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Comparison of Cotton Germplasm Collections for Seed-Protein Content[1]

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ABSTRACT

Gossypium hirsutum **L. germplasm from the cultivated and center-of-origin collections were evaluated for seed-protein content (N × 6.25) to provide information for potential selection and genetic modification of cottonseed quality. Whole, acid-delinted, dried cottonseed were digested for nitrogen determinations by automated microkjeldahl procedures. These data were combined with previous evaluations of physical characteristics and seed-oil content, and this information provided the basis to compare collections of cultivated Upland germplasm with exotic center-of-origin germplasm. Differences in seed constituents between collections and the size of correlations between seed constituents suggests that the potential exists to modify cottonseed quality.**

Additional index words: **Germplasm evaluation, Cottonseed, Seed N.**

COTTONSEED quality and use are determined primarily on the levels of oil, protein, and gossypol. Kohel (1978) reviewed research on the improvement of cottonseed quality and presented the results of a survey of *Gossypium hirsutum* L. germplasm collections for seed-oil percentage and seed characteristics. Seeds from the same samples on which seed-oil contents were determined were analyzed for protein content (N × 6.25). This paper reports results of the

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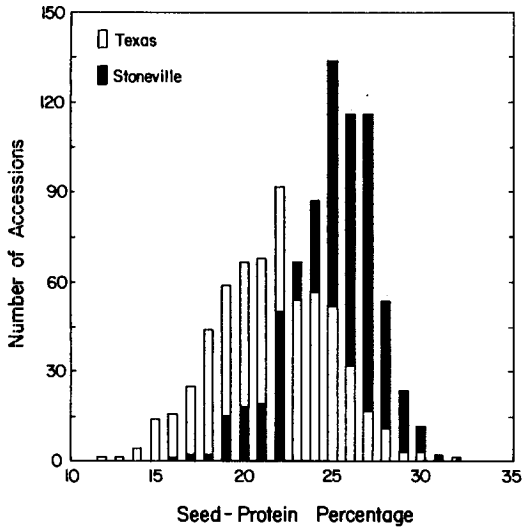

Fig. 1. Distribution of seed-protein percentage in the Texas and Stoneville Collections.

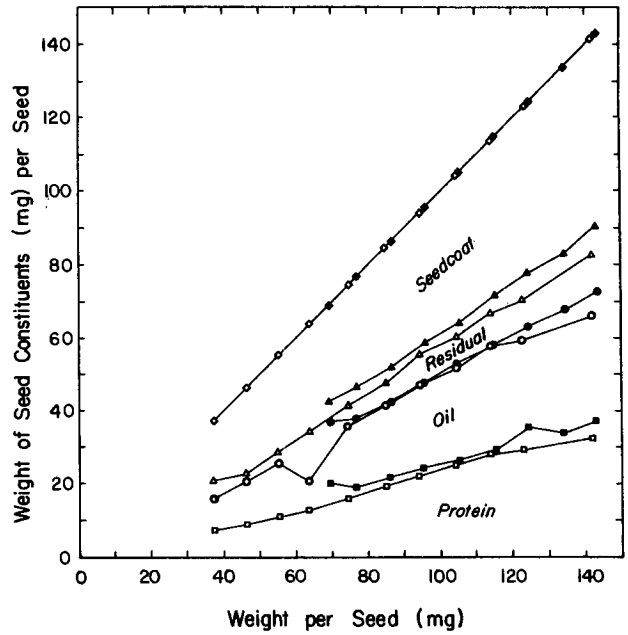

Fig. 2. Weight of seed constituents for each seed-index class in the Texas (open symbols) and Stoneville (closed symbols) Collections.

protein analysis and the combined analyses of the physical and compositional characteristics of cottonseed in these germplasm collections.

