

XIV. A PRELIMINARY NOTE ON INHERITANCE IN COTTON.

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Introduction

Inheritance studies in crops of agricultural importance are of considerable interest and are of value from the standpoint of crop improvement. A knowledge of the mode of inheritance of various characters of a crop plant aid materially in outlining the attack upon a breeding problem and in estimating the relative purity of hybrid lines. The results presented in this preliminary paper were obtained from plants grown under greenhouse conditions and the number of plants was limited. Furthermore, the plants did not take too kindly to greenhouse conditions and as a result very few seeds were obtained from each F_1 plant and these were of low viability. With these conditions, a check of breeding behavior of F_2 plants by testing in the third generation was practically eliminated. The results seem rather clear, however, from a survey of the F_2 generation and agree with other studies of a similar nature in cotton insofar as the same characters are concerned.

Review of Literature

A very recent review of literature on the inheritance of character in cotton is presented by Hayden and Garber in the revised edition of their book "Breeding Crop Plants." The reader, therefore is referred to their careful literature review rather than to repeat a review here.

Materials and Methods

The varieties of cotton used in this study are Lightning Express and Pima. Lightning Express is a variety of upland cotton. It has white petals, cream colored anthers, and lacks stipples on the petals and also lacks the red spot at the base of the petal commonly known as "red center" or "petal spot." Pima is a variety of Egyptian cotton. It has yellow petals, yellow anthers, a distinct petal spot and stipples on the petals.

The crosses were made in the field by manipulation of simple florets and the F_1 plants were grown in the greenhouse. Since presumably, the cross-pollination which takes place under field conditions is effected by insects, no crossing would be expected in the greenhouse as insects of a pollen carrying type were absent. The plants of the F_1 generation were also grown in the greenhouse immediately following the F_1 generation.

Experimental Results

The mode of inheritance of the character pairs yellow petals vs. white petals; yellow anthers vs. cream anthers; petal spots vs. no petal spot; and stippled vs. nonstippled petal will be discussed and later the interrelation of these various character pairs.

The results for each character pair separately are given in Table I for the four character pairs studied.

¹Breeding Crop Plants by H. K. Hayes and R. J. Garber, McGraw-Hill Book Company, New York, 1927.

Table I. Classification of F₂ plants in the cross Lightning Express x Pima.

Petal Color	Yellow : White	136:43=179	Observed
	" "	135:45=180	Calculated
		Deviation=2	PE=3.9
Anther Color	Yellow : Cream	137:42=179	Observed
	" "	135:45=180	Calculated
		Deviation=3	PE=3.9
Petal Stipple	Stippled : non-stippled	129:50=179	Observed
	" "	135:45=180	Calculated
		Deviation=6	PE=3.9
Petal Spot	Spot : No Spot	129:50=179	Observed
	" "	135:45=180	Calculated
		Deviation=6	PE=3.9

In the case of petal color the F₁ plants were intermediate and in F₂ there was considerable variation. It was comparatively easy, however, to distinguish the white petal types from those which had some degree of yellow by using a flower from the Lightning Express parent as a standard. Placing the white petal types in one class and all others in a second class, arbitrarily called yellow, resulted in a ratio of approximately 3 yellow: 1 white. The deviation is well within the limits of the experimental error. This indicates a single factor difference between Pima and Lightning Express for color of petal.

The color of anthers was almost as intense a yellow in the F₁ plants as that of the Pima parent. In the F₂ generation there was some variation in the anther color of the yellow plants but the separation of yellows and creams was comparatively easy. The results indicate a single factor difference for yellow anthers vs. cream anthers in this cross.

Stippled petals is partially dominant to lack of stipple and it was easy to classify this plant in the second generation. The deviation from the calculated ratio is less than two times the probable error which means that such a deviation would be expected on the average once out of 4 or 5 trials.

The petal spot of the F₁ plants was much lighter than that of the Pima parent and frequently one or more flowers on a plant lacked even a trace of spot. In the second generation there was little difficulty in classifying the plants although the fact that there seems to be too many plants without petal spots may mean that in some few cases plants were classified on the basis of one observation. As stated above frequently a plant heterozygous for petal spot may develop some flowers which lack the spot entirely. A number of these were tested and all proved to be carriers of the factor for petal spot.

Yellow Petals vs. White Petals in Relation to the Other Three Character Pairs. The relations of the character pair yellow petals vs. white and the other three character pairs are given in Table II.

