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RESEARCH ARTICLE

ESTIMATION OF HETEROSIS, INBREEDING DEPRESSION AND TRANSGRESSIVE SEGREGATION IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

***Salunke, M. D., Dr. Pithia, M. S. and Dr. Metha, D. R**

Pulses Research Station, Junagadh Agricultural University, Junagadh 362 001, Gujarat, India

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ABSTRACT

Two mungbean crosses namely, GM 4 x BPMR 145 and K 851 x AKM 6822 made during *kharif* season (2012) were studied for estimation of heterosis, inbreeding depression and transgressive segregation. The F_2 and F_3 generations of both the crosses were sown in randomized block design and data were recorded on days to initiation of flower, days to maturity, plant height, number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, 100 seed weight and seed yield per plant. The significant and positive heterosis was fond in 100 seed weight in both the crosses. None of character showed significant inbreeding depression in cross K 851 x AKM 6822 and in cross GM 4 x BPMR 145, 100 seed weight showed positive and significant inbreeding depression. In F_2 generation of GM 4 x BPMR 145, forty per cent plant population showed transgression for seed yield per plant, while in F_3 generation 50 % of plant population showed upper limit transgression segregants for seed yield per plant. However in cross K 851 x AKM 6822, F_2 generation showed the 80 % transgressive segregants for seed yield per plant while in F_3 population maximum 90 % of transgressive segregants were observed for seed yield.

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INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) is an important source of protein in India, Indonesia, Myanmar, Pakistan, Thailand, Vietnam, among other countries. Farmers grow it as a supplemental crop or cash crop. Mungbean is the shortest maturing field crop. However, its yield is low compared to other grain legumes. The annual increase in production comes mainly from the increase in cultivated area. Yield productivity is not easily achieved by the current methods of cultivar improvement and cultural practices. Using hybrid cultivars can improve the yield limitation in pure line cultivars. Heterosis or hybrid vigor is manifested by F_1 hybrids. Hybrid varieties have contributed greatly worldwide to the production of many crop species, including the most important food crops such as maize and rice. The commercial exploitation of heterosis has been one of the driving forces behind the rapid and extensive development of seed production. Heterosis breeding has allowed yield breakthroughs in several crops, including cross-pollinated, often cross-pollinated, and self-pollinated species. The exploitation of heterosis to raise productivity in grain legumes, as in any other crop, depends on three major factors: the magnitude of heterosis, feasibility of large-scale production of hybrid seeds and type of gene action involved.

The conventional idea of hybridization is to combine the desirable characteristic in a new derivative already present in the parents. Perhaps a more imaginative approach to plant breeding is to consider the possibilities of transgressive segregation. Transgressive segregants are obtained in segregating generations due to accumulation of favorable alleles by means of segregation and recombination, from the parent involved in the hybridization. Studies of quantitative traits in segregating hybrid populations sometimes report the presence of phenotypes that are extreme relative to those of either parental line (deVicente and Tanksley,1993; Rieseberg and Ellstrand, 1993; Cosse *et al.*, 1995). The generation of these extreme phenotypes is referred to as transgressive segregation, and this is a major mechanism by which extreme or novel adaptations observed in new hybrid ecotypes or species are thought to arise. If transgressive segregation is frequent, then an important evolutionary role for hybridization is more easily explained. Note that transgressive segregation is a phenomenon specific to segregating hybrid generations and refers to the fraction of individuals that exceed parental phenotypic values in either a negative or positive direction. This is caused in part by heterosis, which is most pronounced in first-generation hybrids, and is implicated when the mean trait value of the hybrids exceeds (in a positive direction only) the phenotypic values of both parental lines. As will be shown below, the genetic basis of transgressive segregation appears to be largely distinct from that underlying heterosis.

****Corresponding author: Salunke, M. D.,***
Pulses Research Station, Junagadh Agricultural University, Junagadh 362 001, Gujarat, India.

Table 1. Estimates of heterosis and inbreeding depression in cross I (GM 4 x BPMR 145) and cross II (K 851 x AKM 6822) of mungbean

