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PARKER, R E WOOTEN, O B 1 OF 1

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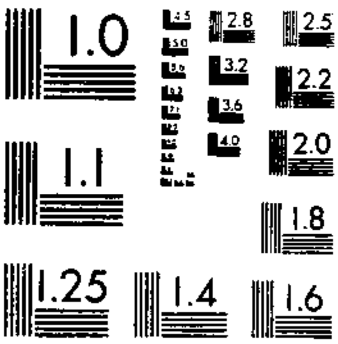

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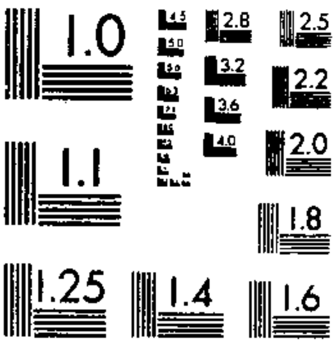

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Sources of Moisture in Mechanically Harvested Seed Cotton and Its Effects on Cotton Quality

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Sources of Moisture in Mechanically Harvested Seed Cotton and Its Effects on Cotton Quality[1]

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INTRODUCTION

The increasing practice of mechanically harvesting cotton in the Mississippi Delta—from 8.2 percent of the crop in 1951 to 55.1 percent in 1960—has resulted in a rate of flow of seed cotton to gins in excess of the gins' processing capacity. Deterioration of harvested seed cotton held in storage awaiting ginning is causing growing concern among producers.

The principal cause of deterioration of seed cotton is moisture, resulting from weather conditions, green material in the harvested cotton, or moistening of spindles to facilitate harvesting. The producer may employ certain practices that will influence the amount of moisture in trash and seed cotton. He may defoliate his fields, and he may delay picking to allow the seed cotton time to dry. But after the seed cotton is harvested, he has no choice but to store it until it can be ginned.

This 2-year study, which was conducted at Stoneville, Miss., was designed to determine how defoliation, seed cotton moisture, and seed cotton storage time ultimately affect the quality of the lint. Data are also included on the effect of these factors on the quality of the cottonseed, a product vitally important to both farmers and certified seed producers.

[1] The research described was done in cooperation with the Mississippi Agricultural Experiment Station, Delta Branch, Stoneville, Miss., and is part of a contribution to Regional Cotton Mechanization Project S–2.

[2] The authors wish to express their appreciation to staff members of the USDA Cotton Classing Office at Greenwood, Miss., for classing of the lint samples; W. P. Caldwell, seed technologist, Seed Technology Laboratory, State College, Miss., for obtaining seed quality data; C. S. Shaw, cotton technologist, and L. D. La Plue, Jr., agricultural engineer, U.S. Cotton Ginning Research Laboratory, Stoneville, Miss., for their cooperation in ginning; E. J. Koch, biometrician, Biometrical Services, USDA Agricultural Research Service, Beltsville, Md., for assistance in analyzing the data; J. E. Clayton and E. B. Williamson, agricultural engineers, USDA Agricultural Engineering Research Division, Stoneville, Miss., and J. K. Jones, agricultural engineer, National Cotton Council, Memphis, Tenn., for their assistance in obtaining field data; and staff members of USDA Agricultural Research Service, Market Quality Research Division, Clemson Laboratory, Clemson, S.C., for fiber quality investigations.

REVIEW OF LITERATURE

Montgomery and Wooten [3] found that damp, early-morning-picked cotton classed almost a full grade lower than afternoon-picked cotton when both were stored in trailers for 8 to 72 hours. They also learned that lint quality was not measurably affected when seed cotton containing excessive moisture was ginned immediately after harvesting.

Ross (*11*)[4] concluded that ". . . the only safe method of avoiding damage, particularly in areas where rain provides the water supply, would be to place in storage only dry, machine-picked cotton and to gin immediately any relatively damp cotton."

Attempts to dry and cool damp seed cotton were made by Griffin (*7*) who pulled and pushed air through cotton stored in trailers. Both methods were found to be inefficient and costly.

Only a small percentage of the total cotton crop is harvested when it contains excessive moisture. Bradley (*2*) was able to store 4,000 dry bales in 10-bale baskets at a cost of only $2.50 to $3.25 per bale. As a result, he was able to gin immediately any seed cotton that had been harvested under adverse conditions. Cash (*4*) used a similar system of storing seed cotton on a much smaller scale at approximately the same overall cost per bale.

It is evident that excessive moisture in seed cotton is the main factor that starts the deterioration of seed cotton in storage. What, then, affects the moisture content of seed cotton? Wooten, Montgomery, and Riley (*15*) found that prevailing atmospheric conditions, namely relative humidity, exerted a greater influence on seed cotton moisture than did different rates of moisture applied to the spindles of mechanical pickers. In addition, they concluded that during an 18-day period, the minimum humidity averaged 8.8 percent lower in defoliated fields than in undefoliated fields. They concluded that leaf cover was one of the major factors influencing the humidity in cotton fields.

Moisture applied to the spindles of mechanical pickers is of immediate concern to producers. However, Wooten and Montgomery (*13*) learned that only 1 percent moisture was added to seed cotton when 5 gallons of water was applied to the spindles while picking one bale. Only 2 percent moisture was added when 13.6 gallons of water per bale was used to keep spindles clean. The picking of a bale of cotton often requires less than 5 gallons of water to keep the spindles clean, especially if a detergent or wetting agent is used.

In pointing out the problems associated with mechanical harvesting, Parker (*8*) emphasized foreign matter in mechanically harvested seed cotton. The foreign matter contained more moisture than did the seed cotton when harvested from undefoliated fields. Riley and Williamson (*10*) also discovered that cotton in defoliated fields dried out quicker in the morning and regained moisture later in the afternoon than did cotton in undefoliated fields. They concluded that this difference increased the safe picking time in defoliated fields by 10 percent per day. In additional moisture studies, Wooten and Montgomery (*14*) picked cotton in undefoliated fields and learned that the transfer of moisture from the green foreign matter to the seed cotton was sufficient to start the "heating" process within 24 hours after harvesting. At the same time, cotton harvested

[3] MONTGOMERY, R. A., and WOOTEN, O. B. LINT QUALITY AND MOISTURE RELATIONSHIPS IN COTTON THROUGH HARVESTING AND GINNING. U.S. Dept. Agr., ARS 42-14. 1958. [Processed.]

[4] Italic numbers in parentheses refer to Literature Cited, p. 24.

from a defoliated field failed to "heat" and could have been stored indefinitely.

Williamson and Riley (*12*) said the following about the future of the entire cotton industry:

> American cotton for the last 20 years has been in a do-or-die race for fiber markets of the world. The evidence is clear that a high-quality product must be delivered to the mills in order to meet the increasing demands of the textile industry and to meet strong competition from synthetics.
>
> Some of the most serious problems in preserving quality are associated with the constantly expanding use of mechanical harvesters and variations in weather elements.
>
> The key to a quality harvest is timing. Seasonally . . . defoliants must be applied on a date that will balance the quality of an early harvest with the quantity of a late harvest. Daily . . . the pickers must operate during the hours of correct seed cotton moisture content in order to minimize staining, moisture, and trash problems.

