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Line x tester analysis in Mungbean [*Vigna radiata* (L.) Wilczek]

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Line x tester analysis of 25 crosses obtained from 5 lines and 5 testers were made for 14 yield and its associated characters in mungbean. Among the parents, PDM 84-178, PS 16, Tap7, Chinamung, CO 4 and KM 1883 which scored high status were found to be best combiner for most of the characters studied. Nine hybrids exhibited highest *per se* performance and sca effects for most of the characters studied. The hybrid, Tap7 x KM1883 was the top performer for sca effects. The variances due to specific combining ability (SCA) were found be higher than general combining ability (GCA) variances for all the fourteen characters studied indicating predominance of non-additive give action in the inheritance of the characters studied.

Key words : Gene action, Combining ability, Mungbean.

INTRODUCTION

Mungbean [*Vigna radiata* (L) Wilczek] is an important pulse crop of India. It is principally grown for its protein rich edible seeds, dry seeds and sprouts. It is an excellent source of easily digestible protein with low flatulence and is consumed as dhal, bean sprouts, noodles, green beans and boiled dry beans. It is a short duration legume, grown in all the three seasons' *viz.*, *kharif*, *rabi* and summer. The *kharif* crop is grown both as inter crop and as sole crop. In summer, the crop can be grown both as sole crop after wheat or in fields vacated by crops like potato, mustard and rice. In Karnataka it is grown in area of 5, 23,384 hectares with production of 82,624 tones and average productivity of 166 kg/ha during 2004-05 (Anon, 2006). The low productivity is attributed to susceptibility of mungbean to biotic and abiotic stresses. Selection of parental lines based on their genetic value is a prime pre requisite for any successful breeding programme. The information on the combining ability status of genotypes will reflect as to how well they combine with a given genotype to produce productive populations. In this context, the information on GCA and SCA (Sprague and Tatum, 1942) aids breeder to make decision upon selection of parents for hybridization programme and to isolate promising genotypes from the segregating population. It gives an idea about nature of gene action which helps in understanding the inheritance pattern of characters. Among the different methods adopted the line x tester analysis proposed by Kempthorne, 1957 has been recommended for early evaluation of parents, because of its simplicity in both experimentation and analysis. Thus, the present investigation was carried out in mungbean involving five lines and five testers which were hybridized in line x tester fashion to produce twenty five hybrids.

MATERIALS AND METHODS

The five Mungbean Yellow Mosaic Virus (MYMV) resistant genotypes (CO 4, BL 849, KM 1883, OBGG 11 and PMB 43) were used as testers and crossed with five MYMV susceptible cultivars (Chinamung, PS16, PDM 84-178, Pusabaisaki and Tap7) and twenty five hybrids synthesized in line x tester fashion. The experiment was laid out in a R.B.D. with three replications at Experimental Field Unit of Genetics and Plant Breeding, UAS, Bangalore during *rabi* 2005. Each entry was sown in 4m length with 30 x 10 cm spacing. Recommended cultural practices were followed. However, plant protection chemicals were not sprayed at any stage of the crop to allow maximum build up of whitefly to transmit MYMV. Susceptible cultivar Chinamung was used as spreader row for MYMV infection. Every five rows of hybrids were alternated with Chinamung. The observations were recorded on ten randomly selected plants in each cross combinations and parents for MYMV incidence, days to 50 per cent flowering, plant height, primary branches per plant, clusters per plant, pods per cluster, pods per plant, pod yield per plant, pod length, seeds per pod, seed yield per plant, test weight, Biomass, shelling percentage and harvest index. The mean values of the data recorded for seed yield per plant and their attributing characters in mungbean were subjected to line x tester analysis of Kempthorne (1957) and keeping view the modification by Arunachalam (1974).