Characters	Cross I (GM 4 x BPMR 145)			Cross II (K 851 x AKM 6822)		
	Per cent heterosis over		Inbreeding depression (%)	Per cent heterosis over		Inbreeding depression (%)
	Better parent	Standard heterosis		Better parent	Standard heterosis	
Days to initiation of flower	4.97 ± 3.18	4.98 ± 3.19	-1.34* ± 3.13	3.41 ± 3.17	10.36 ± 2.91	0.94 ± 2.81
Days to maturity	0.97 ± 2.52	0.41 ± 2.47	-1.35* ± 2.93	1.90 ± 3.73	4.36 ± 3.66	0.29 ± 3.86
Plant height (cm)	-13.48 ± 4.32	0.97 ± 4.33	-7.44 ± 6.39	3.68 ± 5.65	16.70 ± 5.11	-11.30 ± 5.42
Number of branches per plant	3.95 ± 4.23	0.00 ± 0.56	13.30 ± 5.15	9.95 ± 3.51	7.39 ± 0.59	5.66 ± 4.18
Number of clusters per plant	2.75 ± 0.90	45.69 ± 4.23	1.67 ± 1.24	12.64 ± 0.94	52.96 ± 3.73	-7.21 ± 1.22
Number of pods per cluster	11.25 ± 12.63	2.75 ± 0.90	14.76 ± 16.78	14.82 ± 11.02	3.59 ± 0.78	-1.65 ± 16.63
Number of pods per plant	-6.88 ± 0.54	46.70 ± 12.63	3.62 ± 0.53	2.78 ± 0.50	65.07 ± 11.59	2.70 ± 0.64
Pod length (cm)	19.09 ± 2.03	26.28 ± 2.04	17.38 ± 1.76	9.56 ± 2.05	10.27 ± 2.18	7.39 ± 1.85
100- Seed weight (g)	1.61 ± 0.34	29.05** ± 0.40	26.48* ± 0.41	23.13 ± 0.42	20.49** ± 0.50	-11.34 ± 0.51
Seed yield per plant (g)	16.75 ± 2.83	18.51 ± 2.83	9.55 ± 3.93	35.91 ± 2.70	26.71 ± 2.89	-5.82 ± 7.09

*, ** Significant at P=0.05 and P=0.01, respectively

Table 2. Significant transgressive segregants in F_2 and F_3 populations of GM 4 x BPMR 145 (Cross I)

Characters	P_1 (GM 4)	P_2(BPMR 145)	F_2	F_3	Per cent improvement of F_3 over F_2	F_2				F_3			
						No. (L)	%	No. (U)	%	No. (L)	%	No. (U)	%
Days to initiation of flower	40.17 ± 0.58	45.47 ± 0.49	42.73 ± 0.39	41.05 ± 0.33	-3.93	0	0	1	5	2	10	0	0
Days to maturity	65.13 ± 0.48	64.77 ± 0.51	66.28 ± 0.49	67.90 ± 0.38	2.44	4	20	12	60	0	0	19	95
Plant height (cm)	41.07 ± 0.83	47.93 ± 0.72	44.55 ± 1.21	43.98 ± 0.91	-1.28	4	20	4	20	5	25	3	15
Number of branches per plant	2.30 ± 0.14	2.47 ± 0.11	2.22 ± 0.90	2.23 ± 0.10	0.45	8	40	3	15	7	35	4	20
Number of clusters per plant	9.97 ± 0.55	13.47 ± 1.10	12.12 ± 0.76	10.70 ± 0.56	-11.72	4	20	4	20	6	30	2	10
Number of pods per cluster	4.73 ± 0.14	4.53 ± 0.20	4.78 ± 0.22	5.44 ± 0.22	13.81	9	45	6	30	4	20	15	75
Number of pods per plant	29.40 ± 1.80	38.77 ± 3.88	36.77 ± 2.78	35.50 ± 2.07	-3.45	2	10	5	25	3	15	5	25
Pod length (cm)	6.64 ± 0.50	7.02 ± 0.35	6.91 ± 0.27	6.65 ± 0.24	-3.76	4	20	7	35	7	35	4	20
100- seed weight (g)	3.27 ± 0.07	4.15 ± 0.80	3.10 ± 0.07	4.45 ± 0.10	43.55	11	55	0	0	0	0	4	20
Seed yield per plant (g)	13.40 ± 0.56	11.79 ± 0.50	14.08 ± 0.73	14.78 ± 0.76	4.97	4	20	8	40	4	20	10	50

L = Lower limit; U= Upper limit

Table 3. Significant transgressive segregants in F_2 and F_3 populations of K 851 x AKM 6822 (Cross II)

Characters	P_1 (K 851)	P_2 (AKM 68 22)	F_2	F_3	Per cent improvement of F_3 over F_2	F_2				F_3			
						No. (L)	%	No. (U)	%	No. (L)	%	No. (U)	%
Days to initiation of flower	45.40 ± 0.7	42.87 ± 0.54	44.75 ± 0.38	44.77 ± 0.34	0.04	2	10	4	20	2	10	5	25
Days to maturity	67.33 ± 0.66	66.70 ± 0.54	67.77 ± 0.44	68.40 ± 0.60	0.93	3	15	9	45	4	20	12	60
Plant height (cm)	46.23 ± 1.13	45.77 ± 1.30	53.27 ± 0.71	45.62 ± 0.96	-14.36	0	0	19	95	6	30	7	35
Number of branches per plant	2.40 ± 0.10	2.20 ± 0.10	2.40 ± 0.11	2.40 ± 0.09	0.00	5	25	8	40	6	30	10	50
Number of clusters per plant	11.43 ± 0.38	13.20 ± 0.67	13.90 ± 0.57	16.28 ± 0.65	17.12	2	10	9	45	0	0	17	85
Number of pods per cluster	4.20 ± 0.22	4.32 ± 0.25	5.25 ± 0.23	5.29 ± 0.15	0.76	1	5	16	80	0	0	18	90
Number of pods per plant	34.93 ± 1.39	42.27 ± 3.03	49.33 ± 2.95	48.8 ± 2.46	-1.07	2	10	11	55	0	0	11	55
Pod length (cm)	6.26 ± 0.44	6.50 ± 0.36	6.76 ± 0.24	6.96 ± 0.24	2.96	3	15	9	45	3	15	13	65
100- seed weight (g)	3.20 ± 0.05	2.87 ± 0.05	4.39 ± 0.08	3.67 ± 0.05	-16.40	0	0	20	100	0	0	18	90
Seed yield per plant (g)	11.31 ± 0.45	12.41 ± 0.61	16.49 ± 0.75	16.21 ± 0.67	-1.70	1	5	16	80	0	0	18	90

