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Influence of Environment on Seed Quality of Four Cotton Cultivars[1]

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ABSTRACT

Oil content, protein content, seed index, and percent immature seed were determined on 136 cottonseed samples (*Gossypium hirsutum* L.) from the 1973 National Cotton Variety Tests. Samples of four cultivars from two replications at 17 locations were used to study seed quality parameters. Environment influenced the level of oil and seed maturity far more than did the cultivars. A differential response of cultivars across the 17 environments for oil content and seed maturity was explained on the basis of genotypic differences in growth and fruiting patterns and their response to diverse climates. Cultivars had as much influence on protein content as environmental conditions but no interaction was detected. The results indicate that breeders might find it more feasible to screen for protein content than oil content, unless greater diversity for oil content can be found in cotton germplasm.

Additional index words: Immature seeds, Quality parameters, *Gossypium hirsutum* L.

THE quality of cottonseed (*Gossypium hirsutum* L.) as a commercial commodity has received meager attention from production researchers in recent years. Traditionally seed has returned to growers such a low revenue in relation to that obtained from fiber that it commanded only minor consideration. This situation is changing rapidly because of the increasing need for food products. Commodities that can furnish human food, especially protein, have captured worldwide attention.

The value of cottonseed is determined largely by oil and protein content. Investigators (3, 4, 5, 6, 7) who reported cottonseed analyses before 1950 were in general agreement that oil and protein content were influenced by both environment and cultivar. Although the environmental influences were greater, the cultivars differed and maintainel their rank across environments to a large degree. The range of cultivar values obtained by these workers indicated that progress in improving cottonseed quality could be made by breeders but a review of the annual summaries (1) on cottonseed quality indicates that neither oil nor protein content has been increased for the US cottonseed crops from 1950 through 1973.

The purpose of this study was to examine seed of four commercial cultivars currently in production and to ascertain the influence of environment upon cottonseed quality parameters.

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MATERIALS AND METHODS

Seed samples were obtained from 17 locations of the National Cotton Variety Testing Program in 1973. Two replications were obtained for each of the four national standard cultivars: 'Coker 310,' 'Deltapine 16,' 'Lockett 4789A,' and 'Acala 1517-70.' This gave 136 samples of seed, which were subsampled at Knoxville. Subsamples (200 random seeds) were used in the Knoxville Laboratory to determine seed index (wt of 100 seeds, g), and the percentage of immature seeds. Sulphuric acid was used to remove the fiber. After drying, the delinted seed were weighed to determine seed index. While the delinted seed were in a water bath, the floating seed were counted and classed as "immature." The larger subsample of seed (1 kg) was used for analytical determinations of oil and protein content. Methods Aa 4-38 for oil determinations and Ba 4-38 (2) for nitrogen determinations, of the American Oil Chemists Society, were followed by a licensed chemist.

An analysis of variance was calculated for data on four parameters: percent oil, percent protein, seed index, and percent immature seed.

RESULTS AND DISCUSSION

Mean values of four seed parameters are presented by locations in Table 1. Oil content ranged from 17.4 to 22.5% across the 17 locations, while protein content ranged from 18.8 to 22.9%. The locations that gave the highest protein content usually show a reduction in oil content. Seed indices ranged from 8.6 to 10.7, with no apparent relationship to the level of oil and protein. An extremely wide range (11.3 to 56.5%) is shown for the percentage of immature seed. Climate, culture, and genotype have a pronounced influence on seed development.

Table 2 presents cultivar mean values for the four seed quality parameters. The differences were smaller than expected for these cultivars, which represent a wide diversity of genetic types.

The analyses of variance (Table 3) clearly show that environmental influences associated with locations contributed far more than cultivars to the variability in oil content and percentage of immature seeds. However the significant location × cultivar interactions indicates that all cultivars do not respond the same across environments. This differential response could be due to fruiting patterns that characterize these cultivars. Acala 1517-70 is more indeterminate in growth and fruits over a longer period if environmental conditions are favorable. Lockett 4789A, the most determinate genotype of the four, was bred for an ecological region that requires early fruiting; these two cultivars are commonly grown in narrow ecological regions and their response to environmental changes across the Cotton Belt would not be expected to coincide with that of the widely adapted Coker 310 and Deltapine 16 cultivars.

Protein content of the seed was influenced equally by cultivars and locations, as shown by the mean squares in Table 3. The interaction was extremely small relative to that of cultivars, suggesting that cultivars maintain their rank for protein content across environments. It was gratifying to find that differences of such small magnitude between the cultivar means could be detected. Even more encouraging, from a breeder's viewpoint, was the nonsignificant cultivar × environment interaction, which indicates that selection at one location might be effective for a broad range of environments. If protein determinations can be made from early stage breeding lines it would save time and minimize the cost of testing numerous genotypes over several environments.

These results were based on data obtained from a single crop season on only four cultivars. The 17 locations do, however, cover a wide range of climatic and cultural conditions encountered from North Carolina to California and the cultivars tested are a fair representation of the genetic diversity available in commercial cultivars. Additional data are needed before drawing final conclusions but it appears that progress could be made through breeding for higher protein content in cottonseed. Current demand for protein certainly warrants a thorough evaluation of a wide range of genetic stocks within Upland cotton. Once identified, genotypes possessing higher levels of protein will be utilized by breeders if the economic incentive is present.

Table 1. Mean values of four seed quality traits from 17 locations in 1973.

Location	Oil	Protein	Seed index	Immature seed
	%		g	%
Phoenix, Ariz.	19.6	21.2	9.95	18.3
Safford, Ariz.	20.6	20.3	9.62	11.3
El Paso, Texas	20.8	20.9	10.70	24.0
Altus, Okla.	19.1	21.3	10.05	48.6
Bossier City, La.	20.5	21.5	9.84	21.1
St. Joseph, La.	21.7	18.8	9.55	28.4
Clarksdale, Ark.	17.4	22.7	8.61	56.5
Jackson, Tenn.	18.4	22.9	9.65	21.8
Rocky Mount, N.C.	19.9	20.8	9.01	21.3
Chickasha, Okla.	22.5	20.2	10.47	17.9
Maranna, Ariz.	18.1	20.4	9.77	30.1
Portageville, Mo.	19.6	21.5	10.54	35.1
Tulare, Calif.	18.9	21.7	9.74	29.5
Chowchilla, Calif.	18.7	21.4	10.01	34.4
Las Cruces, N. M.	18.9	21.6	10.11	22.1
Rohwer, Ark.	19.3	21.3	9.89	31.5
Arvin, Calif.	19.1	22.4	10.19	17.4

Table 2. Mean values of four seed quality traits for four cultivars.

Cultivars	Oil	Protein	Seed index	Immature seed
	%		g	%
Coker 310	19.5 a*	21.8 a	9.2 c	26.8 b
Deltapine 16	19.5 a	20.8 b	9.3 c	31.3 a
Lockett 4789A	19.6 a	21.5 a	10.2 b	29.7 ab
Acala 1517-70	19.8 a	20.8 b	10.8 a	21.9 c

* Means having the same letter are not different at the 0.05 protection level according to Duncan's multiple range test.

Table 3. Mean squares for four seed quality parameters.

Source	df	Oil	Protein	Seed index	Immature seed
Locations (L)	16	13.6**	0.30**	2.17**	1,143**
Cultivars (C)	3	0.9	0.34**	19.78**	537**
L × C	48	1.0**	0.03	0.69**	110*
Reps in loc.	17	0.2	0.02	0.04	78
Pooled error	51	0.2	0.02	0.13	46

*,** Significant at the 0.05 and 0.01 level of probability, respectively.

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