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Relationship of Yield, Seed Quality, and Fiber Properties in Upland Cotton[1]

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ABSTRACT

Seed and fiber samples of four Upland cotton (*Gossypium hirsutum* L.) cultivars, grown at 17 locations in the 1973 Regional Cotton Variety Test, were examined for yield, seed quality, and fiber quality. Correlation coefficients were calculated among eight agronomic and quality parameters.

No significant correlations were found between yield and oil content or yield and protein content. Three of the cultivars showed positive correlations between oil content and fiber maturity and negative correlations between oil content and percent immature seed. The strongest correlation for protein was a negative relationship with fiber maturity. 'Lockett 4789A' gave a high positive correlation between oil content and seed index. 'Acala 1517-70' showed a strong negative relationship between protein and fiber maturity. Both of these cultivars showed positive correlations between yield and fiber strength.

The feasibility of using Micronaire readings (fiber maturity) as indicators of oil content for cottonseed in the various production zones are discussed.

Additional index words: Production zones, Immature seeds, Oil content, Protein content, Fiber strength, Fiber maturity, Mean length, *Gossypium hirsutum* L.

THERE is mounting interest in cottonseed (*Gossypium hirsutum* L.) quality due to the world's demand for food, especially protein. This interest should stimulate needed research on several aspects of cottonseed quality. It is appropriate that possibilities for improvement of protein and oil in cottonseed be identified. Because the major revenue from the cotton crop is derived from fiber, it is imperative that any improvement in seed yield and quality must not exert adverse effects on fiber yield and quality.

Studies relating to cottonseed quality were reported by various investigators during the first half of this century (2, 5, 6, 7, 9). These reports, however, dealt with cultivars and cultural practices that are now obsolete. Furthermore, the test samples did not represent some important areas of production. In general, these

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Table 1. Correlation of traits for four cotton cultivars.

Traits	Cultivar† Coker 310	Deltapine 16	Lockett 4789A	Acala 1517-70
Yield vs.				
Oil, %	0.09	-0.01	-0.17	0.04
Protein, %	-0.15	-0.22	-0.04	-0.17
Mean length	0.23	-0.02	0.23	0.38
Fiber strength	0.34	0.29	0.57*	0.54*
Micronaire	0.36	0.35	0.01	0.25
Seed index	-0.13	-0.09	-0.32	-0.34
Immature seed, %	-0.23	-0.13	0.02	0.16
Oil vs.				
Protein	-0.55*	-0.50*	-0.45	-0.31
Mean length	0.09	-0.01	0.35	0.27
Fiber strength	-0.06	-0.01	-0.01	-0.20
Micronaire	0.70**	0.50*	0.61**	0.37
Seed index	0.40	0.37	0.74**	-0.26
Immature seed, %	-0.49*	-0.50*	-0.67**	-0.02
Protein vs.				
Mean length	0.09	0.01	-0.26	-0.24
Fiber strength	0.17	0.02	-0.19	0.04
Micronaire	-0.42	-0.32	-0.43	-0.59**
Seed index	-0.01	-0.07	-0.27	-0.01
Immature seed, %	0.07	0.25	0.19	0.16

*,** Significant at 5 and 1% levels, respectively.
† Degrees of freedom for cultivars = 15.

workers reported that climate and cultural systems had a greater influence on oil and protein content than did the cultivars. Small cultivar differences were, however, detected. Ware (9) presented fiber data, but due to variable sampling procedures, made no attempt to relate fiber and seed data. Usually a reduction in protein occurred when either cultivar or environment increased the oil content.

Kohel (3) recently reported that the oil content in cottonseed from a wide range of germplasm ranged from 14 to 32%. No data were obtained on protein in his study. We (8) have shown that four currently grown cultivars differed in protein content and maintained their rank across 17 environments.

Breeders and agronomists need to know what relationships exist among seed quality parameters, yield, and fiber properties within currently grown cultivars across varied environments. The purpose of this paper is to report detected relationships that might aid the improvement of seed and fiber quality and cotton production.

MATERIALS AND METHODS

Fiber samples are received annually at the Cotton Quality Laboratories, Knoxville, Tenn., from two field replications of each entry in the Regional Cotton Variety Tests. In 1973, 17 test locations (8) supplied seed samples in quantities to permit chemical analyses. The seed cotton yields for each plot were supplied also by these cooperators. The four cultivars that served as national standards, 'Coker 310,' 'Deltapine 16,' 'Lockett 4789A,' and 'Acala 1517-70,' were chosen for this study.

Each of the 136 seed samples was subsampled. A subsample of 200 randomly chosen seeds from each sample was used for seed size and seed maturity determinations. The larger subsample (1,000 g) was used for analytical determinations of oil and protein content. Methods Aa 4-38 and Ba 4-38 of the American Oil Chemists Society (1) were followed by a licensed chemist to determine oil and protein content. Seed index (wt/100 seeds) was determined on acid-delinted seed. After each small subsample was delinted, the number of seeds that floated in the water bath was counted and expressed as a percentage. Floating seeds were classed as immature.

