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N Mohan Satyakar Rao
Assistant Professor, Department of Genetics and Plant Breeding, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

G Roopa Lavanya
Associate Professor, Department of Genetics and Plant Breeding, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Corresponding Author:
N Mohan Satyakar Rao
Assistant Professor, Department of Genetics and Plant Breeding, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Evaluation of mungbean (*Vigna radiata* (L.) Wilczek hybrids for high seed yield with early maturity

N Mohan Satyakar Rao and G Roopa Lavanya

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Abstract
Seven lines were crossed with three testers in Line x tester fashion to estimate heterosis, heterobeltiosis and economic heterosis for yield and yield attributing characters in mungbean. Analysis of variance revealed significant differences among genotypes and crosses for most of the characters. The cross KM11-584 X KM11-582 (68.23) exhibited low mean performance for days to maturity. The cross KM11-551 x KM11-587 exhibited high significant positive heterosis (9.51**) and significant positive heterobeltiosis for plant height (4.12**). The cross KM11-563 x KM11-582 showed high significant positive economic heterosis (30.96**) for number of pods per plant and the cross KM11-584 x KM11-582 (24.19*) exhibited high positive economic heterosis for number of seeds per pod.

Keywords: Mungbean, heterosis. Heterobeltios, economic heterosis

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is an economically important short duration grain legume characterized by relatively more palatable, nutritive, cheap source of high quality and easily digestible protein, non-flatulent than other pulses and constitute an important source of cereal based diets in Asia (Kamleshwar *et al*., 2014) [3]. In spite of high demand, yield of mungbean worldwide is very low (384 kg/ha) and limited success has been achieved so far in augmenting its yield. To enhance the present yield levels, a systemic varietal improvement through hybridization and exploitation of generated variability through recombination breeding is essential. To breed a genotype with high yielding potential, the information on the genetic mechanism controlling various traits in the material being handled, is a pre requisite. The estimates of combining ability along with *per se* performance of genotypes in a crop improvement programme have a direct bearing upon the choice of breeding methodology to be followed and to identify the parent and crosses could be exploited for future breeding programme (Khattak *et al*., 2002) [5]. The major constraints in achieving higher yield are lack of exploitable genetic variability, absence of suitable ideotype for different cropping system, poor harvest index, susceptibility to biotic and abiotic stresses, non-availability of quality seeds of improved varieties and narrow genetic base due to repeated usage of few parents with high degree of relatedness in crossing programme (Kumar *et al*. 2011) [6]. Genetic information, especially about the nature of gene action, combining ability and heterosis are required for selecting suitable parents and designing appropriate breeding programmes. Exotic genotypes of mungbean do have some important traits *viz.*, determinate growth habit, synchronised maturity, long pod, shiny and bold seeds which are not observed in present day varieties. The present work was, therefore, undertaken to generate information on heterosis involving exotic lines of mungbean.

Materials and methods

Seven lines namely KM11-575, KM11-582, KM11-587, KM11-551, KM11-563, KM11-564 and KM11-583 were crossed with three testers namely KM11-584, KM11-585 and KM11-586 during kharif, 2015 in Line × Tester fashion at Field Experimentation Centre, Department of Genetics and Plant Breeding, SHIATS, Allahabad, India to generate a total of 21 hybrids.

Adequate rainfall and irrigation conditions are required from flowering to late pod fill in order to ensure good yield and flowering. Lack of proper irrigation and rainfall conditions resulted in reduction in yield and flowering. Hence out of 21 crosses, only eight crosses were successful.

All genotypes (ten parents, eight hybrids and a local check) were evaluated in Randomized Block Design with three replications during *zaid,* 2016. Each genotype was grown in two rows of two meters length with a spacing of 30 cm between rows and 15 cm between plants. Recommended agronomic and plant protection package of practices were followed to raise healthy crop. Data were recorded on five randomly selected competitive plants in each genotype and replication. Mean values on per plant basis were recorded for the characters *viz.,* days to 50% flowering, plant height, number of primary branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod, days to maturity, seed index and seed yield per plant. However, data on days to 50% flowering and days to maturity were recorded on plot basis. Mean data were analysed to compute their variances according to Kempthorne (1957) [4].

