GENETICAL STUDIES ON THE OIL AND PROTEIN CONTENTS IN SOME CROSSES OF COTTON

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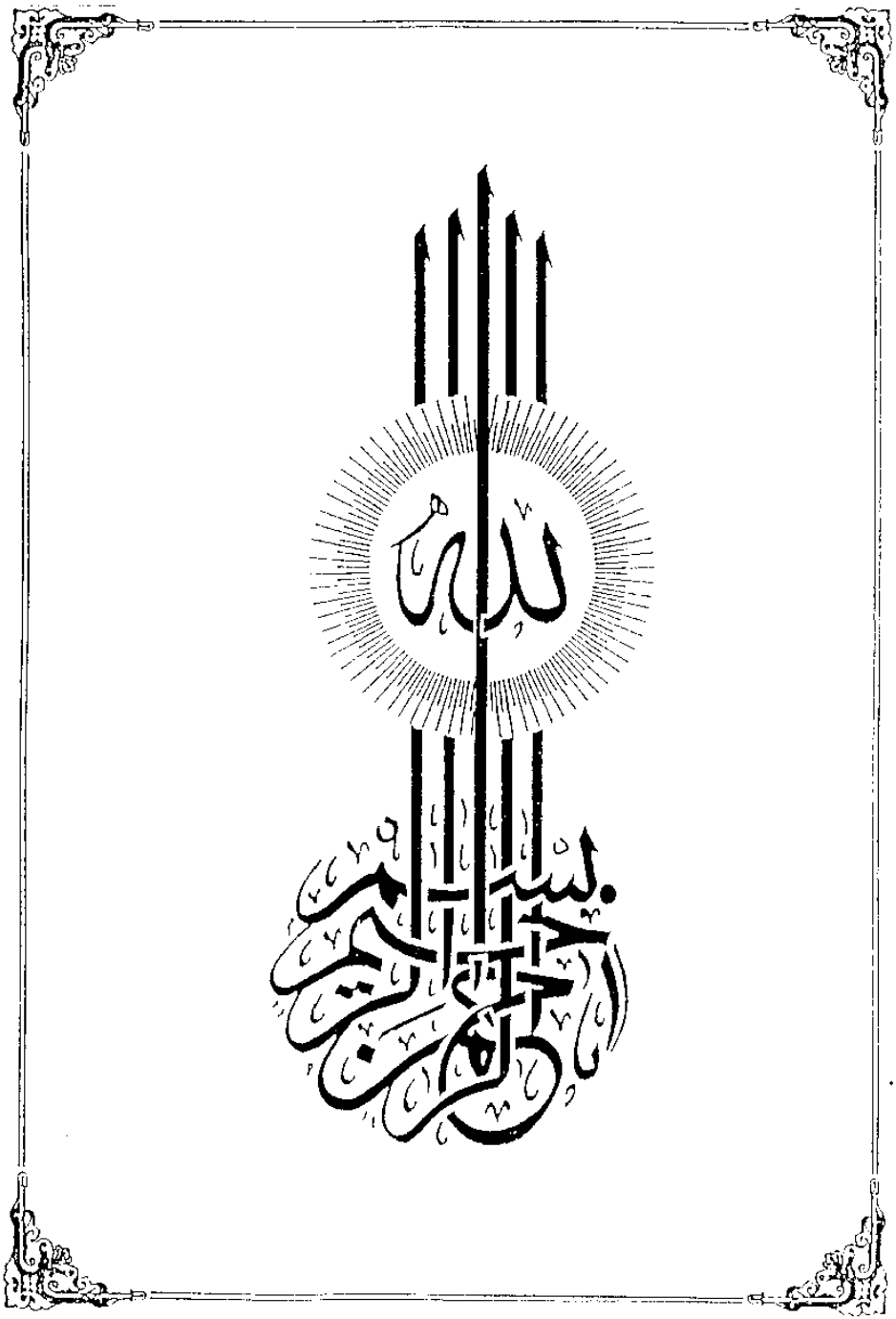