Possibly the most basic factor contributing to the deterioration of seed cotton in storage is the presence of micro-organisms. Parker (*9*) discovered that when seed cotton grown in the Mississippi Delta was stored in an atmosphere high in humidity for 2½ months, 90 percent of the lint was infested with or destroyed by micro-organisms. It is known that these micro-organisms grow and reproduce most rapidly in high-humidity environment. The results of this study correspond to those of Caldwell and Parker (*3*), who discovered a significant correlation between the deterioration of lint quality (fiber length, strength, and color) in the field and the time (hours) seed cotton is exposed to the sum of temperature (degrees F.) plus humidity (percent) in excess of 140. They also learned that prolonged exposure to high humidity and temperature lowers the quality of the seed as well as of the lint.

METHODS, EQUIPMENT, AND INSTRUMENTS USED

Experimental Design

Defoliated and nondefoliated cotton plots were machine picked each year at three stalk seed cotton moisture levels and were stored in trailers from 0 to 3 days in 1960 and from 0 to 2 days in 1961. Four samples of lint and seed were then pulled from each lot after each day of storage for use in fiber and seed-quality tests.

The results from each fiber and seed-quality measurements in the 1960 test were then recorded and statistically analyzed according to the following breakdown:

Source of variation	*Degree of freedom*
Total	95
Defoliation (D)	1
Moisture (M)	2
Storage (S)	3
D×M	2
D×S	3
M×S	6
D×M×S	6
Individuals	72

All cotton was grown, harvested, and stored at the Delta Branch of the Mississippi Agricultural Experiment Station, Stoneville, Miss.

Defoliation and Harvesting Equipment

The field plots were planted in 24-row strips with 4-row alleys. The airblast sprayer shown in figure 1 was used to defoliate cotton on the necessary plots. The comparison of leaf coverage in defoliated and undefoliated plots in 1961 is illustrated in figures 2 and 3. The two-row mechanical harvester, shown in figures 2 and 3, was used to harvest cotton from all plots.

After harvesting, the seed cotton was stored in wire-mesh trailers similar to the one shown in figure 4. During the entire storage period, the loaded trailers were parked under a shed to permit air to circulate through the seed cotton and also to protect it from rain.

FIGURE 1.—Defoliating a 12-row swath of cotton with an airblast sprayer.

FIGURE 2.—Mechanically harvesting defoliated cotton at Stoneville, Miss., October 17, 1961.

FIGURE 3.—Mechanically harvesting nondefoliated cotton at Stoneville, Miss., October 17, 1961.

FIGURE 4.—Dumping seed cotton into a wire-mesh trailer. The open sides of the trailer allow maximum circulation of air through the seed cotton.

Instruments and Measurements

The use of portable meters to determine moisture in seed cotton is steadily increasing in the Mississippi Delta. Because of their initial cost, the meters were purchased primarily by ginning and Agricultural Extension Service personnel. Cotton storage studies require an immediate and reasonably accurate estimation of the seed cotton moisture content just prior to harvesting, so a portable moisture meter like that shown in figure 5 was checked for accuracy and used in the field for this study.

A constantly recording, portable hygrothermograph in a small wire-mesh box (fig. 6) was also placed in the center of each bale lot of stored seed cotton to record temperature and relative humidity. The hygrothermographs consisted of a hair-type, humidity-responsive element and a Bourdon-type thermoelement connected to separate pens that traced continuous records of relative humidity and temperature on a cylindrical chart that revolved once each 176 hours (weekly).

At the end of the storage period, the instruments were removed and the records of humidity and temperature were obtained from the charts. All instruments were checked for accuracy before they were used.

FIGURE 5.—A portable meter used to check seed cotton moisture content in the field.

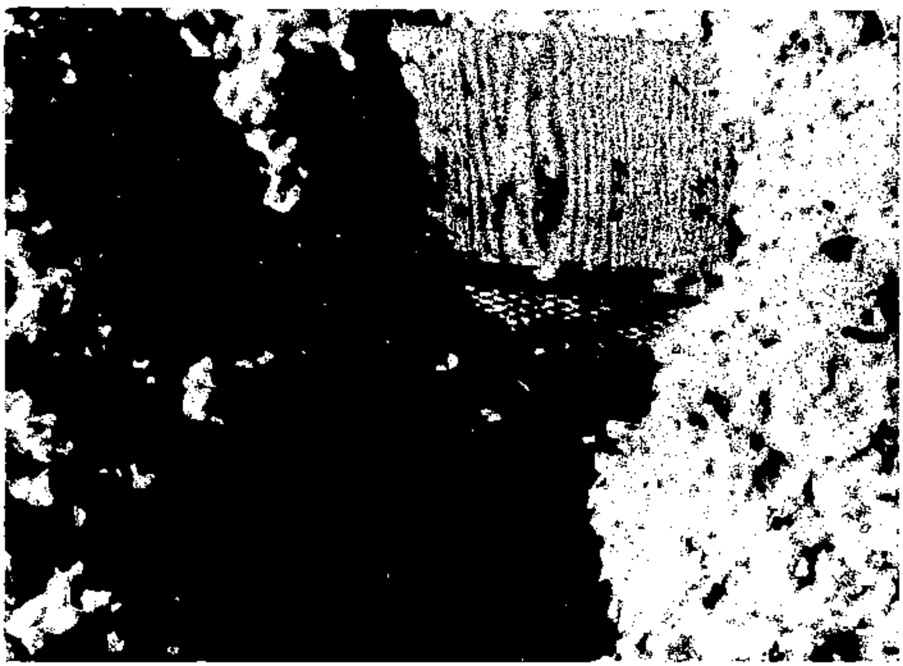

FIGURE 6.—A hygrothermograph placed in the center of a bale of seed cotton to record humidity and temperature throughout an extended storage period.

PROCEDURE

Defoliation

Defoliation of the necessary plots was accomplished by use of an airblast sprayer that covered a strip 12 rows, or 40 feet, in width. The sprayer applied a mixture of 1.5 pints of "Def,"[5] a commercially available defoliant, and 30 gallons of water per acre of cotton. The same sprayer and rate of defoliant were used for both years of the study. The defoliant was applied approximately 2 weeks before harvesting the cotton.

[5] The names of commercial products are given to report factually on available data. The Department neither guarantees nor warrants the standard of the products, and the use of the names implies no approval of the products to the exclusion of others that also may be suitable.

Moisture Meter Check

The moisture meter employed in this test measures the resistance of cotton fibers to direct current. The higher the moisture content, the less the resistance. Readings are made by balancing the current with known resistors. The numbers assigned to the meter posts, or resistors, indicate the condition of the seed cotton sample and not the exact moisture content. Consequently, it is necessary to prepare a calibration curve showing the relationship between the meter reading and the actual seed cotton moisture content.

To show this relationship, 90 samples of seed cotton containing different amounts of moisture were measured for their moisture content by use of the moisture meter before the samples were dried in an oven. The results are shown in figure 7. The overall correlation of the meter and oven readings was 0.8921, which was highly significant. The linear regression line was: Estimated oven reading $= -3.28 + 1.45 \times$ meter reading.

The same moisture meter was then used in the field to measure seed cotton moisture content in defoliated and nondefoliated cotton prior to picking. A rapid method of measuring moisture in seed cotton was required because the original storage test called for harvesting cotton at the same three levels of moisture from both defoliated and nondefoliated plots.

Harvesting

An International Harvester model 220-A mechanical cottonpicker was used to harvest the cotton in all plots. High-moisture seed cotton was first harvested from the defoliated plot and then from the undefoliated plot. The time delay in harvesting usually allowed the undefoliated cotton enough time to dry to the same moisture content as the defoliated cotton. However, the portable moisture meter was used as the final check on seed cotton moisture before harvesting started. The same procedure was followed for harvesting the medium- and low-moisture seed cotton.

