

## Genetic architecture of yield and its component traits in blackgram (*Vigna mungo*) grown under different environments\*

BHAGIRATH RAM<sup>1</sup>, S B S TIKKA<sup>2</sup> and R K KAKANI<sup>3</sup>

S D Agricultural University, Sardarkrushinagar, Gujarat 385 506

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Food legumes are the vital source of protein. These crops contain high amounts of protein, macro- and micronutrients (Ca, P, K, Fe, and Zn), vitamins (niacin, vitamin A, ascorbic acid, inositol), fibre and carbohydrate for balance nutrition. They are rich in lysine, an essential amino acid which is found only at low levels in cereal protein (Solh Mahmoud. 2009). Blackgram [*Vigna mungo* (L.) Hepper] is an important, protein-rich food legume crop of Indian sub-continent. It is mostly grown in Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, Rajasthan and Gujarat during rainy (*kharif*) season and Andhra Pradesh and West Bengal in winter (*rabi*) season. In view of limited information on the genetics of yield and related traits and their inheritance in blackgram under different environmental conditions, the present investigation was conducted to generate information on the relative magnitude of additive and dominance components in the genetic control of characters in planning suitable, economic and efficient breeding strategies to develop high-yielding varieties with reasonably good productivity potential.

Ten genetically diverse genotypes of blackgram [*Vigna mungo* (L.) Hepper], namely 'GU1', 'RBU38', 'IPU99-1', 'IU8-6', 'NUL7', 'Ludhiana U201', 'VBN3', 'VBN4', 'UH84-14' and 'NIC17556' selected on the basis of high and low protein content, high yield, low yield were crossed in diallel fashion (excluding reciprocals) during *kharif* 2006. Few F<sub>1</sub> seeds were planted to develop sufficient quantity of F<sub>2</sub> seed during summer 2007. Ten parents, 45 F<sub>1</sub> crosses and 45 F<sub>2</sub> crosses were evaluated following randomized block design with 3 replications at 3 locations [E<sub>1</sub>: Sardarkrushinagar, E<sub>2</sub>: Aseda and E<sub>3</sub>: Khedbrahma] during *kharif*

2007. At each location, in each replication, each of the homogeneous generations, ie parents, and F<sub>1</sub> were sown in a plot of single row of 5 m length spaced in a plot of three rows of five metre length spaced 25 cm apart, while the segregating generation, ie F<sub>2</sub> was sown in plot of 2 rows of 5 m length spaced 25 cm apart. 10 cm distance between plant-to-plant was maintained in each plot. Non-experimental rows were planted all around the experimental material to avoid any possible border effects. Observations were recorded on 5 random plants in parents and F<sub>1</sub>'s and 15 plants in F<sub>2</sub>'s in each replication for plant height (cm), days to 50% flowering, days to 80% maturity, number of effective branches/plant, pod weight and seed yield/plant (g). The mean values were used for the analysis of variance. Data were first subjected to the usual analysis followed for a randomized block design for individual environment as suggested by Panse and Sukhatme (1967). The genetic components of variation were worked out as per Jinks and Hayman (1953) and Hayman (1954a).

The data from both F<sub>1</sub> and F<sub>2</sub> generations were subjected to diallel cross analysis for finding out components of genetic variance separately for each environment where additive-dominance model was adequate as obtained by significant difference of  $b(Wr - Vr)$  from zero and non-significant value of  $t^2$  as suggested by Hayman (1954b). In the present study the assumptions were satisfied for plant height (E<sub>2</sub>) in both F<sub>1</sub> and F<sub>2</sub> generation, days to 50% flowering (E<sub>1</sub>) in F<sub>1</sub> and F<sub>2</sub> generation, days to 80% maturity in E<sub>3</sub>F<sub>2</sub>, number of effective branches/plant in E<sub>2</sub>F<sub>1</sub>, pod weight in E<sub>1</sub>F<sub>1</sub> and seed yield per plant in E<sub>2</sub>F<sub>1</sub>. While for other characters assumptions of diallel were not satisfied.

The estimates of components of genetic variance exhibited that both additive (D) and dominance (H<sub>1</sub>: dominance effect and H<sub>2</sub>: proportion of dominance due to positive and negative effects of genes) were highly significant for character namely; plant height, days to 50% flowering and seed yield/plant in specific environment. This clearly indicates that both additive and non-additive components are important for inheritance

\*Short note

Based on a part of Ph D thesis of the first author submitted to SDAU, Sardarkrushinagar in 2008.