C O N T E N T S

1. INTRODUCTION

The importance of more and better food to the world population is increasingly felt, especially, by agrarian workers. The biological value of the residues of crop plant species that are really under cultivation, en mass, would contribute great advance to the world natural resources. Therefore, cotton producing countries paid much attention towards cotton seed. Despite of the fact that cotton seed is a utilized by product for oil and cake industries uptil now cotton lint occupied most of the plant genetic research on cotton yield. Although the genetic point of view considers at first the need to better elucidation of the genetic system, the accumulation of basic scientific evidences would lead to the correct track for solving the problems of man against hunger. Protein and fixed oils of cotton seed, if increased through genetics automatically, these will establish a wonderful element for better animal production and human food industries. Breeding programmes based on genetic information on the interbreeding gene pools or populations may contribute better conclusion to the presumed deductions.

Genetics is defined elsewhere, as the confirmation between parent and progeny at the metabolic level. Genetic

analysis of protein and oil content tells on two, among three, major elements of the primary metabolism of the cotton plant. Knowldege with genetic parameters of these metabolic characters and related seed characters such as seed index and lint percentage would through a spot of light for their joint importance.

In the present study each of the two metabolic characters; i.e., oil and protein are genetically analyzed, separately, through intervarietal differential crosses due to the varietal capabilities in the local commercial Egyptian cotton varieties already grown for fiber production. The work includes also the study of the inheritance of seed index and lint percentage and their association with oil or protein contents.

II. REVIEW OF LITERATURE

1. Inheritance of oil content:

The oil content may differ in the seeds of various cotton species, G. herbaceum, G. arboreum, G. hirsutum and G. barbadense as reported by Smirnova (1936), Jarosh (1958), Bhatt et al. (1961), Abdel-Bary et al. (1968) and Sood et al. (1972). It also seems that the oil contents of seed of various varieties differ according to their genetic background; Hancock (1942), Kamal (1958), Jarosh (1958), Youssef (1961), Ali (1964-1966), Afifi et al. (1966), Abdel Bary et al. (1968), Labaneiah (1970) and Pakhmanov and Topvoldiev (1971).

Humbert (1917) found that high oil content was transmitted to the progeny. The same auther, in another report (1917-b) showed the possibility of selecting strains with either high or low oil content.

Hancock (1942) indicated the possibility of obtaining a variety having both high oil and protein contents.

Harland (1946) was able to increase the oil content from 21.8 to 29.2 percent in Tanguis cotton.

Jarosh (1958) reported the possibility of establishing varieties with a high oil content from the isolated forms of G. hirsutum and G. barbadense.

In Russia, Bredihina (1970) reported that the oil content of the F_2 from reciprocal crosses reached that of the seed parents. Her results showed heterosis in oil content. On the other hand, Shapaksova (1971) reported that the best procedure for improving oil content was by hybridzation among varieties having both high seed yield and high oil content of the seeds.

El-Ashry (1972), studying the oil content in two intra-specific crosses of Egyptian cotton varieties, found no heterotic effect, negative inbreeding depression and significant epistasis (E_1) in one cross. However, heterosis and epistasis (E_1) were significant with also no inbreeding depression in the other cross. All genetic variance was due to additive effect. Heritability estimates were 37.46% for both broad and narrow senses.

Muhammad and Hafeez Ullah (1973) concluded that the variability in oil content in commercial cotton of Pakistan was due to three major factors; e.g. variety, locality and season.

For varietal and seasonal variability in oil content, Gad et al. (1961) found no major differences between some Egyptian cotton varieties in oil content.

Malik and Khan (1964) reported that differences due to varieties were not significant in oil content as affected by different seasons.

Ter-Avanesjan and Atlanov (1969) in America and Pandey and Thejappa (1975) in India, found that oil content varied mostly between varieties and localities.

