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HETEROSIS FOR YIELD RELATED ATTRIBUTES IN MUNGBEAN *VIGNA RADIATA* (L.) WILCZEK

MUHAMMAD ZUBAIR[1], SAIF ULLAH AJMAL[2] AND SHAUKAT ALI[1]

[1]Crop Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan
[2]Department of Plant Breeding and Genetics, University of Arid Agriculture, Rawalpindi, Pakistan

Abstract

In the present investigation, heterotic effects were studied over mid parent and better parent values for yield and its components in an 8 parental diallel involving 5 exotic and 3 local mungbean genotypes. Hybrids were evaluated alongwith their parents in the field of National Agricultural Research Centre, Islamabad, Pakistan. High level of hybrid vigour was observed for plant height, number of pods per plant and grain yield per plant. Considering overall performance, the superior F_1s were NM 51 x VC 3902, NM 51 x VC 4982, NM 20-21 x VC 1163, NM 51 x VC 3301 and VC 3301 x VC 1163 that revealed strong heterotic effects for number of pods per plant, number of grain per pod and grain yield per plant. These hybrids are, therefore, suggested to be utilized for developing high yielding mungbean cultivars.

Introduction

The phenomenon of heterosis has generally been associated with the increased yield and vigour obtained by crossing among selected inbred lines developed from heterozygous cross pollinated crops. With the realization of the possibility of producing F_1 hybrids on a large scale, increasing attention has been given to achieve heterosis in self pollinated crops. As far as the breeders of agriculturally important self pollinated crops are concerned, the major considerations are, whether or not it is possible to obtain sufficient heterosis for characters of economic importance under conditions which also give high yields per unit area of land and whether or not it is possible to fix such heterosis in pure breeding lines (Hayes & Foster, 1976). The presence of heterosis in food legumes for grain yield and its components has been reported by several workers e.g., Singh *et al*., (1973); Singh *et al*., (1975); Sagar & Chandra (1977); Arora & Pandya (1987); Malik *et al*., (1987); Shinde & Deshmukh (1989); Ghafoor *et al*., (1990 a,b); Kunta *et al*., (1997); Patil *et al*., (1998); Sharif *et al*., (2001); Gupta *et al*., (2003); Hedge *et al*., (2007) and Adeyanju (2009). Selection of parental cross combinations should be exploited on the basis of manifestation of heterosis for varietal improvement (Joshi, 1979; Zubair *et al*., 1989). The presence of heterosis can only be utilized in pulse crops for development of high yielding pure line varieties (Singh, 1971).

Most of the detailed genetic information regarding the expression of heterosis in self pollinated crops has originated from diallel crosses of selected parents and their F_1 hybrids. The present study was carried out to estimate the extent of heterosis in an 8 parental diallel for exploitation of existing genetic variability to develop high yielding mungbean cultivars.

Materials and Methods

The experimental material consisted of 8 pure lines of mungbean, of which 5 were of exotic origin (VC-4982, VC-4152, VC-3902, VC-3301 and VC-1163) and 3 indigenous (NM 20-21, NM 121-25 and NM- 51). These were crossed in a diallel system under greenhouse condition during the spring season, 2002. The hybrid seeds of 28 crosses alongwith their parents were sown in a randomized complete block design with 3 replications at the experimental fields of National Agricultural Research Centre, Islamabad during summer, 2003. One row of each genotype was dibbled keeping 35 and 10 cm spacing between and within rows, respectively. Basal fertilizer dose of NP (@ 25 kg N + 60 kg P_2O_5 per hectare) was applied during crop growth period. Agronomic practices were used as recommended for mungbean crop. Pesticide (Karate 2.5EC @ 750 ml/ha) was sprayed to save the crop from the infestation of insect pests especially white fly, a vector of Mungbean Yellow Mosaic Virus (MYMV). At maturity, the data were recorded for number of days taken to maturity, plant height, number of pods per plant, pod length, number of grains per pod, 100 grain weight and grain yield per plant. The data for days to maturity were taken when about 90% pods turned brown/black. Other quantitative data i.e., plant height, number of pods per plant and grain yield were recorded on 10 guarded plants selected randomly and then averaged on per plant basis. Pod length and grains per pod were taken on 10 pods selected at random within each genotype. The grains weight was recorded for each genotype after counting 100 grains by seed counter and weighed in grams. The averaged data were subjected to analysis of variance to establish the level of significance (Steel & Torrie, 1980). Heterosis was calculated as percentage increase or decrease over mid parent and better parent values.

