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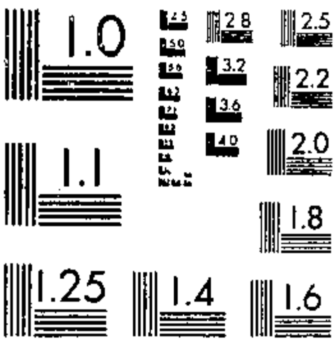

MICROCOPY RESOLUTION TEST CHART
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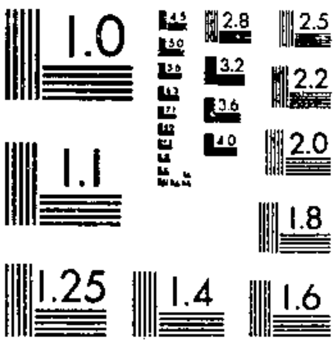

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NATIONAL BUREAU OF STANDARDS-1963-A

Technical Bulletin No. 931 • *December 1946*

UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Fiber and Spinning Properties of Cotton, With Special Reference to Varietal and Environmental Effects[1]

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CONTENTS

EXPERIMENTAL studies were inaugurated with the regional varietal studies in 1935 on fiber properties and spinning performance of leading varieties and strains of cotton produced under varying conditions throughout the Cotton Belt. Through the cooperative efforts of the various State agricultural experiment stations of the cotton area, the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Cotton Branch of the Production and Marketing Administration, valuable data have been gathered and published in various processed reports. In order that these data may be viewed as a whole and in proper perspective, certain of them through 1943 are summarized here, together with data in the Bureau, to emphasize varietal and environmental effects on the various fiber and spinning properties. These summaries are divided into two sections, one dealing with irri-

[1] Submitted for publication January 14, 1946.

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gated and nonirrigated cottons and the other with the data reported from the fiber and spinning laboratories for the 1943 crop. The report may be summarized as follows.

SUMMARY

Irrigated and Nonirrigated Cottons

A persistent prejudice against cotton grown on irrigated lands of the Southwest has existed for many years. Since irrigated and nonirrigated regions are usually characterized by distinct commercial varieties, it has been difficult to determine whether prejudice against irrigated cottons was caused by environmental or varietal factors. Cooperative agronomic, fiber, and spinning studies during the past few years have provided data for evaluating these influences. These data indicate that classer's designation of staple length of varieties that were common to irrigated and nonirrigated regions averaged about one thirty-second of an inch longer for the irrigated region. There was considerable variation within each of the regions. Within the irrigated area the staple from Sacaton, Ariz., tended to be shorter than that from Shafter, Calif., and State College, N. Mex.

Environmentally induced fiber strength, as evaluated by equivalent staple minus classer's staple length, reverses the trend noted for classer's staple. Fiber strength tends to be greater in the so-called "hard cotton" regions of Texas and Oklahoma, where staple length is frequently less than average.

Usually, when better-than-average length occurs within a variety, it is offset by reduced fiber strength, so that performance as measured by equivalent staple length is low. These data confirm previous studies in showing that environmentally induced length is an unreliable basis for evaluating cottons if fiber strength, fineness, and other fiber properties are ignored.

Locations in the nonirrigated areas, where both length and strength tend to be above average, are characterized by a good ground-water supply during the early fruiting stage, followed by a gradual lowering of this supply during the later fruiting season. A suggestion indicated by these data is that irrigation practices may be modified to produce fiber that is both longer and stronger than is usually obtained from rain-grown cotton.

These data seem to confirm previous studies in indicating that under existing conditions yarn-appearance grade is somewhat lower, neps in card web more numerous, and percentage of picker and card waste slightly higher for varieties grown under irrigation.

The most significant fact revealed by these data is that hereditary or varietal factors overshadow environmental factors with respect to valuable fiber properties and spinning performance relationships. Cotton breeders are meeting the challenge by developing varieties with superior fiber qualities adapted to irrigated regions. Hence, it seems reasonable to expect that buyers eventually must recognize that in both the irrigated and nonirrigated regions varieties having superior fiber properties will give better spinning performance than the classer's grade and staple indicate.

1943 Crop

Fiber and spinning measurements for the 1943 cooperative agronomic, fiber, and spinning studies are summarized in tables 4 to 11. These summaries list by varietal types and strains the effects of environmental influences and effects of varietal influences under certain environments, insofar as these data permit. The tabular summary makes evident several interrelationships among various fiber properties and in their apparent association with spinning performance. The principal objective of this report is to enable agronomists, cotton breeders, and others interested in the cotton-improvement program, in the performance of varieties, or in the study of locational effects to view these data as a whole in proper perspective. These data indicate that skein strength of singles 22s yarn is largely determined by fiber length and strength. By using the upper half mean from the Fibrograph and the converted Chandler tensile strength from the Pressley strength index, an approximate formula is presented for estimating skein strength of singles 22s yarn.

A comparison of fiber-length estimates shows that the mean of classer's staple for all varieties exceeded the upper half mean by 0.02 inch, as did the mean equivalent staple estimate. Certain varietal types were rather consistently over or under stapled on the basis of actual fiber-length measurements. This tendency seemed to be associated with yarn-appearance grade that resulted from spinning. Although a close agreement is apparent for upper half mean and mean length, there is little obvious relation between their ratio to each other, that is, uniformity ratio, and to skein strength of different varieties. Nor does it seem evident in these limited data that mean-length measurements would be preferable to, or in fact would be appreciably different from, upper half mean for predicting skein strength.

The percentage of deviations from the mean for equivalent staple minus upper half mean coincides more closely with plus or minus deviations for Pressley index than with those for X-ray determinations. Some interesting exceptions indicate that both measurements are valuable.

In general, good agreement is shown for fiber fineness as measured by weight per inch and by surface area. Usually, low weight per inch and correspondingly high Arealometer measurements characterize varieties or locations that give a low percentage of thick-walled fibers.

A close relationship exists between fineness and yarn-appearance grade. Neps in card web also are related to yarn-appearance grade and fiber fineness. The relation of picker and card waste to fiber fineness is less evident.

Fiber fineness is a desirable property for varieties that are likely to be spun into fine counts, although excessive fiber fineness appears to be an undesirable property where appearance of carded yarns is important, and it contributes little or nothing to skein strength of coarse count singles yarns. For 60s singles yarns an approximate formula is given for estimating skein strength from fiber length plus fiber strength plus fiber weight-per-inch measurements.

When the formulas derived from the 1943 crop were tested on the fiber data from the 1944 crop, it was possible to account for 83 to 84 percent of the varietal variability in the yarn strengths. The formulas were less effective for evaluating environmental effects.

STUDIES ON COTTON GROWN IN IRRIGATED AND NONIRRIGATED REGIONS, 1935-43

Regardless of its origin or cause, a definite prejudice in the spinning trade here and abroad has existed from many years against cotton grown on irrigated lands. When sea-island production almost ceased, following the advent of the cotton boll weevil on our eastern coast, long-staple spinners were forced to use Egyptian cottons. The writers understand that serious complaint from the spinners resulted, but information is meager as to whether slower operation, increased neppiness, and other difficulties were attributable largely to the fact that Egyptian varieties were markedly inferior in spinning properties to sea-island cotton or whether the difficulties found were partly attributable to production under irrigation conditions.

In recent years, this prejudice appears to have disappeared, but again it is not clear whether this has been due primarily to the development of superior Egyptian varieties or whether the growers, ginners, and manufacturers have adopted practices that tend to overcome the difficulties.

One practice has developed that may merit examination. Ginners of Egyptian cotton carefully clean and thoroughly mix the cotton before ginning, and prior to baling add a moderate quantity of moisture.

In the American cotton market, complaints about irrigated cotton have received considerable attention during the past 25 years. A rather exhaustive survey was conducted in 1928 by J. S. Townsend and others, and was summarized in an unpublished report.[2] From the many interviews, it was apparent that the spinners were in fairly general agreement that irrigated cotton was much coarser and more wasty than similar staple lengths from the Mississippi Delta region, and it had a distinct tendency to stick to the steel rollers of the roving frames, to slow up combing operations, and to form neppy yarns. There was some evidence that this difficulty was caused partly by faulty ginning or by lack of patience or experience in making suitable modifications in spinning practices when handling irrigated cottons.

Many subsequent reports on manufacturing experiences with irrigated cottons stress difficulty in dyeing, especially if mixed with nonirrigated growths, the occurrence of neps, more waste, a higher percentage of short fibers, and dryness that makes more "fly" in the mill than occurs in using rain-grown cotton. As a result of these difficulties, whatever their cause, corresponding staples have fre-

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[2] TOWNSEND, J. S., CAMP, W. R., WILLIS, H. H., and WIGINGTON, J. T. NOTES GATHERED IN INTERVIEWS WITH COTTON BROKERS, COTTON MILL PRESIDENTS, SUPERINTENDENTS, AND OTHERS RELATIVE TO THEIR EXPERIENCE WITH IRRIGATED COTTON OF THE SOUTHWEST. Cooperative report of Bureau of Plant Industry and the Bureau of Agricultural Economics. 27 pp. 1928. [Unpublished. Copy in files of Division of Cotton and Other Fiber Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering.]

quently sold from a fraction of 1 cent to 2 cents a pound cheaper for irrigated cottons than for corresponding rain-grown staples. This may partly account for the fact that prior to the loss of our export trade in 1941, much of the irrigated cotton was exported to mills that did not share this prejudice. Increased demands for longer staple cottons since 1941 have resulted in a greater demand for irrigated cotton in American mills.

Since 1920 the several cooperative agencies of the Department of Agriculture have conducted spinning tests of fibers from different varieties grown under varying conditions to determine more precisely the influence of hereditary and environmental factors in contributing to spinning performance.

In a report by M. E. Campbell, issued in 1941,[3] based on spinning tests from composite commercial samples, it was concluded that Delta cottons were more uniform in fiber length but were slightly coarser or heavier in fiber weight per inch than were the irrigated growths. There were no differences between percentage of thin-walled fibers. In total manufactured waste, the irrigated and nonirrigated growths differed, depending upon staple lengths. In the two shorter lengths, the Delta cottons were less wasty, whereas the irrigated cottons showed less waste for the longer staple lengths. In yarn appearance, the Delta cottons were on the average about two-thirds of a grade better than yarns from California cottons and nearly a full grade better than Arizona, New Mexico, Texas, and Oklahoma cottons. The irrigated cottons produced fabrics with a greater average number of neps than the nonirrigated growths. No outstanding differences were noted in the ease or speed of manufacturing operations.

These studies, made on commercial samples, reflect differences that may be attributable partly or wholly to differences in varieties grown in irrigated and nonirrigated regions. Consequently, in the present summarization an attempt has been made to emphasize varietal differences that have resulted from the cooperative agronomic, fiber, and spinning studies conducted during the past several years on varieties grown in irrigated and in nonirrigated regions, as well as to make such evaluations as the data seem to warrant between localities representing these regions.

Experimental Procedure

The data in the tables and charts presented in this section are drawn largely from six varieties of southeastern, mid-South, or Texas and Oklahoma origin that were grown for 1 to 7 years at many locations throughout the Cotton Belt, and from various strains of Acala cottons grown in the irrigated regions and in the Texas-Oklahoma rain-grown section. In several cases, duplicate samples, representing different blocks or different picking dates from the same blocks, were spun. The extensiveness of these data is illustrated by the number of fiber and spinning tests recorded for each variety in table 1—from 6 to 135 tests for each of the 10 varieties listed. These data, it will be realized, are representative of the agricultural experiment stations in the

[3] Campbell, M. E. Tests of irrigated and rain-grown American upland cotton, crop of 1939. U. S. Agr. Market. Serv., 38 pp., illus. 1941. [Processed.]

locations where the cotton was grown rather than of the general region or the farming practices in that region. Hence, the results should be interpreted as not necessarily representing any locality, State, or region. Since many more tests were conducted throughout the rain belt, however, the results are perhaps more nearly those that may be expected for the commercial growth in the nonirrigated than in the irrigated areas.

