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INHERITANCE OF SEED COAT COLOUR PATTERN IN COWPEA [*VIGNA UNGUICULATA* (L.) WALP]

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ABSTRACT
Hybridization experiments were conducted in the screen house to study the inheritance of seed colour pattern in cowpea. Cowpea varieties of varying seed coat colour were used as parents for the investigation. Parental, F_1 and segregating F_2 populations were raised in the field and the study revealed that self colour pattern is dominant over other seed coat colour patterns. The study also revealed that several genes are involved in the control of seed colour patterns and that some of the genes may be allelic.

Key words: hybridization, inheritance, self colour, allelic

INTRODUCTION

Cowpea is an important food legume in the semiarid tropics of Africa, Asia, southern Europe and parts of North and Central America (Singh et al., 1997). In fresh form the young leaves, immature pods, and peas are used as vegetables, while several snacks and main meal dishes are prepared from the grain. All the plant parts that are used for food are nutritious, providing protein, vitamins, and minerals. Cowpea grain contains, on average, 23-25% protein and 50-67% starch. The above ground parts of cowpea, excepting pods, are harvested for fodder (Quin, 1997).Cowpeas grown in different parts of the tropics vary widely in seed colour and type and preference change from region to region (IITA, 1983). In West Africa, the preferred types are white and brown seeds with rough coats, while in East Africa and parts of Latin America red and brown seeds with smooth seed coats are preferred. In other Latin American countries particularly Cuba and parts of Caribbean, the black is preferred (IITA, 1983). These varying preferences show the need to develop varieties with different characteristics, as no single variety can be suitable for all regions. There is a great diversity in pigmentation of cowpea stem, leaf, flower, peduncle, petiole, pod and seeds. Several researchers have studied these traits from 1919 to date. Mann (1914) cited by Fery (1985) showed that anthocyanin and a melanin-like substance are responsible for colour in cowpea and the expression of any pigment on the plant is the result of the interaction between several pigment genes and a general colour factor. The melanin-like pigment is found only in the seed coat and is responsible for a pale yellow to a deep copper-red basal colour. The pigment is always present in the third cell layer and often in the palisade (outer cell) layer of all coloured seed coats and its amount and location vary. This study is aimed at elucidating the inheritance of seed coat colour patterns in cowpea with a view to providing information for use in designing breeding protocols for the growth of cowpea varieties with suitable seed coat colour patterns.

MATERIALS AND METHODS

The study was conducted at the International Institute of Agriculture (IITA) Kano, Nigeria, located at 12 03' N latitude and 8 34' E longitude. Planting was done in the screen house while field trials were conducted at the Research farm located at Minjibir , about 40km north east of Kano. The cowpea varieties used for this study were selected on the basis of their varying seed coat colour. The first cross was between IT88DM-345 self coloured (red) and IT98K-1095-5 self coloured (green), while the second cross was between IT88DM-345 and IT98K-628-1(white seeded with black eye ring). The third cross was between IT98K-628-1 and IT98K-1095-5. Crosses were made in the screen house and the parental and F1 populations were raised in the screen house while the F_2 progenies were grown in the field to study segregation pattern.

The segregation ratios obtained were subjected to Chi-square test to determine the goodness of fit to various genetic ratios.

RESULTS

Cross 1: IT88DM-345 x IT98K-1095-5

The parental lines in this cross were true breeding for red- seeded (345) and green-seeded (1095-5) plants respectively (Plate3) while the F_1 plants derived from the cross had brown-seeded plants (Table 1). Segregation in the F_2 yielded 92 brown-seeded, 36 red-seeded and 81green-seeded plants. This did not fit a 1:2:1 ratio (p>0.05). All reciprocal crosses made were not successful as they failed to yield any seeds.

Cross 2: IT88DM-345 x IT98K-628-1

From Table 2, it could be seen that the parental lines bred true for self coloured (345) and eye ring-colored (628-1) seeds respectively and the F_1 plants derived from the cross had black self coloured seeds (Plate 8).

