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Inheritance and joint segregation pattern of testa colour and plant growth habit in mungbean (*Vigna radiata* (L.) Wilczek)

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ABSTRACT

The mode of inheritance of seed coat (testa) colour, plant growth habit and their joint segregation pattern in mungbean was examined in F_1, F_2, BC_1 and BC_2 of five crosses among six parents which differed for each character. The results showed monogenic inheritance of seed coat colour. Black, black spotted and dull green seed coat colours were dominant over green, nonspotted (green) and shiny green colour respectively. The inheritance of twining plant growth habit was found to be dominant over non-twining growth habit. The joint segregation studies of mungbean seed coat colour and plant growth habit in F_2 and backcrosses revealed that these two traits have no linkage. The absence of linkage between these two traits should make it possible to combine non-twining plant type and shiny green seed coat colour in F_2 and subsequent generations.

Key words: growth habit, inheritance, mungbean, seed colour, *Vigna radiata.*

INTRODUCTION

The initial step in a breeding programme is the assembly of germplasm with a wide range of genetic variability. The breeder acquires his working germplasm collection from the native or improved local cultivars, breeding lines from existing germplasm collections and wild species. Local collections may be supplemented by cultivars and breeding lines from exotic germplasm. The local mungbean collections in Pakistan have mostly tall plant types, twining growth habit and unattractive seed coat colour. The exotic mungbean breeding lines are generally poorly adapted to the local environment. Most of them are prone to pod shattering at maturity (Malik *et al.* 1986) and have dull green seed coat colour. In the present investigation the inheritance of seed coat colour, plant growth habit and linkage between them have been studied in mungbean. The information would facilitate to incorporate these characters in high yielding and well adapted genotypes.

MATERIALS AND METHODS

The varieties/accessions of mungbean used in various cross combinations for the inheritance studies of seed coat colour, plant growth habit and their linkage studies are given in Table 1.

The cross combinations NM 92 x L 24-2, NM 92 x B.M., NM 92 x VC 2272 ,VC 1560D x VC 2272 and VC 1560D x Pusa Baisakhi were used for the inheritance studies of seed coat colour. The inheritance of growth habit and its linkage with seed coat colour was studied in NM 92 x L 24-2 and NM 92 x B.M. crosses.

Table 1. Varieties/accessions used, their origin and characteristics

Variety/accession	Origin	Seed coat colour	Growth habit
NM 92	NIAB, Pakistan	Shiny green	Erect
Blackmung (B.M.)	Local collection	Black	Twining
L24-2	India	Black spotted	"
Pusa Baisakhi	"	Dull green	Erect
VC 2272	AVRDC, Taiwan	"	"
VC 1560D	"	Shiny green	"

All the cross combinations in Table 2 were planted in summer 1997 at the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Pakistan. A spacing of 30 cm between rows and 10 cm between plants in a row was maintained. Data were recorded by counting plants at maturity for growth habit and seed coat colour.

The distribution of phenotypic classes was tested for goodness-of-fit. P values were calculated using [(observed - expected)^2/expected] as a test criterion.

RESULTS AND DISCUSSIONS

Inheritance of seed coat colour

The F_1 and reciprocals for shiny green, dull green, black and black spotted seed coat colour

Table 2. Inheritance of shiny green, dull green, black and black spotted seed coat colour in mungbean.

Cross	Generation	Expected ratio	Seed Coat Colour				Total plants	X^2	P
			Shiny green	Dull green	Black	Black spotted			
NM 92 X L 24-2	F_1	-	-	-	-	All	15	-	-
L 24-2 X NM 92	F_1	-	-	-	-	All	19	-	-
(NM92XL 24-2)XNM 92	BC_1	1:1	12	-	-	13	25	0.04	0.80-0.90
(NM92XL-24-2)XL 24-2	BC_2	-	-	-	-	All	11	-	-
NM 92 X L 24-2	F_2	3:1	55	-	-	155	210	0.16	0.50-0.70
NM 92 X B.M.	F_1	-	-	-	All	-	10	-	-
B.M. X NM 92	F_1	-	-	-	All	-	18	-	-
(NM 92 X B.M.)XNM 92	BC_1	1:1	15	-	11	-	26	0.62	0.30-0.50
(NM92 X B.M.)XB.M.	BC_2	-	-	-	All	-	27	-	-
NM 92 X B.M.	F_2	3:1	91	-	284	-	375	0.12	0.70-0.80
NM 92 X VC 2272	F_1	-	-	All	-	-	35	-	-
VC 2272 X NM 92	F_1	-	-	All	-	-	38	-	-
NM 92 X VC 2272	F_2	3:1	67	233	-	-	300	1.14	0.20-0.30
VC 1560D X VC 2272	F_1	-	-	All	-	-	37	-	-
VC 1560D X VC 2272	F_2	3:1	280	90	-	-	370	0.09	0.70-0.80
VC1560DXPusa Baisakhi	F_1	-	-	All	-	-	39	-	-
VC1560DXPusa Baisakhi	F_2	3:1	164	61	-	-	225	0.53	0.30-0.50

showed that only nuclear genes are responsible for this trait and there was no cytoplasmic effect (Table 2). The F_1 data also revealed that black spotted and black seed coat colours were dominant over nonspotted (green) and shiny green seed coat colour in NM 92 x L 24-2 and NM 92 x B.M. cross. The shiny green seed coat colour was also found to be recessive to dull green seed coat colour in NM 92 x VC 2272, VC 1560D x VC 2272 and VC 1560D x Pusa Baisakhi crosses. The F_2 ratio (3:1) in all the crosses in Table 2 showed monogenic inheritance of seed coat colour. The test cross of NM 92 x L 24-2 and NM 92xB.M. showed 1:1 ratio confirming the dominant behaviour of black mottled and black seed coat colour over shiny green seed coat colour.