Table II. Relation of yellow petals vs. white petals and the character pairs yellow anthers vs. cream anthers, stippled petal vs. non-stippled petal and petal spots vs. no petal spot in the F₂ generation the cross Lightning Express x Pima.

Yellow Petals		White Petals		Total
Yellow Anthers	Cream Anthers	Yellow Anthers	Cream Anthers	
106	30	31	12	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=0.9123$	P=Good fit
Petals Stippled	Non-Stippled	Petal Stippled	Non-Stippled	
96	40	33	10	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=1.5869$	P=.6670
Petal Spot	No Spot	Petal Spot	No Spot	
107	29	22	21	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=13.5909$	P=.0074

The results indicate independent assortment for the factors of this character pair and the factors for stippled vs. non-stippled petals and yellow vs. cream anthers. The fit for independent assortment is very poor for the character pairs yellow vs. white petals and petal spot vs. no petal spot. A deviation as great as the one obtained would occur in random sampling only 74 times out of 10,000 trials or once in 135 trials. This seems rather wide deviation to be attributed to chance variation. A comparison of independent assortment and linkage with crossover will be made for these two character pairs later in the discussion.

Yellow Anthers vs. Cream in Relation to Petals Stippled vs. Non-Stippled and Petal Spot vs. No Spot. The factors for the character pair yellow anthers vs. cream anthers and those for the character pairs petals stippled vs. non-stippled and petal spot vs. no spot appear to be independent. (See Table III.)

Stippled Petals vs. Non-stippled in Relation to Petal Spot vs. No Spot. Table IV contains the results to show the relationship of stippled vs. non-stippled petals and petal spot vs. no spot.

Table III. Relation of yellow anthers vs. cream anthers and the character pairs stippled vs. non-stippled petals and petal spot vs. no petal spot in the F₂ generation of the cross Lightning Express x Pima.

Yellow Anthers		Cream Anthers		
Petals Stippled	Non-Stippled	Petals Stippled	Non-Stippled	
100	37	29	13	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=1.2694$	$P=.7951$
Petal Spot	No Spot	Petal Spot	No Spot	
101	36	28	14	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=1.8051$	$P=.6170$

The deviation of the observed ratios from the calculated are well within the limits of variation due to random sampling.

Table IV. Relation of stippled vs. non-stippled petals and petal spot vs. no spots in the F₂ generation of the cross Lightning Express x Pima.

Petal Spot	No Spot	Petal Spot	No Spot	Total
97	32	32	18	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=4.4243$	$P=.2234$

The deviation of the observed from calculated is greater in this case than in some of the others but a deviation as great or greater than the observed would be expected about once out of four trials due to variation in random sampling. It is assumed, therefore, that the two factor pairs are assorted independently in gamete formation.

Linkage Relations of the Factor Pairs for Yellow Petals vs. White Petals and Petal Spot vs. No Spot.

In Table V. a comparison is made of independent assortment and linkage with crossover for the character pairs yellow vs. white petals and petal spot vs. no spot.

Table V. Comparison of independent assortment and linkage with crossover for the character pairs yellow vs. white petals and petal spot vs. no spot in the F₂ generation of the cross Lightning Express x Pima

Yellow Petals		White Petals		Total
Petal Spot	No Spot	Petal Spot	No Spot	
107	29	22	21	179 Observed
100.8	33.6	33.6	11.2	179.2 Calculated
			$X^2=13.5009$	$P=\text{less than } .0074$
108.75	25.50	25.50	19.25	179 Calculated
			$X^2=1.1481$	$P=.7674$
				34.4 % crossover

The fit for linkage with 34.4% crossover is very good. In fact, a deviation as large or larger than that observed would be expected three times

out of four trials due to variation in random sampling. On the basis of this comparison it can be said that the results conform more nearly to the explanation of linkage with 34.4% crossover than they do to independent assortment of the factors concerned.

Summary

1. The results are given for the F_1 and F_2 generations of the cross Lightning Express x Pima in which four different character pairs are studied. These character pairs are yellow petals vs. white petals and petal spot vs. no petal spot.

2. Each of the four character pairs apparently differed by a single genetic factor, the deviations of observed ratios from calculated on a 3:1 basis being within the limits of experimental error.

3. The four character pairs assort independently of each other with the exception of the one case yellow vs. white petals and petal spot vs. no spot. Except in the one case mentioned the deviations of observed numbers from the calculated would be expected due to variations of random sampling.

4. The results indicate a linkage of the factors for yellow petals vs. white petals and petal spot vs. no spot with a cross-over percentage of 34.4. The fit for linkage and crossover is much better than that for independent assortment.