Results and Discussion

Analysis variance revealed significant variances among lines and testers for all the characters except seeds per pod indicating considerable variability in expression of selected parents (Table 1). Both lines and testers were relatively variable as evident from characters that showed statistical significance. In turn, it has also reflected on the variance of interaction of lines x testers which was significant for days to 50 per cent flowering, plant height, primary branches per plant, pods per cluster, pods per plant, biomass, pod yield per plant, seed yield per plant, pod length, shelling percentage and harvest index. However, line x tester interaction effect was non significant for clusters per plant, seeds per pod and test weight indicating absence of heterosis for these characters.

When hybrids were considered, they were significant for all the characters studied. Similarly, the variance due to parents vs hybrids was also significant for most of the characters studied. However, it was non significant for primary branches per plant, clusters per plant, pod length, test weight and shelling percentage. Higher magnitude of variance in case of hybrids as compared to the parents has been evident for many characters like, plant height, clusters per plant, pod yield per plant, pod length, seeds per pod and shelling percentage indicating the presence of heterosis for these characters.

Combining ability studies provide the information on the genetic mechanism controlling quantitative traits and enable to select suitable parents for further improvement or used in hybrid combination for commercial purpose. Making crosses between good combiners, selected on the basis of combining ability are expected to produce desirable segregants. From the Table 2, it is evident that variances due to lines were significant for days to 50 per cent flowering, primary branches per plants and clusters per plant. Variance due to testers was significant for primary branches, pods per cluster, pods per plant, biomass, pod yield per plant, seed yield per plant, and shelling percentage. These results indicate the presence of considerable variability among hybrids rather than lines and testers. Similar results were obtained by Saxena and Sharma (1989).

Knowledge of gene action involved in governing quantitative traits is of at most importance for any successful plant breeding programme. From the Table 3, it is evident that the variances due to specific combining ability were found be higher than GCA variances for all the fourteen characters studied indicating predominance of non-additive give action in the inheritance of the

Table 1 : Mean sum of squares of parents and hybrids for 14 yield and its contributing characters in mungbean

Source	DF	Plant height (cm)	Days to 50% flowering	Primary branches	Clusters per plant	Pods per cluster	Pods per Plant	Biomass (g)	Pod yield (g)	Seed yield (g)	Pod length (cm)	Seeds per pod	Test weight (g)	Shelling percentage	Harvest index (%)
Replication	2	3.62	0.31	0.04	0.25	0.04	1.45	1.65	0.43	0.03	0.03	0.56	0.01	3.36	0.19
Genotypes	34	213.79**	17.16**	1.47**	8.10**	1.26**	74.86**	134.69**	13.19**	5.85**	1.08**	5.79**	0.91**	46.98**	23.48**
Hybrids	24	207.78**	8.01**	1.45**	9.04**	1.11**	54.10**	112.64**	12.64**	4.88**	1.17**	7.12**	1.05**	48.17**	19.21**
Parents	9	175.18**	34.18**	1.69**	6.45**	1.73**	132.97**	167.50**	11.51**	6.98**	0.97**	1.04	0.63**	47.99**	36.72**
Lines	4	84.99**	4.56**	1.16**	5.18**	2.67**	258.48**	339.77**	16.43**	7.57**	0.90**	1.45	0.15	22.61**	42.30**
Testers	4	87.22**	58.33**	2.31**	9.29**	1.07**	25.80**	10.41**	8.45**	4.76**	0.93**	0.72	1.21**	56.16**	11.12**
Lines Vs Testers	1	887.80**	56.03**	1.32**	0.19	0.61*	59.64**	106.78**	4.10**	13.46**	1.40**	0.74	0.21	116.82**	116.82**
Hybrids Vs Parents	1	705.69**	83.66**	0.0789	0.35	0.61*	50.16**	368.69**	41.40**	18.80**	0.13	16.66**	0.30	9.30	6.84**
Error	68	3.58	1.24	0.0293	0.55	0.10	1.04	1.13	0.21	0.08	0.18	0.81	0.10	2.62	0.45
Total	104														
S.E.±		1.09	0.64	0.09	0.42	0.17	0.58	0.61	0.26	0.16	0.24	0.52	0.18	0.93	0.38
C.D. (P=0.05)		3.05	1.80	0.27	1.19	0.49	1.64	1.71	0.73	0.46	0.68	1.45	0.50	2.61	1.08
(P=0.01)		4.06	2.30	0.36	1.58	0.66	2.18	2.28	0.97	0.61	0.90	1.93	0.67	3.47	1.44

* and ** Significance of values at P= 0.05 and 0.01, respectively.