Results and Discussion

Analysis of variance for various plant traits among F_1 hybrids and their parents is presented in Table 1. Highly significant differences among the parents as well as hybrids were observed for all the traits. Mean values and heterosis percentage over mid parent and better parent for plant height, days to maturity, number of pods per plant and pod length are summarized in Table 2. Table 3 reveals the results regarding mean values and heterosis for number of grains per pod, 100 grains weight and grain yield per plant. The results showed that substantial heterosis occurred in the hybrids for plant height, number per plant and grain yield per plant. The results for plant height revealed that 26 hybrids produced positive heterosis over mid parent and 15 over better parent. Two hybrids showed negative heterotic effects over mid parent while 13 over better parent. The maximum heterosis over mid parent (18.93%) was observed in the hybrid NM 121-25 x VC 3301, whereas over better parent the highest heterosis (14.43%) was noticed in the hybrid NM 20-21 x VC 3902. Average heterosis for plant height was observed as 8.05% and 1.42% over mid and better parent, respectively. Zubair *et al*., (1989) and Ghafoor *et al*., (1990b) observed low heterotic effects in mungbean, while Shinde & Deshmukh (1989) and Ghafoor *et al*., (1990a) reported high heterosis for plant height in urdbean.

In case of number of days to maturity, 21 hybrids produced positive heterosis over mid parent and 14 over better parent (Table 2). Negative heterosis was observed in 7 and 14 hybrids over mid parent and better parent, respectively. Hybrid NM 121-25 x NM 51 expressed the maximum heterosis over mid parent and better parent i.e., 4.83% and 2.17%, respectively. Average heterosis over mid and better parent for days to maturity was 1.42% and –0.28%, respectively. The negative heterosis exhibited by a number of hybrids may be exploited to develop short duration mungbean cultivars.

Table 1. Means square values for various plant traits in an 8 x 8 diallel of mungbean.

Source of variation	Plant height	Days to maturity	Pods per plant	Pod length	Grains per pod	100 Grain weight	Grain yield per pod
Genotypes	309.96**	29.61**	162.37**	2.08**	1.53**	3.41**	24.50**
Replications	188.34	22.23	495.22	0.09	5.75	0.06	53.11
Error	48.13	5.79	43.42	0.26	0.67	0.44	5.43

**= Significant at 1% level of probability

For pods per plant, maximum average heterosis was revealed by three F1 hybrids i.e., NM 51 x VC 4982, NM 20-21 x VC 3902 and NM 51 x VC 3902, as 20. 24%, 19.93% and 19.68%, respectively (Table 2). Only one hybrid exhibited negative heterosis over mid parent while four hybrids over better parent. Similar results for pods per plant have been reported by Zubair *et al*., (1989) and Ghafoor *et al*., (1990) in mungbean whereas Shinde & Deshmukh (1989) and Ghafoor *et al*., (1990a) in urdbean.

The increase for pod length was not pronounced and extent of heterosis for this trait was very low as indicated in Table 2. Only five hybrids produced positive heterosis over mid parent and better parent. Maximum average heterotic effect (0.80%) was expressed by the hybrid VC 3301 x VC 1163 which was followed by the hybrid VC 4152 x VC 1163 with an average value of 0.52%. Zubair *et al*., (1989) and Ghafoor *et al*., (1990a) reported similar results in mungbean and urdbean, respectively.

Twenty seven hybrids produced positive heterotic effects over mid parent and 24 over better parent for number of grains per pod (Table 3). The extent of heterosis for this character was low and parental values for this trait were also not much diversified. F1 hybrid NM 20-21 x VC 3902 produced maximum average heterotic effect (1.68%) followed by the cross NM 51 x VC 3902 with average value of 1.67%. Low heterosis for grains per pod was also reported by Shinde & Deshmukh (1989) and Ghafoor *et al*., (1990) in urdbean, while by Zubair *et al*., (1989) in mungbean.

For 100 grain weight, 15 hybrids excelled over mid parent and 5 over better parent. Maximum average heterotic effect (1.24%) was revealed by the hybrid VC 4982 x VC 3301. The heterotic effects in 100 grain weight were low to medium which imposed restriction on improving this trait in the material used in this study. The results are in agreement with earlier reports (Zubair *et al*., 1989; Ghafoor *et al*., 1990b).

In case of grain yield, all the crosses except one (NM 20-21 x NM 121-25) excelled over mid parent. Twenty six hybrids yielded positive average heterosis with values ranging from 0.51% to 7.34%. The heterotic effects for grain yield were generally higher indicating that grain yield can be improved in existing mungbean material. Singh *et al*., (1973), Singh *et al*., (1975), Malik *et al*., (1987), Shinde & Deshmukh (1989) and Ghafoor *et al*., (1990b) reported similar results.

Heterotic effects were greater for plant height, number of pods per plant and grain yield per plant. Pods per plant represented to be the major yield contributing component to the differences in grain yield between parents and F_1 hybrids. The extent of heterosis in pod length, grain per pod and 100 grain weight was very low as compared to other characteristics restricting improvement in mungbean for these traits in existing genetic stock. Therefore, diversified germplasm is required to be imported for utilization in breeding programme to improve these yield contributing traits in mungbean.

