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Interaction of Genes Controlling Accessory Involucre and Cup Leaf Mutants in Cotton, *Gossypium hirsutum* L.[1]

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A BACKCROSS population was grown to test for genetic linkage between a mutant called accessory involucre and a group of genetic markers which included the cup leaf mutant. In this population two phenotypic classes of cup leaf were expected; however, an unexpected third phenotypic class—extreme cup leaf—was present. This paper reports the basis of the unexpected segregation of the cup leaf mutant.

The accessory involucre mutant is controlled by genes at a single locus.[3] When the genes controlling accessory involucre are homozygous *(ia ia)* plants develop an accessory involucre which appears in the form of trumpet-like growths between the flora bracts. The veins and the base of the leaves grow parallel, which results in distorted leaves. Plants heterozygous for the accessory involucre genes *(Ia ia)* exhibited intermediate forms of the accessory involucre and normal leaves. The cup leaf mutant also is controlled by genes at a single locus.[4] When the genes controlling the cup leaf expansion are homozygous *(cu cu)* the leaf edges roll upward. Plants heterozygous for cup leaf genes *(Cu cu)* have a slight upward turn of the leaf edges. Both of these mutants are classified as recessives but their heterozygotes are detectable in most genetic backgrounds.

In this study, the accessory involucre mutant was crossed to a multiple marker stock containing the cup leaf mutant. The F_1 *(Ia ia Cu cu)* was backcrossed to the cup leaf stock. The backcross population was expected to segregate intermediate accessory involucre and nonaccessory involucre (1:1) and intermediate cup leaf and cup leaf (1:1). However, three cup leaf phenotypic classes were observed: intermediate cup leaf, cup leaf, and extreme cup leaf in the ratio of 1:2:1, respectively. The occurrence of an extreme cup leaf phenotype was not expected from what had previously been learned about the segregation of the cup leaf genes. As the plants matured and were classified for the expression of accessory involucre, it became apparent that the genes controlling accessory involucre were influencing the cup leaf phenotypes. All extreme cup leaf plants were intermediate accessory involucre, and all intermediate cup leaf plants were nonaccessory involucre. The cup leaf class was composed of nonaccessory involucre and accessory involucre phenotypes in approximately equal numbers. These data and the chi-square tests are presented in Table 1. Close observation of the cup leaf phenotypic class revealed that those plants in the portion exhibiting the accessory involucre phenotype were not as cupped as those in the nonaccessory involucre portion. But the difference was not distinct enough to form a basis for classification in the segregating population.

The F_2 population of the cross between accessory involucre and cup leaf was grown to observe the interaction of homozygous accessory involucre genes with the cup leaf genes. As in the case of heterozygous accessory involucre, the phenotype of homozygous accessory involucre was not altered in segregation with cup leaf. The effect of homozygous accessory involucre on the phenotypic expression of cup leaf was to cause both heterozygous cup leaf and homozygous cup leaf to exhibit the extreme cup leaf phenotype. There was an apparent difference in degree of expression between heterozygous and homozygous cup leaf. However, their low viability resulted in such extreme variability, when grown under the field conditions, that it was not possible to classify cup leaf with reliability. Based on the scoring for accessory involucre expression in the fruit forms of extreme cup leaf plants, 11 were classified as *ia ia,* 17 as *Ia ia,* and 22 were not classified. At first it was not thought possible to identify all the extreme cup

Table 1. Segregation and chi-square tests of the accessory involucre (*ia ia*) and cup leaf (*cu cu*) cross backcrossed to cup leaf.

Genotype	Cup leaf phenotype	Number* of plants
IaIaCucu	intermediate cup leaf	42
IaIacucu	cup leaf	44
IaIaCucu	cup leaf	48
IaIacucu	extreme cup leaf	57

* X^2 tests -- Ia:Ia = 1.89; Cu:cu = 0.63; and linkage = 0.27.

Table 2. Segregation of the F_2 population from the cross of accessory involucre (*ia ia*) with cup leaf (*cu cu*).

Genotype	Expected ratio	Cup leaf phenotype	Number* of plants
IaIaCuCu	1	normal cup leaf	9
IaIaCucu	2	intermediate cup leaf	24
IaIacucu	1	cup leaf	11
IaIaCuCu	2	normal leaf	14
IaIaCucu	4	cup leaf	53
IaIacucu	2	extreme cup leaf	18
IaIaCuCu	1	normal leaf	17
IaIaCucu	3	extreme	29
IaIacucu		cup leaf	

* X^2 = 9.83, 7 d.f., p = 2-.1.

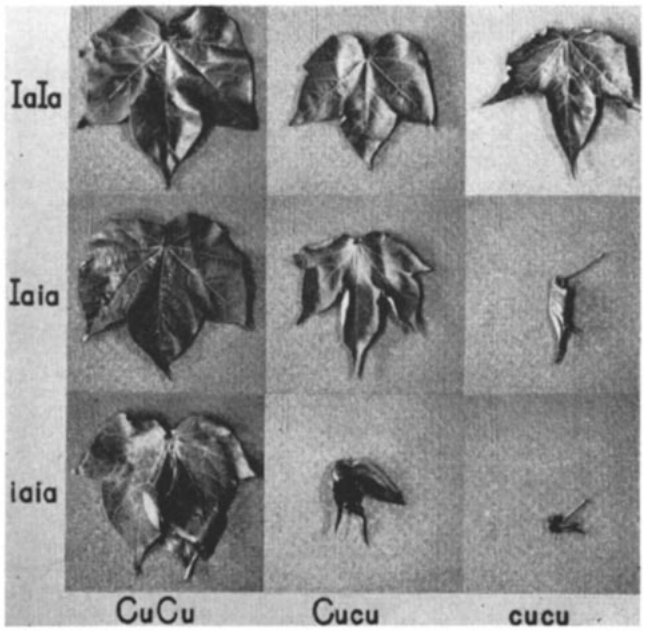

Figure 1. Leaf phenotypes of the 9 F_2 genotypic combinations.

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[3] Kohel, R. J. Inheritance of accessory involucre mutant in American Upland cotton, *Gossypium hirsutum* L. Crop Sci. 5:119–120. 1965.

[4] Lewis, C. F. The inheritance of cup leaf in cotton. J. Hered. 45:127–128. 1954.

leaf phenotypes in respect to homozygous or heterozygous accessory involucre, because the plants were so low in vigor that they did not develop fruit forms. It was then observed that the characteristic parallel veins at the base of the leaves in homozygous accessory involucre plants were detectable in the extreme cup leaf background. On this basis, the unclassified plants were scored for accessory involucre. This classification yielded 29 as *ia ia,* 18 as *Ia ia;* 3 plants died before they could be classified. The F_2 data are presented in Table 2. The leaf phenotypes of the F_2 genotypic combinations are shown in Figure 1.

In the populations segregating for the genes that control accessory involucre and cup leaf, the phenotyyic expression of accessory involucre is not altered, but the cup leaf genes interact with the accessory involucre genes. The interaction is such that each gene dose of the accessory involucre genes, in the presence of the cup leaf genes, has an effect similar to an additional dose of the cup leaf genes.