L = Lower limit; U= Upper limit

MATERIALS AND METHODS

Four diverse genotypes of mungbean *viz.,* GM 4, BPMR 145, K 851 and AKM 6822 were used for crossing. The two crosses, GM 4 x BPMR 145 (Cross I) and K 851 x AKM 8802 (Cross II) were attempted during *kharif* 2012. Half of the F_1 seeds of both the crosses were sown in summer 2013, F_1s were selfed to get F_2 seeds of both the single crosses, and F_2s were selfed to get F_3 seeds of both the single crosses. The final experiment comprising of two F_2s and F_3s along with the parent were grown in randomized block design with three replications at Pulses Research Station, Junagadh Agricultural University, Junagadh during summer 2014. Each plot consisted of 5 meter row length with inner and intra row spacing of 45 x 10 cm, respectively. The parents and F_1s were grown as single row each; whereas, each F_2s and F_3s had two rows. The observations were recorded on 10 randomly selected plants in each parent and F_1s and 20 randomly selected plants for F_2 and F_3 generations for 10 quantitative traits. The heterotic effects in terms of superiority of F_1 over better parent (Heterobeltiosis) as per Fonseca and Patterson (1968) and standard heterosis were worked out, the data on individual plant for each character were taken and mean, range, standard deviations, standard error of means, variances and standard variates were computed following standard statistical methods (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

In this investigation of heterosis and inbreeding depression of both the crosses, there is not a single character which showed significant desirable heterobeltiosis in cross I as well as in cross II, while, in case of standard heterosis, significant and positive heterosis was fond in 100 seed weight in both the crosses (Table 1.). The observed heterosis was found to have resulted either due to the action of dominance component only or due to the epistasis for 100 seed weight. Similar results were reported by Singh and Pathak (1992), Singh *et al.* (1993),Vikas *et al.* (1998), Vikas and Singh (1998), Sawale *et al.* (2003), Patil *et al.* (2014), Yadav *et al.* (2015). It is also interesting to note the prevalence of significant inbreeding depression for 100 seed weight in cross I. But it was negative and non significant in cross II. The extent of heterosis over standard variety GM 4 was more than 45 per cent in case of number of clusters per plant and number of pods per plant in both the crosses. In seed yield, heterosis over better parent and standard variety GM 4 were also considerable with non significant value of inbreeding depression. Similar results were found by Patil *et al.* (1992), Reddy *et al*. (2003), Sawale *et al*. (2003), Khan *et al*. (2005), Tyagi *et al*. (2006), Ramakant and Shrivastava (2012), Patil *et al.* (2014) and Yadav *et al*. (2015). None of character showed significant inbreeding depression in cross II, while in cross I, 100 seed weight showed positive and significant inbreeding depression (Table. 1). Similar results were reported by Joseph and Santosh kumar (2000). But days to initiation of flower and days to maturity showed negative significant inbreeding depression. Ramakant and Srivastava (2012) reported that negative and significant inbreeding depression for days to 50 % flowering and days to maturity during *kharif.* In cross I, the F_2 generation of GM 4 x BPMR 145, forty per cent plant population showed transgression for seed yield per plant, while in F_3 generation 50 % of plant population showed upper limit transgressive segregants for seed yield per plant, with of 4.97 of per cent improvement of F_3 over F_2 (Table 2.). In other hand all the yield contributing traits showed less transgressive segregants in F_2 as well as F_3 except number of pods per cluster (30 %, 75 %) in cross I. In case of cross II, F_2 generation showed the 80 % transgressive segregants for seed yield per plant and 100 % transgressive segregants in 100 seed weight. But in case of F_3 population maximum (90 %) of transgressive segregants were observed for seed yield and 100 seed weight (Table 3.). Most of the yield contributing traits in F_2 and F_3 generation also showed maximum transgressive segregants, such as number of branches per plant (40 %, 50 %) number of pods per cluster (80 %, 90 %), number of pods per plants (55 %, 55 %), pod length (45 %, 65 %). Reddy *et al.* (1999) also reported that F_2 generation showed transgression for seed yield per pod, seed yield per plant and pods per plant. Singh *et al.* (1996) also observed, desirable transgressive segregants in advance generation for plant height, number of branches per plant, pods per plant, pod length and seed yield per plant. Dhole and Reddy (2011) reported that transgressive segregants were recorded in F_2 generation for 100 seed weight and seed yield per plant. Ajay *et al.* (2014) also reported, highest transgressive segregants in F_2 and F_3 generations of mungbean for pods per plant and seed yield per plant.

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