FULL LENGTH RESEARCH ARTICLE

INHERITANCE OF POD COLOUR IN COWPEA (*Vigna unguiculata* (L.) WALP)

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ABSTRACT

Hybridization experiments were conducted in the screen house to study the pattern of inheritance of pod and pod tip pigmentation in cowpea. Segregating F_2 populations were raised along with F_1 and parental lines while F_3 progenies were raised later for progeny testing. Chi-square test was used to analyze the result obtained with a view to determining the number of genes controlling the traits. Pod pigmentation is digenic while pigmentation in the pod tip followed two patterns of inheritance (monogenicity and digenicity). The investigation revealed that pigmentation is dominant over non-pigmentation

Key words: Cowpea, Inheritance, dominant, monogenicity, and digenicity.

INTRODUCTION

Cowpea is an important food legume and an essential component of cropping systems in the drier regions of the tropics. It is cultivated in Asia and Oceania, the Middle East, southern Europe, Africa, southern USA, and Central and South America (Perrino *et al.* 1992). Other benefits derived from cowpea especially by the rural poor include animal feed, cash and spillover benefits to their farmlands through insitu decay of root residues and ground cover from cowpea's spreading and low growth habit (Quin1997).

There is a great diversity in the pigmentation of the different parts of the cowpea plant. 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. (give reference). The pods of many cowpea varieties contain anthocyanin and are either partially or wholly purple. Harland (1920) found that wholly purple pods are dominant to green pods and a single gene governs the trait. Sen & Bhowal (1961) suggested that three alleles at the gene locus govern green pod with purple tip, green pod with purple ventral suture and purple pod with green sutures; and also identified two additional pod pigmentation genes; one conditions green pods with purple sutures, scattered small purple patches and purple tips; and the other conditions green pods with faintly purple sutures. They also reported that amber-straw and brownish-straw colours of dry pods are monogenically dominant over the straw colour.Sangwan and Lodhi (1998) studied the inheritance of flower and pod colour.The observed that black pod colour is partially dominant over white pod colour.

The pattern of inheritance of pod colour in cowpea is of great interest to breeders because its understanding could lead to the development of novel plant types with desirable pod colour characteristics. This study was conducted with a view to elucidating the pattern of inheritance of pod colour in the cowpea.

MATERIALS AND METHODS

The study was conducted at the International Institute of Tropical Agriculture (IITA) Kano, Nigeria, located at 12° 03' N latitude and 8° 34' E longitude. Experiments were carried out in the screen house at the Kano Station, while field trials were conducted at the Research Farm located at Minjibir, about 40 km North East of Kano.

The cowpea varieties used for this study were selected on the basis of their varying pod colour. Segregating populations were derived from two crosses. The first was between TVx-3236-1 (with pod and pod tip) and IT97K-1101-5 (with purple pod and pod tip), while the second cross was between TVx-3236-2 (with green pod and pod tip) and IT97K-1101-5 (with purple pod and pod tip). Crosses were made in the screen house and the F1 progenies were raised to obtain F2 seeds. The parental, F1 and F2 plants were raised in the field to study the segregation pattern. F3 progeny testing was also carried out in the field.

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

RESULTS

The variation for pod colour among the parents used in this study is shown in Plate 1.

Pod pigmentation

Cross 1: TVx-3236-1 x IT97K-1101-5: Table 1 shows that the parental lines used for the crosses were true breeding for non-pigmented (TVx-3236-1) and pigmented (IT97K-1101-5) pods respectively (Plate1) and F_1 plants derived from both crosses had pigmented pods. Segregation in the F_2 yielded 94 plants with pigmented pods and 83 with non-pigmented pods, which fitted closely to a 9:7 ratio (P>0.05).

The reciprocal cross yielded 146 plants with pigmented pods and 108 with non-pigmented pods, which also fitted a 9:7 ratio ($\chi^2 = 0.156$). The evaluated F_3 progenies both fitted closely to a 9:7 (p>0.05) ratio having yielded 523 and 489 plants with pigmented pods and 346 and 338 plants with non-pigmented pods respectively confirming the earlier values obtained.