No replication of treatments could be accomplished in the field because the cotton was drying constantly. Thus, it was most important that each bale be harvested over as short a period of time as possible.

Ginning

Approximately 40 pounds of seed cotton from each lot was ginned on a 20-saw gin after each day of storage, beginning with the day of harvesting. From the 40-pound sample of seed cotton were collected four lint samples for fiber tests, three lint samples for moisture, three trash samples for moisture, three seed samples for moisture, and the rest of the seed for germination and vigor tests. All samples of seed cotton were ginned without drying or lint cleaning. Therefore, any differences between treatments cannot be attributed to these two variables.

TEST RESULTS AND DISCUSSION

Seed Cotton Moisture Levels

Cotton in defoliated fields dries more rapidly during the day than cotton in nondefoliated fields (fig. 8). It is possible to harvest cotton containing the same percent age of moisture from both defoliated and nondefoliated fields with the same mechanical picker if the picking operation is timed perfectly. This was achieved by harvesting the defoliated cotton first. Enough time elapsed (approximately 30 minutes) while picking one bale of defoliated cotton to allow the nondefoliated cotton to dry to the same initial moisture level.

Of course, the graph shown in figure 8 would change according to the existing weather conditions. For instance, if strong winds and no dew existed in the early-morning hours, the moisture content of seed cotton in both defoliated and nondefoliated fields would be much lower than that depicted by the curves of figure 8. On the other hand, if heavy dew and overcast skies prevailed, the rate of natural drying of the seed cotton would be much slower.

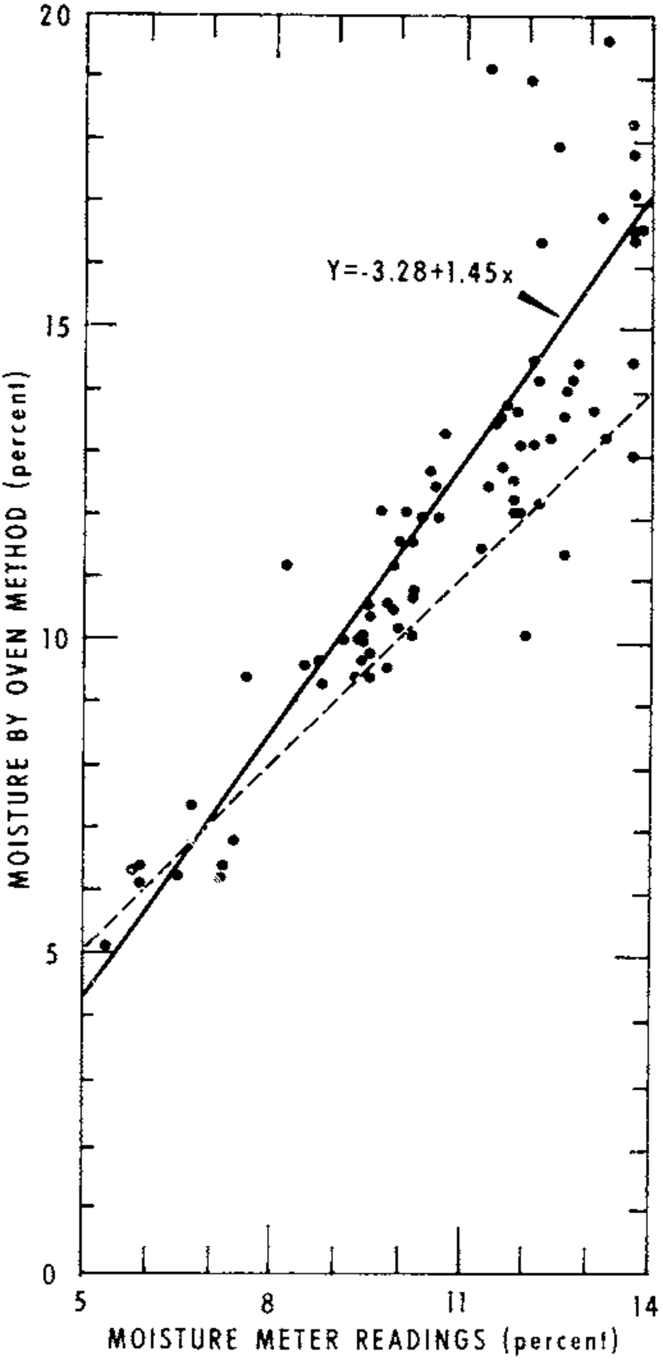

FIGURE 7.—Correction curve for the moisture meter.

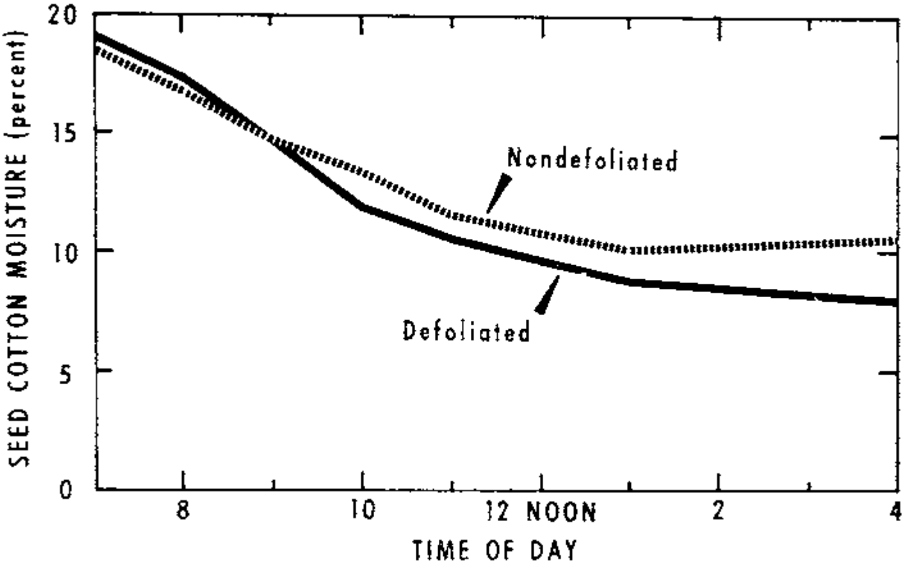

FIGURE 8.—Average seed cotton moisture content in defoliated and nondefoliated fields at Stoneville, Miss., October 3 and 4, 1960.

The specific levels of seed cotton moisture at time of picking were determined by both the meter and oven method and are shown in table 1. The corrected meter readings were accurate enough to give a sufficient difference between the low-, medium-, and high-moisture treatments in the 1960 test. However, because of the long period of dry weather during the harvest, the meter was not so accurate in the 1961 test. The inaccuracy of the meter during the 1961 test was attributed primarily to the relative dryness of the seed. The meter is much more sensitive to variations in lint moisture than to variations in seed moisture. Thus, no one correction factor for the moisture meter would be applicable for all combinations of lint and seed moisture.

Because the low-moisture lots in 1960 contained nearly the same percentage of moisture as the high-moisture lots in 1961, and since there was little difference between the low- and medium-moisture lots in 1961, it must be concluded that seed cotton moisture content at the time of picking was not a controlled variable. Therefore, the linear effect of moisture on the characteristics being measured was investigated to help interpret the results.

Seed Cotton Foreign Matter and Moisture Relationship

In the remainder of this report, all data on moisture in seed cotton, lint, seed, and foreign matter were derived by drying the various components in ovens.