TABLE 1.—*Number of observations at locations and for varieties from which data given in tables 2 and 3 were derived*

Variety or strain	Stations in the irrigated region				Areas in the nonirrigated region				Total for varieties, both regions
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Regional total for varieties	Texas-Oklahoma	Mid-South	Southeast	Regional total for varieties	
Rain-grown type:									
Stoneville 2B	3	4	3	10	16	20	22	58	68
Stoneville 5	9	10	10	29	38	45	23	106	135
Delfos 4 (Missdel)	8	8	8	24	18	26	14	58	82
Deltapine 14	2	1	2	5	12	17	8	37	42
Mebane (Qualla)	2	2	2	6	5	8	2	15	21
Lone Star (Startex)	2	2	2	6	6	8	2	16	22
Total for locations for rain-grown types	26	27	27	80	95	124	71	290	370
Irrigated type:									
Acala, Shafter strains	18	13	6	37	9	...	...	...	46
Acala 1517	9	5	8	22	5	...	...	...	27
Acala N28	2	2	2	6	...	...	...	...	6
Acala Q6	2	2	2	6	...	...	...	...	6
Total for locations for irrigated types	31	22	18	71	14	...	...	14	85
Total for all locations	57	49	45	151	109	124	71	304	455

RESULTS

It is not believed that the data here presented will serve fully to define the fiber and spinning properties of the irrigated and the rain-grown cottons. It is hoped, however, that they may serve to emphasize the relative importance of heritable or varietal factors and of environmental factors, and to develop leads that may be followed in obtaining maximum quality and market value for American irrigated and nonirrigated cottons.

These data are summarized in three tables. Table 1 is of interest in showing that considerable confidence may be placed in the trends shown by the data presented in tables 2 and 3. Table 1 shows the number of observations that form the basis for environmentally induced differences exhibited by varieties at different locations. Likewise it shows the number of observations for each of the listed localities as a basis for judging as to significance of differences in fiber quality or spinning performance for the several varieties under given environmental conditions. Some of the varieties were grown from 1 to 10 years at each of the many locations. The average performance for varieties or localities summarized in tables 2 and 3, therefore, should be considered in relation to number of observations from which such averages are drawn, as shown in table 1.

TABLE 2.—*Comparison of equivalent staple and classer's staple length as affected by environmental or heritable factors*

[The number of observations from which the means listed below were obtained are given in table 1]

Variety or strain	Stations in the irrigated region									Areas in the nonirrigated region									Varietal means, both regions		
	Shafter, Calif.		Sacaton, Ariz.		State College, N. Mex.		Varietal means			Texas-Oklahoma		Mid-South		Southeast		Varietal means					
	Equivalent staple	Classer's staple	Equivalent staple	Classer's staple	Equivalent staple	Classer's staple	Equivalent staple	Classer's staple	Difference[1]	Equivalent staple	Classer's staple	Equivalent staple	Classer's staple	Equivalent staple	Classer's staple	Equivalent staple	Classer's staple	Difference[1]	Equivalent staple	Classer's staple	Difference[1]
	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.	1/32 in.
Rain-grown type:																					
Stoneville 2B	33.7	33.7	30.8	30.0	29.3	32.3	31.3	32.0	−0.7	33.0	32.3	32.9	32.1	33.0	32.6	33.0	32.3	+0.7	32.1	32.2	−0.1
Stoneville 5	32.2	32.1	32.2	31.2	29.6	32.1	31.3	31.8	−.5	32.1	31.0	30.4	30.8	31.6	30.9	31.4	30.9	+.5	31.4	31.4	0
Delfos 4 (Missdel)	31.2	33.4	32.2	32.1	28.1	33.9	30.5	33.1	−2.6	32.3	31.2	33.0	34.0	33.1	35.3	32.8	33.5	−.7	31.6	33.3	−1.7
Deltapine 14	33.0	33.5	29.0	32.0	29.0	32.5	30.3	32.7	−2.4	31.7	32.6	31.9	31.6	31.1	31.5	31.6	31.9	−.3	31.0	32.3	−1.3
Mebane (Qualla)	32.5	32.0	30.0	31.0	27.5	31.5	30.0	31.5	−1.5	29.0	29.3	29.2	30.8	31.5	32.0	29.9	30.7	−.8	30.0	31.1	−1.1
Lone Star (Startex)	32.5	32.5	27.5	31.5	28.5	31.5	29.5	31.8	−2.3	30.2	28.5	30.8	30.4	30.0	30.5	30.3	29.8	+.5	29.9	30.8	−.9
Locational means	32.5	32.9	30.3	31.3	28.7	32.3	30.5	32.2	−1.7	31.4	30.8	31.4	31.6	31.7	32.1	31.5	31.5	0	31.0	31.9	−.9
Irrigated type:																					
Acala, Shafter strains	34.2	34.7	31.8	32.5	30.7	33.0	32.2	33.4	−1.2	33.8	32.2	------	------		------	33.8	32.2	+1.6	32.6	33.1	−.5
Acala 1517	41.4	34.7	38.8	36.6	37.2	35.0	39.1	35.4	+3.7	30.9	33.1	------	------	------	------	39.9	33.1	+6.8	39.3	34.9	+4.4
Acala N28-5	35.5	33.0	32.5	31.0	32.5	33.5	33.5	32.5	+1.0	------	------	------	------	------	------	------	------	------	33.5	32.5	+1.0
Acala Q6	37.0	34.0	36.5	32.5	34.0	34.0	35.8	33.5	+2.3	------	------	------	------	------	------	------	------	------	35.8	33.5	+2.3
Locational means	37.0	34.1	34.9	33.2	33.6	33.9	35.2	33.7	+1.5	36.9	32.7	------	------	------	------	36.9	32.7	+4.2	35.3	33.5	+1.8
Locational means, both types	34.8	33.5	32.6	32.0	30.6	32.9	32.4	32.8	−.4	32.8	31.3	31.4	31.6	31.7	32.1	32.8	31.8	+1.0	32.7	32.5	+.2

[1] A plus sign (+) indicates that equivalent staple was greater than the classer's staple, and conversely, a minus sign (−) indicates that the equivalent staple was less than the classer's staple.

TABLE 3.—*Comparison of yarn-appearance grade, neps, and percentage of waste of cotton representing rain-grown types of Acala cotton developed in the irrigated region*

[The number of observations from which means listed were obtained are given in table 1, and the data on staple length are presented in table 2]

YARN-APPEARANCE GRADE [1] IN 22s

Variety or strain	Stations in the irrigated region				Areas in the nonirrigated region				Varietal means, both regions
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Varietal means	Texas-Oklahoma	Mid-South	Southeast	Varietal means	
Rain-grown type:									
Stoneville 2B	8.7	8.0	7.7	8.1	8.2	8.5	8.7	8.5	8.3
Stoneville 5	8.3	7.6	8.9	8.3	8.3	8.7	9.1	8.7	8.5
Delfos 4 (Missdel)	7.4	7.1	6.5	7.0	7.7	8.1	7.9	7.9	7.4
Deltapine 14	8.0	9.0	7.5	8.2	8.2	8.5	8.5	8.4	8.3
Mebane (Qualla)	9.0	8.0	7.5	8.2	7.4	8.5	10.0	8.6	8.4
Lone Star (Startex)	8.5	6.5	8.0	7.7	8.3	9.2	10.0	9.1	8.4
Locational means	8.3	7.7	7.7	7.9	8.0	8.6	9.0	8.5	8.2
Irrigated type:									
Acala, Shafter strains	8.3	7.5	7.8	7.9	8.1	------	------	8.1	8.0
Acala 1517	8.4	7.0	7.5	7.6	7.4	------	------	7.4	7.5
Acala N28	7.0	7.5	7.5	7.3	------	------	------	------	7.3
Acala Q6	6.4	7.5	6.5	6.7	------	------	------	------	6.7
Locational means	7.5	7.5	7.3	7.4	7.8	------	------	7.8	7.6
Locational means, both types	7.9	7.9	7.5	7.6	7.9	8.6	9.0	8.2	7.9

NEPS [2] IN 100 SQUARE INCHES OF CARD WEB

Variety or strain	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Varietal means	Texas-Oklahoma	Mid-South	Southeast	Varietal means	Varietal means, both regions
Rain-grown type:									
Stoneville 2B	12.3	35.2	28.3	25.3	17.9	19.9	15.2	17.7	21.5
Stoneville 5	------	76.0	17.0	46.5	14.2	22.5	10.0	15.6	31.0
Delfos 4 (Missdel)	------	------	------	------	------	------	------	------	------
Deltapine 14	18.5	16.0	20.5	18.3	21.2	19.1	24.4	16.5	18.4
Mebane (Qualla)	------	------	------	------	------	------	------	------	------
Lone Star (Startex)	------	------	------	------	------	------	------	------	------
Locational means	15.4	42.4	21.9	30.0	17.8	20.5	16.5	18.3	24.2
Irrigated type:									
Acala, Shafter strains	21.8	35.7	31.0	29.5	20.5	------	------	20.5	25.0
Acala 1517	21.2	45.5	37.2	34.6	30.2	------	------	30.2	32.4
Acala N28	------	------	------	------	------	------	------	------	------
Acala Q6	------	------	------	------	------	------	------	------	------
Locational means	21.5	40.6	34.1	[illegible]	25.4	------	------	25.4	28.8
Locational means, both types	18.4	41.5	23.0	31.0	21.6	20.5	16.5	21.8	26.4

PERCENTAGE OF WASTE FROM PICKER AND CARD

Variety or strain	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Varietal means	Texas-Oklahoma	Mid-South	Southeast	Varietal means	Varietal means, both regions
Rain-grown type:									
Stoneville 2B	7.5	9.0	7.7	8.1	6.6	7.4	6.6	6.9	7.5
Stoneville 5	9.1	8.9	6.8	8.3	8.0	8.9	8.3	8.7	8.5
Delfos 4 (Missdel)	10.0	8.7	7.6	8.8	12.1	10.[illegible]	10.7	11.0	9.9
Deltapine 14	7.3	7.3	6.9	7.2	6.7	7.3	6.1	6.7	7.0
Mebane (Qualla)	8.6	9.8	7.7	8.7	12.6	7.7	8.7	9.0	9.2
Lone Star (Startex)	9.6	11.0	8.1	9.6	14.0	8.2	7.1	9.8	9.7
Locational means	8.7	9.1	7.5	8.4	10.2	8.3	7.9	8.8	8.6
Irrigated type:									
Acala, Shafter strains	7.1	7.8	7.0	7.3	7.9	------	------	7.9	7.6
Acala 1517	7.4	7.5	6.5	7.1	6.5	------	------	6.5	6.8
Acala N28-5	8.5	9.3	6.8	8.2	------	------	------	------	8.2
Acala Q6	9.4	8.9	7.6	8.6	------	------	------	------	8.6
Locational means	8.1	8.4	7.0	7.8	7.2	------	------	7.2	7.5
Locational means, both types	8.4	8.8	7.2	8.1	8.7	8.3	7.9	8.0	8.0

[1] To facilitate statistical treatment, yarn-appearance grade, which is usually designated by letters, was assigned numerical values as follows: *A*+=12, *A*=11, *A*−=10, *B*+=9, *B*=8, *B*−=7, *C*+=6, *C*=5, *C*−=4. It is usually considered that *B* (8.0) is average for 22s singles carded yarns.

[2] 1 to 15=low, 16 to 25=average, 26 to 40=high, above 40=very high.

Table 2 presents the classer's staple length averaged for each variety by locations in the irrigated region and by three rather distinct areas in the nonirrigated region. Staple length as determined by customary classing methods has been defined (see footnote 8, p. 13) as a designation which "indicates the length of a 'typical portion' of the fibers in a sample. Uniformity of fiber length, as well as other fiber properties, probably influences to some extent the classer's selection of the 'typical portion' upon which staple length designation is based." In making the summarization given in table 2 consideration was given to including the actual length measurements. Such measurements, however, were not included in view of the fact that conversions would be required. In the earlier studies length was obtained from arrays, whereas in the later test it was determined by the Fibrograph.

Table 2 also shows spinning performance as measured by "equivalent staple length," a term that was adopted to indicate whether the skein strength of the resultant yarn was greater or less than would be expected in spinning fiber of the staple length assigned by the classers. If the skein strength is greater than is expected from a given staple length, the equivalent staple exceeds the classer's staple. Thus the comparison of staple length and equivalent staple length gives a measure of the contribution to yarn strength that is made by fiber properties other than staple length. In other words, it becomes primarily a measure of the influence of fiber strength. The equivalent staple [4] is derived from the formula $L=\frac{SC-428.69+18.142C}{2145.18}$, where L=equivalent staple, S=skein strength, and C=yarn count. The estimates summarized represent the average strength index of the three counts of yarns that were spun.

