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Genetic analysis for quantitative traits in Indian bean (*Lablab purpureus*)

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ABSTRACT

Genetic study conducted for yield and its traits in Indian bean [*Lablab purpureus* (L.) Sweet] revealed that heterosis over better parents was found to the extent of 130.78 and 142.27% for green pod yield/plant, 77.22 and 150.52% for number of pods/plant, 16.41 and 37.16% for pod length, 29.70 and 43.41% for pod width, 16.67 and 25.00% for number of seeds/pod, 54.08 and 57.14% for 100-seed weight, 1.46 and 24.56% for seed length, 6.61 and 26.27 % for seed width, 31.40 and 41.10 % for seed thickness, –31.27 and –17.08% for days to first flowering, –30.39 and –14.47% for days to first picking and 5.37 and 10.83 % for fruit set per cluster. The parents KDB 415, VRSEM 923, VRSEM 8 and VRSEM 11 were observed to be good combiners for most of yield contributing characters whereas, the crosses VRSEM 186 × VRSEM 860, VRSEM 11 × VRSEM 894, VRSEM 11 × VRSEM 860, HADB 4 × VRSEM 887 and VRSEM 8 × VRSEM 860 were observed to be most promising combinations for earliness and yield may be advanced for further generation. Most of the yields contributing characters were governed by non-additive gene action indicating good scope of heterosis breeding in Indian bean for mobilization of yield barrier.

Key words: Combining ability, Genetic analysis, Gene action, Heterosis, Indian bean, Quantitative traits

The wild forms of Indian bean [*Lablab purpureus* (L.) Sweet] are believed to have originated in India (Deka and Sarkar 1990) and were introduced into Africa from South East Asia during the eighth century (Kay 1979). The plant is highly drought tolerant and able to grow in diverse environments with good source of protein, minerals and vitamins (Basu *et al*. 2002) when compared to French bean (Chaudhary 1967). The phenomenon of heterosis which manifests itself by greater vitality, rapid growth, development, higher productivity, resistance, adaptation and uniformity of F_1s has been extensively exploited more in cross and few in self-pollinated crops. The heterotic response over better parents could be informative to identify true heterotic cross combinations. The concept of combining ability has a major landmark in understanding genetic architecture of populations and in planning breeding programmes. General combining ability (GCA) measures the average performance of a parent in hybrid combination. Specific combining ability (SCA) refers to those instances in which the performance of a hybrid is relatively better or worse than would be expected on the basis of the average performance of the parents involved. A relatively large GCA/SCA variance ratio suggests the importance of additive gene effects and a low ratio implies presence of dominant and/or epistatic gene effects. It should also be noted that if additive × additive effects are present, the GCA component will also contain some of those effects in addition to additive effects. Where SCA is small relative to GCA, performance of single cross progeny can be predicted on the basis of the GCA of the parents. Hence, to increase the green pod yield of Indian bean, knowledge of combining ability effects and variances have paramount significance in deciding the selection of parents and breeding method for obtaining new recombinants of desirable type is must. A high magnitude of additive gene effect is useful to the Indian bean breeders involved in developing pure line, whereas, information concerning non-additive gene effect (dominance and epistasis) is important for development of Indian bean hybrids. Therefore, crosses were affected between *Lablab purpureus* var. *typicus* and *lignosus* to study the heterosis, combining ability and gene action.

MATERIALS AND METHODS

Thirteen genetically diverse parents of Indian bean, viz. VRSEM 887, VRSEM 894, VRSEM 860, VRSEM 11, VRSEM 186, VRSEM 8, VRSEM 923, VRSEM 930, VRSEM 933, KDB 415, HADB 3, HADB 4 and Swarn Utkrisht belonging to two inter-specific cultivar groups, viz. *typicus* and *lignosus* were selected for this study and crossed in a line × tester mating design during 2007-08. The experimental material consisting of 43 treatments (13 parents

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Table 1 Heterosis crosses and estimates of heterosis for various traits over better parent in Indian bean