Defoliation greatly influenced the moisture content of harvested seed cotton and its trash (table 2). More trash was obtained with the cotton harvested from undefoliated fields than with cotton from defoliated fields. The trash from undefoliated fields was wetter than that from defoliated fields and resulted in wagon seed cotton harvested from undefoliated fields gaining more in moisture after it was picked than that harvested from defoliated fields. The gain averaged 1.4 percent in cotton harvested

TABLE 1.—*Seed cotton moisture content at time of picking based on moisture meter readings and oven tests at Stoneville, Miss., 1960–61*

Field condition	Seed cotton moisture [1]		
	Meter readings		Oven test
	Actual	Corrected	
1960:			
Defoliated:	*Percent*	*Percent*	*Percent*
Low moisture	7.6	7.7	8.4
Medium moisture	8.2	8.6	10.6
High moisture	13.8	16.7	15.2
Undefoliated:			
Low moisture	7.7	7.9	9.6
Medium moisture	9.4	10.4	11.3
High moisture	13.0	15.6	15.2
1961:			
Defoliated:			
Low moisture	6.0	5.4	5.9
Medium moisture	8.0	8.3	6.5
High moisture	14.0	17.2	10.7
Undefoliated:			
Low moisture	6.2	5.7	6.1
Medium moisture	8.3	8.8	6.7
High moisture	13.8	16.7	9.9

[1] Based on 3 observations each.

from defoliated fields and 4.2 percent in that harvested from undefoliated fields. No attempt was made to establish how much of the increase, or gain, was caused by water applied to the picker spindles. The same amounts of water were used in the harvests of cotton from defoliated and undefoliated plots.

Moisture Content of Seed Cotton Components

Moisture data in 1960 and 1961 again indicated that defoliation had a marked influence on the moisture content of the harvested seed cotton components—seed, lint, and trash (table 3). It may be noted that the moisture content of the seed did not change as rapidly in the field during the day as did that of the lint. Defoliation had a greater overall effect on seed, lint, and trash moisture than did the time of harvesting.

Table 3 also shows the effect of an unusually dry environment on seed and lint moisture. There was less difference in the moisture of seed and of lint in 1961 (the dry year) than in 1960, indicating that the moisture content of these two components had reached near equilibrium in 1961.

Moisture Transfer Within Stored Seed Cotton

After storage of 0, 1, 2, and 3 days, a "core" was extracted from the approximate center of each lot for the purpose of determining the moisture content of the seed cotton's component parts. The samples were immediately ginned without drying or lint cleaning, and subsamples of lint, trash, and seed were extracted and sealed in cans until they could be weighed and placed in ovens.

Moisture transferred from the trash much more rapidly than it did

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TABLE 2.—*The effect of defoliation on the moisture content of seed cotton after it was harvested at Stoneville, Miss., in October 1960*

Field condition	Seed cotton moisture		Seed cotton trash	Trash moisture
	On stalk	In wagon		
	Percent	*Percent*	*Percent*	*Percent*
Defoliated	8. 4	10. 0	8. 05	20. 0
	10. 6	12. 6	4. 72	20. 8
	15. 2	15. 9	6. 91	16. 8
Average	11. 4	12. 8	6. 23	19. 2
Undefoliated	9. 6	13. 7	6. 01	30. 2
	11. 3	17. 7	8. 77	26. 9
	15. 2	17. 6	8. 20	28. 6
Average	12. 1	16. 3	7. 66	28. 6

TABLE 3.—*Moisture content of harvested seed cotton components as affected by different harvesting conditions at Stoneville, Miss., 1960–61*

Field condition	Moisture content of—			
	Wagon seed cotton	Seed	Lint	Trash
	Percent	*Percent*	*Percent*	*Percent*
1960:				
Defoliated	10. 0	12. 0	7. 2	20. 0
	12. 6	10. 3	8. 0	20. 8
	15. 9	12. 7	9. 0	16. 8
Undefoliated	13. 7	14. 0	12. 8	30. 2
	17. 7	14. 3	12. 9	26. 9
	17. 6	14. 0	12. 1	28. 6
1961:				
Defoliated	7. 5	7. 5	5. 7	16. 7
	7. 6	9. 2	7. 8	22. 3
	10. 6	9. 6	9. 1	22. 3
Undefoliated	9. 8	8. 2	8. 1	21. 6
	11. 1	9. 6	10. 1	24. 2
	13. 0	11. 1	10. 9	30. 3

from the lint (fig. 9). The seed gained moisture for the first 2 days, then began to lose moisture. After 2 days of storage, all three components were losing moisture. This indicated that water vapor was escaping from the entire bale into the atmosphere.

It should be pointed out that the seed cotton was stored at a depth of approximately 4 feet in a wire-mesh trailer. The fact that the seed cotton lost moisture indicates that some circulation of air occurred through the seed cotton during the storage period.

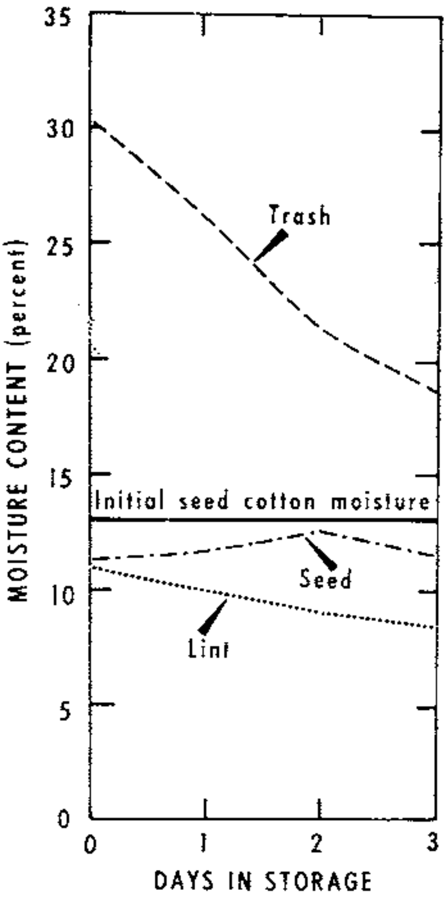

FIGURE 9.—The transfer of moisture from the components of stored seed cotton harvested from an undefoliated field at Stoneville, Miss., October 17, 1961.

Relative Humidity and Temperature in Stored Seed Cotton

The moisture content of stalk seed cotton harvested in 1960 at a medium-moisture level from defoliated and undefoliated fields was about the same—10.6 and 11.3 percent, respectively. However, green foreign matter in the undefoliated cotton increased the moisture content and caused the undefoliated cotton to heat much more than the defoliated cotton (fig. 10). Humidity was also higher in the undefoliated lot. Neither temperature nor humidity fluctuated from day to night as they did in outside air.

It should be emphasized that the combination of relative humidity plus temperature within stored seed cotton harvested from defoliated plants is not as conducive to microbial activity as it is within seed cotton harvested from undefoliated plants. In either case, even if the humidity and temperature were the same within both bales, the degree of microbial activity and consequent seed cotton deterioration would depend primarily upon the initial micro-organism infestation before harvesting.

Cotton Qualities Affected by Defoliation, Storage, and Seed Cotton Moisture

Lint Color

In general, cotton harvested at Stoneville, Miss., on October 17, 1961, had a more desirable color than that harvested on October 11, 1960. Differences in prevailing atmospheric conditions prior to harvest and in the moisture of seed cotton in the 2 experimental years make it necessary to identify all data according to year of harvest. Comparisons between classer's grade are based entirely on lint color because the lint was neither dried nor cleaned in the ginning process.