The standard fiber determinations were made on the 136 fiber samples. Mean length of fiber was measured on the Servo-Fibrograph[3] from the drawing sliver and reported as the average length of all fibers longer than 6 mm. Fiber strength (T_1) was measured on the Stelometer[3] with the jaws holding the fiber bundle separated by a 3 mm (1/8-inch) spacer, expressed in millinewtons per tex. Fiber maturity, as measured by the Micronaire[3] instrument is expressed in standard units. The higher the reading, the more mature the fiber.

Correlation coefficients were computed among eight parameters: 1 — seed cotton yield; 2 — oil content; 3 — protein content; 4 — seed index; 5 — immature seed; 6 — mean fiber length; 7 — fiber strength and 8 — maturity.

RESULTS AND DISCUSSION

Correlation coefficients for yield, oil, and protein percentages with each other and with major fiber and seed properties are presented in Table 1. The coefficients depict environmental influence on the relationship for the specific cultivar.

Yield

Seed cotton weights were used as the measure of yield because both seed and fiber are under consideration. The nonsignificant correlations between yield and both oil and protein are noteworthy. We have previously reported (8) a strong environmental influence upon oil and protein content from this set of seed samples. It is most encouraging to find that the high yielding environments were not associated with reduced oil or protein. Therefore, potential cultural and/or genetic advances in seed quality should command further investigations.

The positive correlations of yield with fiber strength (T_1) for two cultivars were unexpected. Breeders have found it difficult to transfer high fiber strength into productive genotype. Here, however, the positive relationships may be indicative that Acala 1517-70 (the strongest-fibered cultivar of the four) and Lockett 4789A (the weakest of the cultivars) were more sensitive to environmental influences than were the other cultivars. Only in narrow ecological regions do these two cultivars produce satisfactory yields, and these correlations merely reflect the environmental loss in strength obtained from test locations where they produce low yields.

Oil

The negative correlations found between oil and protein percentages were not surprising. Ware (9) pointed out the negative association of these seed parameters among cottonseed samples gathered from widely different environments. In this study, however, only two of the four cultivars show significant negative correlations. If breeders could check early stage breeding lines for oil and protein they well might discover genotypes with both oil and protein at higher levels than current cultivars.

Fiber maturity (Micronaire reading) is positively associated with oil content. The simultaneous stage in which critical developments occur in fiber and seed is probably responsible for this relationship. Fiber length, which is not related to oil development, is determined during the early part of boll development,

[3] Mention of a company or product name is for information only and does not imply its endorsement by the USDA over others not mentioned.

but fiber maturity continues till the final stages of boll development. Evidently, maximum oil storage occurs when environmental conditions are favorable for late stage boll development. Therefore, the possible use of the Micronaire readings (which are obtained rapidly after ginning) for detecting production regions of low or high oil content seed should receive further study. This may be applicable especially for such cultivars as Coker 310 and Deltapine 16 that are grown in several production zones. We previously reported (8) the influence of environment upon oil content and the interaction of cultivars over environment that supports this concept.

A greater sensitivity to environmental conditions is implied between oil content and seed size for the Lockett 4789A than for Acala 1517-70. Since Lockett was developed for production in the short growing seasons of the Texas High Plains, it is distinctly the most determinate of these cultivars. When such cultivars are grown outside the region of adaptation, greater variability is shown for seed size.

The negative relationships detected between oil content and immature seed were not unexpected. Only Acala 1517-70 failed to show the percentage of immature seed decreasing when oil content increased. The genotype attributes of Acala 1517-70 may account for this response. Acala cultivars have been developed specifically for the irrigated regions of the western states. With long growing seasons, arid climate, and relatively low insect populations, Acala cultivars are indeterminate in growth and possess a deep tap root system (4) that sustains growth and fruiting with minimum irrigation. This cultivar did not fluctuate in seed maturity across environments nearly as much as the other cultivars.

Protein

In general, the correlation coefficients between protein and other seed and fiber parameters were of a lower magnitude than those with oil. Breeders might find these relationships advantageous in developing genotypes with increased protein content in that this valuable component does not display wide fluctuation across environments.

The only significant correlation values obtained for protein were with Micronaire reading, and with this relationship, three of the cultivars gave nonsignificant values.

Further study of seed-fiber relationships is needed if progress is to be made in improving cottonseed quality. Although the data used for this correlation study were obtained from a single crop season, the four cultivars and 17 test locations represent wide diversity. Three points seem worthy of further consideration: 1) The more desirable seed quality traits were independent of yield, which is a primary consideration for cotton researchers; 2) Significant correlations were detected more frequently for oil content with other seed and fiber parameters than for protein content; and, 3) Micronaire readings may be useful to both industry and research personnel in screening for "production zones" with higher levels of oil content.

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