In the F_2 the segregation pattern was in the form of 68 plants with self colored seeds: 24 plants with Holstein seeds: 41 plants with coloured-eye ring seeds. This closely fitted a 9:3:4 ratio of self colored: Holstein: coloured- eye ring patterns (χ^2 = 2.465). The reciprocal cross gave 107 self colour-seeded: 41 Holstein-seeded: 59 plants with coloured- eye ring and this also fitted a 9:3:4 ratio (P>0.05).

Cross 3: IT98K-628-1 x IT98K-1095-5

All the parental lines used in the above cross bred true for eye ring- coloured seeds (628-1) and self colour-seeded plants (1095-5) respectively (Plate 4) while the F_1 plants derived from the cross had black self coloured seeds (Table 3). Segregation in the F_2 for the forward cross yielded 52 plants with self-coloured seeds, 15 with Holstein seeds and 16 with coloured eye ring seeds and this fitted a 9:3:4 ratio (P>0.05). The reciprocal cross gave 63 plants with self coloured seeds, 16 with Holstein and 34 with coloured eye ring seeds respectively which did not fit a 9:3:4 ratio (P<0.05).

Plate 1: Seeds of parents used for hybridization studies for seed coat colour pattern (Mag.x2)
A = IT88DM-345 (red), B = IT98K-628-1(white), C = IT98K-1095-5(green)

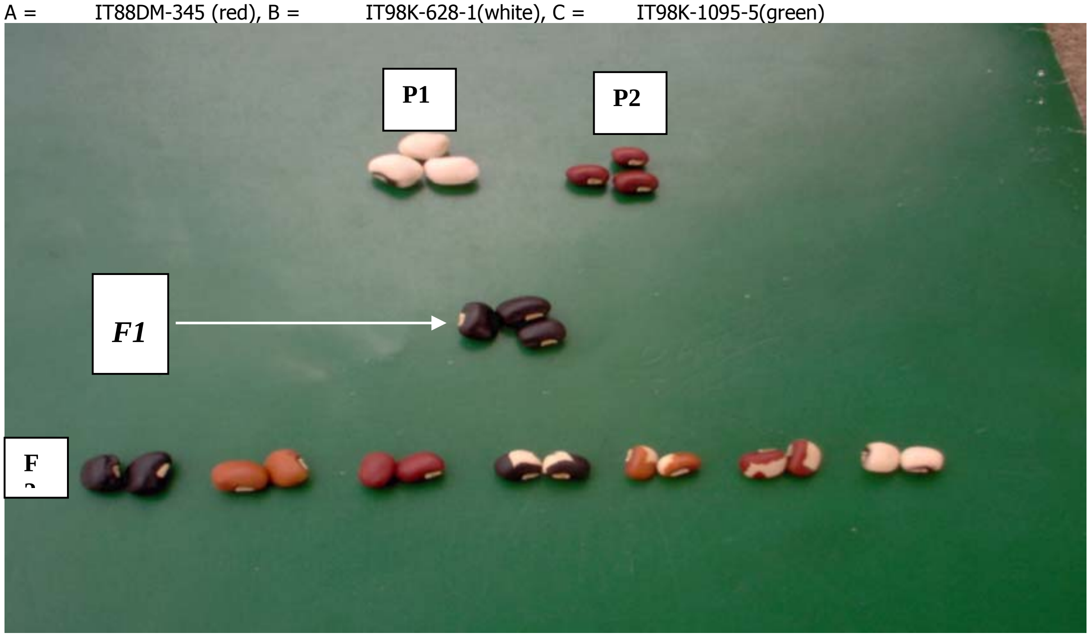

Plate 2: Segregation for seed coat colour pattern in the cross involving IT98K-628-1and IT88DM-345 (Mag.x1)