Results and discussion

Anova

The analysis of variance (Table 1) revealed significant differences among the parents *vs* hybrids, indicating enormous genetic diversity among the materials studied.

Mean performance

The mean sum of squares for the characters studied revealed that the mean sum of squares due to genotypes were significant for all the characters. This suggests that the genotypes selected were genetically variable and considerable amount of variability existed among them. In case of parents, lowest mean for days to maturity (67.49) was showed by parent P_7 (KM11-583). In case of crosses the low mean for days to maturity (68.23), observed for cross P_8 x P_3 (KM11-584 x KM11-582). In case of parents, high mean for seed yield per plant (6.54) was exhibited by the parent P_2 (KM11-575). In case of crosses, high mean for seed yield per plant (6.56) was showed by the cross P_5 x P_3 (KM11-563 x KM11-582). These findings were in conformity with the findings of Sawale *et al.* (2003) [11], Kute *et al.* (2002) [9], and Kumar and Sharma (2007) [7].

Heterosis of F_1 hybrids

The nature and magnitude of heterosis for the plant height revealed that among eight hybrids, the hybrid P_4 x P_1 (KM11-551 x KM11-587) showed significant positive heterosis, (9.51**) indicating that hybrid had high plant height than mid parent. The cross KM11-563 x KM11-582 showed high positive non-significant heterosis (6.29) for seed yield per plant. The heterosis over mid parent for days to 50% flowering, the cross (KM11-564 x KM11-575) exhibited significant positive value. (3.28*). These findings were in conformity with the findings of Soehendi *et al*. (2005) [15], Wankhade *et al*, (2005) [17] and Kunkaew *et al*. (2007) [8].

Heterobeltiosis of F_1 hybrids

Significant positive heterobeltiosis (4.12**) for plant height was observed in the cross, (P_4 x P_1 (KM11-551 x KM11-587). The cross KM11-563 x KM11-582 showed high positive non-significant heterobeltiosis (4.79) for seed yield per plant. The cross KM11-563 x KM11-582 showed high negative significant heterobeltiosis (-3.09**) for days to maturity. These findings were in conformity with the findings of Cheralu and Satyanarayana (2002) [2], Sawale *et al.* (2003) [11], Lakshmi *et al*. (2003) [10] and Kumar *et al*. (2007) [7].

Economic heterosis of F_1 hybrids

Hybrid (KM11-563 x KM11-582) showed the high significant positive economic heterosis (9.98**) for plant height. In case of primary branches per plant, compared to local check Samrat, (KM11-586 x KM11-575) recorded high significant positive economic heterosis (93.89**). Hybrid (KM11-564 x KM11-575) showed positive significant economic heterosis (21.09*) over the local check Samrat for number of clusters per plant. Hybrid (KM11-563 x KM11-582) showed high significant positive heterosis (30.96**) for number of pods per plant. In case of number of seeds per pod, out of eight crosses, three crosses showed significant positive standard heterosis over local check samrat. High economic heterosis (24.19*) was exhibited by cross (KM11-584 x KM11-582) followed by the cross (KM11-583 x KM11-587) (20.95*). The cross KM11-563 x KM11-582 showed high negative non-significant economic heterosis (-3.05) for seed yield per plant These findings were in conformity with the findings of Ismaeli *et al.* (2005) [2], Singh *et al*. (2007) [14], Kumar *et al*. (2007) [7], Baradhan *et al.* (2011) [1] and Dorosti *et al.* (2014) [3]. The reasons behind poor performance of the F_1 hybrids in relation to yield and related traits in wide crosses might be due to meiotic irregularities leading to poor pollen and/or ovule fertility as the parents involved were distantly related and have qualitative differences in genomes (Brink and Cooper, 1947) [1]. High and significant heterosis in negative direction for yield and yield components such as pod length, seeds per pod and 100-seed weight was also noted by earlier workers (Singh, 1974 [13]; Singh and Singh, 1971 [12]. Poor performance of the inter-specific F1 hybrids has been the common feature in majority of crop plants (Stalker, 1980) [16], which in turn resulted in poor or even negative yield heterosis. Interestingly enough, most of the crosses showing poor yield heterosis usually exhibited negative inbreeding depression. This suggests that part of the increase in the F_1 over the superior parent is due to Epistasis and is therefore potentially fixable.