For the purpose of this study, it is believed that the comparison of classer's staple and equivalent staple may be used to determine whether the buyer who is interested primarily in yarn strength is getting less or more than he pays for from the cotton of a particular variety or from a given locality of growth. The values given in table 2 merit detailed examination, especially as to the consistency of trends exhibited and as to the number of observations (table 1) from which the means were obtained.

Table 3 gives a summary of varietal and environmental effects influencing yarn-appearance grade, neps in card web, and total percentage of waste. The yarn-appearance grades are means for 22s only, the neps are the means found per 100 square inches of card web, and percentages of waste are means for the total waste from picker and card. The arrangement of the varieties and stations is similar to tables 1 and 2, and the number of observations also are the same except for neps. No nep data were obtained prior to 1941. There appears to be a slight tendency within variety for yarn-appearance grade to follow equivalent-staple length. A distinct inverse relation is evident between the percentage of waste and yarn-appearance grade, as the coding for grade is here used; in other words, the lower the percentage of waste the higher the yarn-appearance grade.

In considering the data in tables 2 and 3, it should be noted that Acala N28-5 and Acala Q6 were not grown in the rain belt. Santan

[4] UNITED STATES WAR FOOD ADMINISTRATION. COTTON FIBER AND SPINNING TESTING SERVICE. U. S. War Food Admin. 16 pp. 1944. [Processed.]

Acala was included with Shafter at Sacaton. Several selections from Acala 1517 were included under Acala 1517. The data show that Acala (Shafter) and the six varieties of the nonirrigated type gave an equivalent staple that was inferior to classer's staple in the irrigated region, whereas in the nonirrigated region the equivalent staple length equaled or exceeded the classer's staple. Certain varieties, particularly Acala 1517, showed an equivalent staple that was greater at all locations than was the classer's staple. The records show an occasional sample from this variety to have a lower equivalent staple than classer's staple, but such examples are rare.

In considering the detailed varietal or environmental effects, 1 variety of cotton was examined at the individual locations throughout the Cotton Belt. Stoneville 5 was grown at 23 locations from Shafter, Calif., to Florence, S. C. This Delta-bred variety showed an equivalent staple that exceeded the classer's staple at three of the four irrigated locations. Certain stations in the irrigated region, as well as in the rain belt, show marked differences between the equivalent staple and classer's staple. At State College, N. Mex., the equivalent staple was about one-sixteenth of an inch less than the classer's staple. In the rain belt, it was equal to or greater than the classer's staple at all but five locations. Particular attention is called to the low equivalent staple at Baton Rouge, La., and Poplarville, Miss.; the 2-years' results at Poplarville gave a staple one-eighth of an inch less than the classer's staple, the greatest contrast between equivalent and classer's staple. This presumably is the result of biological deterioration in the field.

Interpretation of Results and Discussion

classer's staple

As pointed out by Bonner and others,[5] "It seems clear that the long-accepted standard of grade and staple length as the measures of quality needs to be supplemented by information on variety." (P. 19.)

Table 2 shows that, with two exceptions (Delfos 4 and Stoneville 2B), a longer staple was produced under irrigation than under natural rainfall. The average for the six varieties that extended across the two areas was stapled about one thirty-second of an inch longer for the irrigated region. Within the irrigated area, the cotton from Shafter, Calif., and State College, N. Mex., was rather consistently classed longer than from Sacaton for all 10 varieties. In general, the Southeast produced slightly longer staple than did the mid-South and Texas-Oklahoma regions.

Some of the stations in the areas of low annual rainfall showed a staple one-sixteenth of an inch shorter than many of the stations in the more humid mid-South and Southeast regions. Rain-grown staple, however, may not be definitely classified on a meteorological or geographical basis. Despite low annual rainfall, ample soil moisture—evidently subterranean—resulted in a good fiber length at Chillicothe and Brazos bottoms in the vicinity of College Station, Tex. At Chillicothe the optimum conditions that favor fiber elonga-

[5] Texas Agricultural Experiment Station. gearing texas cotton to war needs. Tex. Agr. Expt. Sta. Bul. 624, 24 pp., illus. 1942.

tion evidently persisted through secondary thickening and resulted in rather poor strength. The high equivalent staple for Brazos bottoms indicates that excellent initial soil moisture may have become somewhat lower as the season progressed, resulting in good environmentally induced length and strength. Even in the more humid mid-South, the influence of a good ground-water supply is evident at Marianna delta (Ark.), at Stoneville (Miss.), and elsewhere.

EQUIVALENT STAPLE AND EQUIVALENT STAPLE MINUS CLASSER'S STAPLE

As suggested in a preceding paragraph, the relation of equivalent staple to classer's staple gives an index of fiber strength, or rather of skein strength that is derived from fiber properties other than fiber length. A spinner who is particularly interested in yarn strength, especially one who may not be very familiar with recently developed rapid devices for determining fiber strength, may prefer to think of yarn strength in terms of staple length of average strength that would be required to give the desired yarn strength. It is, moreover, a convenient way of measuring spinning performance to estimate whether a variety or a locality is producing a cotton that will spin into a yarn that is stronger or weaker than the average for a given staple length. Since the buyer is required to pay a premium for extra staple, it also may be considered as one type of index as to whether a buyer is getting more or less than he pays for, or, conversely, whether the grower is receiving more or less than he is really entitled to. The equivalent staple in general reverses the trend noted for classer's staple; equivalent staple for rain-grown cotton equals or exceeds the average for the longer irrigated lengths (see table 2).

Shafter, Calif., produces a high equivalent staple that is about equal to the classer's staple. Sacaton appears to give a somewhat shorter equivalent staple that is about equal to classer's length for the majority of the varieties. State College, N. Mex., while producing a good classer's staple, shows a sharp drop for equivalent staple. This is partly attributable to a poorer fiber structure, as indicated by the comparatively large X-ray angles and the somewhat lower fiber-strength measurements. The equivalent staple, however, appears to be lower than would be expected on the basis of anticipated poor structure. At high altitudes (for example, at Lubbock, Tex.) or near the northern border of cotton production (as Knoxville, Tenn., and Statesville, N. C.), poor structure frequently results.

Is it possible that there is some biological deterioration as a result of heavy dews, possibly aggravated by maintaining a high late-season soil moisture at State College? In the rain regions, the equivalent staple is slightly higher for the Southeast, as also was the classer's staple. The average mid-South equivalent values were lowered by the poor results from three locations until they equaled the shorter Texas-Oklahoma averages and were slightly inferior to the Southeast. The equivalent staples for Baton Rouge and St. Joseph, La., and particularly Poplarville, Miss., were as low as the values for the poorest irrigated location, State College, N. Mex., or lower. The comparatively low values for equivalent staple that are general along the Gulf coast area apparently result from biological decay in the field and seem to account for the failure of the average equivalent staple in the cotton rain belt to exceed that of the classer's staple.

From the results shown in these studies the buyer gets more extra value from the Texas-Oklahoma and upper delta region, where skein-strength performance is medium or better and where the staple may be average or below. This may account for the preference buyers are said to exhibit for the so-called "hard cottons" that are reputed to characterize these regions. It should be pointed out, however, that several locations in the Southeast also show an approximately equal superiority of equivalent staple over classer's staple. One noteworthy feature of these data is several instances of failure for the usual tendency for environmentally induced fiber length and strength to be compensatory. Frequently, when better-than-average length occurs within a variety, it is offset by reduced fiber strength, so that the performance or equivalent staple is low. As shown in these studies, this does not invariably occur.

The most significant fact revealed by these studies, however, is that hereditary (varietal) factors overshadow environmental factors in the equivalent staple as related to classer's staple. Varieties with unusually strong fibers, as Acala 1517, perform much better than varieties of average strength at all locations, and weak-fiber varieties, as Delfos 4, give relatively poor performance. Poor environmental conditions make a weak variety give poorer performance, but they rarely prevent a strong variety from performing better than an average cotton; whereas good environmental conditions greatly increase the gap between equivalent staple and classer's staple for strong varieties, but rarely result in weak varieties performing appreciably better than expected on the basis of the classer's staple.

Although varieties grown under irrigation appear to average about one thirty-second of an inch longer than the mean for the cotton rain belt, the added length is not reflected in spinning performance. The latter, in fact, reaches its maximum at certain of the rain-belt stations. These data confirm previous studies in showing that environmentally induced length is an unreliable basis for evaluating cottons if fiber strength is ignored.

Despite the fact that a considerable number of tests are represented in these data for the irrigated region, they may not accurately represent the commercial plantings of the area. The influence of irrigation practice upon spinning performance is now being tested and needs extending. Cooperative studies in Arizona indicate the importance of abundant soil moisture, a deep water table at planting time and during vegetative development of the plant, and a gradual lowering of soil moisture during the late fruiting season as a desirable agronomic practice. The data presented here suggest that maximum fiber quality in the rain belt is obtained under somewhat similar conditions and that irrigation practices in relation to fiber properties merit careful study.

YARN-APPEARANCE GRADE

Data on yarn-appearance grade would seem to confirm previous studies in indicating that higher grade, i. e., smoother yarn, is more likely for rain-grown cotton. A distinct tendency is apparent for some varieties, as Delfos 4 and Acala N28 and Acala Q6, to give low yarn-appearance grades. Incidentally these three varieties are characterized by longer than average staple. They are no longer, however, than Acala 1517, which in these tests gave as good average yarn grade as the shorter staple varieties. These data indicate a slight positive relationship within variety between good yarn appearance and long equivalent staple.

NEPS IN CARD WEB

The data on neps in card web were not sufficiently complete in these studies to warrant definite conclusions. There was a strong indication that neps were less frequent in rain-grown cotton. Sacaton was especially high in the number of neps. At Shafter and State College the Acalas appeared to be more neppy than were the six varieties of the rain-grown type. As the number of neps in the card web increased, yarn grade apparently was lower.

PICKER AND CARD WASTE

Total waste reported in these studies shows no appreciable difference for irrigated and rainfall growths. One complication arises, however, in making this comparison: Classer's grade has been shown to influence waste [6] and it has also been shown that classer's grade is higher for irrigated cotton.[7] The writers wish to suggest that these tendencies might then tend to counteract each other. In fact, the data here summarized show a marked inverse relationship, within variety, between the yarn-appearance grade as here coded and the percentage of waste. Incidentally, there is an indication of an inverse relationship, within variety, between percentage of waste and equivalent staple.

Thus, measures of spinning properties—equivalent staple, yarn appearance, and waste—are interrelated, and a favorable combination of the desired fiber properties to give a smooth strong yarn with little manufacturing waste appears more likely to result in certain localities of the rain belt where growers may get by with varieties that would be unacceptable in other regions. It is equally evident, however, that the development of varieties with superior fiber qualities adapted to the irrigated region can produce cottons that should sell for more than the classer's grade and staple would indicate.

COTTON FIBER AND SPINNING TESTS OF THE 1943 CROP

This report summarizes the cooperative fiber and spinning test results that have been reported previously by areas for the 1943 crop.[8]

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[6] Cook, J. M., and Willis, A. Y., Jr. EFFECT OF CARD SPEEDS AND PRODUCTION RATES ON THE QUALITY OF YARN MANUFACTURED FROM VARIOUS GRADES OF COTTON. U. S. Food Distrib. Admin. in coop. with Clemson Agr. Col. 16 pp., illus. 1943. [Processed.]

[7] See footnote 3, p. 5.

[8] The agencies that cooperated in these studies, suggestions for interpretation of test results, together with detailed data were given in processed reports prepared in the Research and Testing Division, Cotton and Fiber Branch, Office of Distribution, War Food Administration. RESULTS OF FIBER AND SPINNING TESTS OF SOME COTTONS GROWN IN THE MIDSOUTH AREA, CROP OF 1943. 9 pp. 1944. [Processed.]; RESULTS OF FIBER AND SPINNING TESTS OF SOME COTTONS GROWN IN TEXAS AND OKLAHOMA, CROP OF 1943. 9 pp. 1944. [Processed.]; RESULTS OF FIBER AND SPINNING TESTS OF SOME COTTONS GROWN IN THE SOUTH-

In addition, the fiber-spinning relationships of the 1943 crop were tested as to applicability to the 1944 crop. Those connected with the cooperative Federal-State cotton breeding and improvement programs are interested in the comparative contribution of varieties and of locations to observed spinning properties and in the consistency of behavior for valuable fiber properties.