For conditions in 1960, the effect of defoliation and of seed cotton moisture and storage on classer's grade depended upon which combination of the three variables was employed in the harvesting procedure. As shown in table 4, seed cotton moisture content had no effect on the lint grade of defoliated cotton, regardless of whether the cotton was stored or not. However, the lint grade of cotton not defoliated prior to harvesting was generally

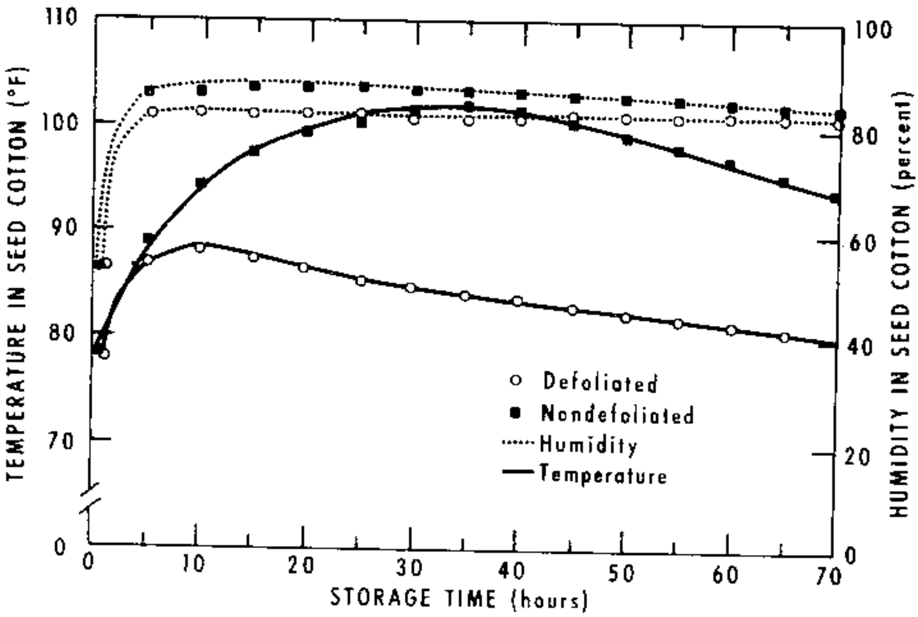

FIGURE 10.—Effect of defoliation on temperature and humidity in stored seed cotton harvested in 1960 at a medium moisture level.

TABLE 4.—*Effect of defoliation and of seed cotton moisture and storage on classer's grade of cotton harvested at Stoneville, Miss., Oct. 11, 1960*

Harvesting condition	Classer's grade following storage of [1]—			
	0 day	1 day	2 days	3 days
Defoliated:				
High moisture	[2] 83.75 ab	85.00 a	85.00 a	83.75 ab
Medium moisture	85.00 a	85.00 a	85.25 abc	85.00 a
Low moisture	85.00 a	85.00 a	85.00 a	85.00 a
Nondefoliated:				
High moisture	80.00 c	80.00 c	80.00 c	80.00 c
Medium moisture	80.00 c	85.00 a	80.00 c	80.00 c
Low moisture	81.25 bc	82.50 abc	80.00 c	82.50 abc

[1] LM=85, SLM=94, M=100, etc.
[2] Values not followed by the same letter or letters are different at the 5-percent level of significance by the Duncan Multiple Range test (*5*).

lower than that from defoliated cotton. There was also an indication that stored cotton harvested at the high moisture range did not have so good lint color as that harvested at the medium and low ranges of moisture.

Lint color in terms of percent light reflectance (Rd) and degree of yellowness (+b) was measured by a Nickerson-Hunter Cotton Colorimeter. The combination of reflectance and yellowness measurements may be converted into universal standard grades by using the graph in figure 11. Lint grades increase as light reflectance increases and as degree of yellowness decreases.

Defoliation resulted in a significant increase in percentage of reflectance—65.3 to 66.5—in 1960. Neither seed cotton moisture nor storage had any influence on the effect of defoliation on lint reflectance. However, seed cotton moisture content at time of picking did have an influence on lint reflectance,

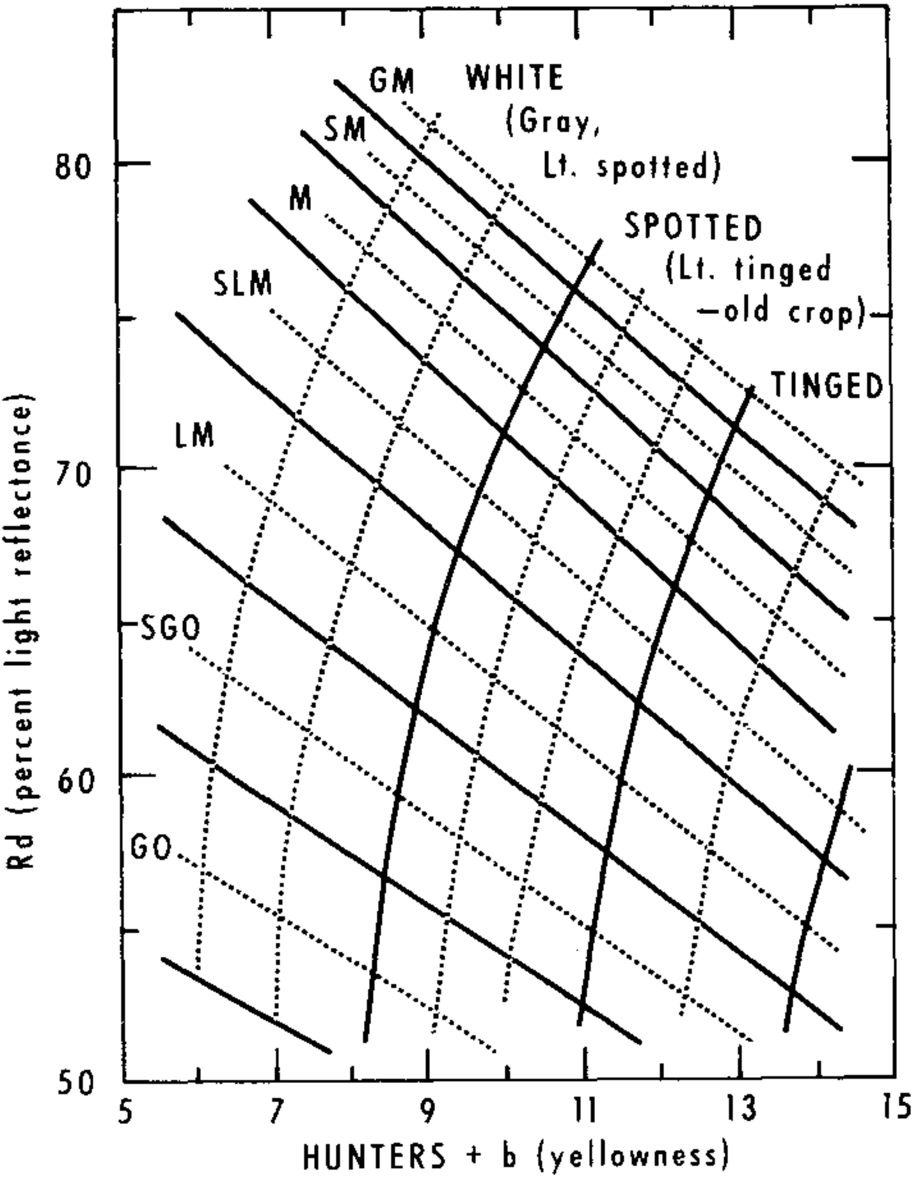

FIGURE 11.—U.S. Department of Agriculture, ARS color diagram for Nickerson-Hunter Cotton Colorimeter (spinlab model) based on universal standards for grade of American Upland Cotton adopted in 1952.

but its effect was not dependent upon defoliation or storage treatments. Furthermore, there appeared to be a linear relationship between seed cotton moisture and lint reflectance. The results in table 5 indicate that lint reflectance is inversely proportional to seed cotton moisture content at time of picking.