Character	Crosses showing heterosis over better parent and specific combining ability effect			
	Heterosis range	Three best crosses	Heterosis (%)	SCA
Days to first flower (No)	-4.43	VRSEM-186 × VRSEM-860	-31.25	-7.11
	to	VRSEM-11 × VRSEM-860	-21.61	-3.94
	-31.25	VRSEM-11 × VRSEM-894	-17.08	-14.00
Days to first picking (No)	-6.38	VRSEM-186 × VRSEM-860	-30.39	-19.91
	to	VRSEM-11 × VRSEM-894	-14.68	-15.69
	-30.39	HADB-4 × VRSEM-887	-14.47	-11.50
Pods per plant (No)	29.64	VRSEM-8 × VRSEM-860	150.52	211.63
	to	HADB-4 × VRSEM-860	84.58	101.26
	150.52	HADB-4 × VRSEM-894	77.22	94.67
Fruit set per cluster (%)	10.13	HADB-4 × VRSEM-887	10.83	8.21
	to	VRSEM-11 × VRSEM-887	10.13	9.81
	10.83	Swarn Utkrisht × VRSEM-887	5.67	5.13
Pod length(cm)	1.98	VRSEM-8 × VRSEM-894	37.16	-0.41
	to	VRSEM-186 × VRSEM-894	28.66	1.24
	37.16	KDB-415 × VRSEM-894	16.41	0.34
Pod width(cm)	1.36	HADB-3 × VRSEM-894	43.41	0.15
	to	VRSEM-8 × VRSEM-860	38.49	-0.05
	43.41	VRSEM-186' × VRSEM-894	29.70	-0.22
Pod thickness (cm)	1.11	Swarn Utkrisht × VRSEM-860	18.56	0.08
	to	KDB-415 × VRSEM-860	5.15	0.01
	18.56	VRSEM-11 × VRSEM-887	4.60	0.06
Seeds per pod (No)	7.14	VRSEM-186 × VRSEM-894	25.00	0.6
	to	VRSEM-186 × VRSEM-887	23.08	0.27
	25.00	VRSEM-8 × VRSEM-894	16.67	-0.18
Seed length (cm)	0.29	VRSEM-1 1 × VRSEM-860	24.56	0.09
	to	HADB-3 × VRSEM-894	8.76	0.11
	24.56	VRSEM-8 × VRSEM-894	1.46	0.06
Seed width (cm)	0.40	VRSEM-186 × VRSEM-894	26.27	0.03
	to	VRSEM-8 × VRSEM-894	24.77	0.05
	26.27	VRSEM-933 × VRSEM-887	6.61	0.01
Seed thickness (cm)	1.30	VRSEM-923 × VRSEM-887	41.10	0.07
	to	SwarnUtkrisht × VRSEM-887	37.00	0.21
	41.10	HADB-4 × VRSEM-887	31.40	0.11
100-seed weight (g)	5.21	VRSEM-186 × VRSEM-894	97.14	6.33
	to	VRSEM-8 × VRSEM-894	75.00	2.50
	97.14	VRSEM-186 × VRSEM-860	54.08	9.28
Pod yield per plant (kg)	9.73	VRSEM-8 × VRSEM-860	142.27	2.99
	to	VRSEM-8 × VRSEM-887	137.75	1.44
	142.27	SwarnUtkrisht × VRSEM-887	130.78	0.99

* Significant at 5 %, ** Significant at 1%

and 30 F_1's) were sown at 2 m row to row and 1 m seed to seed spacing in a randomized block design with three replications during 2008-09 at the Research Farm, Indian Institute of Vegetable Research, Varanasi (Uttar Pradesh). Recommended agronomic practices and plant protection measures were followed during the experiment. Observations were recorded on ten randomly selected plants leaving two border plants at both the ends. Eleven characters, viz. days to first flower and first picking, per cent fruit setting, number of pods per plant, pod length and width (cm), number of seeds per pod, seed length and width (cm), 100-seed weight and green pod yield per plant were studied. The data recorded was subjected to statistical analysis as per Panse and Sukhatme (1989). Heterosis was calculated as percentage increase of F_1 performance in the favorable direction over better parent. The combining ability estimates were calculated according to the method 2 and model I of Griffing (1956), while gene effects were analyzed as per Hayman (1954) and Jinks (1969).