Since few of the 34 varieties that had at least two stations in common were grown at many of the 22 locations, an average of the "within variety" or "within station" effects appeared to be the most valid estimate of locational and varietal effects. It should be emphasized that this is a rough approximation and is of value for indicating trends, rather than for establishing definitive relations for varieties listed or for localities where such varieties were grown. It is also important to realize that the objective of these fiber and spinning studies was to determine comparative performance of the leading varieties or of new strains under different seasonal, soil, and climatic conditions. Consequently, the specific designation of a location does not indicate that the conditions under which these spinning samples were grown are characteristic of the locality or region in which the plantings were made.

Skein Strength in Relation to Fiber Length and Strength

Since fiber length and fiber strength are the most obvious contributors to skein strength, varietal and locational deviations for skein strength, fiber length, and fiber strength are presented in tables 4, 5, 6, and 7.

Table 4 shows how locational effects for skein strength of weighted 22s are estimated as deviations from the unadjusted varietal means. Thus for Shafter, Calif., the mean of deviations for the six varieties that were grown there is −1 pound. Since the mean skein strength for weighted 22s for all 34 varieties gives an average of 96 pounds, these data are interpreted as indicating that the adjusted mean for Shafter should be 96 minus 1, or 95 pounds, to free Shafter from differential varietal effects or to permit approximate environmental or locational comparisons. The work sheet with the values for weighted 22s for each variety and location is not shown here, but it may be reconstructed from table 4 by adding to or subtracting from the observed varietal mean the deviations recorded for each station where the variety was grown. For example, the value for weighted 22s for Acala 1517 at Shafter is 119 minus 3, or 116.

EAST, CROP OF 1943. 9 pp. 1944. [Processed.]; RESULTS OF FIBER AND SPINNING TESTS OF SOME COTTONS GROWN IN ARIZONA, CALIFORNIA, AND NEW MEXICO, CROP OF 1943. U. S. War Food Admin. 10 pp. 1944. [Processed.]

The only detailed data that are not available in these reports are the Arealometer measurements obtained through the cooperation of K. L. Hertel and D. M. Simpson at the Tennessee Agricultural Experiment Station. Measurements of the surface area or "Arealometer measurements," were made on the experimental model described by SULLIVAN, R. R., and HERTEL, K. L. SURFACE PER GRAM OF COTTON FIBRES AS A MEASURE OF FIBRE FINENESS. Textile Res. 11: 30-38, illus. 1940.

Weighted 22s—the average strength for yarns of the two coarser counts (22s and 36s)—were used to obtain a better sampling of spinning performance than might have been obtained from the 22s only. The values for weighted 22s were obtained by adding the reported values for 22s to the converted values for 36s and dividing by 2. The regression formula for obtaining equivalent staple, given in the processed report,[9] was used for constructing regression lines for 22s and 36s. From these the corresponding values of 36s and 22s were obtained.

The general effect of weighting the 22s with the higher counts was to lower the average skein strength of all varieties by about 2 percent. Some varieties were lowered more than others. There appeared to be a tendency for the converted values from 36s to be the same as actual 22s, or about 1 percent lower for the varieties having a low weight-per-unit length, whereas the converted values from 36s for varieties with greater-than-average weight per inch were usually lowered by 2 percent or more. The relation of fineness to skein strength, especially in the higher counts, is discussed more fully on page 32.

The figures in table 5 were obtained in such a way as to insure that they would not reflect the effect on varieties of environmental or locational effects on skein strength of weighted 22s. Thus varietal responses at Shafter are estimated as deviations from the adjusted station mean (95). An average of the deviations within the 22 stations, where more than 1 variety occurs, gives the mean varietal deviations recorded under "Varietal means." Since the breeder may be especially interested in the consistency of varietal behavior at different locations, the detailed divergences shown in this table for varietal effects are based on the deviations from the adjusted instead of the unadjusted station means.

Table 6 shows detailed varietal deviations for fiber length of the upper half mean at each location. It corresponds to table 5 in that it represents detailed varietal deviations from adjusted station means. The detailed deviations from varietal means as a basis for estimating locational effects, as derived from table 4, are not shown; however, table 6 shows the adjusted means for stations at the foot of each column.

Table 7, though similar to table 6, deals with fiber strength reported as estimated fiber tensile strength. This estimate is derived from the Pressley index,[10] devised by E. H. Pressley for rapidly and accurately determining the relative strength of cotton fibers. This index is converted to the more familiar tensile strength by the regression formula:[11] Estimated tensile strength $= (10.8116 \times \text{Pressley index}) - 0.12$.

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[9] See footnote 4, p. 9.

[10] PRESSLEY, E. H. A COTTON FIBER STRENGTH TESTER. Amer. Soc. for Testing Materials Bul. 118: 13–17, illus. 1942.

[11] See pp. 5 and 6 of reference given in footnote 4, p. 9.

TABLE 4.—*Environmental effects on skein strength of weighted 22s,[1] as determined by deviations within varieties*

Varietal types and strains	Stations in the irrigated region				Areas in nonirrigated region																		Varietal means (unadjusted), both regions
					Texas-Oklahoma stations							Mid-South stations					Southeast stations						
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Weslaco, Tex.	Lubbock, Tex.	Chillicothe, Tex.	Chickasha, Okla.	College Station, Tex. (upland)	College Station, Tex. (bottoms)	Temple, Tex.	Greenville, Tex.	Marianna, Ark.	Jackson, Tenn.	Stoneville, Miss.	St. Joseph, La.	State College, Miss.	Auburn, Ala.	Experiment, Ga.	Tifton, Ga.	Florence, S. C.	Knoxville, Tenn.	Statesville, N. C.	
Acala type:	*Lb*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Acala 1517	[2] −3	−10	−20		+2	+9	+11		+7		+5												119
Acala 1517 W29-1	+8	−3	−6																				120
Acala P18	+2	−12	−6				+11				+7												89
Coker 100 type:																							
Coker 100-6	−7	−8	−7									+9	+7	+12						−5	+4	−1	91
Coker 100-7				+2										+6	−2	+4				−10			98
Coker 100 Wilt type:																							
Coker 100 Wilt 2																		+1	−3			+2	93
Coker 100 Wilt 3														+7		+3			−5	−4			96
Delfos type:																							
Delfos 531C									−3			+2		+1	+1	−1							103
Delfos 651														+2	+1	−2							102
Deltapine type:																							
Deltapine 14	−2	−3	−8											+5	+5	+4							95
Deltapine 14 (833)				+6		0	+1		+2	−3	−6	+6	−2	+4	+6	+1	0	+1	−8	−2	0	+1	98
A12 (Arkansas)											−9	+8											96
Rowden type:																							
Rowden 41A							−3	+1		−9	+3	+7											87
Rowden 41B											−4	+3											90
B4 (Arkansas)											−5	+5											109
Stoneville type:																							
Stoneville 2B	−4	−7	−9	+10	−3	+2	+5		+9	−1	−1	+3	−3	+9	+6	+1	0	+1	−9	−3	−3	0	97
Stoneville 2B (8275)							0		−3					+7	+1	−3							103
Stoneville 2C														+5	0	−5							101
Stoneville 62-1-10						+1	+1	−2													0		89
White Gold																	−1	0					96
Empire							+3						−4				+1	+1			0		93
Bobshaw 1													+1				−1						93
E4 (Arkansas)											−5	0		+9				−4					95

See footnotes at end of table.

Stonewilt type:																							
Stonewilt 2																	+1	+1	0	−2			91
Stonewilt 3																	−1	+2					86
Wannamaker's S and C 4																		+2		−1			90
Miscellaneous:																							
Bobdel (Bobshaw 16)														+7		−8							120
Coker 200-4				+7																−5	−3		92
Coker 4 in 1-5				+5											+5				−3	−8			100
Hibred						+4	−5											+1					85
Lonestar and Lankart								−2		+2													96
Mebane 140 and 141					−2	+2	+6			−1	−6												83
Oklahoma Triumph 1128					−2	−1	+3																88
Station 21-24																	+6		−5				80
Means for:																							
Varieties, unadjusted																							96
Station deviations	−1	−7	−9	+6	−1	+2	+3	−1	+2	−2	−2	+5	0	+6	+3	−1	+1	+1	−5	−4	0	0	
Stations, adjusted (96 lbs. ± dev.)	95	89	87	102	95	98	99	95	98	94	94	101	96	102	99	95	97	97	91	92	96	96	

[1] Weighted 22s = mean of 22s plus 36s converted to 22s (formula cited on p. 9).
[2] Difference between weighted 22s from Acala 1517 at Shafter and the unadjusted average, or 116−119 = −3.

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TABLE 5.—*Varietal effects on skein strength of weighted 22s, as determined by deviations within locations*

Varietal types and strains	Stations in the irrigated region					Areas in nonirrigated region: Texas-Oklahoma stations						Areas in nonirrigated region: Mid-South stations					Areas in nonirrigated region: Southeast stations						Varietal means	
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Weslaco, Tex.	Lubbock, Tex.	Chillicothe, Tex.	Chickasha, Okla.	College Station, Tex. (upland)	College Station, Tex. (bottoms)	Temple, Tex.	Greenville, Tex.	Marianna, Ark.	Jackson, Tenn.	Stoneville, Miss.	St. Joseph, La.	State College, Miss.	Auburn, Ala.	Experiment, Ga.	Tifton, Ga.	Florence, S. C.	Knoxville, Tenn.	Statesville, N. C.	Deviations	Adjusted [1]
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Acala type:																								
Acala 1517	[2] +21	+20	+12		+26	+30	+31		+28		+30												+25	121
Acala 1517 W29-1	+33	+28	+27																				+29	125
Acala P18	−4	−12	−4				+1				+2												−3	93
Coker 100 type:																								
Coker 100-6	−11	−6	−3									−1	+2	+1						−6	−1	−6	−3	95
Coker 100-7				−2										+2	−3	+7				−4			0	96
Coker 100 Wilt type:																								
Coker 100 Wilt 2																		−3	−1			−1	−2	94
Coker 100 Wilt 3														+1		+4			0	0			+1	97
Delfos type:																								
Delfos 531C									+2			+4		+2	+5	+7							+4	100
Delfos 651														+2	+4	+5							+4	100
Deltapine type:																								
Deltapine 14	−2	+3	0											−2	+1	+4							+1	97
Deltapine 14 (833)				+2		0	0		+2	+1	−2	+3	0	0	+5	+4	+1	+2	−1	+4	+2	+3	+1	97
A12 (Arkansas)											−7	+3											−2	94
Rowden type:																								
Rowden 41A							−15	−7		−16	−4	−7											−10	86
Rowden 41B											−8	−8											−8	88
B4 (Arkansas)											+10	+13											+12	106
Stoneville type:																								
Stoneville 2B	−2	+1	+1	+5	−1	+1	+3		+8	+2	+2	−1	−3	+4	+4	+3	0	+1	−3	+2	−2	+1	+1	97
Stoneville 2B (S275)							+4		+2					+8	+5	+5							+5	101
Stoneville 2C														+4	+2	+1							+2	98
Stoneville 62-1-10						−8	−9	−6													−7		−8	89
White Gold																	−2	−1					−2	94
Empire							−3						−7				−3	−3			−3		−4	92
Bobshaw 1													−2				−5						−4	92
E4 (Arkansas)											−4	−6		+2				−6					−4	92

See footnotes at end of table.

Stonewilt type:																							
Stonewilt 2																-5	-5	0	-3			-3	93
Stonewilt 3																-12	-9					-10	86
Wannamaker's 8 and C-4																	-5		-3			-4	92
Miscellaneous:																							
Bobdel (Bobshaw 16)														+25		+17						+21	117
Coker 200-4				-3															-5	-7		-5	91
Coker 4 in 1-5				+3											+6			+6	0			+4	100
Hibred						-9	-10										-11					-13	83
Lonestar and Lankart								-1		+4												+2	96
Mebane 140 and 141					-14	-13	-10			-12	-17											-13	83
Oklahoma Triumph 1128					-9	-11	-8															-9	87
Station 21-24																-5		-10				-8	88
Station means, adjusted [4]	95	80	87	102	95	96	90	95	96	94	94	101	96	102	99	95	97	97	91	92	96	96	......	....

