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Genetical Studies in *Cajanus cajan* (L.) Millsp.

I. Genetics of Pod Colour

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Summary. From three sets of crosses involving the phenotypes chocolate, red oxide, green with chocolate streaks and green with red oxide streaks, the action of the genes governing the phenotypes of the pods of *Cajanus cajan* (L.) Millsp. has been proposed. Gene L controls production of chocolate colour, L^r an allelomorph of L hitherto unreported, controls production of red oxide colour and gene D controls distribution of this colour. As regards inheritance of these two genes, the relationships between L and L^r is $L > L^r$ and D is incompletely dominant over d. The genotypes of the different phenotypes have been presented.

Introduction

The importance of study of the mode of inheritance of characters to workers engaged in plant breeding work cannot be over-emphasised. It is one of the basic informations which a plant breeder should have for planning any plant breeding programme and also for efficient handling of the material. So far as *Cajanus cajan* is concerned, literature on this aspect of study is unfortunately not well documented. The work of DAVE (1934), SHAW (1936) and MENEZES (1956) may be mentioned in this connection. In view of the wide range of variability met with in *Cajanus*, particularly with regard to oligogenic characters like those of flower, pod and seed-coat colour, it offers a scope for interesting studies.

The work reported here is an account of the studies made on the genetics of pod colour in *Cajanus cajan*.

Material and Method

The different crosses considered in this study were:

(A) Green with chocolate streaks Vs. Red oxide
(B) Green with chocolate streaks Vs. Green with red oxide streaks
(C) Green with chocolate streaks Vs. Chocolate.

The varieties chosen for the crosses were:

(1) *B.7* — pods green with chocolate streaks
(2) *B.* 34 — pods green with red oxide streaks
(3) Kaki. 1 — pods red oxide
(4) *B.*22 — pods chocolate.

Besides a few other intermediate pod colours, these were the chief ones available. For comparison and deciding the colour, the colour chart of Indian Standard Institution was used.

Crosses were made as A, B and C above in 1960—61, F_1 grown in 1961—62 and F_2 and F_3 were grown subsequently in 1962—63 and 1963—64 respectively. The colour of pod was recorded at immature stage, since at mature stage the character cannot be judged properly unless the pods are washed with water. All the crosses were made in reciprocal directions. But as there was no difference between them it is not being dealt with separately. Since *Cajanus* is very shy in taking cross — the average setting percentage (when crosses are effected) being 2—4 per cent only (SEN, 1960, unpublished and RAMANUJAM, 1961, personal communication) — back-crosses were not attempted and the genetic data were collected from F_2 and F_3 populations. The result is presented below:

Experimental Results

In Table 1 are presented the details of crosses attempted, the characters of the F_1s and of the segregating F_2 plants with the χ^2 values. It is evident from the result that the two genes acted independently to produce colour and the distribution thereof.

Since the F_2 plants of the cross involving *B.7* — green with chocolate streaks and Kaki.1 — red oxide, could be conveniently classified according to the ratio 3:6:1:2:1 and also since a large number of plants were available, it was considered worthwhile to concentrate on this particular cross. A large F_3 population was therefore grown to confirm the assumed genetic model governing expression of the pod character in question. In Table 2 below is presented an account of the study made.

Discussion

The mode of inheritance of important morphological characters of crop plants and their genetic control, apart from their being of theoretical interest, have considerable practical implications. These informations provide the plant breeder with necessary tool to build up a desirable stock. The present study on the genetics of pod colour in *Cajanus cajan* (L.) Millsp. was made with the same idea.

It is evident from Tables 1 and 2 that fairly conclusive idea of the genetical model of the characters under consideration may be had from the results presented.

In the cross between Kaki.1 (red oxide pods) and *B.7* (green with chocolate streaks), the F_1 was intermediate in character — i.e. chocolate with green splashes and the F_2 was composed of six clearly distinguishable classes in the ratio of 3:6:3:1:2:1 — a modified dihybrid ratio. In another cross between

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Table 1. *Details of crosses, F_1s, F_2 segregants and the calculated χ^2 values for the assumed ratio*

S. No.	Details of crosses	F_1	F_2 segregants	Expected proportions	Observed frequencies	Expected frequencies	χ^2	P value between
1	Red oxide (Kaki. 1) Vs. Green with chocolate streaks (B. 7)	Chocolate with green splashes	(a) Chocolate	3	235	218.4375	7.699	.20—.10
			(b) Chocolate with green splashes	6	435	436.8750		
			(c) Green with chocolate streaks	3	233	218.4375		
			(d) Red oxide	1	63	72.8125		
			(e) Red oxide with green splashes	2	122	145.6250		
			(f) Green with red oxide splashes	1	77	72.8125		
2	Green with chocolate streaks (B. 7) Vs. Green with red oxide streaks (B. 34)	Green with with chocolate streaks	(a) Green with chocolate streaks	3	164	155.2500	1.272	.20—.10
			(b) Green with red oxide streaks	1	43	51.7500		
3	Green with chocolate streaks (B. 7) Vs. Chocolate (B. 22)	Chocolate with green splashes	(a) Chocolate	1	50	55.0000	0.607	.50—.30
			(b) Chocolate with green splashes	2	113	110.0000		
			(c) Green with chocolate streaks	1	57	55.0000		