Table 2: Mean sum of squares of combining ability for 14 yield and its contributing characters in mungbean

Source	DF	Plant height (cm)	Days to 50% flowering	Primary branches	Clusters per plant	Pods per cluster	Pods per Plant	Biomass (g)	Pod yield (g)	Seed yield (g)	Pod length (cm)	Seeds per pod	Test weight (g)	Shelling Percentage	Harvest index (%)
Replication	2	1.11	0.84	0.03	0.41	0.01	1.05	1.27	0.39	0.02	0.14	0.42	0.08	1.42	0.28
Hybrids	24	207.78**	8.01**	1.45**	9.04**	1.11**	54.10**	112.64**	12.64**	4.88**	1.17**	7.12**	1.05**	48.17**	19.21**
Lines	4	299.70	28.08**	4.78**	27.29**	0.64	37.45	32.48	8.28	5.53	1.23	9.50	2.48	48.79	37.61
Testers	4	312.06	1.92	2.16**	7.49	2.80*	195.16**	518.77**	43.44**	15.58**	2.05	5.51	0.52	135.29**	13.07
Lines vs Testers	16	158.73**	4.52**	0.44**	4.86**	0.81**	23.01**	31.14**	6.04**	2.05**	0.93**	6.93*	0.83**	26.23**	16.15**
Error	48	2.54	1.27	0.03	0.20	0.07	0.88	1.26	0.13	0.04	0.16	0.78	0.07	1.56	0.40
Total	74														
S.E.±		0.41	0.29	.04	0.11	0.06	0.24	0.29	0.09	0.05	0.10	0.22	0.06	0.32	0.16

* and ** Significance of values at P= 0.05 and 0.01, respectively.

Table 3 : Variances due to general and specific combing ability effects for 14 yield and its associated characters in mungbean

Characters	Variance due to GCA	Variance due to SCA	GCA to SCA ratio
Plant height (cm)	1.22	52.06	1:42.46
Days to 50% flowering	0.08	1.08	1:12.43
Primary branches per plant	0.02	0.13	1:5.38
Clusters per plant	0.10	1.55	1:14.92
Pods per cluster	0.01	0.24	1:32.82
Pods per plant	0.77	7.37	1:9.48
Biomass (g)	2.03	9.96	1:4.88
Pod yield per plant (g)	0.16	1.97	1:11.93
Seed yield per plant (g)	0.07	0.66	1:9.44
Pod length (cm)	0.01	0.25	1:25.91
Seeds per pod	0.01	2.05	1:205.05
Test weight (g)	0.01	0.25	1:25.36
Shelling percentage (%)	0.54	8.22	1:15.01
Harvest index (%)	0.07	5.25	1:5.25

characters studied. These results are in accordance with Manivannan (2002), Singh and Dikshit (2003), Anbumalarmathi *et al*. (2004), Pandiyan *et al*. (2006). Reddy *et al*. (1992) and Reddi Sekhar *et al*. (1994) who reported that seed yield per plant under the control and non-additive give action. However, present results were contradictory to the reports of Saxena and Sharma (1989), Reddy *et al*. (1992) and Ramamoorthi *et al*. (1997) who reported additive gene action for the most of the characters studied.