[2] 96 lbs. ± deviation of varietal means.
[3] Difference between weighted 22s from Acala 1517 at Shafter and the adjusted mean, Shafter station, or 116—95=+21.
[4] Adjustment made as shown in table 4.

TABLE 6.—*Environmental and varietal effects on upper half mean fiber length* [1]

Varietal types and strains	Stations in the irrigated region				Areas in nonirrigated region																		Varietal means	
					Texas-Oklahoma stations							Mid-South stations					Southeast stations							
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Weslaco, Tex.	Lubbock, Tex.	Chillicothe, Tex.	Chickasha, Okla.	College Station, Tex. (upland)	College Station, Tex. (bottoms)	Temple, Tex.	Greenville, Tex.	Marianna, Ark.	Jackson, Tenn.	Stoneville, Miss.	St. Joseph, La.	State College, Miss.	Auburn, Ala.	Experiment, Ga.	Tifton, Ga.	Florence, S. C.	Knoxville, Tenn.	Statesville, N. C.	Deviations	Adjusted [2]
Acala type:	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Acala 1517	+0.09	+0.10	+0.11		+0.08	+0.11	+0.06		+0.10		+0.05												+0.09	1.05
Acala 1517 W29-1	+.08	+.10	+.12																				+.10	1.06
Acala P18	+.06	+.05	+.04				+.04				+.01												+.04	1.00
Coker 100 type:																								
Coker 100-6	+.02	+.02	0									-0.01	+0.02	0						+0.01	+0.02	+0.03	+.01	.97
Coker 100-7				+0.02										-.06	0	+0.03				+.01			0	.96
Coker 100 Wilt type:																								
Coker 100 Wilt 2																		-0.02	-0.01			-.03	-.02	.94
Coker 100 Wilt 3														-.01		0			-.03	-.01			-.01	.95
Delfos type:																								
Delfos 531C									+.06			+.03		+.02	+.05	+.06							+.04	1.00
Delfos 651														+.02	+.05	+.03							+.03	.99
Deltapine type:																								
Deltapine 14	+.05	+.02	+.04											+.02	+.01	+.03							+.03	.99
Deltapine 14 (833)				+.02		+.03	+.02		0	0	-.01	-.01	-.01	+.04	+.04	+.04	0	+.02	+.01	+.01	+.02	-.01	+.01	.97
A12 (Arkansas)											-.01	0											0	.96
Rowden type:																								
Rowden 41A							+.05	-0.05		-.06	-.05	-.05											-.03	.93
Rowden 41B											-.05	-.05											-.05	.91
B4 (Arkansas)											-.03	0											-.02	.94
Stoneville type:																								
Stoneville 2B	+.03	+.02	+.02	+.04	0	-.03	+.01		+.01	-.03	-.02	-.06	0	+.01	+.03	+.02	0	-.01	-.03	+.01	-.02	-.03	0	.96
Stoneville 2B (8275)							-.01		+.02					+.06	+.02	+.01							+.02	.98
Stoneville 2C														+.05	+.04	+.02							+.04	1.00
Stoneville 62-1-10						-.06	-.05	-.09													-.04		-.06	.90
White Gold																	+.02	+.02					+.02	.98
Empire							-.03						-.05				0	-.02			0		-.02	.94
Bobshaw 1													-.02				-.02						-.02	.94
E4 (Arkansas)											+.02	-.05		+.03				+.06					+.02	.98

See footnotes at end of table.

Stoneville type:																								
Stoneville 2																	0	0	−.03	−.01			−.01	.95
Stoneville 3																	+.02	+.02					+.02	.98
Wannamaker's S and C 4																		0		+.07			+.04	1.00
Miscellaneous:																								
Bohdel (Bobshaw 10)														+.12		+.05							+.08	1.04
Coker 200-4				+.04																+.01	+.02		+.02	.98
Coker 4 in 1-5				+.02											+.04				+.03	+.03			+.03	.99
Hibred						−.19	−.21											−.21					−.20	.76
Lonestar and Lankart								−.01		−.03													−.02	.94
Mebane 140 and 141					−.08	−.15	−.09			−.08	−.11												−.10	.86
Oklahoma Triumph 1128					−.08	−.05	−.05																−.06	.90
Station 21-24																	−.04		−.04				−.04	.91
Station means, adjusted[3]	1.00	.94	1.00	1.02	.96	.97	.93	.95	.98	.97	.93	.93	.89	.97	.99	.95	.93	.96	.93	.95	1.02	.94		

[1] Measured by the Fibrograph.
[2] 96 lbs. ± deviation of varietal means.
[3] Adjustment made as shown in table 4.

TABLE 7.—*Environmental and varietal effects on estimated fiber tensile strength* [1]

Varietal types and strains	Stations in the irrigated region				Areas in nonirrigated region: Texas-Oklahoma stations							Areas in nonirrigated region: Mid-South stations					Areas in nonirrigated region: Southeast stations						Varietal means	
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Weslaco, Tex.	Lubbock, Tex.	Chillicothe, Tex.	Chickasha, Okla.	College Station, Tex. (upland)	College Station, Tex. (bottoms)	Temple, Tex.	Greenville, Tex.	Marianna, Ark.	Jackson, Tenn.	Stoneville, Miss.	St. Joseph, La.	State College, Miss.	Auburn, Ala.	Experiment, Ga.	Tifton, Ga.	Florence, S. C.	Knoxville, Tenn.	Statesville, N. C.	Deviations	Adjusted [2]
	1,000 lb.	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*	*1,000 lb.*
Acala type:																								
Acala 1517	+11	+9	+10		+15	+14	+16		+14		+20												+14	95
Acala 1517 W29-1	+15	+16	+13																				+15	96
Acala P18	−11	−11	−9				−5				−3												−8	73
Coker 100 type:																								
Coker 100-6	−1	−2	−3									+3	−4	−4						−4	−2	−3	−2	79
Coker 100-7				−3										+1	−2	−2				−3			−1	80
Coker 100 Wilt type:																								
Coker 100 Wilt 2																		−4	−6			−5	−5	76
Coker 100 Wilt 3														−2		−2			−1	−4			−2	79
Delfos type:																								
Delfos 531C									0			0		+2	−3	−3							−1	80
Delfos 651														−3	−2	−2							−2	79
Deltapine type:																								
Deltapine 14	−7	−2	−3											−2	−4	−2							−3	76
Deltapine 14 (833)				−7		−6	−4		−4	−1	−2	−3	−5	−2	−5	−2	−6	−4	−8	−4	−4	−7	−4	77
A12 (Arkansas)											−2	0											−1	80
Rowden type:																								
Rowden 41A							+3	+7		+4	+3	+4											+4	85
Rowden 41B											+5	+4											+4	85
B4 (Arkansas)											0	+6											+3	84
Stoneville type:																								
Stoneville 2B	−1	−2	−1	−1	+6	+4	+2		+2	+8	+5	+2	0	+1	0	0	−1	−2	−2	−3	+2	+2	+1	82
Stoneville 2B (8275)							0		+1					0	+3	+1							+1	82
Stoneville 2C														−3	+2	+1							0	81
Stoneville 62-1-10						+3	+4	+2													−1		+2	83
White Gold																	−2	−5					−4	77
Empire							+4						+2				−2	0			−2		0	81
Bobshaw 1													+7				0						+4	85
E4 (Arkansas)											0	−2		−2				−4					−2	79

See footnotes at end of table.

Stonewilt type:																								
Stonewilt 2																	−4	−4	−3	−7			−4	
Stonewilt 3																	−8	−10					−9	
Wannamaker's S and C 4																		−3		−4			−4	7
Miscellaneous:																								
Bobdel (Bobshaw 16)														+5		+2							+4	85
Coker 200-4				−5																−7	0		−4	77
Coker 4 in 1-5				−4											−1				−5	−5			−4	77
Hibred						+4	−4											−2					−1	80
Lonestar and Lankart								+5		+8													+6	87
Mebane 140 and 141					−4	+8	+2			−8	+4												0	81
Oklahoma Triumph 1128					−2	−5	−1																−3	78
Station 21-24																	+5		+1				+3	84
Means for:																								
Station deviations	−4	+1	−11	−1	−1	+3	+6	−1	+1	−3	+6	+2	+7	−1	−2	+4	−3	−3	+1	−6	−3	+1		
Stations adjusted [3]	77	82	70	80	80	84	87	80	82	78	87	83	88	80	79	85	78	78	82	75	78	82		

[1] Converted from Pressley index (formula cited on p. 15)
[2] 81,000 lbs. ± deviation of varietal means.
[3] Adjustment made as shown in table 4.

Table 8 summarizes, in columns 2 and 3, the percentage of deviations for varieties and locations shown in tables 6 and 7, respectively. Column 4 summarizes the percentage of deviations obtained, as in tables 6 and 7, for equivalent staple minus the upper half mean. The equivalent staple was taken from the spinning reports and converted to equivalent decimal fractions. Since the estimate for equivalent staple is based on average fiber strength, the equivalent staple minus the upper half mean should give that part of skein strength that may be attributable to abnormal fiber strength or to fiber properties other than length that contribute to skein strength. The close agreement for the percentage of deviations, shown in columns 3 and 4, is interpreted as indicating that skein strength of coarse counts that is not attributable to length is largely accounted for by ± deviations from average fiber strength. The results presented in columns 5 (length deviations + strength deviations) and 6 (deviations for skein strength) further substantiate the assumption that these effects are cumulative.

TABLE 8.—*Relation of varietal and environmental effects on fiber length and strength and on skein strength*

VARIETAL EFFECTS

Varietal types and strains and locations	Deviations					Skein strength predicted from—			
	Upper half mean length [1]	Fiber tensile strength [2]	Equivalent staple − upper half mean [3]	Fiber length + strength [4]	Obtained weighted 22s [5]	Fiber length [6]	± deviations for fiber strength [7]	Fiber length + strength [8]	Obtained weighted 22s [9]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Acala type:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Acala 1517	+9	+17	+17	+26	+25	105	+17	122	121
Acala 1517 W29-1	+10	+18	+22	+28	+32	106	+18	124	125
Acala P18	+4	−10	−8	−6	−3	100	−10	90	93
Coker 100 type:									
Coker 100-6	+4	−2	−5	−1	−2	97	−2	95	93
Coker 100-7	0	−1	0	−1	+2	96	−1	95	96
Coker 100 Wilt type:									
Coker 100 Wilt 2	−2	−6	+1	−8	−1	94	−6	88	94
Coker 100 Wilt 3	−1	−2	+2	−3	+2	95	−2	93	97
Delfos type:									
Delfos 531C	+4	−1	0	+3	+5	100	−1	99	100
Delfos 651	+3	−2	+5	+1	+5	99	−2	97	100
Deltapine type:									
Deltapine 14	+3	−4	−2	−1	0	99	−4	95	97
Deltapine 14 (833)	+1	−5	0	−4	+2	97	−5	92	97
A12 (Arkansas)	0	−1	−2	−1	−2	96	−1	95	94
Rowden type:									
Rowden 41A	−3	+5	−7	+2	−11	93	+5	98	86
Rowden 41B	−5	+5	−6	0	−9	91	+5	96	88
B4 (Arkansas)	−2	+4	+9	+2	+10	94	+4	98	108
Stoneville type:									
Stoneville 2B	0	+1	+2	+1	+2	96	+1	97	97
Stoneville 2B (8275)	+2	+1	+4	+3	+6	98	+1	99	101
Stoneville 2C	+4	0	0	+4	+3	100	0	100	98
Stoneville 62-4-10	−6	+2	−3	−4	−10	90	+2	92	88
White Gold	+2	−5	−3	−3	0	98	−5	93	94
Empire	−2	0	−2	−2	−3	94	0	94	92
Bobshaw 1	−2	+5	−2	+3	−4	94	+5	99	92
E4 (Arkansas)	+2	−2	−6	0	−3	98	−2	96	92
Stonewilt type:									
Stonewilt 2	−1	−5	−2	−6	−3	95	−5	90	93
Stonewilt 3	+2	−11	−8	−9	−9	98	−11	87	86
Wannamaker's S and C 4	+4	−5	−6	−1	−2	100	−5	95	92

See footnotes at end of table.

