

Genetic Analysis of the *Crumpled* Mutant in Cotton, *Gossypium hirsutum* L.¹R. J. Kohel²

ABSTRACT

The mutant *Crumpled* is described, and the results of inheritance and linkage studies reported. The *Crumpled* phenotype is conditioned by a dominant allele at a single locus. The homozygous mutant genotype was assigned the gene symbols *Crp Crp*. Heterozygous *Crumpled* has an intermediate mutant phenotype. Linkage analysis established that *Crumpled* was independent of the marker loci *cu*, *v*, *gl*, *fg*, *cl*, *L*, *R*, *H*, *R*, *Y*, *P*, *Lc*, *N*, and *Lg*.

Additional index words: Linkage, Inheritance.

THE cooperative genetics program at College Station, Texas, has as one of its goals the collection, identification, investigation, and maintenance of mutants of cotton, *Gossypium hirsutum* L. (Anonymous, 1968). To these ends we actively search for and produce mutants. We solicit the cooperation of fellow cotton researchers to make available those aberrant cottons they discover. A mutant strain was made available through such an exchange of material, and this communication reports the results of the inheritance and linkage analysis of the mutant in cotton called *Crumpled*.

DESCRIPTION OF MUTANT

Seeds of a mutant line were sent to me by J. E. Endrizzi, University of Arizona, from W. D. Fisher, Plant Breeder, Cotton Research Center, Phoenix, Arizona. The mutant was tentatively identified as 'Crumpled leaf, deciduous bracts.' When seeds of the mutant were grown, the plants were diminutive with chlorotic leaves (Fig. 1); leaf shape was irregular with indistinct lobes.

The laminal area of the leaves was puckered and the leaf edges were wavy (Fig. 2). Bracteoles were narrow and often withered before the bolls reached maturity.

Hybrids between mutant and normal plants possessed a less pronounced mutant phenotype. The hybrid plants were intermediate in size and the first few leaves appeared normal. Subsequent leaves were smaller, slightly chlorotic, and irregular in shape with wavy margins, causing a cupped shape (Fig. 2). Not all bracteoles were narrow.

MATERIALS AND METHODS

Texas Marker 1 (TM1), a genetic standard for *Gossypium hirsutum* L., was used as the normal parent in the inheritance studies of *Crumpled* (Kohel, Richmond, and Lewis, 1970), and Texas 582 and Texas 586 were used in linkage analysis (Kohel, 1972). Texas 582 is a multiple recessive marker line containing the following loci: Linkage Group III, *cluster* (*cl*); Linkage Group VI, *frego bract* (*fg*); and the independent loci, *cup leaf* (*cu*), *glandless boll* (*gl*), *virescent* (*v*). Texas 586 is a multiple dominant marker line containing the following loci: Linkage Group I, *Brown Lint* (*Lc*) and *Petal Spot* (*R*); Linkage Group II, *Okra Leaf* (*L*) and *Green Lint* (*Lg*); Linkage Group III, *Red Plant* (*R*); Linkage Group IV, *Pilose* (*H*); and the independent loci, *Yellow Petal* (*Y*), *Pollen Color* (*P*), and *Naked Seed* (*N*).

All seed materials in this study were germinated in expandable peat pellets in the greenhouse and transplanted to the field after 2 to 3 weeks growth. In the field, 20 plants were placed in each row with 46 cm spacing between plants and 101 cm spacing between rows. Routine cultural practices of the Cotton Genetics Nursery were followed.

¹ Contribution from Agricultural Research Service, USDA, in cooperation with the Texas Agricultural Experiment Station, College Station, Texas. Received Jan. 26, 1973.

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Fig. 1. A *Crumpled* plant showing the distorted leaves and plant parts.

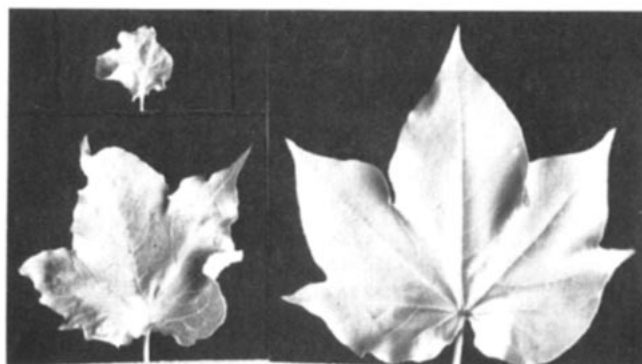


Fig. 2. A comparison of leaves: Left, top: *Crumpled*; Left, bottom: F_1 between *Crumpled* and normal; Right: normal.

RESULTS

Inheritance Analysis. *Crumpled* mutants were crossed with TM1 and the F_1 exhibited an intermediate mutant expression. The F_1 plants were self-pollinated and a small F_2 population was grown from the resulting seed. There were three phenotypes in the F_2 population: normal, *Crumpled* mutant, and intermediate mutant (Table 1). The F_2 population segregation fit the expectation of a simple partial dominant factor.