Inheritance of growth habit

The results of the studies on inheritance of growth habit are given in Table 3 for F_1, BC_1, BC_2 and F_2 of the crosses NM 92 x L 24-2 and NM 92 x B.M. The data of F_1 and their reciprocal crosses indicated that twining growth habit is dominant over non-twining growth habit and there is no cytoplasmic effect in the inheritance of this trait. The F_2 ratios (3 twining: 1 non-twining) in these crosses revealed that a single gene is involved in the inheritance of growth habit. The test crosses provided the 1:1 ratios which confirmed the dominant behaviour of twining growth habit.

Joint segregation of seedcoat colour and plant growth habit

The F_2 and backcross data of 'NM 92 x L 24-2' and 'NM 92 x B.M.' crosses have been summarized for the linkage studies of seed coat colour and plant growth habit in Table 4. The F_2 population of the cross NM 92 x L 24-2 gave a ratio of 9 black spotted twining: 3 black spotted non-twining: 3 green twining: 1 green non-twining for seed coat colour and plant growth habit. The backcross of the same cross involving NM 92 (BC_1) segregated in a ratio 1:1:1:1 for the same four phenotypic classes as mentioned in the F_2 population of the same cross. The second backcross (BC_2) involving L 24-2 had all plants with black spotted seed colour and twining growth habit. The same ratio of 9:3:3:1 and 1:1:1:1 in F_2 and backcross (BC_1) was obtained for four phenotypic classes i.e. black twining, black non-twining, green twining and green non-twining in a cross NM 92 x B.M. The second backcross (BC_2) involving B.M. had only black seeded and twining growth habit plants. The chi-square test gave a good fit to the F_2 and backcross ratios tested from the above crosses. This segregation pattern clearly indicated that seed coat colour and plant growth habit had no linkage in L24-2 and Blackmung.

The seed coat colour traits i.e. black spotted/non spotted (green), black/green and shiny/dull green have been found to be controlled monogenically and seems to have resulted from the testa layers i.e. spotted/non spotted, pigmented and glassy/dull respectively. Van Rheenen (1965) also reported that three testa layers are responsible for the development of seedcoat colour in mungbean. Watt (1975) reported that the seed coat colour developed by each layer is monogenic and is an independently inherited trait. Singh and Singh (1970), Murty and Patel (1972), Singh (1973) and Godhani *et al.* (1979) have reported monogenic inheritance for black, brown, green and black spotted seed coat colours in mungbean. Chhabra *et al.* (1990) have reported five major genes for the inheritance of five seed coat

Table 3. Inheritance of twining growth habit of plant in mungbean.

Cross	Generation	Expected ratio	Growth habit			χ^2	P
			Twining	Nontwining	Total		
NM 92 X L 24-2	F_1	-	All	-	15	-	-
L 24-2 X NM 92	F_1	-	All	-	19	-	-
(NM 92 X L 24-2)XNM 92	BC_1	1:1	14	11	25	0.36	0.50-0.70
(NM 92 X L 24-2)XL 24-2	BC_2	-	All	-	11	-	-
NM 92 X L 24-2	F_2	3:1	152	58	210	0.77	0.30-0.50
NM 92 X B.M.	F_1	-	All	-	10	-	-
B.M. X NM 92	F_1	-	All	-	18	-	-
(NM 92 X B.M.) X NM 92	BC_1	1:1	12	14	26	0.15	0.50-0.70
(NM 92 X B.M.)XB.M.	BC_2	-	All	-	27	-	-
NM 92 X B.M.	F_2	3:1	273	102	375	0.97	0.30-0.50

Table 4. Joint segregation of plant growth habit (twining and non-twining) and seed coat colour (black, blacks potted, shiny green and dull green) in mungbean.

Cross	Generation	Expected ratio	Black twining	Black non-twining	Black spotted twining	Black spotted non-twining	Green twining	Green non-twining	Total	χ^2	P
(NM 92 X L 24-2)X NM 92	BC_1	1:1:1:1	-	-	5	8	6	6	25	0.67	0.80-0.90
(NM92 X L 24-2)X L 24-2	BC_2	-	-	-	All	-	-	-	11	-	-
NM 92 X L 24-2	F_2	9:3:3:1	-	-	128	37	35	10	210	2.2	0.50-0.70
(NM92 X B.M.)X NM 92	BC_1	1:1:1:1	5	6	-	-	7	6	26	0.47	0.90-0.95
(NM 92 X B.M.) X B.M.	BC_2	-	All	-	-	-	-	-	27	-	-
NM 92 X B.M.	F_2	9:3:3:1	221	68	-	-	64	22	375	1.22	0.70-0.80

colours (Sap green, raw sienna, brownish green, densely black spotted, black and greenish yellow) in mungbean. The monogenic dominant inheritance of twining growth habit over non-twining growth habit have also been reported by Sen and Ghosh (1959), whereas, Pathak and Singh (1963) reported non-twining to be dominant over twining. The contradiction in dominance of twining and non-twining growth habit may be due to the differences in genotypes, environment and their interaction. The independent nature of inheritance of seed coat colour and plant growth habit would be very useful in selecting non-twining plant types with desirable seed coat colour in segregating generations of mungbean.

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