TABLE 8.—*Relation of varietal and environmental effects on fiber length and strength and on skein strength*—Continued

VARIETAL EFFECTS—Continued

Varietal types and strains and locations	Deviations					Skein strength predicted from—			
	Upper half mean length [1]	Fiber tensile strength [2]	Equivalent staple − upper half mean [3]	Fiber strength +strength [4]	Obtained weighted 22s [5]	Fiber length [6]	±deviations for fiber strength [7]	Fiber length +strength [8]	Obtained weighted 22s [9]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Miscellaneous:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Bobdel (Bobshaw 16)	+8	+5	+17	+13	+21	104	+5	109	117
Coker 200-4	+2	−5	−7	−3	−4	98	−5	93	91
Coker 4 in 1-5	+3	−5	+1	−2	+5	99	−5	94	100
Hibred	−21	−1	+9	−22	−14	76	−1	75	83
Lonestar and Lankart	−2	+7	+4	+5	+2	94	+7	101	98
Mebane 140 and 141	−10	0	−6	−10	−16	86	0	86	83
Oklahoma Triumph 1128	−6	−4	−4	−10	−10	90	−4	86	87
Station 21-24	−4	+4	−5	0	−9	92	+4	96	88
ENVIRONMENTAL EFFECTS									
Irrigated area:									
Shafter, Calif	+4	−5	−6	−1	−2	100	−5	95	96
Sacaton, Ariz	−2	+1	−6	−1	−8	94	+1	95	88
State College, N. Mex	+4	−14	−15	−10	−9	100	−14	86	86
Weslaco, Tex	+6	−1	0	+5	+6	102	−1	101	102
Texas-Oklahoma area:									
Lubbock, Tex	+2	−1	−2	+1	−1	98	−1	97	96
Chillicothe, Tex	+1	+4	−2	+5	+2	97	+4	101	99
Chickasha, Okla	−3	+7	+5	+4	+3	93	+7	100	100
College Station, Tex. (upland)	−1	−1	+1	−2	0	95	−1	94	96
College Station, Tex. (bottoms)	+2	+1	−1	+3	+2	98	+1	99	99
Temple, Tex	+1	−4	−3	−3	−2	97	−4	93	94
Greenville, Tex.	−3	+7	+1	+4	−2	93	+7	100	94
Mid-South area:									
Marianna, Ark	−3	+2	+9	−1	+5	93	+2	95	102
Jackson, Tenn	−7	+9	+6	+2	−2	89	+8	97	98
Stoneville, Miss	+1	−1	+6	0	+7	97	−1	96	103
St. Joseph, La	+3	−2	+1	+1	+4	99	−2	97	99
State College, Miss	−1	+5	+1	+4	0	95	+5	100	96
Southeast area:									
Auburn, Ala	+2	−4	−2	−2	+1	98	−4	94	97
Experiment, Ga	0	−4	0	−4	0	96	−4	92	97
Tifton, Ga	−3	+1	−2	−2	−5	93	+1	94	92
Florence, S. C.	−1	−7	−5	−8	−5	95	−7	88	92
Knoxville, Tenn	+6	−4	−6	+2	0	102	−4	98	96
Statesville, N. C.	−2	+1	+2	−1	0	94	+1	95	96

[1] *Means for environmental or varietal deviations as given in table 6 were converted to percent of 0.96 inch,* the average upper half mean length for all varieties and locations.

[2] Means for environmental or varietal deviations as given in table 7 were converted to percent of 81,000 pounds, the average estimated tensile strength for all varieties and locations.

[3] Deviations for equivalent staple length minus the upper half mean length were obtained by subtracting the upper half mean length from the equivalent staple, tabulating the ±differences, and estimating deviations for environmental or varietal effects in the manner shown in tables 4 and 5.

[4] *Means for environmental or varietal deviations as given in column 2 plus those given in column 3.*

[5] Means for environmental or varietal deviations for weighted 22s as given in tables 4 and 5 were converted to percent of 96 pounds, the average skein strength for all varieties and locations.

[6] On the basis of these data skein strength imputed to fiber length would be: 0.96 inch for average upper half mean fiber length = 96 pounds for average skein strength for weighted 22s or increments of 0.01 inch for *fiber length = increments of 1 pound for skein strength; or upper half mean length × 100 = expected skein* strength if the fiber is of average strength.

[7] On the basis of these data: 81,000 pounds for average estimated tensile strength = 96 pounds for average skein strength for weighted 22s or increments of 1,000 pounds for fiber tensile strength = increments of 1.185 pounds for skein strength.

[8] The values in column 7 plus those in column 8.

[9] As shown in table 5.

In view of the good agreement of columns 3 and 4 and of 5 and 6, the writers were tempted to make approximate predictions for skein strength of weighted 22s on the basis of simple, straight-line fiber-length and strength values.

Column 7 gives the predicted skein strength of weighted 22s that would be expected on the basis of adjusted values for fiber length for each of the 34 varieties that were grown at more than one location and for each variety at different locations. The prediction was based on the assumption that since an average upper half mean length of 0.96 inch gave an average weighted 22s skein strength of 96 pounds, length increments of 0.01 inch would equal weighted 22s skein strength increments of 1 pound; or multiplying adjusted fiber length for each variety by 100 gives the skein strength that would be expected on the basis of fiber length of average strength.

In column 8 the deviations, plus or minus, that were used to correct the predicted skein strength of weighted 22s for each variety and location are shown. These strength predictions again were on the assumption that, since an average estimated fiber tensile strength of 81,000 pounds produced skein strength of weighted 22s of 96 pounds, increments of 1,000 pounds, estimated fiber tensile strength, should result in increments of 1.185 pounds skein strength of weighted 22s.

Column 9 summarizes the predicted strength that would be attributable to fiber strength and length. In column 10 the observed weighted 22s adjusted for location or for variety may be compared with the predicted values in column 9.

Fiber-Length Estimates

In the discussion of the relation of fiber length to skein strength given in table 8, it was shown that the upper half mean of the Fibrograph furnishes a valuable approximate basis for predicting skein strength of weighted 22s. Consequently it seemed desirable to summarize in table 9 the percentage of deviations for length measurements based on the upper half mean, the mean length, fiber-length uniformity (ratio of upper half mean to mean length), and classer's staple minus upper half mean.

In comparing columns 2 and 3 for varietal estimates of length deviation from the mean of all 34 varieties, it appears that in general there is reasonably good agreement between upper half mean and mean length and it does not appear from these data that predictions based on mean length would give any better or appreciably different results.

These data indicate little apparent relationship between uniformity and skein strength. For what interest or significance it may have, the mean of all varieties for classer's staple exceeded the upper half mean by 0.02 inch, as did the equivalent staple. In general, the varietal deviations (classer's staple minus upper half mean) were small but rather consistently minus for the Acala, Delfos, and Deltapine types and plus for the Rowden and Stoneville types. This apparent over or under stapling also tends to agree with yarn-appearance grade. For environmental effects, the actual deviations from the mean difference (+0.02 inch) were usually 0 or ±1.

TABLE 9.—*Summary of fiber measurements (length, strength, and fineness) picker and card waste, neps in card web, and yarn-appearance grade, shown as the percentage of deviation from the means of all varieties and locations*

VARIETAL EFFECTS

Varietal types and strains and location	Fiber length measurements				Fiber-strength indexes			Fiber fineness and cell-wall development			Waste, neps, and yarn appearance		
	Upper half mean (Fibrograph)[1]	Mean (Fibrograph)[2]	Uniformity ratio[3]	Classer's staple ÷ upper half mean[4]	X-ray angle[5]	Estimated tensile strength[6]	Equivalent staple—upper half mean[7]	Weight per inch[8]	Surface area[9]	Thick-walled fibers[10]	Picker and card waste[11]	Neps in card web[12]	Yarn-appearance grade[13]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Acala type:													
Acala 1517	+9	+11	+1	−2	+12	+17	+17	+17	+11	−4	+3	+57	−10
Acala 1517 W29-1	+10	+17	+5	−3	+12	+18	+22	+22	+5	0	−11	+100	−9
Acala P18	+4	+7	+3	−2	−22	−10	−8	+4	0	+4	−6	+10	−7
Coker 100 type:													
Coker 100-6	+1	−3	−4	+1	−3	−2	−5	+11	+10	−7	−6	+52	−24
Coker 100-7	0	−4	−4	0	−3	−1	0	+13	+12	−5	+6	+43	−9
Coker 100 Wilt type:													
Coker 100 Wilt 2	−2	+1	+4	+1	−6	−6	+1	−4	−3	+1	0	−14	+6
Coker 100 Wilt 3	−1	0	+1	+1	−3	−2	+2	0	+4	−1	−3	0	+3
Delfos type:													
Delfos 531C	+4	−1	−5	−2	−6	−1	0	+15	+12	−4	+11	+24	−20
Delfos 651	+3	+1	−1	+1	−6	−2	+5	+11	+9	−1	+6	+76	−20
Deltapine type:													
Deltapine 14	+3	+6	+3	0	−9	−4	−2	0	−4	+3	−4	−10	+1
Deltapine 14 (833)	+1	+1	0	0	−6	−5	0	+2	−2	+1	−3	+10	0
A12 (Arkansas)	0	0	0	−2	0	−1	−2	0	+3	−3	−6	−10	−3
Rowden type:													
Rowden 41A	−3	−1	+1	+2	+3	+5	−7	−20	−18	+3	+11	−52	+8
Rowden 41B	−5	−1	+4	+2	+6	+5	−6	−26	−22	+5	+6	−57	+11
B4 (Arkansas)	−2	0	+3	0	0	+4	+9	−4	−4	+5	−11	−38	+10
Stoneville type:													
Stoneville 2B	0	−1	−1	+1	+3	+1	+2	+4	+2	−3	−4	−5	+3
Stoneville 2B (8275)	+2	0	−3	+2	+6	+1	+4	+11	+8	−3	+3	+10	0
Stoneville 2C	+4	−1	−5	0	+6	0	0	+9	+9	−5	+6	+10	−12
Stoneville 62-1-10	−6	−3	+4	+4	+6	+2	−3	−6	−7	+1	−2	−31	+11
White Gold	+2	+4	+1	0	0	−5	−3	+2	0	−3	−6	0	+8
Empire	−2	−3	−1	+1	+9	0	−2	+2	+5	−6	−3	+5	0
Bobshaw 1	−2	−1	+1	+4	−3	+5	−2	−6	−7	+3	0	−29	+13
E4 (Arkansas)	+2	−3	−4	0	+6	−2	−6	+4	+10	−3	+8	0	−5
Stonewilt type:													
Stonewilt 2	−1	+1	+3	+2	−6	−5	−2	0	−2	−1	−2	−10	+7
Stonewilt 3	+2	0	−3	0	−6	−11	−8	+4	+3	−5	−11	+10	−3
Wannamaker's S and C 4	+4	+6	+1	−1	−6	−5	−6	+4	−3	+4	−14	−10	0
Miscellaneous:													
Bobdel (Bobshaw 10)	+8	+4	−4	−4	−3	+5	+17	+13	+9	−3	+11	+67	−11
Coker 200-4	+2	+3	+1	+4	0	−5	−7	+2	−2	−3	−4	−20	−12
Coker 4 in 1-5	+3	+7	+4	−1	−12	−5	+1	+4	+4	−3	−11	−5	−1
Hibred	−21	−18	+4	+4	0	−1	+6	−28	−14	+4	+17	−62	+23
Lonestar and Lankart	−2	−1	+1	+2	+6	+7	+4	0	+2	−1	−3	+10	−5
Mebane 140 and 141	−10	−7	+4	0	+3	0	−6	−15	−13	+4	+8	−29	+11
Oklahoma Triumph 1128	−6	−4	+3	0	−3	−4	−4	−6	+8	0	+6	−14	+4
Station 21-24	−4	0	+4	+2	+6	+4	−5	−17	−18	+8	−3	−70	+10

ENVIRONMENTAL EFFECTS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Irrigated area:													
Shafter, Calif.	+4	+6	+1	−1	−3	−5	−6	−4	−6	+3	−6	−10	−5
Sacaton, Ariz.	−2	−4	−3	+2	+6	+1	−6	−4	−2	+4	+27	+43	−16
State College, N. Mex.	+4	+3	−1	−1	−12	−14	−15	0	+2	−3	−4	+5	−12
Weslaco, Tex.	+6	+3	−4	+1	−3	−1	0	+4	+6	−5	−12	0	−4

See footnotes at end of table.