Table 1: Mean performance of parents and hybrids for yield and component characters in Mungbean

S. No	Character	Days to 50% Flowering	Plant Height (cm)	Primary Branches	Clusters per Plant	Pods per Plant	Pods per Cluster	Days to Maturity	Pod Length (cm)	Seeds per Pod	Seed index (g)	Yield per Plant (g)
1	KM11-551 * KM11-587	46.16	50.49	3.26	4.68	13.36	3.43	68.76	7.78	9.28	4.28	6.53
2	KM11-563 * KM11-582	45.66	55.83	2.46	4.46	13.46	2.47	68.56	8.28	9.95	3.99	6.56
3	KM11-564 * KM11-587	46.16	49.66	2.91	4.66	10.43	3.13	68.66	7.81	8.45	3.50	6.48
4	KM11-564 * KM11-575	47.16	50.93	3.35	5.03	10.78	2.45	68.60	7.93	8.68	3.71	6.44
5	KM11-583 * KM11-587	46.16	35.49	2.94	4.56	10.33	3.38	68.56	8.15	10.58	3.98	6.19
6	KM11-584 * KM11-582	46.16	39.49	3.04	4.56	11.35	2.78	68.23	8.78	10.86	4.28	5.98
7	KM11-585 * KM11-575	47.16	50.49	3.58	4.54	11.68	3.15	69.56	7.55	10.29	3.34	5.74
8	KM11-586 * KM11-575	47.16	48.49	4.23	5.01	10.95	2.98	68.59	7.72	10.35	3.40	5.88
9	KM11-587	45.60	48.49	3.03	4.10	9.60	3.29	69.26	7.87	10.43	3.30	6.09
10	KM11-575	45.16	50.59	5.53	4.89	10.59	3.49	69.27	7.91	10.29	3.67	6.54
11	KM11-582	45.23	52.39	3.23	4.04	14.63	1.99	67.83	6.87	10.06	3.72	6.09
12	KM11-551	44.16	43.72	5.03	5.23	16.83	3.46	68.26	7.63	8.96	4.62	6.93
13	KM11-563	45.16	72.36	2.26	4.39	10.99	2.30	70.75	9.50	9.90	4.33	6.26
14	KM11-564	46.16	51.72	2.93	5.16	11.06	2.43	67.76	7.69	8.09	3.80	6.19
15	KM11-583	46.16	32.49	2.86	4.36	11.53	2.46	67.49	8.39	11.03	4.22	6.15
16	KM11-584	45.82	32.62	3.02	3.99	7.86	3.45	69.65	9.96	11.76	4.49	6.27
17	KM11-585	47.16	50.39	2.49	4.72	12.76	3.21	68.96	6.85	10.29	3.20	6.37
18	KM11-586	47.16	47.59	3.59	4.72	11.93	3.43	68.83	7.60	10.69	3.14	5.91
19	Samrat ©	46.66	50.76	2.18	4.15	10.28	2.68	69.13	7.85	8.75	3.74	6.77
20	Mean	46.12	48.11	3.26	4.59	11.60	2.94	68.77	8.00	9.93	3.83	6.28
21	C.V.	2.11	1.39	13.80	9.61	8.30	18.03	1.33	8.33	9.63	14.18	5.50
22	F ratio	2.24	540.89	11.09	2.08	12.60	2.44	2.02	3.87	3.12	2.05	2.40
23	S.E.	0.56	0.38	0.26	0.25	0.55	0.30	0.52	0.38	0.55	0.31	0.19
24	C.D. 5%	1.61	1.10	0.74	0.73	1.59	0.88	1.51	1.10	1.58	0.90	0.57
25	Range Lowest	44.16	32.49	2.18	3.99	7.86	1.99	67.49	6.85	8.09	3.14	5.74
26	Range Highest	47.16	72.36	5.53	5.23	16.83	3.49	70.75	9.96	11.76	4.62	6.93

**,* Significant 1% and 5% level of Significance respectively

Table 2: Heterosis, Heterobeltiosis and Economic Heterosis of Eight hybrids for different characters