The degree of yellowness (+b) of lint is dependent upon the moisture content of cotton at time of picking (table 5). Moreover, the effect of moisture on lint yellowness may also be linear. Defoliation also reduced the degree of yellowness of lint in 1960 from 8.15 to 7.44.

The combination of higher reflectance and lower degrees of yellowness should have resulted in significantly higher classer's grades for the lower moisture cotton. The differences in lint color associated with moisture, however, were too small to be detected by the cotton classer. On the other hand, the differences in lint color associated with defoliation were generally large enough to be detected by the classer in 1960.

In 1961 the cotton classer graded cotton that had been defoliated slightly higher than cotton that had not been defoliated. However, the difference in color was much smaller than in 1960. More important were the interacting effects of seed cotton moisture and storage time. Cotton picked when it contained from 6.5 to 6.7 percent moisture was reduced in grade by the classer when it was stored for 2 days (table 6). Lint grade was not affected by seed cotton moisture content until after 2 days of storage.

Colorimeter readings also indicated an interacting effect of seed cotton moisture and storage on lint reflectance (table 7). Storage had no effect on the lint reflectance of the high-moisture (9.9 to 10.7 percent) cotton but had an adverse effect on the medium-moisture (6.5 to 6.7 percent) and low-moisture (5.9 to 6.1 percent) cottons after only 1 day of storage. Also, the low-moisture cotton had a slightly higher reflectance than the medium- or high-moisture cotton when no storage was imposed.

Colorimeter readings in 1961 also indicated that seed cotton moisture and storage had an interacting effect on the degree (saturation) of yellowness of lint (table 8).

Lint yellowness did not change when the higher moisture cotton was stored. However, at the beginning of the storage period, the degree of yellowness of both the higher and medium-moisture cottons, was considerably more than that of the lower moisture cotton. These dif-

TABLE 5.—*Effect of seed cotton moisture at time of picking on lint color of cotton harvested at Stoneville, Miss., Oct. 11, 1960*

Range of seed cotton moisture	Lint color	
	Rd (percent light reflectance)	+b (Yellowness)
Percent		
15.2 to 15.4	[1] 64.30 a	7.99 a
10.6 to 11.3	66.00 ab	7.76 b
8.4 to 9.6	67.40 b	7.64 b

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

TABLE 6.—*Effect of seed cotton moisture and storage time on classer's grade for cotton harvested at Stoneville, Miss., Oct. 17, 1961*

Range of seed cotton moisture at harvest	Classer's grade following storage of—		
	0 day	1 day	2 days
Percent	*Percent*	*Percent*	*Percent*
5.9 to 6.1	[1] 94.00 a	94.00 a	92.75 ab
6.5 to 6.7	94.00 a	94.00 a	92.12 b
9.9 to 10.7	92.75 ab	93.38 ab	94.00 a

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

TABLE 7.—*Interacting effects of seed cotton moisture and storage on reflectance of lint for cotton harvested at Stoneville, Miss., 1961*

Range of seed cotton moisture at harvest	Light reflectance of lint following storage of—		
	0 day	1 day	2 days
Percent	*Percent*	*Percent*	*Percent*
5.9 to 6.1	[1] 71.82 a	70.25 bcd	69.26 d
6.5 to 6.7	70.68 b	69.45 cd	69.45 cd
9.9 to 10.7	70.40 bc	70.52 bc	70.04 bcd

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

TABLE 8.—*Interacting effects of seed cotton moisture and storage on the yellowness (+b) of lint cotton harvested at Stoneville, Miss., October 1961*

Range of seed cotton moisture at harvest	Yellowness of lint following storage of—		
	0 day	1 day	2 days
Percent	*Percent*	*Percent*	*Percent*
5.9 to 6.1	[1] 6.96 c	7.21 bc	7.50 ab
6.5 to 6.7	7.48 ab	7.25 b	7.65 a
9.9 to 10.7	7.38 ab	7.48 ab	7.36 ab

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

ferences were masked out after only 1 day of storage.

Defoliation had a significant effect on the yellowness of lint in 1961 by reducing the +b value from 7.56 for nondefoliated cotton to 7.17 for defoliated cotton. This relationship agrees with the results of classer's grades for 1960 and 1961 and indicates that the main benefit from defoliation in relation to lint color was in the reduction of the degree of yellowness of the lint. Since the percent reflectance from lint was not affected by defoliation in 1961, this lint characteristic had no influence on the classer's ability to detect a difference in grade between defoliated and nondefoliated cotton. In 1960, the Rd and +b values and the classer's grades were improved by defoliation.

Fiber Length

Fiber length was generally shorter in 1961 than in 1960. This difference may be attributed to the fact that the cotton was dryer when harvested in 1961 than it was in 1960. It should be reemphasized that no drying was imposed on any of the cotton during ginning. Therefore, differences in fiber length between treatments cannot be associated with drying at the gin.

Defoliation significantly reduced fiber mean length in 1960 when the harvested cotton contained 8.4 to 11.3 percent moisture (table 9). The data in table 9 also indicate that a nonlinear relationship may exist between moisture and mean length. The fiber mean length of both defoliated and nondefoliated cotton harvested at the medium-moisture range (10.6 to 11.3 percent) was longer than when the seed cotton was harvested at either the low- or high-moisture ranges. From this, one may assume that an optimum seed cotton moisture level exists at which maximum fiber mean length may be expected and that this optimum moisture level is somewhere between 8.4 and 15.4 percent. This hypothesis is supported by data presented later in this text.

In 1961, defoliation significantly reduced fiber mean length from 0.93 inch for the nondefoliated cotton to 0.91 inch for the defoliated cotton. Furthermore, the effect of defoliation on mean length did not depend upon either seed cotton moisture content at time of picking or on seed cotton storage time.

Fiber mean length in 1961 was significantly influenced by the combination of seed cotton moisture and storage time (table 10). The mean fiber length of harvested cotton containing the lower amount of moisture (5.9 to 6.1 percent) tended to increase with storage. The same trend existed for the medium-moisture cotton (6.5 to 6.7 percent), although the differences were not large enough to be significant. The high-moisture cotton (9.9 to 10.7 percent) tended to lose in fiber mean length, although, again, the differences were not significant.