TABLE 9.—*Summary of fiber measurements (length, strength, and fineness), picker and card waste, neps in card web, and yarn-appearance grade, shown as the percentage of deviation from the means of all varieties and locations*—Continued

ENVIRONMENTAL EFFECTS—Continued

Varietal types and strains and location	Fiber length measurements				Fiber-strength indexes			Fiber fineness and cell-wall development			Waste, neps, and yarn appearance		
	Upper half mean (Fibrograph)[1]	Mean (Fibrograph)[2]	Uniformity ratio[3]	Classer's staple—upper half mean[4]	X-ray angle[5]	Estimated tensile strength[6]	Equivalent staple—upper half mean[7]	Weight per inch[8]	Surface area[9]	Thick-walled fibers[10]	Picker and card waste[11]	Neps in card web[12]	Yarn-appearance grade[13]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Texas-Oklahoma area:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Lubbock, Tex.	+2	+3	+1	−1	−6	−1	−2	+4	+6	−1	−18	0	−4
Chillicothe, Tex.	+1	+3	+1	0	−3	+4	−2	−4	−8	+5	+2	−14	0
Chickasha, Okla.	−3	−3	0	0	+9	+7	+5	−2	−3	+3	+2	0	+5
College Station, Tex. (upland)	−1	−3	−1	0	0	−1	+1	+15	+20	−9	−2	+33	−3
College Station, Tex. (bottoms)	+2	+4	+1	−2	−3	+1	−1	−2	−3	+3	0	+10	−1
Temple, Tex.	+1	0	−1	−1	−6	−4	−3	+6	−5	−1	−2	−14	−1
Greenville, Tex.	−3	−3	0	+1	+6	+7	+1	−4	−2	+5	−2	−10	+3
Mid-South area:													
Marianna, Ark.	−3	−6	−3	+1	+3	+2	+9	+6	+6	−8	+18	+14	+1
Jackson, Tenn.	−7	−7	0	−1	+9	+9	+6	−11	−12	+5	0	−52	+19
Stoneville, Miss.	+1	0	−1	+2	+3	−1	+6	+4	+6	−3	−6	+10	−4
St. Joseph, La.	+3	0	−3	+2	0	−2	+1	+2	−3	0	+4	0	+1
State College, Miss.	−1	−3	−1	−1	+6	+5	+1	0	−3	0	+9	−19	+5
Southeast area:													
Auburn, Ala.	+2	+4	+1	−2	−3	−4	−2	−2	+1	+1	−8	−5	0
Experiment, Ga.	0	+3	+3	+1	−3	−4	0	−2	+1	+3	−12	−14	+5
Tifton, Ga.	−3	−6	−3	+1	+3	+1	−2	+4	+5	−3	+12	+24	−7
Florence, S. C.	−1	+3	+4	−1	−12	−7	−5	0	+3	−3	−2	+24	−1
Knoxville, Tenn.	+6	+7	0	−6	−6	−4	−6	−2	+2	+1	−3	−5	−3
Statesville, N. C.	−2	0	+3	0	−6	+1	+2	−4	+1	−3	−20	−19	+8

[1] Deviations as percentage of the mean value, 0.96 inch.
[2] Deviations as percentage of the mean value, 0.72 inch.
[3] Deviations as percentage of the mean value, 75 percent.
[4] Deviations as percentage of 0.98 inch −0.96 inch, the averages for classer's staple and upper half mean, respectively.
[5] Deviations as percentage of the mean value, 32.1°; to facilitate comparisons, deviations were multiplied by −1.
[6] Deviations as percentage of the mean value, 81,000 pounds.
[7] Deviations as percentage of 0.98 inch −0.96 inch, the averages for equivalent staple and upper half mean, respectively.
[8] Deviations as percentage of the mean value, 4.6 micrograms per inch.
[9] Deviations as percentage of the mean value, 2.93 square centigrams per milligram of fiber.
[10] Deviations as percentage of the mean value, 73 percent of thick-walled fibers.
[11] Deviations as percentage of the mean value, 6.6 percent of total picker and card waste.
[12] Deviations as percentage of the mean value, 21 neps per 100 square inches of card web.
[13] Deviations as percentage of the mean value, 7.5; grades were assigned numerical values as follows: *A*+=12, *A*=11, *A*−=10, *B*+=9, *B*=8, *B*−=7, *C*+=6, *C*=5, *C*−=4, *D*+=3, *D*=2, *D*−=1.

FIBER-STRENGTH ESTIMATES

Previously published reports have indicated that the X-ray angle may be used as an index of inherent fiber strength. It has been observed that strength degradation by photochemical action or by biological deterioration causes little or no appreciable effect on the X-ray angles. Hence, the X-ray index for fiber strength is of little value in predicting skein strength where the fibers have been subjected to prolonged exposure, to weathering in the field, or to biological decay prior to or after harvest.

On the other hand, fiber-strength index, as determined from Pressley index, may be of little value to the breeder in determining which strain might have been superior in strength if degradation, especially differential degradation, has occurred. Table 9 also summarizes varietal and locational deviations for strength as estimated by the X-ray angle, by the estimated Chandler method,[12] and from spinning tests as the equivalent staple length minus the upper half mean. The latter, as was pointed out in discussing table 8, is here used as an index of fiber strength that is better or poorer than average strength.

FIBER FINENESS AND CELL-WALL DEVELOPMENT

In columns 9 and 10 of table 9 a comparison is given of the percentage of deviations for varietal fineness as measured by weight per inch and as surface area determined by the Arealometer, summarized from the detailed data presented in table 10. In general, a good relationship is seen for the varietal and the locational deviations given in columns 9 and 10. Both measurements for fineness are obviously in good agreement with fiber-wall development given in column 11, as percentage of deviation for mature fibers. In exceptional cases where low weight per inch occurs with average or greater-than-average percentage of thick-walled fibers, deviations for surface-area measurements are lower than for those for weight per inch; or, conversely, where high weight per inch occurs with low maturity, the Arealometer fails to follow weight fineness. Low weight-per-inch and high surface-area values generally, however, characterize varieties or locations that give a low percentage of thick-walled fibers.

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[12] RICHARDSON, H. B., BAILEY, T. L. W., JR., and CONRAD, C. M. METHODS FOR THE MEASUREMENT OF CERTAIN CHARACTER PROPERTIES OF RAW COTTON. U. S. Dept. Agr. Tech. Bul. 545, 77 pp., illus. 1937.

TABLE 10.—*Data on surface area or fiber fineness as determined by the Arealometer, and summary of deviations and adjusted means, by variety and location*

Varietal types and strains	Stations																						Varietal means	
	Shafter, Calif.	Sacaton, Ariz.	State College, N. Mex.	Weslaco, Tex.	Lubbock, Tex.	Chillicothe, Tex.	Chickasha, Okla.	College Station, Tex. (upland)	College Station, Tex. (bottoms)	Temple, Tex.	Greenville, Tex.	Marianna, Ark.	Jackson, Tenn.	Stoneville, Miss.	St. Joseph, La.	State College, Miss.	Auburn, Ala.	Experiment, Ga.	Tifton, Ga.	Florence, S. C.	Knoxville, Tenn.	Statesville, N. C.	Deviations	Adjusted [1]
	Cm.²/mg.	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*	*Cm.²/mg.*
Acala type:																								
Acala 1517	2.94	3.10	2.96		3.12	3.12	3.50		3.22		3.40												+0.31	3.24
Acala 1517 W29-1	3.03	3.04	3.01																				+.15	3.08
Acala P18	2.77	2.88	3.02				2.82				2.82												0	2.93
Coker 100 type:																								
Coker 100-6	2.88	3.00	3.30									3.54	2.80	3.52						3.42	3.44	3.17	+.30	3.23
Coker 100-7				3.30										3.72	3.08	3.16				3.33			+.34	3.27
Coker 100 Wilt type:																								
Coker 100 Wilt 2																		2.73	3.11			2.80	−.10	2.83
Coker 100 Wilt 3														3.14		2.78			3.33	3.22			+.11	3.04
Delfos type:																								
Delfos 531C									3.08			3.50		3.56	3.16	3.13							+.34	3.27
Delfos 651														3.30	3.08	3.20							+.27	3.20
Deltapine type:																								
Deltapine 14	2.66	2.68	3.01											2.80	2.72	2.75							−.13	2.80
Deltapine 14 (833)				3.08		2.53	2.52		2.71	2.70	2.78	3.10	2.38	3.04	2.76	2.74	2.84	2.71	3.11	3.28	2.91	3.11	−.07	2.86
A12 (Arkansas)											2.80	3.34											+.08	3.01
Rowden type:																								
Rowden 41A							2.28	3.21		2.30	2.20	2.48											−.53	2.40
Rowden 41B											2.14	2.53											−.65	2.28
B4 (Arkansas)											2.70	3.04											−.12	2.81
Stoneville type:																								
Stoneville 2B	2.78	2.89	3.11	3.31	3.00	2.68	2.88		2.90	2.88	2.97	3.30	2.63	3.08	2.92	3.05	2.96	2.81	3.09	2.98	3.08	3.02	+.05	2.98
Stoneville 2B (8275)							2.92		2.96					3.49	3.11	3.07							+.22	3.15
Stoneville 2C														3.32	3.14	3.06							+.25	3.18
Stoneville 62-1-10						2.42	2.52	3.49													2.82		−.20	2.73
White Gold																	2.99	2.83					−.01	2.92
Empire							3.08						2.62				3.13	3.02			3.14		+.15	3.08
Bobshaw 1													2.50				2.62						−.21	2.72
E4 (Arkansas)											2.97	3.60		3.38				3.14					+.28	3.21

Stonewilt type:																								
Stonewilt 2																	2.95	2.86	2.91	3.02			-.05	2.88
Stonewilt 3																	3.00	3.00					+.08	3.01
Wannamaker's S and C 4																		2.82		2.89			-.10	2.83
Miscellaneous:																								
Bobdel (Bobshaw 16)														3.33		3.15							+.26	3.19
Coker 200-4				3.14																2.92	2.89		-.05	2.88
Coker 4 in 1-5				3.24											2.92				3.28	3.02			+.11	3.04
Hibred						2.18	2.26											2.75					-.41	2.52
Lonestar and Lankart								3.60		2.82													+.05	2.98
Mebane 140 and 141					2.81	2.14	2.30			2.58													-.39	2.54
Oklahoma Triumph 1128					2.84	2.52	2.50																-.24	2.69
Station 21-24																	2.38		2.56				-.54	2.59
Means for:																								
Station deviations	-.16	-.07	+.06	+.17	+.14	-.24	-.10	+.60	-.10	-.14	-.06	+.17	-.34	+.18	-.10	-.09	+.02	-.04	+.15	+.08	+.07	+.04		
Stations, adjusted [2]	2.77	2.86	2.99	3.10	3.07	2.69	2.83	3.53	2.83	2.79	2.87	3.10	2.59	3.11	2.83	2.84	2.95	2.89	3.08	3.01	3.00	2.97		

[1] 203 cm.²/mg.±deviations of varietal mean.
[2] Adjustment made as shown in table 4.

YARN-APPEARANCE GRADE AND RELATED FIBER AND SPINNING PROPERTIES

It has been shown by Pearson,[13] Cook and Willis,[14] and others that yarn-appearance grade and neppiness is related to fiber maturity and fineness, as well as to fiber length and grade. It has also been apparent in previously published reports that neps per 100 square inches of card web are related to yarn-appearance grade. Table 9 consequently presents a summary of percentages of deviations for fineness as measured by the Arealometer and by weight per inch and maturity for any apparent relationships that these may have with neps in card web, amount of card waste, or yarn-appearance grade. For convenience in calculating deviations for yarn-appearance grade, numerical values were assigned, as indicated in footnote 13 for table 9.

