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Heterosis for yield component characters and seed yield in Mungbean (*Vigna radiata* L. Wilczek)

Pradeep Choudhary, G Roopa Lavanya and Bhinwa Ram Chandiwal

Abstract
The present investigation entitled "Heterosis for yield component characters and seed yield in mungbean (*Vigna radiata* L.)." was carried out at Field Experimentation Center, Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology & Sciences - Deemed University, Allahabad during *Kharif,* 2014 and *Zaid,* 2015. The material for the present investigation comprised ten parents and twenty one crosses, *viz.*, RMG-492, RMG-1037, GANGA-8, RMG-1062, RMG-275, RMG-1033, RMG-62, RMG-1052, MSG-118 and G-4. Hybridization was carried out during *Kharif,* 2014 in Line x Tester crossing blocks and F_1s were evaluated in *Zaid,* 2015 in randomized block design with three replications. The ten characters studied were, days to 50% flowering, plant height, primary branches per plant, cluster per plant, pods per plant, pod length, seeds per pod, days to maturity, seed index and seed yield per plant. On the basis of mean performance for seed yield per plant, RMG-275 x RMG-1052. High relative heterosis, heterobeltiosis and economic heterosis performance for quantitative characters was recorded in RMG-275 x RMG-1052.

Keywords: Mungbean, heterosis, heterobeltiosis, economic heterosis

1. Introduction
Mungbean (*Vigna radiata* L. Wilczek), also known as greengram, is an important short duration grain legume with wide adoptability. It is considered to be originated from *Vigna sublobata*. The origin of green gram is supposed to be India (Decandole, 1886, Vavilov, 1926, and Zukoveskij 1962) [2]. Greengram is one of the most important pulse crop extensively grown in India. Among pulses, it ranks third after Bengalgram and redgram. In Maharashtra state, it is second important *kharif* crop grown after redgram. Mungbean is well suited to a large number of cropping system and constitutes an important source of cereal based diet. It is mainly utilized in making *dhal*, curries, soup, sweets and snacks. The germinated seed have nutritional value compared with *Asparagus* or mushroom. During sprouting, there is an increase in thiamine, niacin and ascorbic acid concentration. The food values of mungbean lie in its high and easily digestible protein. The mungbean seeds contain approximately 25-28% protein, 1.0-1.5% oil, 3.5-4.5% fibre, 4.5-5.5% ash and 62-65% carbohydrates on dry weight basis.
The present yield potential of improved varieties is not enough to attract the farmers because of relatively smaller seed size, low yield potential and susceptibility to disease. Study of heterosis and combining ability in mungbean is an important tool for the plant breeder to find out the superior crosses in first generation itself.
The term heterosis was coined by Shull 1914. Heterosis refers to the superiority of F_1 hybrid in one or more character over its parents. In other world, heterosis refers to increase of F_1 in fitness and vigour over the parental values. Heterosis leads to superiority in adaptation, yield, quality, disease resistance, maturity and general vigor over its parents. If the hybrid is superior to mid parent, it is regarded as average heterosis oe relative heterosis. More generally, heterosis is estimated over the superior parent, such an estimate is sometime refer to as heterobeltosis but will be desirable to estimate heterosis in relation to the best commercial variety of the crop, such an estimate it known as economic or standard or useful heterosis.

Materials and methods
The experimental materials consisted of 10 diverse genotypes (7 lines + 3 testers) of mungbean, these were selected on the basis of their diverse geographical origin, wide variation and their adaptability for different agro-climatic zones of India.
The experimental materials were crossed in Line x Tester mating design (Kempthorne, 1957) [4] in Kharif 2014-2015 to generate 21 crosses. These 21 crosses along with 10 parents and 1 checks *viz.*, Samrat were evaluated during *Zaid* 2014-2015 at the Field Experimentation Centre,

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The ten characters studied were, Days to 50% flowering, plant height, primary branches per plant, clusters per plant, pods per plant, pod length, seeds per pod, days to maturity, seed index and yield per plant. Observations were recorded on the randomly selected plants for all the characters from each genotypes in each replication. The data were subjected to analysis of variance for mean performance (Panse and Sukhatme, 1995) [6] and heterosis over better parent (BP) and standard variety (SV) were calculated and tested as specified by Hays, (1955) [3].

