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Effect of the Nectariless Trait on Cottonseed Protein and Amino Acid Composition[1]

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ABSTRACT

Nectariless cottons (*Gossypium hirsutum* L.) are potentially useful agronomic strains of cotton. This experiment was conducted to compare the percent N of seed from nectariless cottons with that of seed from their nectaried recurrent parents. Two nectariless lines ('DES DK ne' and 'DES SL ne') compared in 1969 and 1970 had higher seed percent N than their normal counterparts and one ('DES 7A ne') did not. In another experiment where eight BC_5F_4 nectariless lines were compared with their nectaried recurrent parents in 1974-75, there was no effect of the nectariless trait on seed percent N. There was, however, a significant cultivar by location interaction, indicating considerable influence of the environment on seed percent N. Aspartic acid, threonine, serine, glycine, and alanine contents were significantly higher in the seed from nectariless cotton lines than in seed from normal cotton. The increases in absolute percentage values were, respectively, 0.10, 0.04, 0.03, 0.05, and 0.04. While these values were statistically significant, they would be of little consequence in affecting the quality of protein in seed from nectariless cotton plants.

Additional index words: **Gossypium hirsutum L., Isogenic, Genetic trait, Environmental effects, Nectary physiology.**

NECTARILESS is a trait in cotton (*Gossypium hirsutum* L.) controlled by two pairs of recessive genes, *ne*-1 and *ne*-2 (Meyer and Meyer, 1961). When these genes are in the homozygous recessive condition, both foliar and extrafloral nectaries are absent. Nectariless cottons have been investigated for their agronomic potential (Meredith et al., 1973) as well as their possible value in the suppression of certain insect populations (Lukefahr and Rhyne, 1960; Schuster and Maxwell, 1974).

The composition and total production of cotton nectar in both extrafloral and foliar nectaries have been investigated under field conditions (Butler et al., 1972; Hanny and Elmore, 1974). These studies indicated that cotton nectar, like the nectar of most plants, (Baker and Baker, 1973), is mainly sugar and water but does contain amino acids. Butler et al. (1972) also showed that the yield of nectar is substantial [up to 3.8 liters of nectar/ha/day in *G. barbadense* L.]. Thus, nectaries are a substantial sink for photosynthate and may compete with the developing boll and seed for nutrients.

Milburn (1975) proposed that extrafloral nectaries function as complicated hydraulic bleed-valves to secrete sugar but not minerals and amino acids, consequently enriching the phloem contents in minerals and amino acids. This would allow relatively more minerals and amino acids than sugar to be translocated to developing fruit. There are, therefore, two contrasting hypotheses concerning expectations of the effect of nectariless on seed percent N. One suggests that there will be no effect, but that the yield or seed production will be increased. The other (Milburn, 1975) suggests that seed percent N could be increased. It is reasonable to determine if the absence of extrafloral and foliar nectaries affects the percent N of cottonseed. Our experiments attempted to answer this question by the use of near isogenic cultivars of nectariless and normal cotton.

MATERIALS AND METHODS

Our first investigations were with three nectariless cotton lines and their nectaried recurrent parents (identified in Table 1) grown in three environments. The three environments included one test site in 1969 and two in 1970, all near Stoneville, Miss. Five replications were used in 1969 and four in each of the 1970 studies. The nectariless cottons were in the BC_4F_4 and BC_5F_4 generation in 1969 and 1970, respectively. The intact seed samples from each replication were analyzed for percent N by Barrow-Agee[3], a commercial cottonseed testing company.

In 1974 and 1975 four replications of eight BC_5F_4 nectariless cotton lines and their recurrent parents were grown in Stoneville. In addition to the three cultivars previously used 'New Mexico 9608' (DES 9608 ne), 'PD 3967' (DES 3967 ne), 'Stoneville 508' (DES 508 ne), 'Coker 413-66' (DES 413-66 ne), and 'Deltapine 16' (DES 16 ne) were included. These nectariless cotton lines listed in parentheses after each cultivar designation were recently registered (Meredith and Bridge, 1977). All experiments included standard fertilization (90 Kg N/ha) and cultural practices. The experimental design was a split-plot with cultivars used as whole plots. Seed percent N was determined on dehulled seed with a Coleman Nitrogen Analyzer[3]. Since dehulled seed and a different analytical procedure were used for this second experiment, percent N values should not be compared with the percent N values in the first experiment. Amino acid composition was determined on two replications for the 1974 and 1975 studies with a Beckman Model 121 Amino Acid Analyzer[3].

RESULTS AND DISCUSSION

Seed from two of three nectariless cottons – 'Dixie King' and 'Deltapine Smoothleaf' – had significantly more percent N than seed from the comparable nectaried cultivars (Table 1). 'Stoneville 7A' nectariless cottonseed did not differ significantly from its normal counterpart.

In 1974 and 1975, dehulled seed from eight cultivars were evaluated. The ANOV for seed percent N is shown in Table 2. Seed from the nectariless cotton lines averaged 5.42% N compared with 5.39% for seed from the recurrent parents. Cultivars differed significantly among themselves, and the cultivar by year interaction was also significant for seed percent N. The mean for all cultivars and their nectariless counterpart lines was 5.40% in 1974 and 5.41% in 1975.