Among lines Tap 7, Chinamung and PDM 84-178 were significant in the desired direction for plant height and two testers PMB 43 and KM 1883 exhibited significant gca effect in desired direction. For days to 50 per cent flowering two lines, Chinamung and PDM 84-178 recorded significant gca effect in the desired direction. None of testers showed significance for this character. The gca effect for primary branches per plant were found to be significant in case of single line PS 16 and single tester, KM 1883. Among lines only PS 16 revealed significant gca effect for clusters per plant and three testers, BL 849, KM 1883 and OBGG 11 also exhibited significant gca effect for this character. The gca effect of pods per cluster was found to be significant for two lines, PS 16, Chinamung and two testers, CO 4 and BL 849. Pods per plant was found to have significant gca effect for three lines Tap7, Chinamung and PDM 84-178 and two testers KM 1883 and OBGG 11. Reddy *et al*. (1992) reported similar results. The gca effect of biomass were found to be positively significant for two lines Tap

7, Pusabaisaki and two testers KM 1883 and OBGG 11. Pod yield per plant was found to have positively significant gca effect for two lines Chinamung, PDM 84-178 and two testers CO 4, KM 1883.Seed yield per plant showed positively significant gca effects for three lines Tap 7, Chinamung and PDM 84-178 and two testers KM 1883 and OBGG 11. Pod length recorded positively significant gca effect incase of two lines PS 16, Pusabaisaki and three testers CO 4, PMB 43, BL 849. Reddy *et al*. (1992) reported similar results. The gca effect of seeds per pod were found to be positively significant for two lines, Pusabaisaki, PDM84-178 and two testers CO 4 and OBGG 11. Reddy *et al*. (1992) reported similar results. The trait test weight exhibited positively significant gca effect in case of two lines PS 16, Chinamung and single tester CO 4. The trait shelling percentage recorded positively significant gca effect for two lines PS 16, Tap 7 and three testers BL 849, KM 1883, and OBGG 11.The gca effect of harvest index was found to be positively significant for three lines, PS 16, Chinamung, PDM84-178 and two testers, CO 4, PMB 43 (Table 4).

Specific combining ability (sca) is used to designate these instances which certain combinations perform relatively better or worse than expected on the basis of the average performance of parental lines (Sprague and Tatum, 1942). The sca effects could be used as an index to determine the usefulness of a particular cross combination.

In the present investigation desirable sca effects for different characters were evaluated to identify potential hybrids (Table 5). For plant height eight hybrids *viz*., PS 16 x CO 4, PS 16 x OBGG 11, Tap 7 x KM 1883, Tap 7 x OBGG 11, Pusabaisaki x BL 849, Chinamung x PMB 43, Chinamung x BL 849, and PDM 84-178 x PMB 43 recorded desired negatively significant sca effects for plant height. The trait days to 50 per cent flowering found to have negatively significant sca effects for four hybrids *viz*., Pusabaisaki x OBGG 11, Chinamung x PMB 43, PDM 84-178 x CO 4 and PDM 84-178 x KM 1883. The above crosses for the above two traits belonged to different parental combination (both high and low gca status) as far the gca effects of parents are concerned indicating the involvement of non-additive gene action for these traits.

The character primary branches per plant were found to have positively significant sca effects for five hybrids *viz*., PS 16 x BL 849, PS 16 x OBGG 11, Tap 7 x KM 1883, Chinamung x KM 1883, PDM 84-178 x CO 4. The trait clusters per plant recorded positively significant sca effects for five hybrids, PS 16 x KM 1883, PS 16 x OBGG 11, Tap 7 x KM 1883, Chinamung x OBGG 11 and

Table 4: General combining ability effects of parents (lines and testers) for 14 yield and its component characters in mungbean