B.7 (green with chocolate streaks) and B.34 (green with red oxide streaks), the F_1 was like *B.7* showing dominance of *B.7* pod character and F_2 gave two phenotypes like the two parents in 3:1 ratio — giving a monogenic segregation; the third cross between *B.7* (green with chocolate streaks) and *B.22* (chocolate), the F_1 was intermediate showing incomplete dominance and the F_2 segregated into three phenotypes in 1:2:1 ratio; this is in general agreement with the observations made by DAVE (1934), although, it appears, he combined the two phenotypes, the dominant parental class and the intermediate into one to give a 3:1 ratio.

It thus appears that in *Cajanus* two genes are responsible for the phenotypic expression of pod colour. Using the same gene symbols as proposed by DAVE (1934) and used by subsequent workers later (MENEZES, 1956; JAIN and JOSHI, 1964) the gene action may be proposed thus: gene *L* controls the production of colour and gene *D* controls distribution of the colour so produced. *L* produces chocolate colour while *L'*, an allelomorph of *L*, hitherto unreported, controls production of red oxide colour. Under recessive condition of both of these no colour is produced so that the pods are green. Gene *D*, which controls the distribution of the colour, does so uniformly in homozygous dominant (*DD*) condition. In heterozygous condition of this gene (*Dd*), the distribution is not complete — green islands, which have been termed by us as green splashes, in the main colour background, appear, e.g. chocolate with green splashes, red oxide with green splashes. If the gene is present

Table 2. *F_3 of the cross involving B. 7 and Kaki. 1*

S. No.	F_2 phenotype	Total no. of families studied	F_3 segregation pattern	Ratio	Proposed genotypes of F_2 plants
1	Chocolate	36	(i) Breeds true		*LLDD*
			(ii) Chocolate and red oxide	3:1	*LL'DD*
2	Chocolate with green splashes	66	A (i) Chocolate	1:2:1	*LLDd*
			(ii) Chocolate with green splashes		
			(iii) Green with chocolate streaks		
			B (i) Chocolate	3:6:3:1:2:1	*LL'Dd*
			(ii) Chocolate with green splashes		
			(iii) Green with chocolate streaks		
			(iv) Red oxide		
			(v) Red oxide with green splashes		
			(vi) Green with red oxide streaks		
3	Green with chocolate streaks	34	A (i) Breeds true		*LLdd*
			B (i) Green with chocolate streaks		
			(ii) Green with red oxide streaks	3:1	*LL'dd*
4	Red oxide	13	Breeds true		*L'L'DD*
5	Red oxide with green splashes	19	(i) Red oxide	1:2:1	*L'L'Dd*
			(ii) Red oxide with green splashes		
			(iii) Green with red oxide streaks		
6	Green with red oxide streaks	19	Breeds true		*L'L'dd*

in homozygous recessive condition, the distribution is affected so much so that the colour produced becomes localized in certain areas in the form of long streaks over the fruit surface.

As regards inheritance of these two genes individually, it appears that chocolate is completely dominant over red oxide, i.e. $L > L^r$ and D is incompletely dominant over d — resulting in three phenotypes as is evident in the cross *B.7* × *B.22*. On the basis of this assumption the genotypes of the various phenotypes handled in the present study can be built up as follows:

Phenotypes	Genotypes
Chocolate	*LLDD*
	LL^{r}DD
Chocolate with green splashes	*LLDd*
	LL^{r}Dd
Green with chocolate streaks	*LLdd*
	LL^{r}dd
Red oxide	*L^{r}L^{r}DD*
Red oxide with green splashes	*L^{r}L^{r}Dd*
Green with red oxide streaks	*L^{r}L^{r}dd*

A strong support to this assumption is provided by the result of the F_3 family study presented in Table 2. In our present study unfortunately the green fruited type could not be included due to non-availability of a suitable culture. However, from the study of the wide spectrum of F_2 segregants obtained from *B.7* × Kaki.1 cross, which represented all but one available phenotypes, the construction of the genetic model on the premise that basically colour reproduction depends on two factors appears to be quite conclusive.

Zusammenfassung

An drei Kreuzungsreihen von Sorten unterschiedlicher Hülsenfarbe (schokoladenbraun, rostrot, grün mit schokoladenbraunen Streifen und grün mit rostroten Streifen) wurde die Vererbung dieses Merkmals bei der Straucherbse (*Cajanus cajan* (L.) Millsp.) untersucht. Für das Auftreten der schokoladenbraunen Hülsenfarbe ist das Gen L verantwortlich, L^r, ein bisher unbekanntes Allelomorph von L, für die rostrote Farbe, während das Gen D die Verteilung der Farbe steuert. L ist vollständig dominant über L^r und D unvollständig dominant über d. Auf Grund der gemachten Feststellungen werden die Genotypen für die einzelnen Phänotypen angegeben.

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