J. Hort. Sci.
Vol. 2 (1):63-66, 2007

Short communication

Studies on combining ability in bitter gourd (*Momordica charantia* L.)

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ABSTRACT

Combining ability study in eight bitter gourd lines, to identify suitable parents and crosses for further exploitation, indicated that the lines MC 13 (L_1) and Panruti Local (L_2) were good general combiners for yield per vine. The lines Ayakudi Local (L_3) and Mithipagal (L_5) recorded negative general combining ability and lower *per se* for days to first female flowering and days to fruit maturity. This can be utilized in breeding programme to develop earliness in bitter gourd. The hybrids MC 13 x Arka Harit (L_1 x T_3), Panruti Local x VK 1 Priya (L_2 x T_2) and MC 13 x Co 1 (L_1 x T_1) registered higher *per se* and specific combining ability for fruit length, individual fruit weight and yield per vine. The study revealed that additive x additive and additive x dominance type of interactions played a major role for days to first female flowering, days to fruit maturity, number of fruits per vine, fruit length, fruit size index, cavity size index, single fruit weight and yield per vine. The lines L_1, L_2, L_3 and L_5 expressed higher *per se* and general combining ability for most of the characters can successfully be utilized for developing superior hybrids in bitter gourd hybridization programmes.

Key words: Line x Tester analysis, combining ability, bitter gourd

Bitter gourd (*Momordica charantia* L.) is one of the most important, nutritious vegetables known for its bitter principle. In India, it is grown throughout the country as rainy and summer season vegetable. It is a highly cross-pollinated crop and its monoecious nature has resulted in wider variation in several qualitative and quantitative characters. However, it does not suffer from inbreeding depression and it seems that the population structure is similar to that of inbreeders than outbreeders (Allard, 1960). In breeding programmes, the common approach of selecting parents on the basis of *per se* performance dose not lead to fruitful results. Hence, potential parents need to be selected based on their genetic architecture and combining ability.

The experiment consisted of line x tester analysis involving five lines, viz., MC 13 (L_1), Panruti Local (L_2), Ayakudi Local (L_3), Long Green (L_4) and Mithipagal (L_5) and three testers, viz., Co-1 (T_1), VK-1 Priya (T_2) and Arka Harit (T_3). The seeds of the selected parents were selfed for five generations to obtain homozygosity. The selfed seeds were raised in a crossing block and crossing was made in line x tester mating system. In all, 15 F_1 hybrids and eight parental lines were raised for evaluation in a randomized block design (RBD) with three replications. Biometrical observations, viz., days to first female flowering, days to fruit maturity, number of fruits per vine, fruit length, fruit size index, cavity size index, individual fruit weight and yield per vine were made on randomly selected plants. Data were subjected to statistical analysis, and, general and specific combining ability study for eight characters was carried out as per the model of Kempthrone (1957).

Analysis of variance (ANOVA), due to parents and hybrids, showed significant differences for all the characters studied, and further, indicated presence of sufficient diversity in the lines and testers. Parental lines recorded higher significant variance for all the characters (Table 1). Mean square due to testers recorded significant variance for most of the characters except days to fruit maturity, cavity size index, single fruit weight and yield per vine, while variance due to interaction effect (line x tester) was significant for all the characters.

Significance of parents can be judged through *per se* performance and general combining ability (*gca*) of parents to obtain a desirable recombinant. In the present investigation, among the five lines used, the line L_1 recorded higher *per se* performance for the characters, namely, fruit

Table 1. Analysis of variance(ANOVA)

Source	D.F	Days to first female flowering	Days to fruit maturity	Number of fruits per vine	Fruit length (cm)	Fruit size index (cm)	Cavity size index (cm)	Individual fruit weight(g)	Yield per vine(g)
Replication	2	9.17	1.101	13.22	1.56	252.68	33.43	3.63	30812
Parent	7	97.33**	52.99**	195.9**	85.47**	14365.76**	1127.62**	2295.94**	412152.9**
Lines	4	62.56**	78.51**	315.2**	135.9**	33621.44**	281.31**	5958.55**	901694.5**
Testers	2	84.78**	3.68	34.98**	3.16*	1063.81**	26.86	39.89	36927
Line x Tester	8	28.87**	4.68*	23.46**	16.33**	3806.5**	225.83**	383.92**	208599.3**
Hybrid	14	46.49**	25.63**	108.46**	48.45	11993.24**	1231.68**	1927.52**	382101.9**
Error	44	3.95	1.04	1.95	0.53	126.79	13.67	32.13	11607.2

*Significant at 5%, **Significant at 1%

length, fruit size index, cavity size index, individual fruit weight and yield per vine. The line L_5 showed lower *per se* performance for days to first female flowering, days to fruit maturity and it ranked first in the number of fruits per vine. This was followed by line L_3. Higher number of fruits per vine observed in L_5 and L_3 may be due to early flowering and small size of fruits as suggested by Richard Kennedy *et al* (1995). Among the three testers, T_1 expressed the best *per se* performance for number of fruits per vine, individual fruit weight and yield per vine, and, lower *per se* for days to first female flowering and days to fruit maturity. The tester T_2 ranked first for fruit length, fruit size index and cavity size index and second for days to first female flowering, days to fruit maturity, individual fruit weight and yield per vine (Table 2).