Parents Lines	Plant height (cm)	Days to 50% flowering	Primary branches	Clusters per plant	Pods per cluster	Pods per Plant	Biomass (g)	Pod yield (g)	Seed yield (g)	Pod length (g)	Seeds per pod	Test weight (g)	Shelling percentage	Harvest index (%)
PS 16	6.33 **	1.74 **	1.00 **	2.27 **	0.21 **	-0.58 *	-0.79 **	-0.39 **	-0.13 *	0.28 **	-0.25	0.27 **	1.14 **	0.34 *
Tap 7	-1.16 **	0.59 *	-0.26 **	-0.03	-0.19 **	1.23 **	2.12 **	-0.16	0.26 **	-0.26 *	-1.06 **	-0.33 **	1.62 **	-0.37 *
Pusabaisaki	2.67 **	0.45	-0.32 **	-0.36 **	-0.11	-2.51 **	0.95 **	-0.85 **	-0.95 **	0.34 **	0.67 **	-0.49 **	-2.99 **	-2.45 **
Chinamung	-4.46 **	-1.52 **	-0.09	-1.25 **	0.24 **	0.73 **	-1.22 **	0.29 **	0.14 *	-0.18	-0.27	0.49 **	-0.10	0.65 **
PDM 84178	-3.38 **	-1.26 **	-0.33 **	-0.64 **	-0.14 *	1.14 **	-1.07 **	1.11 **	0.68 **	-0.19	0.91 **	0.05	0.34	1.83 **
Testers														
CO 4	4.07 **	0.25	-0.01	-1.09 **	0.37 **	-1.39 **	-1.65 **	1.78 **	-0.12 *	0.22 *	0.57 *	0.29 **	-4.71 **	0.39 *
PMB 43	-5.62 **	-0.16	-0.32 **	-0.29 *	-0.05	2.33 **	-6.45 **	-0.98 **	-0.61 **	0.21 *	0.15	-0.19 **	-0.75 *	1.17 **
BL 849	0.04	0.11	-0.15 **	0.27 *	0.50 **	-5.72 **	-3.90 **	-2.35 **	-1.19 **	0.21 *	-0.73 **	-0.08	0.67 *	-1.27 **
KM 1883	-3.36 **	0.34	0.65 **	0.72 **	-0.33 **	2.90 **	7.87 **	1.37 **	1.47 **	-0.01	-0.54 *	-0.07	3.21 **	0.25
OBGG 11	4.87 **	-0.54	-0.17 **	0.38 **	-0.50 **	1.89 **	4.12 **	0.18	0.44 **	-0.64 **	0.55 *	0.05	1.59 **	-0.54 **
S.E.±	0.58	0.41	0.06	0.16	0.09	0.34	0.41	0.13	0.07	0.14	0.32	0.09	0.45	0.23

* and ** Significance of values at P= 0.05 and 0.01, respectively.

Table 5 : Estimates of specific combing ability effects for 14 yield and contributing characters in mungbean

