Published November, 1971

Brief Articles

AN ASYNAPTIC CHARACTER IN COTTON INHERITED AS A DOUBLE RECESSIVE[1]

J. B. Weaver, Jr.[2]

ABSTRACT

An F_2 population of cotton plants (*Gossypium hirsutum* L.) from 'Atlas 66-103' × 'R2-67, 26N' produced a ratio of 1 female-sterile: 15 normal plants. F_3 progeny from fertile F_2's provided further evidence that the female-sterile character was inherited as a double recessive. Cytological examination of megasporogenesis and microsporogenesis showed that female- and male-sterility was due to asynapsis. The gene symbols as_1 and as_2 are proposed for this character.

Additional index words: *G. hirsutum*, Male-sterile, Female-sterile, Genome, Frego bract.

BEASLEY and Brown (1) found a ratio of 15 fertile: 1 sterile in an F_2 progeny of *Gossypium hirsutum* × *G. barbadense*. The sterility was due to asynapsis. Brown and Menzel (2) also observed 15:1 ratios due to asynapsis in interspecific hybrids. They concluded that *G. hirsutum* has a gene for asynapsis on both the A and D subgenomes.

Stroman (4) reported that a common form of "rogue" plants found in fields of 'Acala No. 8' was due to female-sterility. He concluded that the female-sterility was due to a single recessive gene but that two families did not fit a 3:1 ratio very closely. His female-sterile plants produced some viable pollen. More recently, Justus and Meyer (3) reported a perfect fit to a 3:1 ratio for a female-sterile cotton that was also partially male-sterile.

The objective of this study was to determine the mode of inheritance of a female-sterile character that we discovered in our cotton breeding nursery.

MATERIALS AND METHODS

In the summer of 1968 cross pollinations were made between 'Atlas 66-103' and a strain of cotton obtained from the Texas A & M breeding nursery designated as 'R2-67, 26N' (Frego, B_2 B_6 genes). The F_1 seeds were advanced to the F_2 generation at Iguala, Mexico during the winter of 1968-69.

The F_2 seeds were planted at a rate of two seeds per hill with hills 4.7 cm apart. For those hills in which two plants emerged, the seedlings were randomly thinned to one plant per hill. The original objective was to study differences in boll rot susceptibility between plants with Frego bract and plants with normal bracts. We discovered early in the blooming period that some of the plants were male-sterile. As the plants progressed in development, it became obvious that the male-sterile plants were also female-sterile. An effort was made to self-pollinate each of the fertile plants. Self-pollinated seed from 112 fertile F_2 plants were planted in progeny rows in 1970.

RESULTS AND DISCUSSION

In the F_2 generation 176 normal fertile plants and 13 sterile plants were obtained. This gave a nearly perfect fit for a 15:1 ratio expected for a character conditioned by two pairs of recessive genes. The X^2 value was 0.1273 with a probability level greater than 75%.

In the F_3 progeny rows grown in 1970, there were 59 progenies that did not segregate and 53 progenies with sterile plants. If the sterility is controlled by two pairs of recessive genes the expected number of nonsegregating families is 7/15 of 112, or 52.3 families. As indicated above, there were 59 progenies that produced no sterile plants. Although most of the progeny rows contained from 50 to 100 plants, a few rows had only 15 to 20 plants. The shortage of total plants on these rows could account for the slight deficiency in the number of families that segregated for sterile plants. Sufficient counts were made of the ratio of normal fertiles to steriles within the F_3 families to indicate that some were segregating in a 3:1 ratio, and others in a 15:1 ratio.

Cytological studies were made of megasporogenesis and microsporogenesis during the winter of 1970-71. There was no development of embryo sacs. Some abnormal and nonviable pollen grains were produced. Failure of normal development was due to asynapsis.