Crumpled \times normal F_1 hybrids were backcrossed to both parents, and in the resulting populations, the segregation followed the expectations of a single partial dominant gene controlling the expression of *Crumpled* (Table 1). In most cases, the mutant classes contained a deficient number of plants.

Twenty plants from the backcross TM1 (*Crumpled* \times TM1) were self-pollinated, and the progeny of each plant were grown and classified as mutant, intermediate mutant, and normal plants (Table 2). Of the 20 plants, 5 were classified as normal and 15 as intermediate mutant. The progeny from the normal plants bred true for normal plants; the progeny from the intermediate mutant plants segregated. The pooled segregation of the progenies from the intermediate mutant parents conformed to a 1:2:1 ratio of a single partial dominant gene.

Table 1. Segregation in F_2 and backcross populations in the inheritance tests of the *Crumpled* mutant of cotton.

Population	Segregation by class (no. of plants)				χ^2 analysis (ratio tested)	
	Mutant	Intermediate	Normal	Total	χ^2	P
(<i>Crumpled</i> \times TM1) F_2	12	14	14	40	2.13 (3:1)	0.2-0.1
(<i>Crumpled</i> \times TM1) \times <i>Crumpled</i>	17	23	0	40	0.90 (1:1)	0.5-0.3
TM1 \times (<i>Crumpled</i> \times TM1)	1. --	19	17	36	0.11 (1:1)	0.8-0.7
	2. --	15	14	29	0.03 (1:1)	0.9-0.8
(<i>Crumpled</i> \times TM1) \times TM1	3. --	27	31	58	0.28 (1:1)	0.7-0.5
TM1 \times (TM1 \times <i>Crumpled</i>)	4. --	15	22	37	1.32 (1:1)	0.3-0.2
(<i>Crumpled</i> \times T582) \times T582	5. --	32	50	82	3.95 (1:1)	0.05-0.02
(<i>Crumpled</i> \times T586) \times TM1	6. --	62	72	134	0.75 (1:1)	0.5-0.3
Total	--	170	206	376	3.45 (1:1)	0.1-0.05
Heterogeneity					2.99	0.8-0.7

Table 2. Segregation in the progenies from the self-pollination of selected plants in the population [TM1(*Crumpled* \times TM1)].

Segregation by class (no. of plants)					
Normal	Total	Mutant	Intermediate	Normal	Total
Normal parental phenotype		Intermediate mutant parental phenotype			
19	19	5	12	2	19
20	20	5	8	7	20
20	20	7	5	5	17
20	20	5	8	7	20
19	19	5	13	6	20
98	98	6	13	1	20
		2	10	8	20
		2	6	2	10
		3	13	3	19
		5	8	7	20
		5	9	6	20
		50	101	54	205*

* Chi-square deviation (1:2:1) = 0.20.

Table 3. The chi-squared deviation for linkage and the recombination percentage between *Crumpled* and the genetic markers in populations resulting from the crosses [(*Crumpled* \times T582)T582] and [(*Crumpled* \times T586)TM1].

Marker locus	Linkage χ^2	Recombination (%)	Marker locus	Linkage χ^2	Recombination (%)
cup leaf	0.44	53.6	Pilose	0.12	51.5
virescent-1	0.05	48.7	Petal Spot	0.12	48.5
glandless-1	0.20	52.4	Yellow Petals	0.75	46.3
frego bract*	--	56.0	Pollen Color	0.48	47.0
cluster-1	0.47	46.0	Brown Lint-1	0.91	45.9
Okra Leaf	0.75	46.2	Naked Seed	0.01	49.6
Red Plant	0.12	48.5	Green Lint	3.98	58.6

* Frego bract could not be scored in combination with *Crumpled*, and the recombination value was obtained from the non-crumpled segregants.

Linkage Analysis. *Crumpled* was crossed and backcrossed with Texas 582 [(*Crumpled* \times T582)T582], the multiple recessive line, and with Texas 586 [(*Crumpled* \times T586)TM1], the multiple dominant tester line. These populations were classified for segregation of *Crumpled* and the 14 genetic markers were analyzed for linkage associations. No significant linkage associations were detected (Table 3).

DISCUSSION

Crumpled mutant is described, its inheritance is determined, and its independence of 14 known marker loci is established. The phenotype of *Crumpled* is distinctively different from other known leaf mutants of cotton and it is concluded that it is a new mutant in cotton. The *Crumpled* phenotype is partly dominant to normal; that is to say, the heterozygote is intermediate in expression, but as far as genetic manipulation is concerned, it is best considered a dominant. It is proposed that the homozygous mutant phenotype be named *Crumpled* and the character be assigned the gene symbol *Crp* with the normal allele *crp*.

A mutant phenotype called *Crumpled* has been reported in Asiatic diploid cottons (Hutchinson, 1932). This mutant is described as having crumpled leaves associated with semisterility and in some cases inviable seeds. Two dominant complementary genes control the expression of this mutant. The phenotypic description and inheritance of the *Crumpled* mutant of Asiatic diploid cottons distinguishes it from *G. hirsutum* L. *Crumpled*. The symbols Cp_a , Cp_b have been assigned to the Asiatic *Crumpled* (Hutchinson and Silow, 1939).

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