MORPHOLOGICAL AND CYTOLOGICAL STUDIES IN HAPLOID EGYPTIAN COTTON

By

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I. INTRODUCTION

Since the first discovery of haploidy in *Datura stramonium* by Blakeslee *et al.* (1922), this phenomenon has been found among several flowering plants. The classification of haploids suggested by Kimber and Riley (1963 a) divides haploids into two large groups , euhaploids and aneuhaploids. Euphaploids may possess either the basic chromosome number termed as (monoploids) as in maize and tomatoes, or an exact multiple of it which is known as (polyhaploids). These polyhaploids might be derived from autopolyploid plants as in potatoes and alfalfa suggested to be known as (autopolyhaploids). Meanwhile, polyhaploids originated from allopolyploid species are called (allopolyhaploids) such as in hexaploid wheat and tetraploid cotton.

Allopolyhaploids in cotton was reported in Upland cotton *Gossypium hirsutum* L. by Rour (1958) as one or both members of twin-embryo seed in a frequency of one twin embryo in 20,000 to 25,000 seeds. Kimber (1958) estimated it as one twin in 127,500 seeds and Blank and Allison (1963) reported a range from one twin in 20,511 to 2,639 seeds, and the latter high frequency was obtained from a selected line for this trait. In *G. barbadense*, the frequency of twin embryo seeds is higher than in

Others in the United States. Silow and Stephens (1944) reported one twin in 300 to 500 seeds of the Sea Island cotton and De Garcia (1962) found one twin per 2,369 seeds of Tanguis. Turcotte and Feaster (1963) found one twin in 8,167, 8,342 and 18,000 germinated seeds in three Pima cotton strains, respectively. Owings, Sarvella and Meyer (1964) found in a line of G. barbadense cotton, Z 101, 9.4 twin embryos and 7.7 haploid plants in 1,000 germinated seeds. Most of the twins consisted of one (n) and one (2n) embryos, and they speculated that the polyhaploids developed from an extra embryo derived from a cell other than the egg in the embryo sac, and suggested that a synergid was the most likely source of the extra embryo.

In this country, Baseem (1973) studied twin embryo seedlings in Egyptian cotton G. barbadense observed in cotton seeds inspected for germinability in the Seed Testing Laboratory of the Ministry of Agriculture at Giza. He estimated the ratio of twin embryos to be one twin in 38,395 seeds in the varieties Menoufi and one twin in 50,496 seeds in the cultivar Giza 67 and an average of 1 twin in 39,303 seeds. These estimations are lower than that reported by the above mentioned authors. For that reason, Harland (1936) stated that neither twin embryos nor haploids have been found in Egyptian cotton Enan's Brown.

Allopolyhaploids was rarely found in Upland cotton in the field plantings in Arizona by Mayer and Justus (1961) and they stated that a frequency of 1 to 3 in 25,000 plants is not uncommon for Pima cotton (which originated from the Egyptian variety Maarad). These plants can be distinguished from amphidiploid cotton cytologically by having 26 vs 52 chromosomes, respectively and by some morphological characteristics as smaller plant parts, zigzag stems and lack of pollen shedding. Some of these plants were collected by the writer from Egyptian cotton fields growing as scrawny weak sterile plants in a very low ratios.

Polyhaploids as a consequence of their unique genomic constitution offer improved means of investigating many fundamental problems in genetics such as the study of the expression of a single allele and its dosage effect on plant physiology and morphogenesis. They offer also an opportunity to study the effect of different levels of ploidy on vigour and productivity as reported by [illegible] ([illegible]) in triploid sugar beets yielding more sugar per acre than diploids or tetraploids. The homozygous double haploids can also be used as genetic constants in many types of laboratory and field experiments to measure the environmental variations as stated by Magoon and Khanna (1963). Meredith et al. (1970) compared double haploids with their parent varieties in productivity of their crosses in cotton, interaction with location and type of gene action and concluded that they did not differ from other varieties of similar genetic background. Baseem (1973) came to the same conclusion except for some quality characters overpassing their parental variety. Cytological studies on monoploids and polyhaploids helped in determining the nature and ploidy status of species from which they were derived. The amount of pairing between chromosomes is a good indication of the extent of relationships between the genomes that have gone into their constitution. Mutations, gene-cytoplasmic and gene-environmental interactions can be more readily detected and studied without interference of heterozygosity. Moreover, critical information regarding chromosomal homologies, chromosomal and genome evolution and the basis of meiotic pairing which is easier to be stated in polyhaploids.

Polyhaploids selfed or cross pollinated from amphidiploids are considered as a source of aneuploids as in the development of monosomic series in wheat by Sears (1954). Moreover, Schertz (1963) and [illegible] (1971) obtained primary and tertiary trisomics in the progeny of monoploid-diploid crosses in *Sorghum vulgare*. Bingham and Gillies (1971) reported the production of trisomics in the progeny of autopolyhaploid X autotetraploids in alfalfa.

The aim of the present work is to study the incidence of natural allopolyhaploid cotton in Egyptian cotton fields, to be used in cytological studies on its gametogenesis, its fertility as males and females and its uses in the production of aneuploids especially monosomics. The study included also attempts for induction of polyhaploids artificially from [illegible] amphidiploid cotton to be used in the production of double allopoly-haploid cottons for breeding and genetical use.

[illegible]

1- [illegible] haploids in cotton :

Harland (1936) described the haploid state in Sea Island cotton. He screened several thousands seeds of Sea Island cotton and noticed twenty seeds containing two embryos. One of the two was usually smaller than the second. By careful culture, Harland was able to raise to maturity sixteen pairs of plants. Fourteen pairs of them consisted of one haploid and one diploid and the other two pairs each of them were of identical diploids.