Hybrids	Plant height (cm)	Days to 50% flowering	Primary branches	Clusters per plant	Pods per cluster	Pods per Plant	Biomass (g)	Pod yield (g)	Seed yield (g)	Pod length (cm)	Seeds per pod	Test weight (g)	Shelling percentage	Harvest index (%)
PS 16 X CO 4	-7.49 **	1.02	0.05	0.43	-1.13 **	0.03	-1.81 **	0.09	0.02	0.13	0.04	0.99 **	-1.00	0.33
PS 16 X PMB 43	1.44	-0.91	-0.26 *	-1.80 **	0.42 **	1.04	-5.11 **	2.05 **	0.74 **	0.30	0.35	-0.72 **	-2.26 **	4.01 **
PS 16 X BL 849	6.08 **	-0.18	0.46 **	-1.29 **	-0.09	-0.15	3.81 **	-0.48 *	0.65 **	-0.49 *	2.83 **	-0.10	5.65 **	-0.22
PS 16 X KM 1883	9.65 **	0.59	-0.50 **	3.49 **	0.17	1.80 **	1.98 **	1.13 **	-0.21	0.09	-2.42 **	0.43 **	-4.63 **	-1.24 **
PS 16 X OBGG11	-9.69 **	-0.52	0.25 *	-0.83 **	0.64 **	-2.72 **	1.13	-2.78 **	-1.21 **	-0.01	-0.81	-0.59 **	2.23 **	-2.88 **
Tap 7 X CO 4	3.14 **	-1.16	-0.23 *	-0.03	0.13	-1.08	1.59 *	-0.18	-0.40 **	0.60 *	0.89	-0.15	-1.55 *	-1.19 **
Tap 7 X PMB 43	2.30 *	0.58	0.06	0.63 *	-0.35 *	-0.70	1.12	-0.39	-0.25 *	-0.56 *	-0.30	0.44 **	0.33	-0.98 **
Tap 7 X BL 849	8.11 **	0.31	-0.12	0.31	0.11	3.15 **	-0.76	-0.71 **	-0.73 **	-0.29	-2.32 **	-0.17	-1.70 *	-1.21 **
Tap 7 X KM 1883	-10.13 **	0.08	0.58 **	-0.14	0.73 **	0.29	-1.36 *	-0.44 *	0.27 *	0.66 **	1.86 **	-0.21	2.56 **	1.04 **
Tap 7 X OBGG11	-3.43 **	0.20	-0.30 **	-0.77 **	-0.63 **	-1.66 **	-0.58	1.72 **	1.11 **	-0.41	-0.13	0.10	0.35	2.33 **
Pusabaisaki X CO4	0.01	0.84	-0.07	-0.37	0.29	0.49	3.49 **	0.57 **	1.08 **	-0.23	0.56	-0.05	4.03 **	1.18 **
Pusabaisaki X PMB 43	8.07 **	0.88	0.15	0.47	0.27	0.17	1.15	-2.97 **	-1.63 **	-0.29	0.54	-0.57 **	-0.93	-4.91 **
Pusabaisaki X BL 849	-11.53 **	-0.72	-0.09	0.25	-0.07	-0.65	-5.23 **	1.17 **	0.35 **	-0.39	-1.71 **	0.32 *	-1.85 *	2.57 **
Pusabaisaki X KM1883	-1.29	0.55	-0.02	-0.64 *	-0.31 *	-1.07	-0.33	0.95 **	0.55 **	0.23	-0.50	0.18	0.84	1.61 **
Pusabaisaki X OBGG11	4.74 **	-1.56 *	0.03	0.30	-0.17	1.05	0.92	0.27	-0.35 **	0.69 **	1.11 *	0.13	-2.10 **	-0.46
Chinamung X CO 4	3.54 **	0.62	-0.36 **	0.33	0.07	-0.68	-2.64 **	-0.47 *	-0.01	-0.25	0.39	-0.03	0.94	0.98 **
Chinamung X PMB 43	-6.53 **	-2.31 **	-0.01	0.23	-0.08	-0.37	4.99 **	1.16 **	0.47 **	0.09	0.11	0.62 **	-0.45	-0.87 *
Chinamung X BL 849	-3.13 **	0.76	-0.15	-0.09	-0.16	-4.59 **	3.05 **	0.01	0.02	0.17	0.19	0.07	-0.08	-0.87 *
Chinamung X KM 1883	-0.59	0.19	0.55 **	-1.45 **	-0.30 *	-1.41 *	-2.15 **	-1.16 **	-0.21	0.05	-0.37	-0.60 **	2.11 **	0.18
Chinamung X OBGG11	6.71 **	0.74	-0.03	0.99 **	0.47 **	7.04 **	-3.24 **	0.47 *	-0.27 *	-0.05	-0.33	-0.05	-2.53 **	0.57
PDM 84178 X CO 4	0.79	-1.32 *	0.61 **	-0.35	0.65 **	1.24 *	-0.62	-0.01	-0.69 **	-0.24	-1.89 **	-0.75 **	-2.43 **	-1.30 **
PDM 84178 X PMB 43	-5.28 **	1.76 **	0.06	0.48	-0.27	-0.15	-2.15 **	0.15	0.67 **	0.47 *	-0.71	0.23	3.31 **	2.75 **
PDM 84178 X BL 849	0.46	-0.18	-0.11	0.83 **	0.22	2.23 **	-0.87	0.02	-0.29 *	1.01 **	1.01	-0.11	-2.02 **	-0.28
PDM 84178 X KM 1883	2.36 *	-1.41 *	-0.61 **	-1.26 **	-0.29	0.38	1.87 **	-0.47 *	-0.41 **	-1.01 **	1.42 **	0.21	-0.89	-1.60 **
PDM 84178 X OBGG11	1.66	1.14	0.04	0.31	-0.31 *	-3.71 **	1.78 **	0.32	0.72 **	-0.21	0.16	0.43 **	2.03 **	0.43

* and ** Significance of values at P= 0.05 and 0.01, respectively.