<sup>1</sup>Scientist (Genetics) (e mail: bhagirathram\_cazri@yahoo.com), CAZRI, Regional Station, Kukma, Bhuj 370105

<sup>2</sup>Director of Research (e mail: sbstikka@yahoo.com)

<sup>3</sup>Senior Scientist (Plant Breeding) (e mail: rkkakani.nrcss@rediffmail.com), NRCSS, Tabiji, Ajmer, Rajasthan 305206

Table 1 Estimates of components of genetic variance and the statistics worked out for different characters in individual environments using parents and F<sub>1</sub> data

Component	Plant height (cm)			Days to 50% flowering			Days to 80% maturity			Effective branches/plant			Pod weight (g)			Seed yield/plant (g)		
	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>
D	39.69	36.32*	13.77**	2.02**	2.76**	-0.43**	-1.10	1.15**	3.66**	2.76	4.25*	11.79*	1.60	0.038	3.75	-0.18	1.17*	1.95
SE±	20.71	3.41	26.71	5.56	6.13	6.16	7.79	6.68	5.80	3.42	1.17	5.78	1.13	1.91	5.53	0.99	0.39	3.46
H <sub>1</sub>	235.95*	59.67*	292.24*	22.25**	24.38**	23.58**	70.23*	34.52	50.60*	34.55	23.39*	54.49*	16.01*	19.96*	52.88*	6.62*	8.88*	23.58*
SE±	44.08	7.27	56.85	11.84	113.06	13.12	16.56	14.23	12.34	7.29	2.51	12.30	2.41	4.06	11.78	2.12	0.84	7.36
H <sub>2</sub>	163.01*	52.54*	268.13*	21.16*	26.13*	24.36*	62.30*	34.00	49.16*	32.63	18.12*	46.68*	14.49*	17.24*	42.03*	7.07*	7.10*	18.75*
SE±	37.46	6.18	56.85	10.06	11.10	11.15	14.09	12.09	10.49	6.19	2.13	10.45	2.05	3.45	10.01	1.80	0.71	6.26
F	54.54	31.57*	12.89**	-0.70**	-7.88**	-1.43	3.37*	3.27	-4.10**	-5.29	6.62*	17.34	2.55	0.64	7.37	-1.21	2.66*	4.05
SE±	47.78	7.88	61.62	12.84	14.16	14.22	17.98	15.42	13.38	7.90	2.72	13.33	2.61	4.40	12.77	2.29	0.91	7.98
h <sup>2</sup>	163.83	74.82*	17.60	-3.31**	16.74*	82.83*	-5.84	-6.65	10.86**	35.96	5.07*	0.07	4.42*	12.83*	21.19*	1.82	17.24*	18.28*
SE±	25.07	4.13	32.34	6.73	7.43	7.46	9.43	8.09	7.02	4.14	1.42	6.99	1.37	2.31	6.70	1.20	0.48	4.19
E	9.21	10.20*	27.76*	11.65*	14.83*	15.69*	22.31	18.35	17.59*	3.36	0.33**	1.26	1.48*	1.08	1.63	0.90*	0.019	0.076
SE±	6.24	1.03	8.05	1.67	1.85	1.85	2.34	2.01	1.74	1.03	0.35	1.74	0.34	0.57	1.66	0.300	0.11	1.04
(H <sub>1</sub> /D) <sup>1/2</sup>	2.43	1.28	4.60	3.31	2.97	7.40	7.99	5.47	3.71	3.53	2.34	2.14	3.16	22.91	3.75	-6.06	2.75	3.47
H <sub>2</sub> /4 H <sub>1</sub>	0.17	0.22	0.22	0.23	0.26	0.25	0.22	0.24	0.242	0.23	0.185	0.21	0.22	0.21	0.19	0.26	0.19	0.19
[1/2(H <sub>1</sub> /D)] <sup>1/2</sup>	1.72	0.90	3.25	2.34	2.10	5.23	5.65	3.87	2.62	2.50	1.65	1.52	2.23	16.20	2.65	-4.28	1.94	2.45
(4 DH <sub>1</sub> ) <sup>1/2</sup> + F	1.39	2.02	1.22	0.86	0.35	0.74	1.47	2.11	0.73	0.57	1.99	2.03	1.67	1.15	1.70	3.49	2.40	1.85
(4 DH <sub>1</sub> ) <sup>1/2</sup> - F																		
h <sup>2</sup> /H <sub>2</sub>	1.00	1.42	0.065	0.15	0.64	3.40	0.093	0.195	0.22	1.10	0.27	0.001	0.30	0.74	0.50	0.25	2.42	0.97
h <sup>2</sup> (ns)	36.8	20.3	11.6	10.2	7.3	0.5	4.4	3.1	3	16.2	22.9	8.10	5.3	16.4	22.9	9.9	7.5	22.3
t <sup>2</sup>	4.74**	0.27	9.31**	0.583	1.13**	1.08	1.00**	0.002	0.79**	190.83**	0.094	0.55	7.77	15.20**	11.29**	17.91**	0.23	78.33**