TABLE 9.—*Interrelated effects of defoliation and seed cotton moisture on fiber length of cotton harvested at Stoneville, Miss., October 1960*

Range in seed cotton moisture	Fiber length	
	Defoliated	Undefoliated
Percent	*Inch*	*Inch*
15.2 to 15.4	[1] 0.911 bc	0.923 b
10.6 to 11.3	.915 b	.954 a
8.4 to 9.6	.899 c	.943 a

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

TABLE 10.—*Interrelated effects of seed cotton moisture and storage time on fiber mean length for cotton harvested at Stoneville, Miss., October 1961*

Range of seed cotton moisture at harvest	Fiber mean length following storage of—		
	0 day	1 day	2 days
Percent	*Inch*	*Inch*	*Inch*
5.9 to 6.1	[1] 0.886 c	0.911 bc	0.925 ab
6.5 to 6.7	.919 abc	.936 ab	.948 a
9.9 to 10.7	.939 ab	.919 abc	.908 bc

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

When the cotton was not stored in 1961, maximum mean fiber length was obtained by harvesting when the seed cotton contained the higher amount of moisture (9.9 to 10.7 percent). This behavior is in accord with, but does not prove, the hypothesis made concerning the mean length results of the 1960 test. The relationship of fiber mean length to seed cotton moisture content at harvest time is shown in figure 12.

The specific mean length values plotted in figure 12 represent the average mean length for all storage periods for the 1960 curves, because storage had no effect on mean length in 1960. However, the 1961 curves represent fiber mean length only for the nonstored cotton, because, as pointed out previously, storage did affect mean length in 1961.

Fiber upper half mean length was affected by defoliation, seed cotton moisture, and storage in about the same measure as was fiber mean

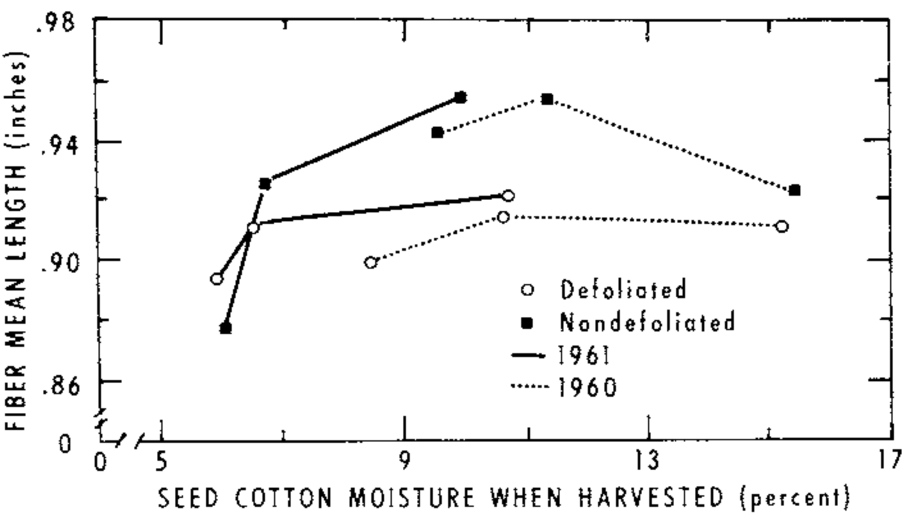

FIGURE 12.—Relationship of fiber mean length to seed cotton moisture for cotton harvested from defoliated and nondefoliated fields at Stoneville, Miss., 1960 and 1961.

length. The major difference was that defoliation did not affect upper half mean length (UHML) in 1961, whereas it did affect mean length in 1961. The relationship of UHML to seed cotton moisture was generally the same as it was for fiber mean length (fig. 13).

The degree to which seed cotton moisture at harvest time in 1961 affected fiber UHML, as it did fiber mean length, depended upon whether the cotton was stored prior to being ginned (table 11). For nonstored cotton, UHML tended to increase up to a moisture range of 9.9 to 10.7 percent. Also, UHML of the dryer cotton (5.9 to 6.1 percent moisture) tended to increase by storing the cotton.

Defoliation significantly reduced UHML in 1960 from 1.147 inches to 1.122 inches.

Fiber strength

Although the practice of defoliating had an adverse effect on fiber strength, the degree of the effect depended somewhat upon the moisture content of the seed cotton when it was harvested.

In 1960 the fiber strength of defoliated cotton harvested at a high moisture content was comparable to that of nondefoliated cotton harvested at a low moisture content. In 1961 the fiber strength of defoliated cotton harvested at a high moisture content was comparable to that of nondefoliated cotton (table 12).

The interacting effect of seed cotton moisture and storage was significant in 1960. When the cotton was not stored, seed cotton moisture had no effect on fiber strength (table 13). After 3 days of storage, only the medium-moisture cotton had significantly gained in fiber strength. No clearcut explanation for this behavior can be made from this data. Also after 3 days of storage, highest fiber strength resulted from cotton that was harvested at the medium-moisture level (10.6 to 11.3 percent).

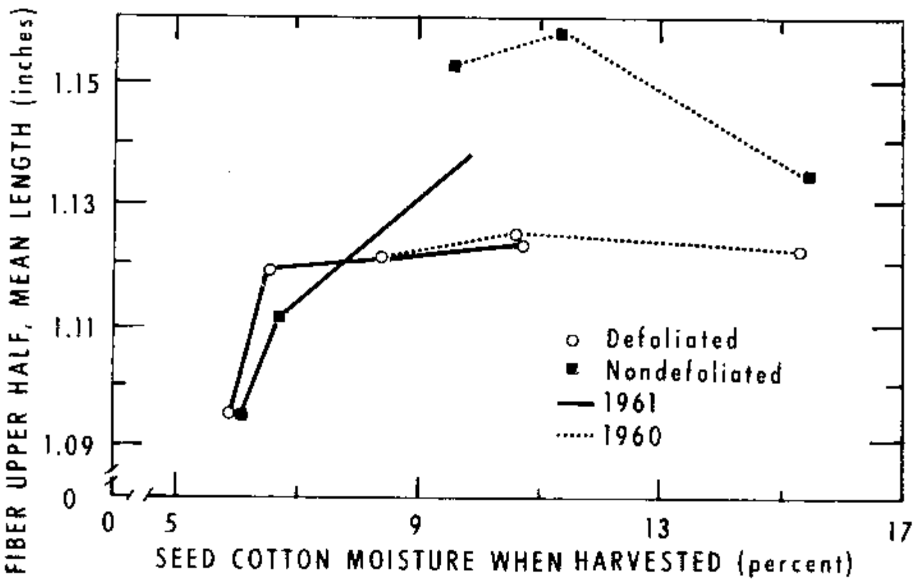

FIGURE 13.—Relationship of fiber upper half mean length to seed cotton moisture for cotton harvested from defoliated and nondefoliated fields at Stoneville, Miss., 1960 and 1961.

TABLE 11.—*Effect of seed cotton moisture and storage time on fiber upper half mean length of cotton harvested at Stoneville, Miss., October 1961*

Range of seed cotton moisture at harvest	Upper half mean length of cotton stored—		
	0 day	1 day	2 days
Percent	*Inch*	*Inch*	*Inch*
5.9 to 6.1	[1] 1.095 c	1.115 abc	1.124 ab
6.5 to 6.7	1.114 abc	1.119 abc	1.135 a
9.9 to 10.7	1.130 ab	1.119 abc	1.109 bc

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

TABLE 12.—*Interrelated effects of defoliation and seed cotton moisture on fiber strength for cotton harvested at Stoneville, Miss., October 1960 and 1961*

Range of seed cotton moisture at harvest	Fiber strength	
	Defoliated	Nondefoliated
1960: *Percent*	*Grams per tex*	*Grams per tex*
8.4 to 9.6	[1] 20.70 d	21.75 bc
10.6 to 11.3	20.78 d	22.96 a
15.2 to 15.4	21.18 cd	22.21 b
1961:		
5.9 to 6.1	21.33 b	22.56 a
6.5 to 6.7	21.23 b	22.68 a
9.9 to 10.7	22.13 a	22.54 a

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

TABLE 13.—*Effects of seed cotton moisture and storage time on fiber strength for cotton harvested at Stoneville, Miss., October 1960*

Range of seed cotton moisture at harvest	Fiber strength of cotton stored—			
	0 day	1 day	2 days	3 days
Percent	*Grams per tex*	*Grams per tex*	*Grams per tex*	*Grams per tex*
8.4 to 9.6	[1] 21.41 bc	20.46 d	21.35 bc	21.68 bc
10.6 to 11.3	21.71 bc	21.54 bc	21.48 bc	22.76 a
15.2 to 15.4	22.31 ab	21.82 bc	21.18 cd	21.48 bc

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

Seed cotton storage had no effect on fiber strength when harvested under the field conditions existing in 1961.