Results and discussion

Table-1, the mean performance revealed that out of ten parental genotypes selected for the study. The parental genotype with the highest seed yield was found to be MSG-118 (9.90 g), which was performing better than the check i.e. GANGA-1 (9.69 g). MSG-118 also showed desirable results with respect to other yield attributing traits like seed index (3.05g).Lowest yield was exhibited by GANGA -8 (7.74g), this may be due to some environmental effects which has resulted in low yield**.**

Table-2, The F1 genotype with the highest seed yield was found to be RMG-275 x RMG-1052 (11.64g), which was performing better than the check i.e. GANGA-1 (9.69 g). RMG-275 x RMG-1052 also showed desirable results with respect to other traits *viz*. seed index(3.26g), days to 50% flowering (39.66) and Seeds/ Pods (11.26).

Table-3, the average heterosis revealed that out of 21 F_1 genotypes used in the study. The cross combination RMG-275 x RMG-1052 had the highest (42.73**) significant positive heterosis for this character. Apart from seed yield, the hybrid RMG-275 x RMG-1052 also showed significant results for other characters like Seeds/Pods and days to maturity. Similar results were observed by Vikae *et al.* (1999) and Naidu *et al.* (1993) [5].

Table-4, the cross combination RMG-275 x RMG-1052 had the highest (41.34**) significant positive heterosis for this character, followed by GANGA-8 x RMG-1052 (37.30**), RMG-62 x RMG-1052 (35.92**), the genotype GANGA-8 x RMG-1052 found desirable for days of maturity (-4.66**). Similar results were observed by Aher *et al.* (2000) [1] and Gawande *et al.* (2001).

Table-5, the cross combination RMG-275 x RMG-1052 had the highest (20.11**) significant positive heterosis for this character, followed by RMG-62 x RMG-1052 (19.15**). The genotype RMG-62 x RMG-1052 was found desirable for various characters *viz* Primary Branches/ Plant (6.05**) and days to maturity (-2.65*)

Table 1: Mean performances of parents for yield component characters and seed yield in Mungbean

S. No.	Genotypes	Days to 50% flowering	Plant height	Number of branches per plant	Clusters per plant	Pods per plant	Pod length	Seeds per pod	Days Of maturity	Seed index	Yield per plant
1	RMG-492	42.00	57.37	6.93	6.57	16.20	7.28	10.77	62.00	3.30	8.61
2	RMG-1037	41.67	55.17	7.10	6.43	15.97	7.32	11.27	62.00	3.02	8.57
3	GANGA-8	42.00	54.93	7.07	6.73	15.27	8.03	11.63	64.33	3.00	7.74
4	RMG-1062	40.67	56.00	6.73	6.60	16.67	7.42	12.07	62.33	2.92	8.45
5	RMG-275	42.33	56.17	6.80	6.67	16.60	7.29	12.40	64.00	2.97	8.08
6	RMG-1033	40.33	57.93	6.87	6.80	17.00	7.43	12.60	63.00	3.09	9.23
7	RMG-62	40.67	59.47	6.67	7.27	17.40	7.27	11.73	61.33	2.87	8.50
8	RMG-1052	42.33	57.97	7.00	7.13	16.47	7.43	12.20	63.67	3.08	8.24
9	MSG-118	41.67	57.50	7.07	6.67	15.93	7.49	10.33	65.33	3.05	9.90
10	G-4	42.33	57.27	6.93	6.73	16.40	7.33	10.47	62.33	2.91	8.81
11	GANGA-1 ©	40.67	53.17	7.17	7.13	18.50	8.41	11.83	63.00	3.12	9.70
12	Parents mean	41.60	56.98	6.92	6.76	16.39	7.43	11.55	63.03	3.02	8.61
13	Maximum	42.33	59.47	7.10	7.27	17.40	8.03	12.60	65.33	3.30	9.90
14	Minimum	40.33	54.93	6.67	6.43	15.27	7.27	10.33	61.33	2.87	7.74
15	CD (5%)	1.32	2.50	0.40	0.42	1.27	0.62	1.01	1.79	0.23	1.19