RESULTS AND DISCUSSION

Negative heterosis coupled with SCA for flowering and pod picking is an indication of earliness in yield. Data presented in Table1 revealed that negative and significant

Table 2 General combining ability (GCA) of parents for 13 traits in line ´ tester analysis in Indian bean

Parents	Days to first flower	Days to first picking	Pods/plant (No.)	Fruit set/ cluster(%)	Pod length (cm)	Pod width (cm)	Pod thickness (cm)	Seeds/ pod (cm)	Seed length (cm)	Seed width (cm)	Seed thickness (cm)	Seeds weight (g)	Pod yield/ plant(kg)
VRSEM-11	5.42**	3.62**	3.94**	1.23	2.61**	0.04	-0.04**	0.43*	0.05*	0.03	-0.04**	5.42**	0.49**
VRSEM-186	8.87**	9.07**	-24.28**	0.23	2.03**	-0.11**	-0.02	0.10	-0.04	0.03	0.04**	-4.24**	0.09
VRSEM-8	5.76**	-9.60**	-112.94**	0.58	1.75**	0.07*	-0.05**	-0.34*	0.07**	-0.02	0.08**	-1.47	-0.45**
VRSEM-923	-1.02**	4.16**	-33.94**	1.96	0.80**	0.17**	0.00	0.21	0.01	0.07**	0.12**	5.53**	-0.02
VRSEM-930	0.87*	-2.38**	-54.28**	-4.46**	-1.43**	-0.05	-0.04	0.10	-0.02	0.01	0.02	-3.02**	-0.53**
VRSEM-933	7.42**	7.18**	-26.39**	-0.70	-0.42	0.05	0.00	-0.01	-0.01	-0.03	0.02	-5.24**	-0.39**
KDB-415	-6.58**	-6.82**	167.17**	4.32*	-0.73**	0.17**	-0.01	-0.34*	0.04	0.02	-0.06**	5.42**	1.37**
HADB-3	-18.36**	-9.16**	52.61**	-4.50**	-1.37**	-0.20**	0.04**	-0.34*	-0.03	-0.02	-0.06**	4.09**	-0.27**
HACB-4	-1.02**	3.84**	10.83**	1.30	-1.77**	-0.14**	0.05**	0.10	-0.03	-0.06*	-0.08**	-6.13**	-0.10**
Swarn Utkri.	-1.36**	0.07**	17.28**	0.05	-1.47**	-0.02	0.06**	0.10	-0.05*	-0.02	-0.04**	-0.36	-0.20**
VRSEM-887	0.56*	-7.76**	-11.67*	-1.97	0.37**	0.04	-0.02	-0.01	0.01	-0.01	0.01	1.17	0.08
VRSEM-894	0.06	3.28**	-13.70*	2.89*	-0.29**	-0.04	-0.02	-0.04	0.02	-0.01	0.00	0.05	-0.29**
VRSEM-860	-0.61*	4.49**	25.37**	-0.92	-0.09	0.00	0.04	0.06	-0.04	0.02	-0.01	-1.67	0.21**
SE Female	0.28	0.47	0.47	1.28	0.19	0.03	0.01	0.15	0.02	0.02	0.01	0.87	0.04
SE Male	0.13	0.22	2.11	0.60	0.09	0.02	0.01	0.07	0.01	0.01	0.01	0.41	0.02

*Significant at 5 %, **significant at 1%

heterosis for days to flowering and first pod picking ranged from -4.43 to -31.25% and -6.38 to -30.39%, respectively. Out of 30 cross combinations, the cross combinations, viz. VRSEM 186 × VRSEM 860 and VRSEM 11 × VRSEM 894 were found early flowering and pod picking as evidenced by significant negatative heterosis and SCA. In present scenario the yield of most of the legume vegetables including Indian bean is very low as compare to other vegetable crops. Hence enhancement of yield is an ultimate goal of any legume breeder. Yield is a complex trait governed by polygenes and depend upon other contributing traits like pod number, fruit set/cluster, pod length, breadth and thickness, seed number in pod and seed weight, length, width and thickness. The cross combination VRSEM 8 × VRSEM 860 had maximum heterosis (152.52 %) over better parent along with SCA (211.63) for pods/plant, whereas, HADB 4 × VRSEM 887 had maximum heterosis (10.83 %) along with SCA (8.21) for fruit set per cluster (Table 1). While, for pod length VRSEM 8 × VRSEM 894 exhibited maximum heterosis (37.16 %) with SCA value of 0.41. The cross combinations HADB 3 × VRSEM 894 and Swarn Utkrisht × VRSEM 860 had maximum heterosis (43.41% and 18.56 %) along with SCA (0.15 and 0.08) for pod width and pod thickness, respectively. For number of seeds/pod and seed length, cross combinations VRSEM 186 × VRSEM 894 and VRSEM 11 × VRSEM 860 exhibited maximum heterosis (25.00% and 24.56%) over better parents along with SCA (0.6 and 0.09), respectively. The VRSEM 186 × VRSEM 894 and VRSEM 923 × VRSEM 887 cross combinations had maximum heterosis (26.27 and 41.10 %) over better parent along with SCA (0.03 and 0.07) for seed width and seed thickness. For 100-seed weight and pod yield/plant, cross combinations VRSEM 186 × VRSEM 894 and VRSEM 8 × VRSEM 860 were exhibited maximum heterosis (97.14 and 142.27%) over better parents along with SCA (6.33 and 2.99), respectively (Table 1).