P1 = IT98K-628-1, P2 = IT88DM-345

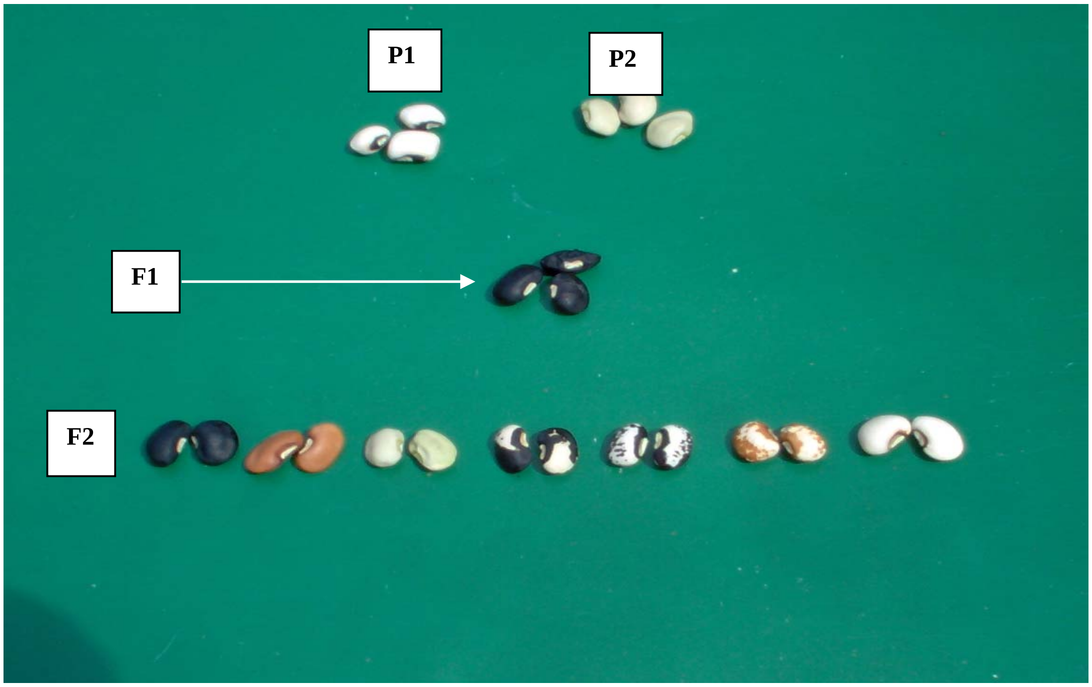

Plate 3: Segregation for seed coat colour pattern in the cross involving IT98K-628-1and IT98K-1095-5 (Mag.x1)
P1 = IT98K-628-1, P2 = IT98K-1095-5

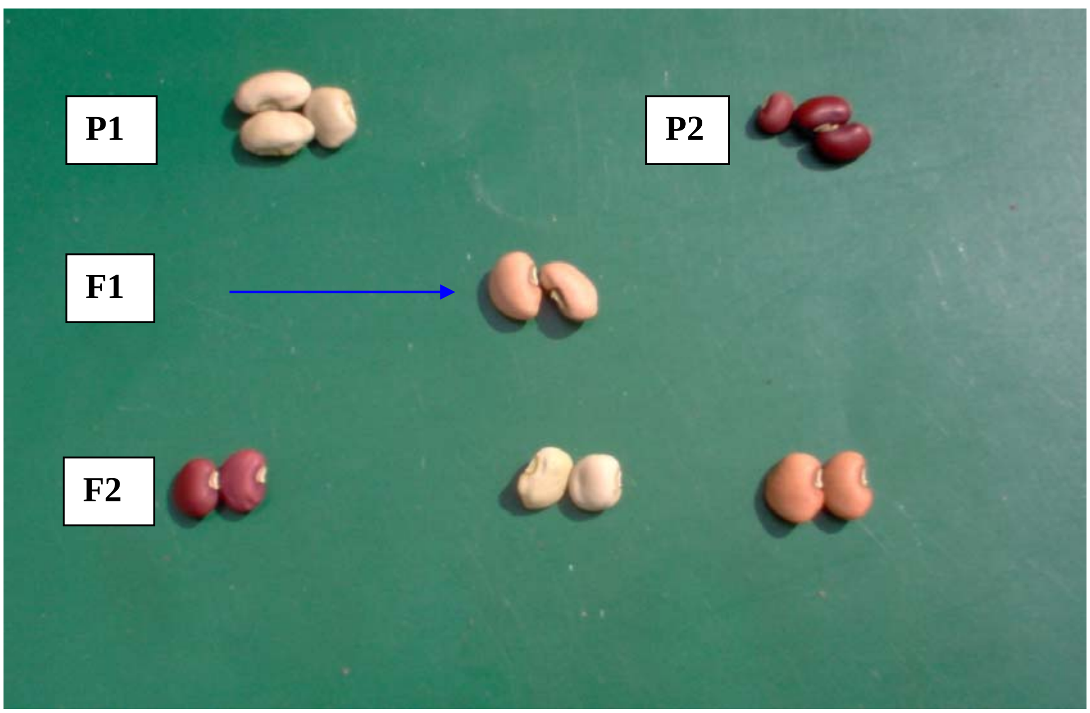

Plate 4: Segregation for seed coat colour pattern in the cross involving IT98K-1095-5 and IT88DM-345 (Mag.x1)
P1 = IT98K-1095-5, P2 = IT88DM-345