Table 2: Mean performances of hybrids for yield component characters and seed yield in Mungbean

S. No.	Genotypes	Days to 50% flowering	Plant height	Number of branches per plant	Clusters per plant	Pods per plant	Pod length	Seeds per pod	Days of maturity	Seed index	Yield per plant
1	RMG-492*RMG-1052	40.33	57.93	7.07	7.67	17.77	7.61	12.27	62.33	3.12	10.27
2	RMG-492*MSG-118	40.00	57.67	7.53	7.53	17.60	7.96	11.67	63.33	2.93	10.87
3	RMG-492*G-4	40.67	57.87	7.20	7.60	17.07	7.64	12.20	61.33	3.00	10.63
4	RMG-1037*RMG-1052	40.33	57.40	7.33	7.60	18.27	8.02	12.27	62.00	3.15	10.70
5	RMG-1037*MSG-118	42.67	57.70	7.40	7.67	17.07	7.47	12.27	63.67	2.95	9.60
6	RMG-1037*G-4	40.33	57.80	7.40	7.47	17.60	7.83	11.87	61.67	2.97	10.32
7	GANGA-8*RMG-1052	39.33	57.47	6.87	7.33	18.27	7.45	12.27	61.33	3.17	11.31
8	GANGA-8*MSG-118	41.00	58.20	7.27	7.53	17.60	7.69	11.93	62.67	3.09	9.40
9	GANGA-8*G-4	40.33	58.03	7.33	7.53	17.73	7.77	11.53	65.33	2.99	10.33

10	RMG-1062*RMG-1052	39.67	58.03	7.07	7.67	17.80	7.49	11.93	62.33	3.23	11.36
11	RMG-1062*MSG-118	39.67	57.00	6.87	7.13	17.80	8.36	12.47	61.33	2.83	10.05
12	RMG-1062*G-4	41.00	57.87	7.07	7.47	17.40	7.50	12.20	63.33	2.89	9.85
13	RMG-275*RMG-1052	39.67	57.73	7.13	7.53	18.00	7.50	11.27	63.33	3.27	11.65
14	RMG-275*MSG-118	41.00	58.43	7.40	7.80	17.20	7.61	12.13	63.00	2.78	10.22
15	RMG-275*G-4	39.67	56.93	7.53	7.80	18.20	7.45	12.27	61.67	3.05	11.47
16	RMG-1033*RMG-1052	40.67	57.80	7.27	7.73	17.67	7.45	12.07	64.00	3.12	10.35
17	RMG-1033*MSG-118	41.00	57.40	7.27	7.60	17.27	7.77	12.13	61.67	2.91	9.94
18	RMG-1033*G-4	41.33	58.53	7.27	7.53	17.33	7.69	12.13	61.00	2.91	9.35
19	RMG-62*RMG-1052	40.33	57.93	7.60	7.47	17.60	7.68	12.00	61.33	3.18	11.55
20	RMG-62*MSG-118	41.33	57.20	7.27	7.67	17.40	7.90	12.53	62.00	3.01	10.18
21	RMG-62*G-4	41.33	57.80	7.47	7.60	17.93	8.15	12.53	62.67	2.75	10.39
22	GANGA-1 ©	40.67	53.17	7.17	7.13	18.50	8.41	11.83	63.00	3.12	9.70
23	Hybrids mean	40.56	57.75	7.27	7.57	17.65	7.71	12.09	62.44	3.01	10.47
24	Maximum	42.67	58.53	7.60	7.80	18.27	8.36	12.53	65.33	3.27	11.65
25	Minimum	39.33	57.00	6.87	7.13	17.07	7.45	11.27	61.00	2.75	9.35
26	CD (5%)	1.32	2.50	0.40	0.42	1.27	0.62	1.01	1.79	0.23	1.19