Fiber fineness

Fiber fineness as measured by the micronaire did not consistently vary with treatments as did lint color, fiber length, and fiber strength. In 1960, only the seed cotton moisture treatment affected the fiber fineness measured by the micronaire. That year seed cotton moisture affected fiber finenesss as follows.

Range of seed cotton moisture (percent):	*Micronaire units*		
8.4 to 9.6	[1] 4.34	a	
10.6 to 11.3	4.33	a	
15.2 to 15.4	4.44		b

[1] Values not followed by the same letter are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

According to Bailey and Baggett (*1*), the optimum fiber fineness would be a micronaire reading of 4.4. Therefore, the fiber fineness of cotton harvested at any of the seed cotton moisture levels was less than optimum.

In 1961, defoliation reduced the micronaire readings significantly. However, storage of nondefoliated cotton reduced the micronaire readings to a level comparable to those for defoliated cotton (table 14).

Cottonseed Quality

Because of the unsatisfactory quality of cottonseed produced in Mississippi for the past several years, certification standards have been lowered and State laws temporarily altered to meet the demands for planting seed. Viability has averaged between 60 and 70 percent. It has been as low as 40 percent for many lots since 1957. Consequently, farmers, certified seed producers, and research personnel are considerably interested in having the causes of deterioration in cottonseed quality investigated.

As mentioned previously, Caldwell and Parker (*3*) learned that cottonseed deterioration can be expected if the seed is exposed more than 1 week in the field. In addition, the degree of deterioration was significantly affected by the combination of temperature and humidity to which the seed was exposed.

In cooperation with the Seed Technology Laboratory at Mississippi State University and as part of an overall program of research conducted on cottonseed quality, cotton-mechanization and ginning researchers at Stoneville, Miss., are currently investigating the possible effects of harvesting, storing, and ginning on the quality of cottonseed. In the defoliation-seed cotton moisture-storage test of 1960 at Stoneville, cottonseed quality and lint quality were measured.

Defoliation reduced the free fatty acid content of cottonseed to 4.0 percent from 5.6 percent for the nondefoliated cotton. This reduction of free fatty acid through defoliation was closely associated with the moisture content of the seed. As shown previously in table 3, seed moisture averaged more than 14 percent when seed cotton was harvested from undefoliated plants and only 11.7 percent when harvested from defoliated plants. In addition, there was still a highly significant correlation after each day of storage between seed moisture and the content of free fatty acid in both defoliated and nondefoliated cotton. The higher the content of moisture in seed, the higher the content of free fatty acid.

There was also a significant negative correlation between seed moisture and seed viability. Defoliation tended to preserve the quality of the seed by reducing seed moisture content. Seed moisture was even more important when the seed cotton was stored. The difference in germination before storage of seed cotton

TABLE 14.—*Effects of defoliation and seed cotton storage on fiber fineness for cotton harvested at Stoneville, Miss., October 1961*

Field condition	Fiber finesess when stored—		
	0 day	1 day	2 days
	Micronaire units	*Micronaire units*	*Micronaire units*
Defoliated	[1] 4. 32 b	4. 32 b	4. 34 b
Nondefoliated	4. 51 a	4. 39 b	4. 36 b

[1] Values not followed by the same letter or letters are different at the 5-percent level of significance according to the Duncan Multiple Range test (*5*).

from defoliated and nondefoliated plants was 1.8 percent, but after 3 days of storage this difference increased to 22.2 percent in favor of defoliation. For all seed cotton moisture and storage treatments, the germination of the seed from the defoliated and undefoliated fields was 64.0 percent and 51.1 percent, respectively. Even though defoliation tended to preserve seed quality, the viability of the seed was still below the certification standards. The major portion of the cottonseed quality losses in 1960 can be attributed to adverse climatic conditions prior to harvesting.

On the basis of the characteristics measured in 1960, the producer could have better quality seed by harvesting defoliated cotton of low moisture content. He would risk losing some of the seed quality if he stored seed cotton that was harvested from an undefoliated field.

The results of this study tend to confirm the results reported by Fulton (*6*), who learned that cottonseed deterioration is more pronounced if the seed contains more than 12 percent moisture and is stored under relatively high temperatures. In 1960, seed moisture averaged over 14 percent when the seed cotton was harvested from undefoliated plants. Also, when this seed cotton was stored prior to ginning, the temperature within the seed cotton mass (and consequently around the seed) went well over 100° F.

CONCLUSIONS

For conditions varying widely from those that existed during the testing periods, the effects of defoliation, seed cotton moisture, and storage may not be consistently repeated. The following conclusions are based on results of testing cotton harvested at Stoneville, Miss., October 11, 1960, and October 17, 1961.

1. No one correction factor for a portable seed cotton moisture meter is applicable for all combinations of lint and seed moistures.

2. More trash is harvested from undefoliated cotton plants and this trash contains more moisture than that harvested from defoliated plants.

3. Defoliation is an effective means of reducing the moisture content of harvested seed cotton components—seed, lint, and foreign matter.

4. Moisture in stored seed cotton foreign matter transfers either into the seed and lint or into the atmosphere, depending upon the depth of the mass of stored seed cotton.

5. Relative humidity and temperature within bales of stored seed

cotton will be higher in cotton harvested from undefoliated plants than in cotton harvested from defoliated plants, even if the cotton was harvested at approximately the same stalk seed cotton moisture level.

6. Defoliation has an adverse effect on fiber length and strength. On the other hand, defoliation tends to preserve the color of the lint and the quality of the cottonseed.

7. Lint color tends to vary inversely with seed cotton moisture at time of harvest—the higher the moisture, the lower the color quality.

8. Seed cotton storage alone has no effect on cotton quality. However, the quality of cotton can change when seed cotton is stored, but the change depends upon the moisture content of the seed cotton mass.

9. Fiber length depends upon the moisture content of seed cotton at time of picking. However, this relationship is not linear. Harvesting seed cotton when it has 10 to 12 percent moisture should assure a maximum fiber length, provided no drying is imposed at the gin.

10. Maximum cottonseed quality will be realized by harvesting defoliated cotton at a low moisture level.

11. The most important factor that must be considered when storing seed cotton is its moisture content. Defoliation has no "direct" influence on the quality of stored seed cotton.

As a rule, cotton harvesting practices that tend to preserve lint color and grade generally have an adverse effect on fiber length and fiber strength. Defoliated cotton harvested when it has a moisture content of 10 to 12 percent would result in the maximum overall quality of cotton. Storage of this cotton would then have no effect on any of the lint or seed characteristics mentioned.

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