2. Inheritance of protein content:

Different ranges for protein content were reported from various cotton species which might be due to the differences in their genetic background as reported by Jarosh (1958) in G. arboreum, G. herbaceum, G. hirsutum and G. barbadense; Frampton et al. (1960) in G. triphyllum and G. klotzchianium. Moreover, varieties within the species differ in their protein contents as reported by Meloy (1939), Pope and Ware (1945) in Upland cotton, G. hirsutum; Gad et al. (1961), Youssef (1961) and Afifi et al. (1966) in Egyptian cotton, G. barbadense.

Lee and Smith (1970) analysed the data of hybrid seed from an interspecific cross between G. barbadense and G. davidsonii and suggested that G. davidsonii would not be of much value for improving the protein composition of cultivated cotton.

In barbadense cottons, El-Ashry (1972) studied two intraspecific crosses in Egyptian cotton (G. barbadense) and found that heterosis and inbreeding depression were positive and significant for cross Giza 47 x Giza 45, while it was negative and significant for the cross Giza 68 x Ashmouni. Epistasis was significant and negative for the first cross only. All genetic variance was due to additive effect. Heritability estimates were 64.10% for both broad and narrow senses for the first cross. For the second cross, it was 56.03% in the broad sense.

Haikal (1976), working on three crosses between Egyptian cotton varieties, reported that neither heterosis nor inbreeding depression were significant in the three crosses. Epistatic effect was not significant in two crosses. All genetic variance was additive in two crosses, while in the third, the additive genetic variance was about 8.6 times the dominance variance. Heritability estimates were 35.63% and 40.81% in both broad and narrow senses for crosses I and III, respectively. For cross II heritability estimates were 55.88% and 50.04% in the broad and narrow senses, respectively.

In Upland cotton, Pope and Ware (1945) and Wahhab and Hussain (1952) in Pakistan reported that the variability in protein content depends upon differences in varieties as well as edaphic and climatic differences of the environments.

3. Inheritance of seed index:

Studies conducted with seed index in cotton showed that this character behaved as a quantitative character. These studies extended, generally to the nature of genetic variance, gene action and the heritability value as a major constituent of the predicated genetic advance.

In Upland cotton, Mason (1951) and Richmond and Lewis (1951) reported partial dominance of large seed over small seed size.

Abdo (1964) and Abou-Alam (1975) found that large seed slightly dominates over small seed size in Egyptian cotton.

On the other side, Young (1953) and Gomaa (1962) obtained partial dominance of small seed over large seed size in both the Upland and Egyptian cottons, respectively.

Complete dominance of large seed index was reported in the Egyptian cotton varieties, by Abo-El-Zahab (1969) and Bedair (1971).

Absence of dominance for seed index was detected by White and Richmond (1963), White (1966) and El-Agamy (1971).

For the gene interaction, Ramey and Miller (1966) obtained a negative estimate of dominance genetic variance.

Meanwhile, White (1966) and El-Agamy (1971) noted the presence of epistatic effects in Upland and Egyptian cotton crosses, but Al-Rawi and Kohel (1969) and Haikal (1976) found no such effects on Upland and Egyptian crosses.

Studies on heterosis by Al-Rawi and Kohel (1969), Bedair (1971), Meredith and Bridge (1972) and Abou-Alam (1975) showed significant heterosis effect for seed index. However, White and Richmond (1963) and Haikal (1976) found no significant heterosis in varietal Upland and Egyptian crosses.

For inbreeding depression, Al-Rawi and Kohel (1969) obtained highly significant inbreeding depression in all varietal crosses, also Bedair (1971) found significant positive inbreeding depression in one cross only. Abou-Alam (1975) reported also inbreeding depression. However, Haikal (1976) found no significant inbreeding depression in varietal Egyptian crosses.

