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INHERITANCE OF COLOUR PATTERNS IN COWPEA (*VIGNA UNGUICULATA* L. WALP.)

M. I. UGURU

Department of Crop Science, University of Nigeria, Nsukka, Nigeria

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ABSTRACT

The inheritance patterns of the contrasting petal colour, purple and white; pod colour, purple and straw-white; and shoot colour, purple and green were studied. Analysis of the F_2 and backcross populations showed that petal colour is governed by one allelic pair *WW*, while pod and shoot colours appear to be determined pleiotropically by two allelic pairs, *PrPr* and *GrGr*, interacting in as recessive suppressors. The *PrPr* gene seems to be a set of localized alleles that determine the different purple colour intensities on pods. Deep purple pods are produced by the genotype *PrPr*; light purple by *Prpr*; and straw-white pods by prpr. Because *prpr* is capable of suppressing *Gr-* (recessive suppressor) the genotypes *prpr Gr–* produced normal green shoots or with very mild streaks of anthocyanin and straw-white pods. The genotypes *Pr– Gr–*, *Pr– grgr* and *prpr grgr* produced pigmented shoots and pods.

Key words: Colour, inheritance, cowpea, *Vigna unguiculata.*

Pigmentation is a common feature of most Nigerian vegetable cowpeas and its presence is due to the anthocyanin pigment. This soluble compound imparts purple colour on the shoot, pods and petals of cowpea. However, colour intensity on the pods tends to vary from very deep purple to light purple at full maturity and in dry pods.

Whereas any plant with purple shoot has purple pods, plants with purple petals may have either purple or green shoots in vegetable cowpea.

Inheritance studies on pigmentation in grain cowpea have been frequently made but similar studies on the vegetable cowpea are lacking in published literature. The present paper deals with the latter.

MATERIALS AND METHODS

Two accessions each of vegetable and grain cowpeas with the following characteristics were used in the study.

P_1 = AN-16-D: a vegetable cowpea with purple shoots, purple pods, and purple petals

P_2 = AE-36-S: a vegetable cowpea with green shoots, straw-white pods, and purple petals

P_3 = AD-36-W_B: a grain cowpea with green shoots, straw-white pods, and white petal

P_4 = AD-36-W: a grain cowpea with green shoots, straw-white pods, and purple petals

The seeds of these accessions were planted in small plots of 1.2 x 1.8 m each at the spacing of 90 x 30 cm [1]. Hybrid seeds (AE-36-S x AN-16-D) and (AD-36-W_B x AD-36-W) were produced by hand pollination using the method of Utuk [2]. The F_2 and F_3 generations were obtained by allowing natural self-pollination of the F_1 and F_2 populations, respectively. Backcrosses were made during flowering by crossing the F_1 hybrids with both parents. Numerical counts were made in the segregating populations to determine the inheritance pattern of different characters under investigation.

The χ^2 test was used to ascertain the goodness of fit to the expected phenotypic ratio.

RESULTS AND DISCUSSION

PETAL COLOUR

The F_2 plants resulting from the cross between the white flowered AD-36-W_B and the purple flowered AD-36-W had nearly intermediate (light purple) colour, so that the purple petal colour appeared to be partially dominant over the white petal colour. The F_2 population segregated into 44 purple : 102 light purple : 39 white (Table 1), a good fit to 1 purple : 2 light purple : 1 white ($\chi^2 = 2.2$, $p > 0.10$). A combination of the intermediate and the true purple colours gave another good fit to 3 purple : 1 white ($\chi^2 = 0.146$, $p > 0.50$). Further analysis on the assumption of a 15 purple : 1 white ratio did not show a good fit to the data ($\chi^2 = 64.96$, $p < 0.01$).

The backcross (AD-36-W_B x AD-36-W) x AD-36-W produced progeny with only purple petals, while the other backcross (AD-36-W_B x AD-36-W) x AD-36-W_B produced plants that segregated into 67 purple and 61 white petaled plants (Table 1). This is a good fit to 1 : 1 purple : white ratio ($\chi^2 = 0.28$, $P > 0.50$). The good fit to both 1 : 2 : 1 and 3 : 1 ratios stresses the need for a more critical evaluation of the results. The χ^2 value of 0.146 for perfect dominance is about 16 times lower than 2.22 obtained for incomplete dominance. This coupled with the considerable remoteness of the p value > 0.5 of the perfect dominance from $p = 0.05$ when compared to that of the incomplete dominance $p > 0.1$ confirms the 3 : 1

Table 1. Segregation pattern of petal colour in F_1, F_2 and backcross populations of cowpea

Cross	F_1 pheno-type	Segregation in F_2						Segregation in backcross populations					
		purple	light purple	white	ratio	χ^2	P	purple	light purple	white	ratio	χ^2	P
AD-36-W_B x AD-36-W	Purple	44	102	39	1:2:1	2.22	0.50–0.10	—	—	—			
		146	—	39	3:1	0.146	0.80–0.50	—	—	—			
		146	—	39	15:1	64.96	< 0.01	—	—	—			
(AD-36-W_B x AD-36-W) x AD-36-W_B	—	—	—	—	—	—	—	67	—	61	1:1	0.28	0.90–0.50
(AD-36-W_B x AD-36-W) x AD-36-W	—	—	—	—	—	—	—	All plants produced purple petals					