MATERIALS AND METHODS

Two groups of cottonseed, the Stoneville and Texas Collections, were evaluated. The Stoneville Collection, maintained by R.R. Bridge at the Delta Branch Experiment Station, Stoneville, MS, contains an assortment of Upland cotton cultivars, breeding lines, and genetic stocks. The 747 accessions tested from this collection represent cultivated Upland cotton, principally from the U.S. Cotton Belt. The second group of seeds was from the Texas Collection, maintained by A.E. Percival at the Cotton and Grain Crops Genetics Laboratory, College Station, TX, which constitutes center-of-origin germplasm from which the modern Upland cultivars were developed. There were 626 accessions from a single increase season tested from this collection.

Oil analysis by wide-line nuclear magnetic resonance (Kohel, 1978) used a 10 g sample of seed that was acid-delinted to remove all seed fibers and dried with forced air at 38°C for 48 h. A subsample was taken for N determination after the oil analysis. Nitrogen determinations by automated microkjeldahl procedures (Anon., 1976) were made on whole seed. Use of whole seed reduced frothing during digestion and eliminated further sample preparation, as well as reducing the amount of seed needed for analysis.

The nitrogen determinations were multiplied by 6.25 to provide the standard expression of protein. Protein content was expressed as a percentage of total seed weight (seed-protein percentage), percentage of embryo weight (embryo-protein percentage), and weight (mg) per seed (seed-protein index). Protein content data were analyzed in combination with previously determined values of seed oil and seed weight; seed-oil percentage, embryo-oil percentage, seed-oil index, seed index, and embryo index (Kohel, 1978).

RESULTS AND DISCUSSION

For the sake of brevity protein determination of the 1373 individual entries are not presented. These values will be included in the revision of the *Gossypium* Germplasm Catalog (Anon., 1974). We will present only a summary of the data and interrelations of the various factors measured.

Distributions of seed-protein percentages in the two collections (Fig. 1) were similar to those for seed-oil percentage (Kohel, 1978). The Texas Collection contained a wider range of values (12 to 32%) than the Stoneville Collection (16 to 32%) and the mean seed-protein percentage was lower in the Texas Collection (22%) than that of the Stoneville Collection (24%).

The combined data provide a graphic representation of the cottonseed components. Entries from each collection were grouped by seed size. Classes of seed index 30.1 to 40.0, 40.1 to 50.0, etc., were arranged and the mean component values were calculated. In Fig. 2 the mean weights (mg per seed) of protein, oil, and seed coat are plotted for the mean of each seed-index class. The Texas Collection contains smaller seed than the Stoneville Collection in its lower range, but the upper limits of seed size are similar in both collections. A trend exists for similar amounts of oil plus protein in the two collections, but the Texas Collection has consistently more oil and less protein than the Stoneville Collection. In addition, the Texas Collection has consistently more seed coat and less residual material (sugar, crude fiber, minerals, etc.) in the embryo portion.

The relative patterns of constituents with respect to seed-index classes are similar (Fig. 3). This similarity suggests a relatively stable relationship between seed components and seed size in *G. hirsutum*, although the two collections differ by a larger relative embryo size in the Stoneville Collection. This increased embryo size may reflect selection for large embryos that are capable of rapid germination and growth for annual crop production, coupled with selection against the hard-seededness of the more primitive germplasm that ensured survival in the wild. The larger amounts of protein are probably associated with overall embryo size.

Table 1. Correlation values between seed characteristics in the Stoneville (upper value) and Texas (lower value) Collections of *G. hirsutum*.†

Characteristic	Embryo index	Seed-oil index	Seed-protein index	Embryo %	Seed-oil %	Seed-protein %	Embryo-oil %	Embryo-protein
Seed index	0.96 0.98	0.92 0.96	0.83 0.92	0.19 0.53	0.20 NS	NS 0.45	NS −0.35	NS NS
Embryo index		0.90 0.95	0.84 0.90	0.45 0.70	0.24 0.21	NS 0.44	NS −0.44	NS NS
Seed oil index			0.68 0.85	0.24 0.60	0.57 0.42	NS 0.36	0.38 −0.18	−0.20 NS
Seed protein index				0.29 0.50	NS NS	0.60 0.75	−0.20 −0.42	0.47 0.46
Embryo %					0.21 0.39	0.27 0.28	−0.41 −0.57	−0.20 −0.30
Seed-oil %						−0.35 −0.17	0.81 0.52	−0.45 −0.38
Seed-protein %							−0.48 −0.38	0.89 0.83
Embryo-oil %								−0.30 NS

† NS = nonsignificant at the P = 0.05 for 718 and 619 d.f., respectively.