Table 3: Heterosis of hybrids for yield component characters and seed yield in Mungbean

S. No.	Genotypes	Days to 50% flowering	Plant height	Number of branches per plant	Clusters per plant	Pods per plant	Pod length	Seeds per pod	Days of maturity	Seed index	Yield per plant
1.	RMG-492*RMG-1052	-4.35**	0.46	1.44	11.92**	8.78*	3.40	6.82	-0.80	-2.30	21.86**
2.	RMG-492*MSG-118	-4.38**	0.41	7.62**	13.85**	9.54**	7.76*	10.58*	-0.52	-7.82*	17.41**
3.	RMG-492*G-4	-3.56*	0.96	3.85	14.29**	4.70	4.56	14.91**	-1.34	-3.33	22.03**
4.	RMG-1037*RMG-1052	-3.97**	1.47	4.02	12.04**	12.64**	8.72*	4.55	-1.33	3.44	27.29**
5.	RMG-1037*MSG-118	2.40	2.43	4.47	17.05**	7.00	0.90	13.58**	0.00	-2.86	3.97
6.	RMG-1037*G-4	-3.97**	2.82	5.46*	13.42**	8.75*	6.82	9.20*	-0.80	0.06	18.80**
7.	GANGA-8*RMG-1052	-6.72**	1.80	-2.37	5.77*	15.13**	-3.62	2.94	-4.17**	4.44	41.59**
8.	GANGA-8*MSG-118	-1.99	3.53	2.83	12.44**	12.82**	-0.90	8.65*	-3.34**	2.32	6.58
9.	GANGA-8*G-4	-4.35**	3.45	4.76	11.88**	12.00**	1.17	4.37	3.16*	1.30	24.90**
10.	RMG-1062*RMG-1052	-4.42**	1.84	2.91	11.65**	7.44*	0.81	-1.65	-1.06	7.72*	36.20**
11.	RMG-1062*MSG-118	-3.64*	0.44	-0.48	7.54*	9.20*	12.11**	11.31**	-3.92**	-5.13	9.56
12.	RMG-1062*G-4	-1.20	2.18	3.41	12.00**	5.24	1.67	8.28*	1.60	-0.86	14.18*
13.	RMG-275*RMG-1052	-6.30**	1.17	3.38	9.18**	8.87*	1.86	-8.40*	-0.78	7.99*	42.73**
14.	RMG-275*MSG-118	-2.38	2.82	6.73*	17.00**	5.74	2.89	6.74	-2.58*	-7.75*	13.64*
15.	RMG-275*G-4	-6.30**	0.38	9.71**	16.42**	10.30**	1.82	7.29	-2.37	3.68	35.81**
16.	RMG-1033*RMG-1052	-1.61	-0.26	4.81	11.00**	5.58	0.18	-2.69	1.05	1.08	18.47**

17.	RMG-1033*MSG-118	0.00	-0.55	4.31	12.87**	4.86	4.15	5.81	-3.90**	-5.16	3.90
18.	RMG-1033*G-4	0.00	1.62	5.31*	11.33**	3.79	4.11	5.20	-2.66*	-3.00	3.66
19.	RMG-62*RMG-1052	-2.81*	-1.33	11.22**	3.70	3.94	4.44	0.28	-1.87	7.06*	38.03**
20.	RMG-62*MSG-118	0.40	-2.19	5.83*	10.05**	4.40	7.00	13.60**	-2.11	1.86	10.69
21.	RMG-62*G-4	-0.40	-0.97	9.80**	8.57**	6.11	11.55**	12.91**	1.35	-4.96	20.07**