The present study revealed that the crosses viz., NM 51 x VC 3902, NM 51 x VC 4982, NM 20-21 x VC 1163, NM 51 x VC 3301 and VC 3301 x VC 1163 that produced high heterotic effects for number of grains per pod, pods per plant and grain yield might be exploited for the above traits to develop high yielding mungbean cultivars.

Table 2. Mean values and heterosis over mid parent (MP) and better parent (BP) for plant height, days to maturity, pods per plant and pod length in an 8 x 8 diallel of mungbean.

Hybrid	Plant height			Days to maturity			Pods per plant			Pod length		
	Mean	Heterosis % over		Mean	Heterosis % over		Mean	Heterosis % over		Mean	Heterosis % over	
		MP	BP		MP	BP		MP	BP		MP	BP
NM 20-21 x NM 121-25	92.95	7.57	2.83	68.67	3.83	-0.33	15.77	-4.10	-7.90	7.69	0.23	-0.09
NM 20-21 x NM 51	93.58	10.37	7.35	65.00	2.83	1.33	24.20	10.30	8.13	7.88	-0.31	-1.34
NM 20-21 x VC 4982	82.37	16.35	2.17	61.67	-0.50	-2.00	25.98	9.30	8.68	7.21	0.24	0.08
NM 20-21 x VC 4152	72.72	-4.32	-7.48	63.67	1.83	0.67	24.50	7.40	6.37	8.08	-0.01	-0.96
NM 20-21 x VC 3902	97.70	15.97	14.43	67.33	3.67	0.67	25.43	11.93	9.36	8.47	-0.06	-1.45
NM 20-21 x VC 3301	90.17	12.83	9.97	65.67	2.67	0.33	20.42	5.41	4.34	8.18	0.13	-0.77
NM 20-21 x VC 1163	77.38	0.70	-2.81	62.00	1.33	1.33	35.60	20.33	19.53	7.92	-0.03	-0.84
NM 121-25 x NM 51	100.60	12.20	10.03	71.17	4.83	2.17	19.85	2.15	-3.82	8.83	0.33	-0.39
NM 121-25 x VC 4982	85.78	14.58	-4.78	66.00	-0.33	-3.00	25.33	4.85	1.67	7.74	0.45	-0.04
NM 121-25 x VC 4152	89.72	7.50	-0.85	67.83	1.83	-1.17	31.47	10.57	7.80	8.15	-0.27	-0.89
NM 121-25 x VC 3902	97.38	10.47	6.82	69.83	2.00	0.83	21.02	3.72	-2.65	8.36	-0.49	-1.56
NM 121-25 x VC 3301	101.45	18.93	10.88	68.67	1.50	-0.33	18.92	0.12	-4.75	8.60	0.24	-0.35
NM 121-25 x VC 1163	88.72	6.85	-1.85	65.33	0.50	-3.67	22.53	3.47	-1.13	8.29	0.02	-0.47
NM 51 x VC 4982	83.22	14.18	-3.02	65.83	2.17	2.17	36.15	21.63	18.85	7.32	-0.69	-1.90
NM 51 x VC 4152	82.23	2.18	-4.00	64.17	0.83	0.50	24.83	9.90	6.71	9.03	-0.10	-0.19
NM 51 x VC 3902	85.88	1.13	-0.35	67.67	2.50	1.00	31.22	19.88	19.48	9.04	-0.53	-0.87
NM 51 x VC 3301	88.93	8.58	2.70	67.00	2.50	1.67	25.22	12.38	11.28	9.04	-0.05	-0.18
NM 51 x VC 1163	82.72	3.02	-3.52	65.67	3.50	2.00	28.65	15.55	14.18	8.71	-0.28	-0.51
VC 4982 x VC 4152	71.70	8.85	-2.17	62.83	-0.50	-0.83	21.10	3.39	2.97	8.15	0.23	-0.89
VC 4982 x VC 3902	82.13	14.58	-1.13	64.67	-0.50	-2.00	22.32	8.20	5.02	9.11	0.75	-0.81
VC 4982 x VC 3301	74.25	11.10	-0.22	67.17	2.67	1.83	19.40	3.78	2.10	8.36	0.48	-0.59
VC 4982 x VC 1163	76.73	14.23	3.57	64.00	1.83	0.33	26.08	10.20	8.78	8.17	0.39	-0.59
VC 4152 x VC 3902	78.23	-0.33	-5.03	64.17	-0.67	-2.50	20.15	5.62	2.02	9.43	-0.05	-0.49
VC 4152 x VC 3301	76.35	2.18	1.88	63.00	-1.17	-2.33	22.33	6.30	4.21	9.40	0.40	0.36
VC 4152 x VC 1163	74.07	0.55	0.20	62.17	0.33	-0.83	19.60	3.30	1.47	9.49	0.59	0.45
VC 3902 x VC 3301	84.08	5.22	0.82	65.67	-0.33	-1.00	18.03	5.60	4.10	10.15	0.71	0.23
VC 3902 x VC 1163	85.42	7.20	2.15	64.00	0.33	-2.67	22.08	9.38	7.62	9.16	-0.18	-0.76
VC 3301 x VC 1163	76.62	2.80	2.15	63.33	0.33	-2.00	25.23	11.03	10.77	9.70	0.85	0.75
Average	84.75	8.05	1.42	65.51	1.42	-0.28	24.05	8.27	5.90	8.56	0.11	-0.54