Webber (1940) stated that the twins were mainly haploid-diploid in the tetraploid species (n = 26) and diploid-diploid in the diploid species (n = 13).

Beasley (1941) found that haploid-diploid twins occurred frequently in G. barbadense L., and rarely in G. hirstutum L.

Silow and Stephens (1944) showed that twinning was much more common in Sea Island cotton than in other cultivated cottons and most Sea Island twins were diploid-haploid. They reported that twins in Asiatic cottons were usually diploid-diploid.

[illegible] (1955) gave information on the natural occurrence of haploid in G. barbadense L., G. hirsutum L. and their hybrids. He explained the practical methods by which haploids may be useful in breeding and in the study of mutation rates and other genetical problems.

Kimber (1958) mentioned that cryptic twins, in which very small embryos were present in the folds of the cotyledons of normal seedlings, had been found in strain V 135 of Sea Island and in an Uganda strain of Upland in which the smaller member of such twins died at the cotyledon stage. Both members were however raised to maturity in one case of cryptic twinning in V 135. The smaller member was haploid and the larger was diploid.

Roux (1958) reported that it was probable that a tendency to polyembryony was an inherited character in cotton.

Roux and Chirinian (1959) noted that although haploidy in cotton was previously considered exceptional; research work at Bebedjia in 1958 - 1959 resulted in the

[illegible]
tion of [illegible] varieties of Upland cotton.

[illegible] and Allison (19[illegible]3) showed that the incidence of polyembryony was observed in a number of varieties and strains of Upland cotton (*G. hirsutum* L.), most of which have an Acala background.

Owings *et al.* (1964) mentioned that in the Sea Island cotton Z 101 and its hybrids with five marker lines contained twins. Most of the twins consisted of a haploid and an amphidiploid; the haploid having small stomata, leaves, flowers and small pollen grains. They reported that the most likely supposition for the development of the polyembryonic haploids was the formation of an extra embryo from a cell of the embryo sac other than the egg-cell. Such haploid would probably develop from an unfertilized synergid, since the polar nuclei are needed for endosperm development and since the antipodals possibly degenerate prior to maturation of the egg apparatus. They mentioned other [illegible] two possibilities for the occurrence of the haploids first that two embryo-sacs within a single ovule; the second a 16-nucleated embryo-sac with only one egg cell being fertilized. The most logical explanation for the mono-embryonic haploids would be development without fertilization of a cell of the egg apparatus.

Dergach (1971) reported that haploid plants were selected from twin-embryo seeds of *G. arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense*. The largest number of twins and haploids occurred in *G. barbadense* and its variety 87361. A haploid plant was also found in variety 9155 I.

Baseem (1973) showed that haploid seedlings were found as twin members in seed lots of two Egyptian cotton cultivars Giza 67 & Menufi (*G. barbadense* L.). Twin seedlings were classified visually according to their vigour into three groups, diploid/diploid, diploid/haploid (weak) and haploid/haploid. Haploid plants were weaker than normal, having smaller leaves, squares and flowers, their stomata were smaller in size than diploids.

2- Frequency of Polyhaploids in cotton :

Beasly (1941) cited that haploid-diploid twins such as frequently occurred in *G. barbadense* L. had been found though extremely rare in *G. hirsutum* L.

[illegible] (19[illegible]) reported that amongst 44,000 seeds of various Sea Island cotton examined at Stoneville, 141 pairs of twin embryos were found, of these, 112 appeared to consist of one diploid and one haploid. The percentage of haploids varied between 0.1 and 1.6 % amongst these varieties. In G. hirsutum L. cotton, the average frequency of twin embryos was one pair in 20,000 to 25,000 seeds but the proportions of diploids and haploids were not known.

Blank and Allison (1963), in examining 330,130 seedlings from a number of varieties and strains of Upland cotton, G. hirsutum L., 20 twin embryos were found (an over-all frequency of 1 : 16,506). The twin embryos were brought to flower and the seed increased in field plantings. Of major importance is the finding of a line yielding 23 twin embryos in 60,698 seedlings from the first increased seed. This line had a ratio of 1 : 2,639 a highly significant increase in the incidence of polyembryony.

Turcotte and Feaster (1963) reported that the progenies of a doubled haploid line, L 57-4 of G. barbadense Pima S (1), contained a high proportion of haploid plants. These plants, in contrast to those previously reported in cotton originated from single rather than twin-embryo seeds. The frequency of haploids was greater in greenhouse than in field plantings, probably because the environmental conditions during emergence and early growth were more hazardous for haploid than for diploid seedlings.

Owings _et al_. (1964), in their studies on Sea Island cotton Z 101 and it hybrids with five marker lines reported that the incidence of haploids (7.7 per 1000 emerged seedlings) were closely parallel to that of twinning (9.4 pairs per 1000 germinated seeds).

Bascom (1973) reported that the frequency of twin pairs per 1000 viable seeds in two Egyptian cultivars (_G. barbadense_) was about 0.020/1000 or (20/million) in the cultivar Giza 67 and nearly 0.026/1000 or (26/million) in Menufi cultivar, with an average of 0.025/1000 or (25/million) in both of them. Forty twin pairs were found in both cultivars, out of them 27 were haploids and the frequency of haploid per 1000 viable seeds was 0.01717 or (17.17/million). These ratios are much lower than in other _G. barbadense_ cottons and are also