Stroman (5) stated that his female-sterile plants were "devoid of bolls." Justus and Meyer (3) stated that their female-sterile plants set several small bolls but that the carpels were always empty and that the "youngest detectable flower-bud ovaries do not contain ovules." The female-sterile reported in this paper differs from those previously described in that the plants set numerous bolls that reached approximately one-third the diameter of normal bolls. The carpels contained a full complement of ovules. During boll development, the ovules remained attached to the placental ridges but did not develop true lint hairs or increase in size. Boll retention was much greater than that which occurred on normal fertile plants that were not pollinated. Figure 1 shows two bolls from an asynaptic sterile plant.

No apparent linkage was observed between female-sterility and Frego bract. The B_2B_6 genes carried by R2-67, 26N are for bacterial blight resistance. Our breeding program does not include research on bacterial blight resistance. Thus, no observations were

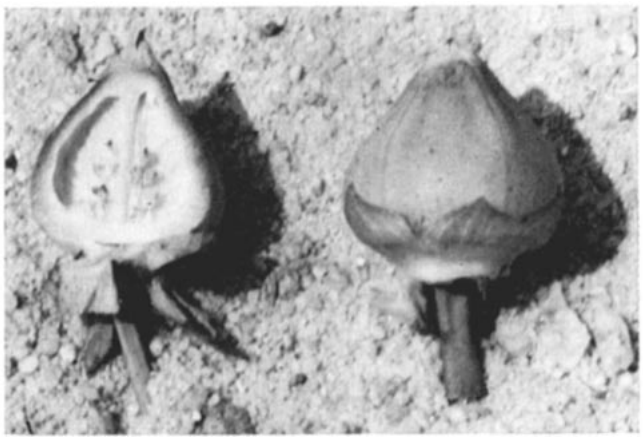

Fig. 1. Two bolls from a female-sterile plant.

[1] Journal Series Paper No. 964 of the University of Georgia, College of Agriculture Experiment Stations, College Station, Athens, Ga. 30601. Received Feb. 1, 1971.

[2] Assistant Professor of Agronomy, University of Georgia, Athens, Ga. 30601.

made regarding possible association between sterility and B_2B_6. There is a remote possibility that one of the genes for asynapsis is linked to B_2 or B_6 since the latter two genes were transferred into R2-67, 26N from *G. barbadense*. *G. barbadense* has been previously reported (1, 2) as carrying a gene for asynapsis.

Justus and Meyer (3) assigned the gene symbol *fs*-1 for their simple recessive female-sterile. Although the gross morphological development of the bolls observed in this study appears to differ from that found by Justus and Meyer, there remains the possibility that their female-sterility could have been due to asynapsis. There have been several other published reports of female-sterility in cotton. Some or all of these may have been due to asynapsis.

Although Beasley and Brown (1) and Brown and Menzel (2) described sterility due to asynapsis, they did not assign gene symbols. Menzel and Brown (4) used *a* and *A* to describe the genetic basis of asynapsis, but they did not propose these for gene symbols. The gene symbol as_1 and as_2 is proposed for these genes. These new genes should contribute to chromosomal mapping in *Gossypium hirsutum* and may be useful to cotton physiologists in boll-retention studies. They also offer additional evidence of duplicate gene loci in amphidiploid cotton. Further, this female-sterile stock may be useful in studies concerning the growth and development of the pink bollworm on "seedless" cotton.

LITERATURE CITED

1. Beasley, J. O., and M. S. Brown. 1942. Asynaptic Gossypium plants and their polyploids. J. Agr. Res. 65:421-427.
2. Brown, M. S., and M. Y. Menzel. 1953. The genetic basis of chromosome pairing in *Gossypium*. Proc. of the IX International Congress of Genetics. p. 899.
3. Justus, Norman, and James R. Meyer. 1963. A female-sterile mutation in a doubled haploid of Upland cotton. J. Hered. 54:65-66.
4. Menzel, M. Y., and M. S. Brown. 1955. Isolating mechanisms in hybrids of *Gossypium gossypioides*. Amer. J. Bot. 42:49-57.
5. Stroman, G. N. 1941. A heritable female-sterile type in cotton. J. Hered. 32:167-168.