Table 3. Mean values and heterosis over mid parent (MP) and better parent (BP) for grains per pod, 100 grain weight and grain yield per plant in an 8 x 8 diallel of mungbean.

Hybrid	Grains per pod			100 Grain weight			Grain yield per plant		
	Mean	Heterosis % over		Mean	Heterosis % over		Mean	Heterosis % over	
		MP	BT		MP	BT		MP	BT
NM 20-21 x NM 121-25	12.08	0.52	0.22	4.05	0.44	0.26	4.18	-1.11	-2.92
NM 20-21 x NM 51	12.42	1.25	1.15	4.06	-0.64	-1.94	7.01	3.08	2.63
NM 20-21 x VC 4982	11.63	0.60	0.37	3.46	0.45	0.05	5.69	2.18	2.15
NM 20-21 x VC 4152	11.68	0.52	0.42	4.28	-0.81	-2.49	8.67	3.63	2.07
NM 20-21 x VC 3902	12.70	1.93	1.43	4.72	-0.22	-1.76	9.06	4.96	4.35
NM 20-21 x VC 3301	11.57	0.30	0.30	4.87	0.72	-0.01	6.36	2.27	1.65
NM 20-21 x VC 1163	12.32	1.02	0.98	4.78	-0.13	-1.64	11.39	6.98	6.05
NM 121-25 x NM 51	12.92	1.45	1.05	4.79	-0.10	-1.20	7.51	1.78	0.42
NM 121-25 x VC 4982	11.67	0.33	-0.20	3.78	0.59	-0.01	6.81	1.49	-0.28
NM 121-25 x VC 4152	12.05	0.58	0.18	5.29	0.01	-1.48	12.27	5.42	5.17
NM 121-25 x VC 3902	11.93	0.87	0.07	5.10	-0.04	-1.38	8.50	2.60	1.40
NM 121-25 x VC 3301	11.98	0.42	0.12	4.72	0.39	-0.15	7.70	1.80	0.61
NM 121-25 x VC 1163	12.02	0.42	0.15	4.64	-0.46	-1.78	7.17	0.95	0.08
NM 51 x VC 4982	11.95	1.02	0.88	4.22	-0.07	-1.77	10.74	6.78	6.37
NM 51 x VC 4152	11.88	0.82	0.82	6.08	-0.30	-0.69	9.45	3.96	2.85
NM 51 x VC 3902	12.53	1.87	1.47	5.92	-0.32	-0.56	11.97	7.43	7.26
NM 51 x VC 3301	11.63	0.47	0.37	5.77	0.34	-0.23	10.78	6.24	6.08
NM 51 x VC 1163	11.52	0.32	0.19	6.04	-0.17	-0.38	9.40	4.53	4.05
VC 4982 x VC 4152	10.14	-0.79	-0.92	4.81	0.12	-1.96	5.72	0.65	-0.87
VC 4982 x VC 3902	11.47	0.93	0.67	4.61	0.07	-1.86	6.66	2.54	1.96
VC 4982 x VC 3301	11.60	0.57	0.33	5.54	1.81	0.67	6.62	2.49	1.91
VC 4982 x VC 1163	11.36	0.29	0.03	5.32	0.81	-1.10	8.30	3.85	2.96
VC 4152 x VC 3902	10.93	0.26	-0.14	6.86	0.24	0.09	9.89	4.24	3.29
VC 4152 x VC 3301	11.58	0.42	0.32	6.20	0.37	-0.57	8.35	2.69	1.74
VC 4152 x VC 1163	11.97	0.77	0.63	6.34	-0.25	-0.43	7.67	1.70	1.07
VC 3902 x VC 3301	11.10	0.33	-0.17	6.93	1.25	0.45	7.63	2.92	2.92
VC 3902 x VC 1163	11.49	0.69	0.16	5.79	-0.66	-0.69	8.71	3.69	3.37
VC 3301 x VC 1163	12.25	0.95	0.92	6.10	0.46	-0.32	10.43	5.41	5.09
Average	11.80	0.68	0.42	5.18	0.14	-0.82	8.38	3.40	2.55

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