PDM84-178 x CO 4. The above hybrids belonged to H x H or H x L combinations indicating the role non-additive gene action for these traits.

Pods per plant registered positively significant sca effects for four hybrids *viz*., PS 16 x KM 1883, Tap 7 x BL 849, Chinamung x OBGG 11 and PDM 84-178 x BL 849. Biomass exhibited positive sca effects for eight hybrids *viz*., PS 16 x BL 849, PS 16 x KM 1883, Tap 7 x CO 4, Pusabaisaki x CO 4, Chinamung x PMB 43, Chinamung x BL 849, PDM 84-178 x KM 1883, and PDM 84-178 x OBGG 11. Pod yield per plant revealed positively significant SCA effects for eight hybrids *viz*., PS 16 x PMB 43, PS 16 x KM 1883, Tap 7 x OBGG 11, Pusabaisaki x CO 4, Pusabaisaki x BL 849, Pusabaisaki x KM 1883, Chinamung x PMB 43, and Chinamung x OBGG 11. The above hybrids belonged to H x H, H x L, L x L combinations indicating the role non-additive gene action for these traits.

Seed yield per plant exhibited positively significant sca effects for ten hybrids *viz*., PS16 x PMB 43, PS 16 x BL 849, Tap 7 x KM 1883, Tap 7 x OBGG 11, Pusabaisaki x CO 4, Pusabaisaki x BL 849, Pusabaisaki x KM 1883, Chinamung x PMB 43, PDM 84-178 x PMB 43 and PDM 84-178 x OBGG 11. The trait pod length recorded positively significant sca effects for four hybrids *viz*., Tap 7 x CO 4, Tap 7 x KM 1883, Pusabaisaki x OBGG 11 and PDM 84-178 x PMB 43. Seeds per pods recorded positively significant sca effects for four hybrids *viz*., PS 16 x BL 849, Tap 7 x KM 1883, Pusabaisaki x OBGG 11 and PDM 84-178 x KM 1883. The above hybrids belonged to H x H, H x L, L x L combinations indicating the role non-additive gene action for these traits.

Shelling percentage recorded positively significant sca effects for seven hybrids *viz*., PS 16 x BL 849, PS 16 x OBGG 11, Tap 7 x KM 1883, Pusabaisaki x CO 4, Chinamung x KM 1883, PDM 84-178 x PMB 43 and PDM 84-178 x OBGG 11. Harvest index registered positively significant sca effects of for eight hybrids *viz*., PS 16 x PMB 43, Tap 7 x KM 1883, Tap 7 x OBGG 11, Pusabaisaki x CO 4, Pusabaisaki x BL 849, Pusabaisaki x KM 1883, Chinamung x CO 4, and PDM 84-178 x PMB 43. The above hybrids belonged to H x H, H x L, L x L combinations indicating the role non-additive gene action for these traits.

All the F_1's showed resistant reaction to MYMV incidence under field condition. These F_1's needs to be further evaluated under glass house condition for confirmation. Six parents *viz*., PDM 84-178, PS 16, Tap7, Chinamung, CO 4 and KM 1883 were found to be best general combiners. Eight hybrids *viz*., PS 16 x CO 4, PS 16 x PMB 43, PS 16 x BL 849, Tap 7 x KM 1883, Pusabaisaki x KM 1883, Chinamung x PMB 43, PDM 84-178 x PMB 43, PDM 84-178 x BL 849 were found to be superior hybrids based on their *per se* performance and sca effects over standard parent. These Eight hybrids needs to be further evaluated and especially the hybrid combination, Tap7 x KM 1883 and Pusabaisaki x KM 1883 since genotype KM 1883 recoded resistance to all MYMV, powdery mildew and Cercospora leaf spot diseases during screening.

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