PLATE 1: VARIATION FOR POD COLOUR IN THE COWPEA VARIETIES USED FOR HYBRIDIZATION STUDIES AT IITA KANO STATION (scale x0.5)

A = Purple pod and pod tip, B =Green pod with purple tip, C =Green pod.

Cross2: TVx-3236-2 x 1T97K1101-5: Table 2 shows that the parental lines bred true for pigmented (IT97K-1101-5) and non-pigmented (TVx-3236-2) pods while the F_1 plants derived from both crosses all had pigmented pods. The F_2 plants segregated into 78 with pigmented pods and 42 with non-pigmented pods while the reciprocal cross yielded 121 and 90 plants with pigmented and non-pigmented pods respectively and both fitted a 9:7 ratio (P>0.05). The segregating F_3 progenies yielded 205 and 352 plants with pigmented pods and 150 and 281 with non-pigmented pods respectively and both fitted a 9:7 ratio. These indicated that the trait is inherited digenically.

Pod tip Pigmentation

Cross 3: TVx-3236-1 x 1T97K 1101-5: The lines used as parents bred true for non-pigmented (TVx-3236-1) and pigmented (IT97K-1101-5) pod tips (Plate1) and all the F1 plants had pigmented pod tips indicating dominance of pigmentation over non-pigmentation.

The F_2 segregated into 110 plants with pigment pod tips and 84 with non-pigmented pod tips, which fitted closely to a 9:7 ratio. The reciprocal cross gave 155 and 180 plants with pigmented and non-pigmented pod tips respectively, which also fitted a 9:7 ratio (P>0.05) further confirming that the trait is digenically inherited (Table 3). The F_3 progenies evaluated also fitted a 9:7 ratio in both crosses (χ^2 = 1.901; 1.584) having yielded 513 and 608 plants with pigmented pod tips and 363 and 437 with non-pigmented pod tips respectively.

Cross 4: TVx-3236-2 x 1T97K 1101-5: The parental lines all bred true for non-pigmented pod tips (TVx-3236-2) and pigmented pod tips (IT97K-1101-5). Segregation in F2 yielded 96 plants with pigmented pod tips and 33 with non-pigmented pod tips while the reciprocal cross gave 168 and 65 plants with pigmented and non-pigmented pod tips respectively and both fitted closely to a 3:1 ratio (Table 4).

TABLE 1. SEGREGATION FOR POD PIGMENTATION IN DIFFERENT POPULATIONS OF THE CROSS INVOLVING TVX-3236-1 AND 1T97K-1101-5

Population	Generation	Number of Plants With		Expected Ratio	χ^2	Probability
		*PP	NPP			
TVx3236-1 (TVx-1)	Parent	0	25			
IT97K-1101-5 (1101-5)	Parent	25	0			
TVx –1 x 1101-5	F_1	32	0			
	F_2	94	83	9:7	0.711	0.3-0.5
	F_3	523	346	9:7	5.465	P<0.05
1101-5 x TVx-1	F_1	38	0			
	F_2	146	108	9:7	0.156	0.5-0.7
	F_3	489	338	9:7	2.785	0.05-0.1

*PP = Pigmented Pods, NPP = Non-pigmented Pods.

TABLE 2. SEGREGATION FOR POD PIGMENTATION IN DIFFERENT POPULATIONS OF THE CROSS INVOLVING TVX-3236-2 AND 1T97K-1101-5

Population	Generation	Number of Plants With		Expected Ratio	χ^2	Probability
		*PP	NPP			
TVx3236-2 (TVx-2)	Parent	0	25			
IT97K-1101-5 (1101-5)	Parent	25	0			
TVx –2 x 1101-5	F_1	36	0			
	F_2	78	42	9:7	3.73	0.05-0.1
	F_3	205	150	9:7	0.322	0.5-0.7
1101-5 x TVx-2	F_1	42	0			
	F_2	121	90	9:7	0.103	0.7-0.8
	F_3	352	281	9:7	0.105	0.7-0.8

*PP = Pigmented Pods, NPP = Non-pigmented Pods.