Various studies were reported for additive genetic variance in seed index. The studies of Ramey and Miller (1966) and El-Adl and Miller (1971) indicated that additive genetic variance was greater than dominance genetic variance. Meanwhile, El-Agamy (1971) and El-Ashry (1972) found that all genetic variance was due to additive genetic variance in a varietal crosses between Giza 69 x Zero-type, Giza 47 x Giza 45 and Giza 68 x Ashmouni, respectively.

For the nature of gene action, Gomaa (1962) studied the inheritance of seed index in the cross Giza 30 x Giza 55 and did not reach any conclusion concerning the nature of gene action if it was additive or multiplicative. Abdo (1964) showed that nature of gene action could not be figured out on a clear cut basis for the very small difference between the parental cultivars Ashmouni x Giza 63.

For estimation of gene number, Mason (1951) concluded, in Upland cotton that seed size was governed by 2 to 3 pairs of genes plus some modifiers. While, Therman (1953) found, in two crosses of Upland cotton, that seed index was governed by one major pair of genes. Gomaa (1962) suggested in Egyptian cotton two pairs of genes plus some modifiers to be responsible for seed index. Abdo (1964) found that 1.4 pairs of genes plus some modifiers to be responsible for the mean difference between the parents.

Heritability estimated by Mason (1951) in a cross of two Upland cotton varieties calculated in the broad sense was 63.0% and Therman (1953) obtained heritability estimates of 52.0 and 73% in broad sense for two crosses of Upland cotton varieties. However, Young (1953) reported higher broad sense heritability estimates of 79 and 80% from F_2 and F_3 data, respectively. In crosses of Egyptian cotton varieties Gomaa (1962) and Abdo (1964) obtained broad sense heritability of

4.49 and 24.50 percent, respectively. El-Agamy (1971) and El-Ashry (1972) obtained low heritability estimates of 22.91 and 41.00% for both broad and narrow senses, respectively. Abo-Alam (1975) estimated heritability values as 46.33 and 73.09% in the broad sense, 34.82 and 65.57% in the narrow sense for crosses I and II, respectively. Moreover, Haikal (1976) estimated heritability values in the broad and narrow senses. It was 53.10 and 50.29% for cross I, while it was 59.39% in both broad and narrow sense for the other cross.

4. Inheritance of lint percentage:

Stith (1956) working with Upland cotton and Awad (1973) with Egyptian cotton reported partial dominance for high lint percentage over low lint percentage.

On the contrary, Kamel and Gomaa (1962), El-Fawal (1966), Sallam (1970) and Mohamed (1974) working with intraspecific crosses of G. barbadense, and interspecific crosses of G. barbadense x G. hirsutum reported that the low lint percentage showed partial dominance to high lint percentage.

Complete dominance of high lint percentage was reported by Abdo (1964) and absence of dominance for lint percentage were detected by White (1966) and Abo-El-Zahab (1969).

Meredith et al. (1970) found highly significant dominance and epistasis for lint percentage. Meanwhile,

El-Agamy (1971) found absence of dominance and epistasis in two crosses; and significant dominance and epistasis were detected in the third cross.

Highly significant heterosis and inbreeding depression for lint percentage was detected by Al-Rawi and Kohel (1969) and Meredith et al. (1970).

On the other hand, Lee et al. (1967) and Meredith and Bridge (1972) estimated a small degree of heterosis about 1.7 and 1.1 percent, respectively for lint percentage, but it was significant. Meanwhile, Bedair (1971) found no heterotic effects or inbreeding depression for lint percentage.

Several workers reported an additive genetic variance for lint percentage. White (1966) and Lee et al. (1967) detected high estimates of additive variance for lint percentage. Bedair (1971) reported that all genetic variance was due to additive variance for this character in two Egyptian cotton crosses. However, El-Agamy (1971) indicated that dominance genetic variance was greater than additive genetic variance. Meredith and Bridge (1972) in Upland cotton and Mohamed (1974) in Egyptian cotton found that additive effect predominated non-additive for lint percentage.