Table 2 Estimates of components of genetic variance and the statistics worked out for different characters in individual environments using parents and F<sub>2</sub> data

Component	Plant height (cm)			Days to 50% flowering			Days to 80% maturity			Effective branches/plant			Pod weight (g)			Seed yield/plant (g)		
	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>
SE±	39.24	42.03*	25.38	5.16*	6.07	6.43	10.64	7.67	1.82	-3.85	4.24	12.25*	0.568	0.033	4.34	-0.25	1.15	1.97
H <sub>1</sub>	20.81	9.31	24.36	2.55	3.53	4.28	6.59	9.16	3.95	9.96	2.67	6.21	6.76	3.98	15.37	2.29	1.89	3.26
SE±	1488.9*	511.8*	1510.2*	121.09*	141.65*	141.66*	223.59*	213.73*	204.99*	375.86*	159.52*	296.38*	243.20*	197.95*	480.70*	66.88*	75.65*	210.74*
H <sub>2</sub>	177.25	79.29	207.43	21.74	30.07	36.45	56.14	78.00	33.68	84.79	22.77	52.95	57.64	33.94	130.94	19.50	16.12	27.77
SE±	1209.8*	385.2*	1371.5*	123.12*	132.75*	139.30*	174.87*	167.94*	178.37*	300.21*	112.47*	253.62*	229.90*	172.122*	374.51	66.29*	62.42*	167.82*
F	150.64	67.39	176.29	18.48	25.55	30.98	47.71	66.29	28.62	72.06	19.35	45.00	48.98	28.85	111.28	16.57	13.70	23.60
SE±	162.43	124.91	24.89	0.057	14.33	8.52	24.91	-1.21	-5.97	-10.86	25.47*	29.58	-1.47	0.317	37.54	-1.45	4.00	10.50
SE±	96.06	42.97	112.42	11.78	16.29	19.75	30.42	42.27	18.25	45.95	12.34	28.70	31.23	18.39	70.96	10.57	8.73	15.05
h <sup>2</sup>	123.74	699.67	431.85*	42.10*	209.21*	474.23*	12.37	-16.99	46.56*	766.41	155.92*	30.12	159.31	82.86*	183.38	26.64	0.36	140.15
SE±	100.83	45.10	118.00	12.37	17.01	20.73	31.93	44.37	19.16	48.23	12.95	1.01	32.79	19.31	74.49	11.09	9.17	15.80
E	9.66	4.48	16.65*	8.51*	6.00*	8.82*	10.56*	11.83*	12.10*	4.45	0.33	0.80	2.52	1.086	1.04	0.97	0.030	0.056
SE±	6.27	2.80	7.34	0.77	1.06	1.29	1.98	2.76	1.19	3.00	0.80	1.87	2.04	1.20	4.63	0.69	0.57	0.98
[1/4(H <sub>1</sub> /D)] <sup>1/2</sup>	3.07	1.74	3.85	2.42	2.41	2.34	2.29	2.63	1.23	-2.34	3.06	2.45	10.34	38.72	5.26	-8.17	4.05	5.17
H <sub>2</sub> /4 H <sub>1</sub>	0.20	0.18	0.22	0.25	0.23	0.24	0.19	0.19	0.21	0.19	0.17	0.21	0.23	0.21	0.19	0.24	0.20	0.19
[{1/4(4D H <sub>1</sub> ) <sup>1/2</sup> + F}]	5.09	12.48	1.29	1.00	2.91	1.78	3.00	0.99	0.52	1.79	97.11	2.92	0.77	1.28	10.23	2.10	2.50	1.52
h <sup>2</sup> /H <sub>2</sub>	0.10	1.81	0.31	0.34	1.57	3.40	0.070	-0.10	0.26	2.55	1.38	0.11	0.69	0.48	0.48	0.40	0.005	0.83
h <sup>2</sup> (ms)	20.0	17.8	0.16	3.8	0.8	0.3	24.1	33.7	23.3	34.2	31.2	16.5	11.3	22.5	27.8	4.9	24.9	29.0
t <sup>2</sup>	0.023	0.58	1.16**	0.24	0.43	2.85**	0.26	0.19	0.12	150.76*	1.50**	1.60*	76.16**	26.33**	3.55**	165.22*	11.14**	21.71**

