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SEED COAT INHERITANCE IN THE COWPEA (*VIGNA UNGUICULATA* (L.) WALP)

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Abstract

Seed coat inheritance in the cowpea was studied, using the three cowpea varieties "1977", "Ibadan Market" (IM), and Local sesquipedalis (LS). The following crosses were made: solid black (IM) × brown small eye (1977) and brown small eye (1977) × solid red (LS). Four Mendelian factors *Bl, R, H* and *W* interacted to produce the seed cost patterns observed. *Bl* is the gene controlling black seed coat, *R* is the gene controlling red seed coat pattern, *H* is the gene controlling hostein seed coat pattern and *W* is the gene controlling watson seed coat pattern . The gene *R* is dominant to gene *Bl*; gene *R* is a suppressor gene that suppresses the gene combination *hhww* responsible for small eye, modifying it to the dominant state *H-W-* to give a solid seed coat pattern. The recessive gene *bl* in the homozygous state is epistatic to the dominant gene *R* , this is evidence of recessive epistasis.

Introduction

Seed coat pattern is a description of the mode of distribution of colour on the coat of the seed. Earlier works have suggested that seed coat patterns are the result of gene interaction. Spillman (1911) was the first to attempt an explanation of seed coat pattern inheritance. Watson pattern from a variety name was first described by Spillman who gave it the symbol name , *W*. Another gene called Holstein by Spillman & Sando (1930) was described and given the symbol name, *H*. They found that interaction of the two genes *W* and *H* resulted in a solid-coloured seed coat. Gene for black seed coat was first donated by Harland (1920) as *B*. Spillman & Sando (1930) assigned the gene symbol, *W* to the whippoorwill mottle pattern but Fery (Singh & Rachie, 1985) suggested *Wh* instead, since the former gene designation had been assigned to a different character already. Franckowiack and Barker (Singh & Rachie, 1985) concluded that several of the genes are allelic to the gene governing black seed coat. Seed coat patterns: watson, holstein, eye and hilum ring are the result of interaction of at least three genes which also determine flower colour (Harland, 1920). The gene *R* for red seed coat pattern appears to act also as a basic colour gene. All seed coat colours, except red, are the result of interaction of two or more genes. Agble (1969), in his work on cowpea, suggested three Mendelian factors governing seed coat patterns. This paper reports on the results of the investigation into gene interaction in the cowpea; it was observed that interaction of four Mendelian factors produced seed coat patterns.

Experimental

Three cowpea varieties *(Vigna unguiculata* (L.) Walp), "1977", "Ibadan Market" (IM) and Local sesquipedalis (LS), collected from Department of Crop Science, University of Ghana , Legon, were used for the study. Seed coat patterns for these varities were: "1977" - small brown eye; IM - solid black; LS - solid red. Table 1 describes other seed coat patters mentioned in the test according to Saunders (1959).

The investigation was carried out on an experimental plot in the Department of Botany , University of Ghana, Legon. Crosses were made between August and October, 1990. F_2 generation was raised from F_1 generation between January and March, 1991. The crosses were: "1977" × IM ; "1977" × LS. Genotypes for F_1 and F_2 generations were suggested by using gene symbols of

Spillman & Sando (1930) and Harland (1920). Chi-square test of significance was used to determine mode of inheritance in F_2 seed coat patterns.

TABLE 1
Description of the five seed coat patterns mentioned in the work

Seed coat	*Description*
Holstein	Seed colour has definite eye margin which extends over a large portion of the seed coat (Saunders, 1959).
Small eye	Colour around the hilum is discontinuous, consisting of two separate elongated colour on either side of, and parallel to, the hilum (Saunders, 1959).
Solid	Seed colour extends more or less evenly over the entire seed coat (Saunders, 1959).
Watson	Edges of coloured area around hilum are not sharply demarcated but are broken up into separate fine spots especially at the micropylar end of seed (Saunders, 1959).
Whippoorwill	Seed coat has irregular areas of dark shade separated by lighter area (Singh & Rachie, 1985).

Results and discussion

Solid black (IM) × brown small eye ("1977")

Results for the cross are presented in Table 2. The F_1 progenies are solid black indicating that solid black is dominant to brown small eye. Five different classes were observed in the F_2 generation where the two parental classes showed higher numbers. Three F_2 extension seed coat patterns, namely whippoorwill brown mottled, black watson and black holstein, were recognized. The following seed coat patterns segregate in the classical Mendelian ratio 3:1; solid : whippoorwill brown mottle (χ^2 =1.2549, P = 0.30 - 0.20) and whippoorwill brown mottled : black small eye (χ^2 = 0.6732, P = 0.50 - 0.30). The three patterns, black small eye: watson black : holstein black, segregate in the ratio 12:3:1 (χ^2 =1.8745, P = 0.20 - 0.10). The total of

TABLE 2
Seed coat patterns for F_1 and F_2 of the cross: IM × "1977"

P		IM (solid black)		"1977" (brown eye)	
F_1			solid black		
F_2	solid black (212)	whippoorwill mottled (60)	watson black (32)	holstein black (14)	small eye black (158)

this ratio is 16 indicating that two pairs of genes are involved in the production of these three seed coat patterns.