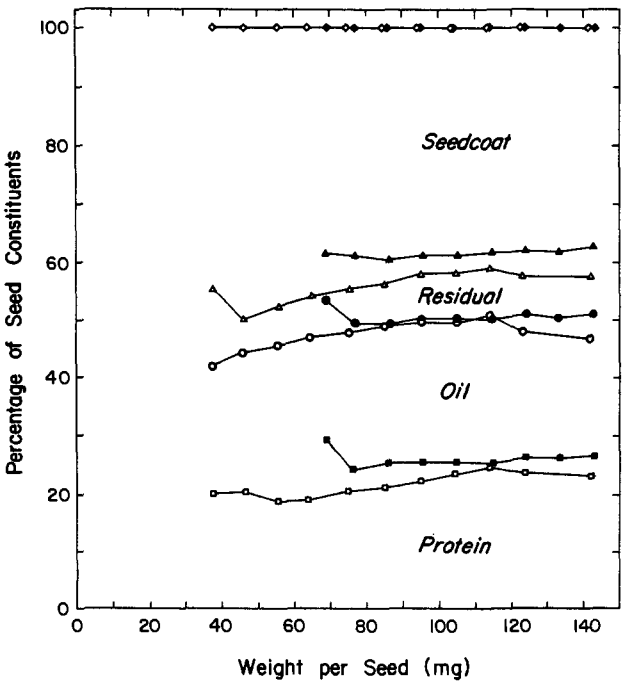

Fig. 3. Percentage of seed constituents for each seed-index class in the Texas (open symbols) and Stoneville (closed symbols) Collections.

A seed quality program ideally would want to increase both protein and oil. To increase oil and protein within a given seed size would require the increase to take place at the expense of the constituents that make up the residual portion of the embryo, or by a reduction of seed coat. For example, research has shown that elimination of gossypol results in an associated increase in oil (Kohel, 1980). The data show that the cultivated Uplands represent a decrease in seed coat content relative to their primitive ancestors. Few data exist on the range of relative seed-coat content in cultivated cotton.

In cultivated cotton the seed coat is required not only as a protective cover during development of the embryo, but it must also retain its integrity during the removal of the seed fibers during the ginning and delinting operations. Certain strains of cotton were noted to have seed coats that broke during ginning, producing fragments that were removed with the fibers, and presented problems with fiber processing. These strains were termed thin seed-coat lines, and they were removed from production. While the exact nature of the seed coat problem was not determined, it illustrates that the seed coat must be considered before major changes can be contemplated.

The constituents that would fall into the residual category represent about 10% of the seed weight in the Stoneville Collection and about 7% in the Texas Collection. Since both groups of germplasm contain vigorous and viable seeds, from these data we can conclude that a portion of the residual is composed of nonessential constituents.

We interpret the above to indicate an opportunity to change the constituents of cottonseed is possible. The use of means by seed-index class tells us little about the variability and relationships that exist within the germplasm. The matrix of simple phenotypic correlations between the characteristics measured are presented in Table 1. As suggested by Fig. 2, the weights of the various components are highly and positively correlated in both collections, however the correlation values are consistently larger for the Texas Collection. The correlations between the percentages of the various components are not as large as those for the weights. The relations between percentage of protein and oil are significantly negative except for a nonsignificant correlation between embryo-oil and embryo-protein percentages. The size of the correlations do show that variation exists among the various components. This variation suggests selection could be practiced to change the various components. Kohel (1980) has shown that seed-oil content responds to selection.

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