Table 4: Heterobeltiosis of hybrids for yield component characters and seed yield in Mungbean

S. No.	Genotypes	Days to 50% flowering	Plant height	Number of branches per plant	Clusters per plant	Pods per plant	Pod length	Seeds per pod	Days of maturity	Seed index	Yield per plant
1.	RMG-492*RMG-1052	-4.72**	-0.06	0.95	7.48*	7.89	2.33	0.55	-2.09	-5.56	19.24**
2.	RMG-492*MSG-118	-4.76**	0.29	6.60*	13.00**	8.64*	6.23	8.36	-3.06*	-11.31**	9.76
3.	RMG-492*G-4	-3.94*	0.87	3.85	12.87**	4.07	4.18	13.31**	-1.60	-8.99*	20.67**
4.	RMG-1037*RMG-1052	-4.72**	-0.98	3.29	6.54*	10.93**	7.89	0.55	-2.62	2.38	24.86**
5.	RMG-1037*MSG-118	2.40	0.35	4.23	15.00**	6.89	-0.27	8.88	-2.55	-3.39	-3.03
6.	RMG-1037*G-4	-4.72**	0.93	4.23	10.89**	7.32	6.73	5.33	-1.07	-1.66	17.18*
7.	GANGA-8*RMG-1052	-7.09**	-0.86	-2.83	2.80	10.93**	-7.22	0.55	-4.66**	3.03	37.30**
8.	GANGA-8*MSG-118	-2.38	1.22	2.83	11.88**	10.46*	-4.23	2.58	-4.08**	1.42	-5.05
9.	GANGA-8*G-4	-4.72**	1.34	3.77	11.88**	8.13*	-3.24	-0.86	1.55	-0.11	17.34*
10.	RMG-1062*RMG-1052	-6.30**	0.12	0.95	7.48*	6.80	0.72	-2.19	-2.09	4.98	34.53**
11.	RMG-1062*MSG-118	-4.80**	-0.87	-2.83	7.00*	6.80	11.57**	3.31	-6.12**	-7.10	1.52
12.	RMG-1062*G-4	-3.15	1.05	1.92	10.89**	4.40	1.08	1.10	1.60	-1.03	11.85
13.	RMG-275*RMG-1052	-6.30**	-0.40	1.90	5.61	8.43*	0.90	-9.14*	-1.04	6.06	41.34**
14.	RMG-275*MSG-118	-3.15	1.62	4.72	17.00**	3.61	1.51	-2.15	-3.57	-8.96*	3.20
15.	RMG-275*G-4	-6.30**	-0.58	8.65**	15.84**	9.64*	1.55	-1.08	-3.65	2.69	30.20**
16.	RMG-1033*RMG-1052	-3.94*	-0.29	3.81	8.41**	3.92	0.18	-4.23	0.52	0.97	12.09
17.	RMG-1033*MSG-118	-1.60	-0.92	2.83	11.76**	1.57	3.74	-3.70	-5.61**	-5.72	0.40
18.	RMG-1033*G-4	-2.36	1.04	4.81	10.78**	1.96	3.41	-3.70	-3.17*	-5.72	1.26
19.	RMG-62*RMG-1052	-4.72**	-2.58	8.57**	2.75	1.15	3.32	-1.64	-3.66*	3.35	35.92**
20.	RMG-62*MSG-118	-0.80	-3.81	2.83	5.50	0.00	5.43	6.82	-5.10**	-1.20	2.86
21.	RMG-62*G-4	-2.36	-2.80	7.69*	4.59	3.07	11.09*	6.82	0.53	-5.72	17.98*

Table 5: Standard heterosis of hybrids for yield component characters and seed yield in Mungbean