TABLE 3. SEGREGATION FOR POD TIP PIGMENTATION IN DIFFERENT POPULATIONS OF THE CROSS INVOLVING TVX-3236-1 AND 1T97K-1101-5

Population	Generation	Number of Plants With		Expected Ratio	χ^2	Probability
		*PPtip	NPPtip			
TVx-3236-1 (TVx-1)	Parent	0	25			
IT97K-1101-5 (1101-5)	Parent	25	0			
TVx -1x 1101-5	F_1	32	0			
	F_2	110	84	9:7	0.0016	0.95-0.98
	F_3	513	363	9:7	1.901	0.1-0.2
1101-5 x TVx-1	F_1	38	0			
	F_2	155	108	9:7	0.77	0.3-0.5
	F_3	608	437	9:7	1.584	0.2-0.3

*PPtip = Pigmented Podtips, NPPtip = Non-pigmented Podtips.

TABLE 4. SEGREGATION FOR POD TIP PIGMENTATION IN DIFFERENT POPULATIONS OF THE CROSS INVOLVING TVX-3236-2 AND 1T97K-1101-5

Population	Generation	Number of Plants With		Expected Ratio	χ^2	Probability
		*PPtip	NPPtip			
TVx3236-2 (TVx-2)	Parent	0	25			
IT97K-1101-5 (1101-5)	Parent	25	0			
TVx -2x 1101-5	F_1	36	0			
	F_2	96	33	3:1	0.023	0.8-0.9
	F_3	294	118	3:1	2.908	0.05-0.1
1101-5 x TVx-2	F_1	42	0			
	F_2	168	65	3:1	1.043	0.3-0.5
	F_3	408	143	3:1	0.267	0.5-0.7

*PPtip = Pigmented Podtips, NPPtip = Non-pigmented Podtips.

This indicated that the trait is monogenically inherited and that segregation occurred with respect to one gene only. The F3 progenies further confirmed the monogenic inheritance of this trait for both crosses by yielding 294 and 408 plants with pigmented pod tips and 118 and 143 with non-pigmented pod tips respectively and both fitted a 3:1 ratio (P>0.05).

DISCUSSION

Pod pigmentation appears to be digenically inherited as indicated by the 9:7 ratio in F_2 and F_3 progenies for the cross combinations evaluated. This shows the dominance of pigmentation over non-pigmentation, which is in agreement with the work of Harland (1920) who reported that wholly purple pods are dominant over green pods. Complementarity is suggested as the mode of interaction between the genes controlling the trait such that the two alleles must be present for purple colour to show on pods. In a similar investigation, Uguru (1995) showed that pod colour appears to be determined pleiotropically by two allelic pairs. In an investigation of the inheritance of inverted V-shaped marks on leaves, pod dehiscence and dry pod colour in cowpea crosses involving wild, weedy, and cultivated varieties, Aliboh *et al.* (1996) reported monogenic dominant inheritance for all three traits while studying segregation pattern in F_2 and backcross generations.

Pigmentation on the pod tip was dominant over non-pigmentation and two pairs of genes appeared to control the trait in a complementary manner. In the cross involving TVx-3236-2 and 1101-5 however, a different pattern of inheritance suggesting the involvement of a single gene pair was observed. While the former statement agreed with the findings of Harland (1920) the latter does not This could be explained based on the fact that TVx-3236-2 had pigmentation on its flower (wing) an indication of the presence of the colour factor which is also present in IT97K-1101-5.Segregation thus occurred with respect to one gene (3:1 ratio) as against two genes in the TVx-3236-1 x IT97K-1101-5 cross. This meant that variety TVx-3236-1 is recessive for both colour factor and pod tip pigmentation genes; variety TVx-3236-2 is dominant for colour factor gene but recessive pod tip pigmentation gene while 1101-5 had both genes in the dominant form.

Based on the findings of this investigation it could be concluded that pod pigmentation is digenic while pod tip pigmentation follows two patterns of inheritance (monogenicity and digenicity).

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