It is likely that these two pairs of genes interact with a third pair to account for the six F_2 seed coat patterns. Holstein and watson seed coat patterns are controlled by the two dominant genes *H* and *W*, respectively (Spillman, 1911; Spillman & Sando, 1930) which combine to give self-colour or solid seed coat pattern. Small eye is the result of the double recessives of these two genes. The experimental results indicate that there is complementary gene action of the genes *H* and *W* on a background of a third gene locus controlling colour. Therefore, three Mendelian factors interact to produce the seed coat patterns in the F_2 progenies of the cross. A scheme suggesting how the three Mendelian factors interact to produce the seed coat patterns is presented in Table 3. From the table, eight different seed coat patterns were expected. However, only six were recovered in the experimental results, possibly due to small sample size.

The proposed gene, *Bl_*, for black colour interact with the combination H_W_ to produce solid black, while the double recessive gene *bl* in the homozygous condition interact with *H_W_* to produce whippoorwill brown mottle pattern. *Bl* interact with *hhww* to produce black small eye, *blbl* interact with *hhww* to produce brown small eye, while *blbl* interact with *H-ww* to produce holstein brown.

TABLE 3

Suggested genotypes for F_2 progeny of the cross: solid black × brown eye (IM × "1977")

	*W_*	*ww*
	blbl	
*H_*	*blblh_W_* (whippoorwill mottled brown)	*blblH_ww* (holstein brown)
hh	**blblhhW_* (watson brown)	**blblhhww* (brown small eye)
	Bl_	
*H_*	*Bl_H_W_* (solid black)	*Bl_H_ww* (hostein black)
hh	*Bl_hhW_* (watson black)	*Bl_hhww* (black small eye)

* Not recovered in experimental results

Brown small eye ("1977") × solid red (LS)

Results for the cross are shown in Table 4. All F_1 progenies showed solid brown seed coat pattern. In the F_2, five classes were observed, the two parental seed coat patterns and three extension seed coat patterns solid brown, solid black and holstein brown. From the data, the parental varieties differ by one locus in the following seed coat paterns: solid black and small eye ($\chi^2 = 0.9231, P =$

TABLE 4
Seed coat patterns for F_1 and F_2 of the cross: "1977" × LS

P		"1977" (brown small eye)		LS (solid red)	
F_1			solid brown		
F_2	solid brown (86)	solid black (22)	holstein (38)	small eye brown (8)	solid red (54)

0.50 - 0.30); holstein brown and small brown eye ($\chi^2 = 0.0778$, $P = 0.80 - 0.70$); solid red and solid black ($\chi^2 = 0.6056$, $P = 0.50 - 0.30$) and solid brown and solid red ($\chi^2 = 1.2345$, $P = 0.30 - 0.20$). Solid brown, solid black and small brown eye segregated in the ratio 12:3:1 ($\chi^2 = 0.0919$, $P = 0.80$-0.70). genes to produce the five different types of seed coat patterns in the F_2.

The experimental results suggest the presence of a gene which might be responsible for red colour. Table 5 shows suggested genotypes for the F_2 progenies. The seed coat patterns solid brown,

TABLE 5
Suggested genotypes for F_2 progeny of the cross: brown small eye × solid red ("1977" × LS)

	blblww	
	*R_*	*rr*
*H_*	*blblH_wwR_* (holstein brown)	**blblH_wwrr* (holstein black)
hh	*blblhhwwR_* (solid brown)	*blblhhwwrr* (brown small eye)
	*Bl_W_*	
	*R_*	*rr*
*H_*	*Bl_H_W_R_* (solid red)	*Bl_H_W_rr* (solid black)
hh	**Bl_hhW_R_* (watson red)	**Bl_hhW_rr* (watson)

* Not recovered in experimental results.

Solid brown, solid red, small brown eye segregated in the ratio 9:6:1 ($\chi^2 = 1.1999$, $P = 0.30 - 0.20$). These ratios suggest that two pairs of genes are involved in the segregation of these seed coat patterns. These two pairs of genes might interact with other solid red and solid black are assigned the genotypes *blblhhwwR_*, *Bl_H_W_R_* and *Bl_H_W_rr*, respectively. The patterns holstein brown and brown small eye are assigned the genotypes *blblH_wwR_* and *blblhhwwrr*, respectively. Combination of the two dominant genes *H* and *W* results in solid seed coat colour (Spillman & Sando, 1930), while combination *hhww* of their recessives results in small eye pattern (Spillman, 1911). In the experimental results, the genotype *blblhhwwR_* produces a solid seed coat pattern, instead of small eye, as a result of gene interaction. It is likely that the gene *R_* suppresses the effect of *hhww* modifying it into its dominant state *H_W_* to give a solid seed coat. The genotype *Bl _H_W_R_* produces solid red thus suggesting that *R*, the gene for red, is dominant to *Bl,* the gene for black. The genotype *blblH_wwR_* produces holstein brown though *R_* is present. This suggests that *bl* in the homozygous condition is epistatic to the dominant gene *R*.

Conclusion

The following four Mendelian factors: Bl, gene responsible for black seed coat; *R*, gene responsible for red seed coat; *H*, gene responsible for holstein seed coat pattern and *W*, gene responsible for watson seed coat pattern, interacted to produce the seed coat patterns. The gene *R* is dominant to gene *Bl*; gene *R* is a suppressor gene which suppreses the gene combination *hhww* for small eye and modifies it to the dominant state *H_W_* to produce a solid seed coat; this is an evidence of dominant epistasis. The recessive gene *bl* responsible for brown is epistasic to dominant gene *R*; this is an example of recessive epistasis.

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