DISCUSSION

The cross between green and red seeded plants produced brown seeded F1 progeny, an indication of incomplete dominance of the red seeded parent over the green. In the segregating F2, red, brown and green seeded plants were observed which did not fit the expected 1 :2 : 1 ratio. This could probably be due to the rather small number of seeds obtained. The intermediate dominance relation between red and green seeded plants further
suggests that the two parents are allelic variants and the pattern of inheritance is monogenic.

According to Sangwam and Lodhi (1998) flower and seed colour follow a monogenic Mendelian inheritance where allelic variants are crossed. The cross between red-seeded and white-seeded plants gave three categories of segregating F2 plants that fitted a 9: 3: 4 ratio of self-colour: Holstein: coloured eye ring patterns respectively. This result indicates a recessive epistatic interaction between the genes controlling the traits. In the red-seeded plants, the self-colour gene was in the homozygous dominant form while in the white-seeded plants it was in the heterozygous form. Hybridization could have resulted in self-coloured black seeds in the F1 and segregation in F2 gave the observed ratio. The self-colour black-seeded F1 plants are an indication of the dominance of self-colour gene over the others.

In the cross between green-seeded and white-seeded plants a segregation pattern similar to the one above was observed, an indication that several pairs of genes are involved in the control of seed coat pattern. The F1 seeds were black in colour an indication of the dominance of black colour gene even though it was restricted to the eye in the white parent. Spillman and Sando (1980) suggested five genes controlling various seed coat patterns while Fery (1980), went on to suggest that several of the genes governing the trait may be allelic. It could be concluded that several genes are involved in the control of seed coat colour patterns and they interact to produce varying patterns.

Table 1: Segregation for Seed Coat Colour in different Populations of the cross involving 1T88DM-345 and 1T98K-1095-5

Population	Generation	Number of Plants With			Expected Ratio	χ^2	Probability
		* RS	Brws	GS			
1T88DM-345 (345)	Parent	0	25	0			
IT978K-1095-5 (1095-5)	Parent	0	0	25			
	F_1	33	0	0			
	F_2	36	92	81	1:2:1	22.02	P<0.05

*RS=Red seeds ,BrwS=Brown seeds, GS=Green seeds.

Table 2: Segregation for Seed Coat Colour Patterns in different Populations of the cross involving 1T88DM-345 and 1T98K 628-1

Population	Generation	Number of Plants With			Expected Ratio	χ^2	Probability
		*SCS	HS	CES			
IT88DM-345 (345)	Parent	25	0	0			
IT978K-628-1 (628-1)	Parent	0	0	25			
345 x 628-1	F_1	35	0	0			
	F_2	68	24	41	9:3:4	2.465	0.2-0.3
628-1x345	F_1	39	0	0			
	F_2	107	41	59	9:3:4	1.94	0.3-0.5

*SCS= Self colour seeds, HS = Holstein seeds, CES = Coloured eye ring seeds.

Table 3: Segregation for Seed Coat Colour Patterns in different Populations of the cross involving 1T98K-628-1 and 1T98K-1095-5

Population	Generation	Number of Plants With			Expected Ratio	χ^2	Probability
		*SCS	HS	CES			
1T98K-628-1(628-1)	Parent	0	0	25			
IT978K-1095-5 (1095-5)	Parent	25	0	0			
628-1 x 1095-5	F_1	34	0	0			
	F_2	52	15	16	9:3:4	1.841	0.3-0.5
1095-5 x 628-1	F_1	42	0	0			
	F_2	63	16	34	9:3:4	13.065	P<0.05

*SCS =Self colour seeds, HS = Holstein seeds, CES= Coloured eye ring seeds.

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