can be determined readily when the sensing element of the thermometer is placed at the recommended 8-inch depth in the center of the preplanting bed. A thin-stemmed thermometer such as a dial thermometer with a bimetallic sensing unit can be inserted easily into the soil to the desired depth. The minimum soil temperatures should be taken daily between 7:30 and 8:30 a.m. and recorded for at least 10 days."

Acknowledgments

This research was conducted cooperatively by the Texas Agricultural Experiment Station, Substation No. 8, Lubbock, Texas, and the Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture, and is a contributing project to the Regional Cotton Mechanization Project S-2. These investigations were conducted by Rex F. Colwick during the 1949-50 seasons, by E. B. Hudspeth during the 1951-56 seasons and by E. R. Holekamp during the 1957-61 seasons.

The authors express their appreciation to D. L. Jones, agronomist emeritus, Substation No. 8, for assistance in planning and conducting the investigations, and to the following manufacturers of farm machinery for the loan or gifts of equipment and parts used in these studies: International Harvester Co., J. I. Case Co., John Deere Co., Cline Industries, Dempster Mill Co., Kelly Plow Co. and others.

References

1. Bilbro, J. D., Jr. and L. L. Ray, Performance of Four Cotton Varieties in Relation to Planting Date on the High Plains of Texas, 1960, Texas Agri. Exp. Sta. Progress Report 2197, July, 1961.

2. Colwick, Rex F., *et al.*, Mechanization of Cotton Production, Southern Cooperative Series Bulletin No. 33, June, 1953.

3. Colwick, Rex F., *et al.*, Planting in the Mechanization of Cotton Production, Southern Cooperative Series Bulletin No. 49, February, 1957.

4. Colwick, Rex. F., *et al.*, Weed Control Equipment and Methods for Mechanized Cotton Production, Southern Cooperative Series Bulletin No. 71, April, 1960.

5. Covey, W. G., R. J. Hildreth and E. L. Thaxton, Jr., Rainfall at Lubbock, Texas, Texas Agri. Exp. Sta. Misc. Publication 211, June, 1957.

6. Garner, Thomas H., Henry D. Bowen and James A. Luscombe, Effect of Weed Control on Quality of Mechanically Harvested Cotton, The Cotton Gin and Oil Mill Press, September 6, 1958.

7. Holekamp, E. R., E. B. Hudspeth and L. L. Ray, Soil Temperature—A Guide to Timely Cotton Planting, Texas Agri. Exp. Sta. Misc. Publication 465, October, 1960.

8. Hudspeth, E. B. and D. L. Jones, Influence of Depth of Planting Furrow on Emergence, Harvester Efficiency and Other Related Factors in Cotton Production on the High Plains, Texas Agri. Exp. Sta. Progress Report 1484, August 1952.

9. Hudspeth, E. B., L. L. Ray and D. L. Jones, The Use of Fuzzy, Machine and Chemically Delinted Cotton Seed for Planting on the High Plains of Texas, Texas Agri. Exp. Sta. Progress Report 1547, February, 1953.

10. Hudspeth, E. B. and D. L. Jones, Planter Equipment Test, Lubbock 1949-53, Texas Agri. Exp. Sta. Progress Report 1673, April, 1954.

11. Hudspeth, E. B. and D. L. Jones, Emergence and Yield of Cotton as Affected by Depth of Covering Seed. Texas Agri. Exp. Sta. Progress Report 1688, June, 1954.

12. Jones, D. L., *et al.*, Cotton Production on the Texas High Plains, Texas Agri. Exp. Sta. Bulletin 830, April, 1956.

13. Porterfield, J. and E. M. Smith, Development and Test Performance of a New Seedbed for Cotton, Oklahoma Agri. Exp. Sta. Bulletin 449, February, 1955.

14. Ray, L. L., E. B. Hudspeth and D. L. Jones, Influence of Rate of Planting on Seedling Emergence of Cotton Under Crusting Conditions, Texas Agri. Exp. Sta. Progress Report 1415, November, 1951.

15. Ray, L. L., E. B. Hudspeth and E. R. Holekamp, Cotton Planting Rate Studies on the High Plains, Texas Agri. Exp. Sta. Misc. Publication 358, May, 1959.

16. Smith, H. P. and D. L. Jones, Mechanized Production of Cotton in Texas, Texas Agri. Exp. Sta. Bulletin 704, September, 1948.

17. U. S. Department of Agriculture, Agricultural Research Service, Agricultural Engineering Research Division, Unpublished data, Annual Report, 1960.

18. Wilborn, Ed, Press Wheel for Sticky Blacklands, Progressive Farmer, February, 1959.

19. Williamson, E. B. and F. E. Fulgham, The Influence of Spacing on Mechanical Harvesting of Cotton, Mississippi Farm Research, Mississippi Agri. Exp. Sta., February, 1956.

[Blank Page in Original Bulletin]

[Blank Page in Original Bulletin]

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

★

The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of the parts of the A&M College of Texas.

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 13 subject-matter departments, 3 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 20 substations and 10 field laboratories. In addition, there are 13 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 450 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

Conservation and improvement of soil	Beef cattle
Conservation and use of water	Dairy cattle
Grasses and legumes	Sheep and goats
Grain crops	Swine
Cotton and other fiber crops	Chickens and turkeys
Vegetable crops	Animal diseases and parasites
Citrus and other subtropical fruits	Fish and game
Fruits and nuts	Farm and ranch engineering
Oil seed crops	Farm and ranch business
Ornamental plants	Marketing agricultural products
Brush and weeds	Rural home economics
Insects	Rural agricultural economics

Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress