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HETEROSIS, HERITABILITY AND GENETIC ADVANCE IN *VIGNA RADIATA* (L.) WILCZEK

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Abstract

Heterosis, heritability estimates, genetic advance and dominance estimates were calculated in 7 crosses of mungbean (*Vigna radiata* (L.) Wilczek) involving 7 parents of which 5 were local and 2 exotic. Varying degrees of variances were observed for 6 characters in 7 crosses. The cross combinations viz., NCM 5 x Type - 77 and NM 13-1 x Type - 77 exhibited high heterotic effects in either generations and high heritability estimates alongwith high genetic advance for yield and its components. It was concluded that the simple selection should be followed carefully in large segregating populations of these two cross combinations to find out the transgressive segregants for effective mungbean improvement.

Introduction

Heterosis has generally been associated with deviation from the parent means which is generally expressed in increase in vigour and productivity obtained by crossing pure lines. The selection of potential cross combinations on the basis of manifestation of heterosis in legumes may be utilized for pulses improvement (Sagar & Chandra, 1977; Joshi, 1979; Malik *et al.*, 1987). Although, heterosis is being exploited in most of the field crops, yet its usefulness remained unexplored in legumes mainly because of high percentage of self pollination (cleistogamous in nature) and lack of male sterile lines.

The studies regarding genetic informations like inheritance of quantitative characters, heterosis, heritability, genetic advance and dominance estimates are very important to identify the genes of economic importance distributed frequently in the population and predict the behaviour of the parents to be utilized in any breeding programme for selecting high yielding cultivars in any field crop with better quality. High genetic advance coupled with high heritability estimates offers a most effective condition for selection (Johnson *et al.*, 1955a). Govindarasu & Sampath (1983) reported high heritability for plant height, pods per plant and grain yield in *Phaseolus vulgaris*. Ramana & Singh (1987) estimated high heritability for pods per plant and grain yield in mungbean. Selection from the cross combinations with high heritability and genetic advance should be followed in the proceeding generations to improve the legumes (Sharma & Rao, 1988). The present study was thus conducted to investigate the heterosis, heritability, genetic advance and dominance estimates in seven crosses of mungbean.

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Materials and Methods

The experimental material consisted 7 parents, of which 5 were indigenous (NCM 5, NCM 7, MCM 87, NM 121-25 and NM 13-1) and 2 exotic (Type - 77 and MI 5). These were crossed during spring 1987 under green house conditions and hybrid seed of following crosses were obtained.

1-	NCM 5	X	Type - 77
2-	NCM 5	X	MI 5
3-	NCM 7	X	Type - 77
4-	NCM 87	X	MI 5
5-	NM 121-25	X	Type - 77
6-	NM 13-1	X	NCM 7
7-	NM 13-1	X	Type - 77

The F_1 seed from all the crosses were planted in field during kharif 1987 to raise F_2 populations. The breeding material comprising F_1s (hybrids), F_2s (segregating generation) alongwith parents were planted in a triplicated randomized complete block design during 1988 in the field, keeping 35 and 10 cm spacing between and within rows, respectively. Each replication consisted one row of four meter length for each non-segregating materials (Parents and F_1s) and 20 rows of segregating generations (F_2s). At maturity the data were recorded on 30 and 75 randomly selected plants from non-segregating and segregating populations, respectively. The observations were recorded on plant height (cm), pods per plant, pod length (cm), seeds per pod, 100-seed weight (g) and grain yield per plant (g).

The means and standard deviations were computed by standard statistical techniques. The heterosis was calculated as percent increase or decrease on mid parent values. The heritability estimates in broad sense were calculated by using the formula given by Mahmood & Kramer (1951) as follows:

$$h\,(BS) = [VF2 - \sqrt{VP1 \times VP2}]/VF2 \times 100$$

where h (BS) is heritability in broad sense, VP1, VP2 and VF2 are the variances of parent 1, parent 2 and F_2 populations, respectively. Genetic advance was calculated using the formula given below (Allard, 1960):

$$Gs = K \sqrt{VF2\ .\ H}$$

where Gs is genetic advance, K is selection differential (K = 1.7 using 10% selection intensity) and H is the coefficient of heritability. The dominance estimates were computed by using "Potence ratio" method (Griffing, 1950).

$$hp = \frac{IFI - MPI}{IBP - MPI}$$

where hp is the dominance value, F_1, MP and BP are observed means of the hybrids, mid parent and the better parent, respectively.

Results and Discussion

The results regarding heterosis depicted in the Table 2 showed that of the 7 crosses, 3 exhibited positive heterosis in both generations. The average heterotic effects were -4.47 and 5.95% in F_1 and F_2, respectively. The negative heterosis may be exploited to develop short statured mungbean cultivars. For pods per plant, all the crosses produced positive heterotic effects in F1, 2 crosses (NM 121-25 X Type - 77 and NM 13-1 X Type - 77) deteriorated in F_2 and the remaining 5 showed positive heterosis. The average heterotic effects for pods per plant in F_1 and F_2 were 47.00 and 23.61 percent, respectively. The positive heterosis for pods per plant was also observed by Sagar & Chandra (1977) in urdbean. Five crosses produced positive heterosis in F_1 and one in F_2 for pod length. The increase in pod length was not pronounced. Four crosses produced positive heterosis for seeds per pod in F_1 and also 2 in F_2 namely NCM 5 X Type - 77 and NCM 5 X MI 5. Similar type of results have been reported by Singh *et al*., (1973) in bengal gram. Three crosses increased in F_1 and none in F_2 for 100-seed weight. All the crosses excelled over mid-parent in F_1, for grain yield per plant with mean value of 37.02 percent whereas, only 3 exhibited increase in F_2. The average heterosis in F_2 was 1.15%. Sagar & Chandra (1977) observed heterosis in grain yield in urdbean and Singh *et al.*, (1975) in lentil. The F1s of almost all the crosses exhibited heterosis in all the characters under study whereas, the means of F_2 segregating populations showed a slight deterioration over the means of F_1s which indicated varying degrees of in-breeding depression for different cross combinations. The cross NCM 5 X Type - 77 gave better heterotic effects for pods per plant and grain yield. The hybrid NM 13-1 X Type - 77 exhibited slight deterioration in F_2. Therefore, the segregants of these crosses (NCM 5 X Type - 77 and NM 13-1 X Type - 77) should be observed carefully to sort out some desirable transgressive segregates in the later generations.

The means and standard deviation presented in Table 1 for 6 characters in 7 crosses revealed a considerable magnitude of variance observed in the populations. The F_2 populations of the crosses viz., NCM 5 X Type - 77 and NM 13-1 X Type - 77 showed maximum variance for grain yield and yield components. The estimated broad sense heritability (h), genetic advance (GA) and dominance estimates (DE) depicted in the Table 2, revealed low to high heritability estimates alongwith medium to high genetic advance and dominance estimates for plant height, pods per plant, pod length, 100-seed weight and grain yield per plant, whereas moderate to high heritability with medium to high genetic

Table 1. The means and standard deviation performance of six parameters in seven crosses of mungbean *(Vigna radiata* L. Wilczek)

		Plant height		Pods per plant		Pod length	
		X	SD	X	SD	X	SD
NCM 5 X	P_1	52.97±1.27	6.93	28.13±1.08	5.91	6.71±0.14	0.77
	P_2	65.87±1.29	7.08	10.27±1.07	5.84	5.64±0.20	1.10
	F_1	51.13±1.69	9.25	19.47±1.47	8.03	6.57±0.22	1.21
	F_2	50.95±1.38	11.92	33.77±1.09	9.46	6.08±0.14	1.21
NCM 5XMI5	P_1	52.97±1.27	6.93	28.13±1.08	5.91	6.71±0.14	0.77
	P_2	45.80±1.11	6.09	5.60±0.60	3.31	7.37±0.10	0.56
	F_1	56.47±1.31	7.16	24.86±1.42	7.77	7.29±0.15	0.82
	F_2	52.55±1.77	15.30	18.18±1.01	8.79	6.55±0.12	1.01
NCM 7 X Type-77	P_1	47.27±1.18	6.46	24.86±0.88	4.82	7.05±0.11	0.58
	P_2	65.87±1.29	7.08	10.27±1.07	5.84	5.64±0.20	1.10
	F_1	52.47±1.32	7.23	44.13±1.77	9.67	6.67±0.21	1.15
	F_2	49.43±1.29	11.20	31.18±1.16	10.01	6.13±0.13	1.16
NCM 87 X MI 5	P_1	47.38±1.27	6.96	29.13±1.39	7.62	6.80±0.14	0.76
	P_2	45.80±1.11	6.09	5.60±0.60	3.31	7.37±0.10	0.56
	F_1	50.33±1.36	7.46	24.93±1.44	7.91	6.47±0.18	0.97
	F_2	51.33±1.10	9.55	18.85±0.99	8.56	6.48±0.12	1.03
NM 121-25 X Type-77	P_1	50.67±1.27	6.96	35.60±1.56	8.53	7.26±0.07	0.41
	P_2	65.87±1.29	7.08	10.27±1.07	5.84	5.64±0.20	1.10
	F_1	47.93±1.34	7.33	85.33±1.93	10.58	7.19±0.22	1.23
	F_2	47.13±13.0	8.22	17.33±1.30	11.22	6.88±0.14	1.25
NM 13-1 X NCM 7	P_1	54.0±1.05	5.73	21.20±0.88	4.84	7.22±0.10	0.56
	P_2	47.27±1.18	6.46	24.86±0.88	4.82	7.05±0.11	0.58
	F_1	55.87±1.37	7.50	23.40±0.99	5.42	7.40±0.12	0.64
	F_2	56.98±1.15	9.94	15.20±0.65	5.65	6.78±0.08	0.78
NM 13-1 X Type-77	P_1	54.01±1.05	5.73	21.20±0.88	4.84	7.28±0.10	0.56
	P_2	65.87±1.29	7.08	10.27±1.07	5.84	5.64±0.20	1.10
	F_1	44.93±1.59	8.70	87.27±1.26	6.91	6.15=±0.23	1.27
	F_2	45.15±1.12	9.68	24.23±0.98	8.52	6.08±0.15	1.27
NCM 5 X Type-77	P_1	8.67±0.16	0.90	3.74±0.05	0.26	5.73±0.37	2.05
	P_2	10.13±0.28	1.51	4.60±0.08	0.42	3.01±0.45	2.45
	F_1	10.67±0.33	1.80	3.81±0.08	0.43	5.78±0.56	3.04
	F_2	10.26±0.22	1.87	3.37±0.06	0.53	6.13±0.46	3.99

NCM 5 X MI 5	P_1	8.67±0.16	0.90	3.74±0.05	0.26	5.73±0.37	2.05
	P_2	8.93±0.26	1.44	3.82±0.05	0.25	3.48±0.28	1.51
	F_1	9.53±0.32	1.77	4.19±0.06	0.34	6.71±0.41	2.23
	F_2	9.31±0.25	2.15	3.13±0.05	0.43	4.39±0.33	2.87
NCM 7 X Type-77	P_1	9.07±0.16	0.88	3.57±0.05	0.29	8.54±0.47	2.57
	P_2	10.13±0.28	1.51	4.60±0.08	0.42	3.01±0.45	2.45
	F_1	9.02±0.31	1.71	3.53±0.09	0.51	9.67±0.52	2.84
	F_2	9.32±0.21	1.81	3.41±0.06	0.56	5.92±0.37	3.22
NCM 87 X MI 5	P_1	10.47±0.18	0.99	3.33±0.05	0.27	7.51±0.56	3.06
	P_2	8.93±0.26	1.44	3.82±0.05	0.25	3.48±0.28	1.51
	F_1	8.93±0.30	1.62	3.65±0.05	0.27	8.17±0.64	3.51
	F_2	9.79±0.21	1.81	3.15±0.04	0.31	4.23±0.41	3.54
NM 121-25 X Type-77	P_1	11.20±0.17	0.94	3.09±0.06	0.31	4.93±0.30	1.63
	P_2	10.13±0.28	1.51	4.60±0.08	0.42	3.01±0.45	2.45
	F_1	10.93±0.29	1.58	3.28±0.08	0.45	3.99±0.46	2.52
	F_2	10.28±0.22	1.85	3.31±0.06	0.51	3.55±0.37	3.19
NM 13-1 X NCM 7	P_1	11.27±0.18	0.99	3.15±0.05	0.89	6.11±0.38	2.08
	P_2	9.07±0.16	0.88	3.57±0.05	0.29	8.54±0.47	2.57
	F_1	10.87±0.23	1.25	3.74±0.06	0.34	9.07±0.45	2.44
	F_2	10.08±0.20	1.76	3.35±0.05	0.40	3.35±0.36	3.10
NM 13-1 X Type-77	P_1	11.27±0.18	0.99	3.15±0.05	0.29	6.11±0.38	2.08
	P_2	10.13±0.28	1.51	4.60±0.08	0.42	3.01±0.45	2.45
	F_1	9.80±0.33	1.82	3.43±0.09	0.50	6.44±0.45	2.49
	F_2	9.72±0.22	1.84	3.23±0.07	0.58	6.15±0.42	3.60

X = Observed mean.
SD = Standard Deviation from the population mean.