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[3] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA, and does not imply its approval to the exclusion of other products that may also be suitable.

Table 1. Cottonseed percent N of three cultivars grown in 1969 and 1970.†

Cultivar	Normal	Nectariless
	% N	
Dixie King (DES DK ne)	3.74	3.84**
Deltapine Smoothleaf (DES SL ne)	3.64	3.78**
Stoneville 7A (DES 7A ne)	3.69	3.70

** Indicates significantly higher percent N at the 0.01 level using the L.S.D. test.
† Data are for whole cottonseed.

Table 2. Combined analysis of variance for percent N in nectariless and normal cottonseed grown in 1974 and 1975.

Source	df	ms†
Years (Y)	1	112
Reps Wn years	6	2,493**
Cultivars (C)	7	3,737**
Cultivars X years	7	1,555*
Error a	42	592
Nectariless (N)	1	180
N X Y	1	294
N X C	7	159
N X Y X C	7	224
Error b	48	225

*,** Indicates significant differences at the 0.05 and 0.01 levels of probability, respectively. † MS $\times 10^4$.

The percent N of most seed is greatly influenced by environment and cultural practices, such as N fertilization (Deckard et al., 1973; Trevino and Murray, 1975). Recent data on cottonseed suggest that they too are influenced by both environment and cultural practices (Turner et al., 1976). Turner et al., however, did not show a cultivar $\times$ location interraction. Meredith and Bridge (1973), showed that the seed index consistently started out high, plateaued until fruit set diminished considerably (cutout), then declined markedly. Elmore et al., (1976) indicated that shifts in percent N accompanied the seed index decline (percent N goes down) and that N fertilizer increased seed percent N. Thus, to fairly compare cottonseed for percent N among genotypes and be certain that the effect is due to the genotype, we feel that the seed should be from comparable flowering periods of comparable plants.

Getting comparable cottonseed, of course, is a problem when comparing normal with nectariless cotton. In the greenhouse Thomas (1975) has shown that nectariless cotton lines fruit longer than normal cottons before apparent cutout. Field observations suggest, however, that nectariless cotton lines tend to be earlier (Meredith et al., 1973). Both of these observations may be due to the absence of nectaries. In the greenhouse, where most stresses were eliminated, nectariless cotton lines fruited longer, possibly by utilizing the extra photosynthate made available by eliminating the nectaries. In the field, however, where many stresses occur during early plant development, nectaried cottons may be unable to set as many early bolls because of competition from the nectaries for photosynthate. Consequently the absence of nectaries may result in earlier fruiting. It is entirely possible that at certain points in the season, seed percent N differences between nectariless and normal cotton lines could be present some years. However, it will most likely be a very small effect and, when averaged over the entire fruiting season, will generally be inconsequential.

Table 3. Average seed amino acid composition from eight nectariless lines and their nectaried recurrent parents.

Amino acid	Normal	Nectariless
	g/16 g N	
Lysine	4.71	4.70
Histidine	2.72	2.69
Ammonia	2.32	2.31
Arginine	11.87	11.75
Aspartic acid	9.95	10.05**
Threonine	3.38	3.42**
Serine	4.85	4.88*
Glutamic acid	23.21	23.18
Proline	4.04	4.00
Glycine	4.45	4.50**
Alanine	4.22	4.26**
1/2 Cystine	1.36	1.36
Valine	3.81	3.80
Methionine	1.67	1.67
Isoleucine	2.70	2.67
Leucine	6.19	6.20
Tyrosine	3.17	3.17
Phenylalanine	5.41	5.40

*,** Indicates significantly higher composition at the 0.05 and 0.01 levels of probability, respectively using the L.S.D. test.

Table 3 contains the data for amino acid composition of seed. Five amino acids were significantly higher in the cottonseed from nectariless cotton than in seed from their normal counterparts; these differences, however, were small and of no apparent practical significance. Differences among cultivars for lysine and tyrosine were significant, as was the three way interaction of nectarliess $\times$ cultivar $\times$ year for aspartic acid. The cultivar $\times$ year interaction was significant (0.05 level) for lysine, proline, and alanine.

A significant difference for amino acids between the cultivars was not surprising, but differences between nectariless and normal was. Since cultivars differed for percent N and since some amino acids are correlated with percent N within cultivars (Elmore et al., 1976; Meredith and Elmore, 1976), a change in percent N could result in a significant change for that amino acid among cultivars. The significant cultivar $\times$ year interaction for amino acids is probably the consequence of the same effects which resulted in a significant interaction term for percent N.

We conclude that the nectariless trait per se has no appreciable effect upon seed percent N and has only small effects on five amino acids. This result indicates that no detrimental effect upon seed quality or seed performance should result whenever a cultivar is converted to nectariless, and seed percent N is unrelated to the genetic trait. This is positive and encouraging and poses no limitation upon efforts to convert lines to nectariless. The results of this study do suggest that there are cultivar differences for percent N and amino acid composition of cottonseed, and these may very well be genetically manipulated in cotton breeding programs to produce better quality cottonseed.

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