of these characters. The  $H_1$  component was greater than the 'D' component for plant height, days to 50% flowering, days to 80% maturity, number of effective branches/plant, pod weight and seed yield/plant. These results suggested that although additive and dominance gene actions were important for these traits but preponderance of dominance gene actions existed in the material used. The estimates of dominance gene effects corrected for gene distributed ( $H_2$ ) were positive and significant and therefore, agreed with the  $H_1$  estimates obtained (Tables 1, 2). These results are in confirmity with the results of Hegde *et al.* (1994), Das *et al.* (1998), Khattak *et al.* (2002), Singh *et al.* (2005) and Sharma *et al.* (2008) as they reported both additive and dominance effects controlling various characters studied with preponderance of dominance gene actions.

In the present study, the ratio of  $H_2/4H_1$  was close to 0.25 for plant height in  $E_2F_1$ ; days to 50% flowering in  $E_1$  of both  $F_1$  and  $F_2$  generations; days to 80% maturity in  $E_3F_2$ ; number of effective branches/plant in  $E_2F_1$  and pod weight in  $E_1F_1$ , indicating that dominant and recessive alleles were in almost equal frequencies for these characters. For rest of the characters  $H_2/4H_1$  ratio being not close to 0.25 indicated unequal frequencies of dominant and recessive genes in the present studies. The ratio  $[(4DH_1)^{1/2} + F]/[(4DH_1)^{1/2} - F]$  for  $F_1$  and  $[\{ \frac{1}{4} (4DH_1)^{1/2} + F \}]/[\{ \frac{1}{4} (4DH_1)^{1/2} - F \}]$  for  $F_2$  generation indicates the type of alleles which are more dominant alleles than recessive ones as this ratio was positive and  $> 1.0$ —in all characters except for days to 50% flowering in  $E_1F_1$  and days to 80% maturity in  $E_3F_2$ . This was further supported by the positive value of 'F' in most of the cases. On the contrary 'F' was negative for days to 50% flowering in  $E_1F_1$  and days to 80% maturity in  $E_3F_2$  indicating more recessive alleles than dominant alleles controlling these characters.

The narrow sense heritability estimates were moderately low for plant height in  $E_2$  and number of effective branches/plant in  $E_2$ , while it was low for days to 50% flowering in  $E_1$ , pod weight in  $E_1$  and seed yield per plant in  $E_2$ , but for  $F_2$  it was moderately low for days to 50% flowering in  $E_3$  and low for plant height in  $E_2$  and days to 50% flowering in  $E_1$ . Heritability estimates as would be expected were, in general, high in  $F_1$  in comparison to  $F_2$ . The results clearly indicated that the degree of heritability was much influenced by environment and generations. Sharma *et al.* (1987), Hegde *et al.* (1994), Das *et al.* (1998), Khattak *et al.* (2002), Singh *et al.* (2005) and Sharma *et al.* (2008) also reported variable heritability estimates for different character in blackgram, cowpea and mungbean. However, the  $H_1$  component was greater than the D component for plant height, days to 50% flowering, days to 80% maturity, number of effective branches/plant, pod weight and seed yield/plant, indicating preponderance of dominant gene actions. Thus, non-conventional breeding methods like recurrent selection by way of intermating most desirable segregants followed by

selection or diallel selective mating or biparental mating in early segregating generations may be followed, for improvement in blackgram.

#### SUMMARY

An experiment was conducted during rainy (*khari*) season of 2007 to generate informations on the relative magnitude of additive and dominance components in the genetic control of characters in planning suitable and efficient breeding strategies to develop high-yielding varieties with reasonably good productivity potential for seed yield/plant and its components traits in 100 genotypes of blackgram [*Vigna mungo* (L.) Hepper]. The estimates of components of genetic variance exhibited that both additive (D) and dominance ( $H_1$ ; dominance effect and  $H_2$ ; proportion of dominance due to positive and negative effects of genes) were highly significant for character, viz plant height, days to 50% flowering and seed yield/plant in specific environment. The  $H_1$  component was greater than the D component for plant height, days to 50% flowering, days to 80% maturity, number of effective branches/plant, pod weight and seed yield/plant. These results suggested that although additive and dominance gene action were important for these traits but preponderance of dominance gene actions existed in the material used.

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