advance was observed for seeds per pod. The crosses NCM 5 X Type - 77, NCM 87 X MI 5 and NM 13-1 X Type - 77 showed moderate heritabilty and high genetic advance for grain yield. The cross NCM 5 X MI 5 gave high heritability and moderate genetic advance and dominance estimates for grain yield per plant. High heritability estimates alongwith high genetic advance and dominance estimates indicated the substantial contribution of additive genetic variance in the expression (Govindarasu & Sampath, 1983; Sharma & Rao, 1988). Further the high heritability coupled with high genetic advance and dominance estimates indicates the exploitation of the cross combinations viz., NCM 5 X Type - 77, NCM 87 X MI 5 and NM 13-1 X Type - 77 to get transgressive segregation in the later generations. Hence the direct selection pressure should be imposed in a large segregating population for further improvement in mungbean. The rest of characters in various crosses showed high to low heritability estimates coupled with medium to low genetic advance and dominance estimates, revealing the greater contribution of non-addi-

Table 2. The broad sense heritabilities (h), Genetic advance (GA) and Dominance estimates (DE) of six parameters in seven crosses of mungbean (*Vigna radiata* L. Wilczek)

Crosses	Genetic parameters	Plant height (cm)	Pods per plant	Pod length	Seeds per pod	100-seed weight	Yield per plant (g)
NCM 5 X	h	65.44	61.43	42.51	61.13	62.07	68.43
Type-77	Gs	13.26	9.88	0.87	1.94	0.56	4.64
	DE	1.29	0.03	0.74	1.73	0.84	1.04
	Het.over F_1	–13.95	1.41	6.40	13.51	– 8.63	32.27
	Het.over F_2	–14.25	75.89	– 1.54	9.15	–19.18	40.27
NCM 5 X	h	81.97	74.64	57.84	72.02	65.82	82.45
MI 5	Gs	21.32	11.15	0.99	2.63	0.48	3.05
	DE	1.98	0.71	0.76	5.62	10.25	1.87
	Het.over F_1	14.35	47.41	3.55	8.30	10.85	45.74
	Het.over F_2	6.41	7.80	–6.96	5.80	–17.20	– 4.67
NCM 7 X	h	63.52	71.92	52.44	59.29	61.40	39.39
Type-77	Gs	12.09	12.24	1.03	1.82	0.58	2.16
	DE	0.44	3.64	0.46	1.00	1.08	1.41
	Het.over F_1	–7.25	151.24	5.12	– 5.52	–13.59	67.45
	Het.over F_2	–12.62	77.51	– 3.39	– 2.92	–16.52	2.52
NCM 87 X	h	52.54	65.4	59.66	56.53	30.87	63.22
MI 5	Gs	8.69	9.52	1.04	1.74	0.16	3.80
	DE	4.73	0.64	2.16	1.00	0.31	1.33
	Het.over F_1	8.03	43.56	– 8.68	– 7.94	2.10	48.68
	Het.over F_2	10.17	8.55	– 8.54	0.01	–11.89	–23.02
NM 121-25 X	h	27.12	60.47	70.88	58.57	50.58	60.69
Type-77	Gs	3.79	11.53	1.51	1.84	0.44	3.29
	DE	1.36	0.19	0.91	0.50	0.75	0.02
	Het.over F_1	–17.74	10.44	11.47	2.48	–14.69	0.02
	Het.over F_2	–19.12	–24.44	3.57	– 3.61	–13.91	–10.58
NM 13-1 X	h	62.47	26.89	38.85	71.86	48.00	44.46
NCM 7	Gs	10.56	2.58	0.48	2.15	0.33	2.34
	DE	1.55	0.20	2.04	0.64	1.81	1.44
	Het.over F_1	10.33	1.61	3.28	6.88	11.31	23.82
	Het.over F_2	12.42	–34.00	– 5.37	– 0.01	—	–47.44
NM 13-1 X	h	56.65	61.08	61.87	56.09	64.48	60.77
Type-77	Gs	9.32	8.85	1.34	1.75	0.64	3.72
	DE	2.53	2.11	0.38	1.58	0.61	1.21
	Het.over F_1	–25.04	73.31	– 4.80	– 8.41	–11.48	41.23
	Het.over F_2	–24.67	53.99	– 5.88	– 9.16	–16.65	34.87
Average heterosis over F_2		– 4.47	47.00	2.33	1.33	– 3.45	37.02
Average heterosis over F_2		– 5.95	23.61	– 4.02	– 0.11	–15.89	– 1.15

h = Heritability (Broad sense)
Gs = Genetic advances at 10% selection intensity.
DE = Dominance estimates.

tive (dominance and epistasis) genetic variance for the expression of these characters by which the estimates of heritability are biased (Sharma & Rao, 1988).

The cross combinations viz., NCM 5 X Type - 77 and NM 13-1 X Type - 77 exhibited high heterotic effects in either generations and high heritability estimates alongwith high genetic advance for yield and its components. Hence, it is suggested that simple selection may be followed in large segregating population of these two crosses to sort out the transgressive segregants.

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