S No	crosses	Days to 50% Flowering			Plant Height			Primary Branches			Clusters per Plant			Pods per Plant			Pods per Cluster		
		Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic
1	KM11-551 * KM11-587	2.86	1.24	-1.07	9.51	4.12	-0.53	-19.09	-35.17	49.47	0.32	-10.52	12.59	1.13	-20.59**	29.98**	1.58	-0.96	27.95
2	KM11-563 * KM11-582	1.03	0.96	-2.14	-10.5	-22.85	9.98	-10.37	-23.81	12.82	5.8	1.59	7.46	5.1	-7.97	30.96**	15.37	7.68	-7.7
3	KM11-564 * KM11-587	0.62	0	-1.07	-0.89	-3.98	-2.17	-2.35	-3.96	33.44	0.65	-9.74	12.19	0.98	-5.69	1.46	9.43	-4.86	16.77
4	KM11-564 * KM11-575	3.28	2.17	1.07	-0.44	-1.53	0.33	-20.79	-39.4	53.59	0.03	-2.58	21.09*	-0.42	-2.53	4.86	-17.21	-29.77*	-8.57
5	KM11-583 * KM11-587	0.62	0	-1.07	-12.35	-26.81	-30.08	-0.17	-2.97	34.81	7.87	4.58	9.86	-2.21	-10.4	0.49	17.66	2.83	26.21
6	KM11-584 * KM11-582	1.4	0.74	-1.07	-7.09	-24.62	-22.2	-2.72	-5.88	39.39	13.55	12.85	9.86	0.93	-22.41**	10.41	2.27	-19.32	3.73
7	KM11-585 * KM11-575	2.17	0	1.07	0	-0.2	-0.53	-10.75	-35.24	64.12	-5.65	-7.28	9.22	0.04	-8.46	13.61	-5.96	-9.73	17.52
8	KM11-586 * KM11-575	2.17	0	1.07	-1.22	-4.15	-4.47	-7.23	-23.49	93.89	4.19	2.38	20.61*	-2.75	-8.21	6.52	-13.86	-14.6	11.18

**,* Significant 1% and 5% level of Significance respectively

Table 3: Heterosis, Heterobeltiosis and Economic Heterosis of Eight hybrids for different characters

S.No	crosses	Days to Maturity			Pod Length			Seeds per Pod			Seed index			Seed yield		
		Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic	Heterosis	Heterobeltoisis	Economic
1	KM11-551 * KM11-587	0	-0.72	-0.53	0.39	-1.14	-0.89	-4.28	-11.02	6.1	8.07	-7.35	14.41	0.26	-5.82	-3.59
2	KM11-563 * KM11-582	-1.05	-3.09**	-0.82	1.16	-12.84*	5.48	-0.3	-1.09	13.75	-0.87	-7.84	6.67	6.29	4.79	-3.05
3	KM11-564 * KM11-587	0.22	-0.87	-0.68	0.39	-0.76	-0.51	-8.74	-18.98*	-3.39	-1.41	-7.88	-6.41	5.48	4.63	-4.33
4	KM11-564 * KM11-575	0.12	-0.97	-0.77	1.67	0.25	1.02	-5.55	-15.64*	-0.76	-0.67	-2.36	-0.8	1.23	-1.48	-4.82
5	KM11-583 * KM11-587	0.27	-1.01	-0.82	0.25	-2.86	3.82	-1.4	-4.08	20.95*	5.93	-5.53	6.41	1.14	0.65	-8.56*
6	KM11-584 * KM11-582	-0.74	-2.04	-1.3	4.34	-11.84*	11.84	-0.43	-7.62	24.19*	4.34	-4.53	14.41	-3.15	-4.57	-11.61**
7	KM11-585 * KM11-575	0.65	0.42	0.63	2.3	-4.55	-3.82	0	0	17.64	-2.76	-8.98	-10.68	-11.15**	-12.28**	-15.26**
8	KM11-586 * KM11-575	-0.66	-0.98	-0.78	-0.45	-2.4	-1.66	-1.33	-3.18	18.32*	-0.15	-7.34	-9.07	-5.49	-10.04*	-13.09**

**,* Significant 1% and 5% level of Significance respectively

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