Among thirteen parental lines as presented in Table 2 VRSEM 860 showed highest negative significant gca effect for days to first flowering (–0.61) and VRSEM 930 for

Table 3 Effect of parents on morphological characters on their $F_{1's}$

Character	P_1	P_2	F_1
Stem colour	Green	Red	Red
	Green	Reddish green	Reddish green
	Red	Green	Red
	Red	Reddish green	Red
Flower colour	White	Pink	Pink
	Pink	White	Pink
Pod colour	Green	Yellow	Green
	Green	Reddish green	Reddish green
	Yellow	Reddish green	Reddish green
	Reddish green	Yellow	Reddish green
Seed colour	Brown	Cream	Brown
	Black	Cream	Black
	Brown	Black	Black

Table 4 Estimate of GCA and SCA variance, A and D component of genetic variance in Indian bean

Parameter	Days to first flower	Days to first picking	No. of pods/ plant	Fruitset/ cluster (%)	Pod length (cm)	Pod width (cm)	Pod thickness (cm)	Seeds/ pod (No.)	Seed length (cm)	Seed width (cm)	Seed thickness (cm)	100-seeds weight (g)	Pod yield/ plant (kg)
σ^2 GCA for female	43.85	12.69	1626.93	-4.57	2.02	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.01
σ^2 GCA for male	-5.87	35.70	-671.09	2.93	-0.10	0.00	0.00	-0.02	0.00	0.00	0.00	-3.53	-0.03
σ^2 SCA	61.77	96.61	11451.84	28.13	1.95	0.03	0.00	0.09	0.02	0.00	0.01	53.37	0.93
σ^2 A	11.20	60.79	-281.56	2.41	0.78	0.00	0.0	-0.02	0.00	0.00	0.00	-3.94	-0.04
σ^2 D	61.77	96.61	11451.84	28.13	1.95	0.03	0.00	0.09	0.02	0.00	0.01	53.57	0.93

days to first picking (–2.38). The parent KDB 415 showed maximum GCA for pod yield/plant (167.17), % fruit set per cluster (4.32), pod width (0.17) and pod yield/plant (1.37). Similarly, parent VRSEM 11 exhibited maximum GCA for pod length and seed/pod (0.43). Parent Swarn Utkrisht had significantly highest GCA for pod thickness (0.06). Parent VRSEM 8 showed maximum GCA for seed length (0.07). VRSEM 923 parent showed maximum GCA for seed width (0.07), seed thickness (0.12) and 100-seed weight (5.53). The importance of heterosis breeding for mobilization of low yield in legume vegetables has also been reported in Indian bean (Virja *et al.* 2006 and Sawant *et al.* 2007), French bean (Ram and Rajput 1998) and cowpea (Patil and Navale 2006, Patil and Gosavi 2007) which supports our findings. The effect of parents on morphological characters, viz. stem, flower, pod colour and seed colour (Table 3). F_1's revealed that red stem colour was dominant over green and reddish green while reddish green was dominant over green colour. Similarly, the pink flower colour was dominant over white flower colour while, green pods colour was dominant over yellow, whereas, reddish green was dominant over green and yellow in F_1 generation. The brown seed colour was dominant over cream and black was dominant over cream and brown.

Though Indian bean is purely self- pollinated crop but there is a good scope of hybridization as data presented in Table 4 revealed that there was preponderance of non-additive component for days to first flowering, days to first picking, number of pods/plant, per cent pod set/cluster, pod length, pod width, pod thickness, number of seeds/pod, seed length, seed width, seed thickness, 100-seed weight and pod yield/plant as exhibited high magnitude of dominance variance (σ^2 D) than additive variance (σ^2 A) indicating ample scope of heterosis breeding in Indian bean for mobilization of its low yield barrier which is in conformity with findings of Chauhan *et al.* (2003) in cowpea and Barad *et al.* (2008) in mung bean.

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