Fair agreement for fineness and maturity and for yarn-appearance grade is readily apparent. There is an apparent relationship between fiber length and yarn-appearance grade, but since the varieties having a short staple were usually above average for weight-per-unit length and percentage of maturity, it is difficult to interpret such trends on the basis of these data. In the various tables it may be noted that, with the exception of fiber-length uniformity, the range of deviations for varieties was approximately twice that observed for environmental effects. While this approximate difference continues to hold for fineness, in table 9 it may be noted that the range of deviations for maturity, for neps per 100 square inches of card web, for picker and card waste, and for yarn-appearance grade is about equal for varietal and environmental effects.

FIBER FINENESS AS RELATED TO SKEIN STRENGTH OF HIGHER COUNTS

In the foregoing discussion it was indicated that fineness, as measured by weight-per-unit length, is related to yarn-appearance grade, neps in card web, and to certain fiber properties shown in table 9. In discussing tables 4 to 8, it was pointed out that fineness apparently had little influence on skein strength of 22s, and that while it somewhat affected converted 22s derived from 36s, it did not appear necessary to take fineness into account for approximate weighted 22s skein-strength predictions. These and other data, however, indicate that the skein strength for 36s singles is somewhat affected by extreme variations in fiber fineness. Fineness very consistently influences skein strength of counts higher than 36s. For this reason counts finer than 36s were excluded from converted or weighted 22s. The effect of fiber fineness, in addition to fiber length plus strength, on skein strength of the higher counts is shown in table 11.

[13] PEARSON, N. L. NEPS IN COTTON YARNS AS RELATED TO VARIETY, LOCATION, AND SEASON OF GROWTH. U. S. Dept. Agr. Tech. Bul. 878, 18 pp., illus. 1944.
[14] See footnote 6, p. 13.

TABLE 11.—*Varietal and environmental effects on skein strength of 60s singles carded yarns*

VARIETAL EFFECTS

Variety or location	Skein strength				
	Predicted from—				Observed [5]
	Fiber length [1]	±deviation for fiber strength [2]	±deviation for fiber weight [3]	Fiber length+strength+weight [4]	
(1)	(2)	(3)	(4)	(5)	(6)
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Acala type:					
Acala 1517	26	+4	+4	34	33
Acala 1517 W29-1	26	+4	+5	35	35
Acala P18	25	−2	+1	24	23
Coker 100 type:					
Coker 100-6	24	−1	+3	26	24
Coker 100-7	24	0	+3	27	20
Coker 100 Wilt type:					
Coker 100 Wilt 2	24	−1	−1	22	23
Coker 100 Wilt 3	24	−1	0	23	25
Delfos type:					
Delfos 531C	25	0	+4	29	27
Delfos 651	25	−1	+3	27	27
Deltapine type:					
Deltapine 14	25	−1	0	24	24
Deltapine 14 (833)	24	−1	0	23	25
A12 (Arkansas)	24	0	0	24	22
Rowden type:					
Rowden 41A	23	+1	−5	19	18
Rowden 41B	23	+1	−6	18	19
B4 (Arkansas)	24	+1	−1	24	26
Stoneville type:					
Stoneville 2B	24	0	+1	25	25
Stoneville 2B (8275)	24	0	+3	27	28
Stoneville 2C	25	0	+2	27	26
Stoneville 62-4-10	22	+1	−2	21	20
White Gold	24	−1	0	23	24
Empire	24	0	0	24	23
Bobshaw 1	24	+1	−2	23	23
E4 (Arkansas)	24	−1	+1	24	23
Stonewilt type:					
Stonewilt 2	24	−1	0	23	23
Stonewilt 3	24	−3	+1	22	20
Wannamaker's S and C 4	25	−1	+1	25	22
Miscellaneous:					
Bobdel (Bobshaw 16)	26	+1	+3	30	31
Coker 200-4	24	−1	0	23	22
Coker 4 in 1-5	25	−1	+1	25	26
Hibred	19	0	−7	12	18
Lonestar and Lankart	24	+2	0	26	25
Mebane 140 and 141	22	0	−4	18	17
Oklahoma Triumph 1128	22	−1	−2	19	19
Station 21-24	23	+1	−4	20	20

ENVIRONMENTAL EFFECTS

Variety or location	(2)	(3)	(4)	(5)	(6)
Irrigated area:					
Shafter, Calif	25	−1	−1	23	23
Sacaton, Ariz.	24	0	−1	23	20
State College, N. Mex	25	−3	0	22	21
Weslaco, Tex	26	0	+1	27	26
Texas-Oklahoma area:					
Lubbock, Tex	24	0	+1	25	24
Chillicothe, Tex	24	+1	−1	24	25
Chickasha, Okla	23	+2	0	25	24
College Station, Tex. (upland)	24	0	+4	28	25
College Station, Tex. (bottoms)	24	0	0	24	24
Temple, Tex	24	−1	+2	25	23
Greenville, Tex	23	+2	−1	24	23

See footnotes at end of table.

TABLE 11.—*Varietal and environmental effects on skein strength of 60s singles carded yarns*—Continued

ENVIRONMENTAL EFFECTS—Continued

Variety or location	Skein strength				
	Predicted from—				Observed [5]
	Fiber length [1]	±deviation for fiber strength [2]	±deviation for fiber weight [3]	Fiber length+strength+weight [4]	
(1)	(2)	(3)	(4)	(5)	(6)
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Mid-South area:					
Marianna, Ark.	23	+1	+2	26	26
Jackson, Tenn	22	+2	−3	21	21
Stoneville, Miss	24	0	+1	25	27
St. Joseph, La	25	−1	0	24	26
State College, Miss	24	+1	0	25	24
Southeast area:					
Auburn, Ala	24	−1	0	23	24
Experiment, Ga	24	−1	0	23	24
Tifton, Ga	23	0	+1	24	22
Florence, S. C	24	−2	0	22	22
Knoxville, Tenn	26	−1	0	25	24
Statesville, N. C	24	0	−1	23	24

[1] Skein strength attributable to upper half mean, on the basis of these data: Upper half mean of 0.96 inch=skein strength of 24 pounds, the average for varieties and locations; or UHM×25=skein strength imputed to fiber length of average strength and fineness.

[2] If 81,000 pounds for estimated fiber tensile strength for average length and fineness=24 pounds for skein strength, increments of 1,000 pounds for fiber strength=increments of 0.296 pound for skein strength.

[3] If fiber fineness, as measured by weight per inch, of 4.6 micrograms=skein strength of 24 pounds, increments of 0.1 microgram=increments of 0.5217 pound for skein strength.

[4] Sum of columns 2, 3, and 4 (or as derived from the formula for predicted skein strength of 60s, p. 9).

[5] The means for observed values for varieties or locations were obtained by estimating ±deviations for locations or varieties in the manner described in tables 4 and 5; where the finest count was coarser than 60s, conversions to 60s were made by the formula cited on p. 9.

In table 11 actual 60s were used where the samples were spun into 60s. Where the highest count was coarser than 60s, the regression formula (see p. 9) was used to convert the highest count to 60s. While it is true that 60s is much too fine to be practicable or possible for many of these lengths, this conversion, as would any other equivalent count, puts the lengths on a theoretically comparable basis. For obvious reasons the weight-per-unit length deviations in micrograms that were greater or less (+ or −) than the mean for the 34 varieties (4.6 μg.) were multiplied by minus 1 to change the signs of the increments recorded in columns 4 and 10.

This, of course, becomes a needless step if, instead of subtracting the mean from the observed value as for length or strength where the relationship to skein strength is direct, the observed weight-per-unit length is subtracted from the mean. For simplicity of table construction, the figures given in table 11 are rounded off to the nearest whole number. This obviously results in a considerable error in dealing with such small values as for 60s skein strength.

These results, in conjunction with unpublished studies of similar results obtained in an analysis of 1,400 spinning tests, indicate that skein strength of singles yarn not finer than 36s can be predicted with considerable accuracy on the basis of fiber length and strength, but that in predicting skein strength of counts finer than 36s, fiber fineness must be taken into consideration. The procedure outlined above for obtaining predicted skein strength may be simplified by condensing the steps into the following formulas:

(*a*) Skein strength of singles carded 22s (or counts not finer than 36s converted to 22s) = 100 (*UHM*) + 0.0012 (TS − 81,000), where *UHM* = upper half mean length of the Fibrograph and *TS* = estimated fiber tensile strength.

(*b*) Skein strength of singles carded 60s = 25 (*UHM*) + 0.0003 (*TS* − 81,000) + 5 (4.6 − *WI*), where *UHM* and *TS* are defined as in formula above and *WI* = fiber weight per inch.

It is appreciated, of course, that the 1943 data alone are inadequate for constructing formulas for accurate skein-strength predictions. In order to test how well the formulas that were derived from the 1943 data would predict varietal performance from data other than that from which the formulas were derived, the fiber and spinning data of the 1944 crop were tested. The results are shown in figure 1.

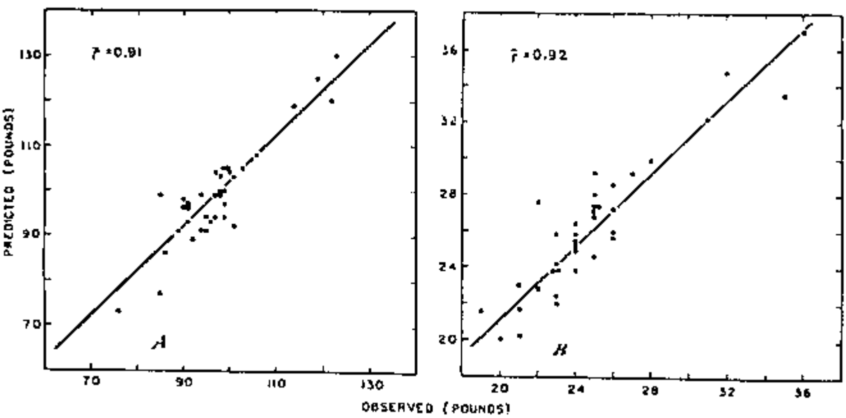

FIGURE 1.—The predicted and observed skein strengths of 37 varieties from the 1944 crop. *A*, The predicted skein strength of 22s yarn plotted against the observed skein strength of 22s, weighted by the converted skein strength of 36s. *B*, The predicted skein strength of 60s yarn plotted against the observed skein strength of 60s, or of the highest count (44s or 50s) converted to 60s. The formulas given on this page for predicting skein strength were derived from the 1943 crop.

The predicted values for the 1944 crop agreed as closely with those observed as did the imputed values from the 1943 data. For the most part, these predictions seem to fall within the limits of the spinning technique, as set forth by Campbell.[15]

CONCLUSIONS

The coefficient of correlation for predicted and observed skein strength for 22s was 0.878 for the 1943 crop, from which the formula was derived, and 0.908 for the 1944. For the predicted and observed 60s, the coefficient of correlation was 0.922 for the 1943 crop and 0.924 for the 1944. Consequently, it is suggested that for those who are concerned with the cotton improvement program the following tentative conclusions may be of value:

[15] CAMPBELL, M. E. THE POSSIBILITIES AND LIMITATIONS OF THE SPINNING TEST AS A MEANS OF DETERMINING COTTON QUALITY. Textile Res. 8: 263–269. 1938.

Singles yarn strength of coarse to medium counts may be increased by increasing fiber length or strength. If short fiber is processed more easily than long, the spinner may eventually pay a greater premium for fiber strength than for length.

Fiber fineness or low weight-per-unit length may be an undesirable fiber property where carded yarn appearance grade is highly important, especially in lengths that are usually consumed in carded singles yarns of coarse to medium counts.

For cotton that is likely to be spun into counts finer than 36s, fineness is a very desirable fiber property that in value approximately equals fiber length and strength.

Until a more reliable basis for prediction is established from a much larger and more representative sample than was available from the 1943 tests, the cotton breeder may find the following formulas useful in establishing relative spinning performance from fiber data:

(a) Skein strength of singles carded 22s (or counts not finer than 36s converted to 22s) = 100 (UHM) + 0.0012 (TS − 81,000), where UHM = upper half mean length of the Fibrograph and TS = estimated fiber tensile strength.

(b) Skein strength of singles carded 60s = 25 (UHM) + 0.0003 (TS − 81,000) + 5 (4.6 − WI), where UHM and TS are defined as in formula above and WI = fiber weight per inch.

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