S. No.	Genotypes	Days to 50% flowering	Plant height	Number of branches per plant	Clusters per plant	Pods per plant	Pod length	Seeds per pod	Days of maturity	Seed index	Yield per plant
1.	RMG-492*RMG-1052	-0.82	8.97**	-1.40	7.48*	-3.96	-9.59*	3.66	-1.06	-0.11	5.88
2.	RMG-492*MSG-118	-1.64	8.46**	5.12	5.61	-4.86	-5.39	-1.41	0.53	-6.20	12.07
3.	RMG-492*G-4	0.00	8.84**	0.47	6.54*	-7.75*	-9.19*	3.10	-2.65	-3.74	9.59
4.	RMG-1037*RMG-1052	-0.82	7.96**	2.33	6.54*	-1.26	-4.68	3.66	-1.59	1.07	10.31
5.	RMG-1037*MSG-118	4.92**	8.53**	3.26	7.48*	-7.75*	-11.17**	3.66	1.06	-5.56	-1.00
6.	RMG-1037*G-4	-0.82	8.71**	3.26	4.67	-4.86	-6.97	0.28	-2.12	-4.91	6.43
7.	GANGA-8*RMG-1052	-3.28	8.09**	-4.19	2.80	-1.26	-11.41**	3.66	-2.65	1.71	16.67*
8.	GANGA-8*MSG-118	0.82	9.47**	1.40	5.61	-4.86	-8.56*	0.85	-0.53	-0.85	-3.06
9.	GANGA-8*G-4	-0.82	9.15**	2.33	5.61	-4.14	-7.61*	-2.54	3.70*	-4.06	6.57
10.	RMG-1062*RMG-1052	-2.46	9.15**	-1.40	7.48*	-3.78	-11.01**	0.85	-1.06	3.63	17.19**
11.	RMG-1062*MSG-118	-2.46	7.21**	-4.19	0.00	-3.78	-0.63	5.35	-2.65	-9.19*	3.64
12.	RMG-1062*G-4	0.82	8.84**	-1.40	4.67	-5.95	-10.86**	3.10	0.53	-7.26	1.58
13.	RMG-275*RMG-1052	-2.46	8.59**	-0.47	5.61	-2.70	-10.86**	-4.79	0.53	4.70	20.11**
14.	RMG-275*MSG-118	0.82	9.91**	3.26	9.35**	-7.03	-9.59*	2.54	0.00	-11.00**	5.36
15.	RMG-275*G-4	-2.46	7.08**	5.12	9.35**	-1.62	-11.49**	3.66	-2.12	-2.24	18.25**
16.	RMG-1033*RMG-1052	0.00	8.71**	1.40	8.41**	-4.50	-11.49**	1.97	1.59	-0.11	6.74
17.	RMG-1033*MSG-118	0.82	7.96**	1.40	6.54*	-6.67	-7.61*	2.54	-2.12	-6.73	2.51
18.	RMG-1033*G-4	1.64	10.09**	1.40	5.61	-6.31	-8.64*	2.54	-3.17*	-6.73	-3.58
19.	RMG-62*RMG-1052	-0.82	8.97**	6.05*	4.67	-4.86	-8.72*	1.41	-2.65	2.03	19.15**
20.	RMG-62*MSG-118	1.64	7.59**	1.40	7.48*	-5.95	-6.10	5.92	-1.59	-3.42	5.02
21.	RMG-62*G-4	1.64	8.71**	4.19	6.54*	-3.06	-3.17	5.92	-0.53	-11.97**	7.15

Conclusion

It can be concluded from the present study that the cross RMG-275 x RMG-1052 was found best as it showed high positive significant heterosis for seed yield per plant (42.73**), days of maturity (-0.78*) and seed index (7.99**). The cross RMG-275 x RMG-1052 was found best as it showed high positive significant heterobeltiosis for seed yield per plant (41.34**) and days of 50% flowering (-6.30**). The cross RMG-275 x RMG-1052 was found best as it showed high positive significant economic heterosis for seed yield per plant (20.11**) and seed index (4.70*).

Further evaluation is suggested for confirmation of these results.

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