Table 2. Mode of inheritance of shoot and pod colours in F_1, F_2, F_3 and backcross generations

Cross	F_1 Pheno-type	Segregation in F_2 13 : 3				Behaviour of F_3 families 7 : 8 : 1					Segregation pattern in backcrosses 1 : 1			
		purple shoots and pod	green shoots, white pods	χ^2	P	purple shoots and pods	segr. white pods	green shoots, and pods	χ^2	P	purple shoots	green shoots, white pods	χ^2	P
AE-36-S x AN-16-D	Purple shoots and pods	Obs. 548 Exp. 539.5	116 124.5	0.714	0.50–0.10	Obs. 83 Exp. 87.5	108 100	9 12.5	1.85	0.5–0.10	—	—	—	—
AE-36-S x AN-16-D	—	—	—	—	—	—					Obs. 187 Exp. 124.5	62 124.5	94.37	< 0.01

monohybrid ratio. Thus, one allele pair, *WW*, governs the inheritance of petal colour. The genotype *WW* produces purple, *Ww* relatively lighter purple, and *ww* white petals. The 3 : 1 monohybrid ratio is in agreement with earlier reports [3, 4].

POD AND SHOOT COLOURS

Table 2 shows joint segregation of pod and shoot colours in the F_2, F_3 and backcross populations. The F_1 progeny of the cross AN-36-S x AN 16-D had pigmented shoot and pods, an indication of dominance of pigmented shoot over the nonpigmented [4]. All F_2 plants with purple shoots produced purple pods and the normal green plants produced straw-white pods. However, a few plants with mild streaks of anthocyanin on the shoot produced straw-white pods. This scheme tends to suggest that the genes governing pigmentation on shoots are the same as those which pleiotropically determine different purple shades on the pods [5]. The F_2 segregation ratio of 548 plants with pigmented shoots and pods : 116 plants with nonpigmented shoots and pods (Table 2) is a good fit to 13 : 3 ratio ($\chi^2 = 0.714$, $P > 0.10$). Support for this scheme was obtained from the segregation pattern of 200 F_3 families. Eighty-three F_3 families bred true for purple shoot and pod; 108 segregated; and 9 bred true for green shoots and straw-white pods, a good fit to 7 : 8 : 1 ratio ($\chi^2 = 1.85$, $P > 0.10$). The 13 : 3 ratio appears to implicate two separate loci as proposed by [6, 7]. However, the 13 : 3 ratio does not support duplicate gene action hypothesis of the former authors. Rather, it implicates a modifier gene interaction in the form of a recessive suppressor. Two allelic pairs, one major pair (*GrGr*) and a localized pair (*PrPr*) seem to interact and govern the inheritance of pigmentation on the cowpea shoots and pods. The localized alleles may, depending on the forms in which they are present, produce deep purple, light purple or straw-white pods. Deep purple pods are produced in dominant homozygous (*PrPr*) condition; light purple pods appear in the genotype *PrPr*, while straw-white pods are produced by the genotype *prpr*. Since *prpr* is capable of suppressing *Gr–* (recessive suppressor), the cowpea shoots with either green colour or mild streaks of anthocyanin produce straw-white pods. Both the shoots and pods were pigmented in the *Pr– Gr–*, *Pr– grgr* and *prpr grgr* genotypes.

In conclusion, the possible genotypes of the experimental strains may be represented as:

AN-16-D (pigmented shoots, pods and petals): *Pr– Gr– Wr–*, *Pr– grgr W–* and *prpr grgr W–*

AN-36-S (nonpigmented shoots and pods, and pigmented petals): *prpr Gr– W–*

AD-36-W (nonpigmented shoots and pods, pigmented petals): *prpr Gr– W–*

AD-36-W_B (nonpigmented shoots, pods and petals): *prpr Gr– WW*.

REFERENCES

1. B. A. C. Enyi. 1971. A spacing time of planting trial with cowpea (*Vigna unguiculata*). Ghana J. Sci., **13**(1): 78–85.

2. V. E. Utuk. 1974. Optimum time for Artificial Pollination in Cowpea (*Vigna sinensis* Endl.). Research Bulletin No. 1. Federal Department of Agric. Res., Ibadan: 1–9.

3. S. Premsekar and V. S. Raman. 1972. A genetic analysis of the progeny of the hybrid *Vigna sinensis* (L.) and *Vigna sesquipedalis* (L.) Frauw. Madras Agric. J., **59**: 449–456.

4. A. K. Kolhe. 1970. Genetic studies in *Vigna* sp. Poona Agric. Coll. Mag., **59**: 126–137.

5. N. D. Das and S. Dana. 1980. Linkage in rice bean. Indian J. Genet., **40**(1): 105–116.

6. R. Viruopal and J. V. Goud. 1977. Inheritance of pigmentation of cowpea. Curr. Sci., **46**(8): 277.

7. A. R. Saunders. 1960. Inheritance in cowpea (*Vigna sinensis* Endl.). 2. Seed coat colour pattern, flower, plant and pod colour. South Afr. J. Agric. Sci., **3**(2): 141–162.