INHERITANCE OF BUD AND POD COLOR, POD ATTACHMENT, AND GROWTH HABIT IN COWPEAS[1]

K. B. Singh and L. N. Jindla[2]

ABSTRACT

Genetic analysis showed that green bud color (*Gr*) in cowpeas (*Vigna sinensis* L.) was monogenically dominant over white (*gr*). Green pod color was dominant over white pod color and controlled by a single gene pair (G, g). Erect pod attachment *E* was monogenically dominant over drooping pod attachment *e*. Trailing growth habit was dominant over erect growth habit. This character is governed by three genes (T_1, T_2, and T_3) that interact in such a manner that genotypes included in the categories T_1-T_2-T_3-, T_1-T_2-t_3t_3, and $t_1t_1t_2t_2T_3$- have the trailing growth habit. All other genotypes have the erect growth habit.

[1] Contribution from the Plant Breeding Department, Punjab Agricultural University, Ludhiana, India. Received Dec. 5, 1969.
[2] Pulse Breeder and Graduate Student, Department of Plant Breeding, Punjab Agricultural University, Ludhiana, India, respectively.

THE cowpea (*Vigna sinensis* L.) is one of the important grain legumes of India and other Southeast Asian and African countries. In spite of the importance of this crop, little work on varietal improvement and basic genetic research has been done. Breeding work was initiated during 1967 in India at Punjab Agricultural University, Ludhiana. Inheritance of bud color, pod color, pod attachment, and growth habit, which have an important bearing on varietal improvement programs, were studied and are reported here.

Harland (3) observed that a dominant factor *P* was responsible for purple pod color in cowpeas. Capinpin (2) reported that black pod color was dominant over white and assigned the symbols *B* and *b* to this pair. Studies made by Krishnaswami, Nabiar, and Mariakulandai (4) showed that two complementary factors, i_1 and i_2, gave straw yellow-colored fruits. Mortensen and Brittingham (5) distinguished four types of colors: purple, straw, red tip, and drab color. Saunders (6) reported two pairs of genes affecting fruit color with *P–C–* and *P–cc* giving purple *p p C–* giving cerise; and *pp cc* giving straw-colored pods. Brown and speckled colors also exist in some varieties. Brittingham (1) observed that climbing habit in compeas was dominant over bushy habit and was controlled by a single gene pair (*T, t*). Later Saunders (7) reported that spindly growth habit was inherited independently by a single recessive gene. Information on genetics of bud color, pod color, and pod attachment is reported here for the first time.

Materials and Methods

Two divergent strains, C 34 and C 85, were used in this study. Strain C 34 has green bud color, green unripe pod color, erect pod attachment, and erect growth habit, while strain C 85 has white bud color, white unripe pod color, drooping pod attachment, and trailing growth habit. The parents and their F_1, F_2, B_1, and B_2 progenies were grown at the Punjab Agricultural University Experiment Station, Ludhiana, from July to October 1968. Spacings between and within rows were maintained at 120 and 90 cm, respectively. Due to an adverse growing season the crop growth was suppressed considerably, and observations could only be recorded on unripe pod color and growth habit. Another crop of parents, F_1, F_2 populations, and F_3 families were raised from March to June 1969.

Observations on bud color were recorded 1 day before bud opening. Pod color was noted as green or white when the pods were fully developed but still unripe. Data on pod attachment (erect or drooping) were collected just before harvest of the crop. The observation on growth habit was recorded as erect or trailing when plants attained full growth. The chi-square test was used to measure goodness of fit to expected ratios.

Results and Discussion

Bud Color. Green bud color × white bud color crosses produced green bud color F_1 progenies. Plants within F_2 families segregated 301 green to 93 white showing a good fit to 3 green:1 white ratio ($X^2 = .41$, $.70 > P > .50$) indicating single gene dominance. Support for this Mendelian scheme was obtained from 46 F_3 families, 15 of which were true breeding green and 31 were segregating green and white. A good fit to the expected ratio of 1 true breeding green bud color: 2 segregating for green and white bud color families was found ($X^2 = .01$, $.95 > P > .90$). The gene symbols *Gr* and *gr* are assigned for green and white bud colors, respectively.