The line L_1 expressed the best *gca* for fruit length, fruit size index, cavity size index, individual fruit weight and yield per vine. This was followed by the lines L_4 and L_2. The line L_5 recorded negative significant *gca* for days to first female flowering and days to fruit maturity and ranked first for number of fruits per vine and was followed by the line L_3. The tester T_1 recorded negative significant *gca* for days to first female flowering and days to fruit maturity and higher *gca* for fruit length, fruit size index, cavity size index and individual fruit weight. The results assumed that a good combiner for any economic character need not be a good combiner for all other characters (Haripriya, 1991). High general combining ability effects observed for different characters may be helpful in identifying sorting out outstanding parents with favourable

Table 2. ***Per se* performance and general combining ability effects (*gca*) of parents**

Parent	Days to first female flowering	Days to fruit maturity	Number of fruits per vine	Fruit length (cm)	Fruit size index (cm)	Cavity size index (cm)	Individual fruit weight(g)	Yield per vine(g)
L_1	47.99	23.55	14.89	16.89	213.67	63.24	86.66	1286.11
	0.15	*2.40*	*-3.53*	*4.20*	*74.19*	*19.85*	*21.97*	*327.77*
L_2	47.44	15.00	13.33	12.89	146.66	50.12	56.11	776.66
	1.22	*2.22*	*-3.97*	*1.43*	*24.83*	*8.54*	*21.97*	*269.73*
L_3	38.11	10.55	24.33	5.42	58.01	20.83	17.22	416.66
	-1.22	*-2.99*	*4.18*	*-4.39*	*-51.19*	*-18.42*	*-26.51*	*-331.01*
L_4	50.77	16.66	13.89	13.78	121.22	44.53	45.55	641.66
	3.45	*1.51*	*-5.01*	*2.57*	*26.37*	*15.67*	*11.64*	*61.03*
L_5	36.66	10.00	36.44	5.02	53.08	14.89	11.55	431.99
	-3.59	*-3.45*	*8.33*	*-3.81*	*-74.19*	*-25.64*	*-29.07*	*-327.53*
T_1	46.22	15.99	18.77	17.994	161.65	59.66	78.89	1433.33
	-1.95	*-0.19*	*1.76*	*-0.2*	*-8.43*	*-0.48*	*0.29*	*48.90*
T_2	46.33	16.11	13.33	19.00	249.05	68.94	74.44	952.99
	2.65	*-0.37*	*-0.81*	*-0.29*	*0.01*	*-1.03*	*-1.76*	*-50.79*
T_3	52.99	16.88	14.78	14.33	179.33	45.33	58.89	912.22
	-0.70	*0.56*	*-0.95*	*0.53*	*8.42*	*1.51*	*1.45*	*1.39*
SE CD (*P=0.05*)	1.406	0.724	0.988	0.519	7.963	2.164	4.008	76.175
	0.198	0.102	0.139	0.078	1.126	0.369	0.566	10.772
SE(gi)±SE (gi-gj) ±	*0.662*	*0.341*	*0.460*	*0.204*	*3.750*	*1.232*	*1.880*	*35.910*
	0.513	*0.264*	*0.360*	*0.189*	*2.900*	*0.954*	*1.460*	*27.810*

*General combining ability values are in italics

Table 3. *Per se* performance and specific combining ability effects (*sca*)

Hybrid	Days to first female flowering	Days to fruit maturity	Number of fruits per vine	Fruit length (cm)	Fruit size index (cm)	Cavity size index (cm)	Individual fruit weight(g)	Yield per vine(g)
L_1xT_1	49.44	18.11	15.66	19.22	257.44	66.88	71.11	1125.55
	*2.87**	*1.64**	*-2.32**	*1.27**	*23.94**	*-1.07*	*1.77*	*75.45**
L_1xT_2	50.33	15.55	14.99	15.55	194.88	59.33	48.77	756.89
	-0.83	*-0.74**	*-0.41*	*-2.34**	*-47.10**	*-8.07**	*-18.50**	*-344.92**
L_1xT_3	45.33	16.33	17.99	19.77	273.49	79.09	87.22	1573.89
	*-2.04**	*-0.89**	*2.73**	*1.06**	*23.16**	*9.14**	*16.72**	*420.38**
L_2xT_1	44.44	15.99	16.66	14.55	176.16	58.79	61.11	1014.99
	*-3.20**	*-0.29**	*-0.88*	*-0.67**	*-7.98**	*2.15**	*-8.21**	*-127.97**
L_2xT_2	57.44	17.11	17.44	15.66	195.37	51.90	82.21	1418.33
	*5.20**	*0.99**	*2.48**	*0.55**	*2.80*	*-4.19**	*14.94**	*374.55**
L_2xT_3	46.89	16.33	13.22	15.99	206.15	60.68	63.78	848.88
	*-2.00**	*-0.71**	*-1.61**	*0.06*	*5.17*	*2.04*	*-6.72**	*-246.57**
L_3xT_1	45.33	9.89	25.11	6.22	67.11	20.68	24.44	611.11
	0.14	*-1.81**	*-0.56*	*-3.13**	*-41.00**	*-8.99**	*3.59**	*68.87**
L_3xT_2	46.98	9.99	22.99*x*	10.88	128.51	35.08	18.33	426.11
	*-2.31**	*-0.88**	*0.69*	*1.59**	*11.96**	*5.95**	*-0.46*	*-16.92*
L_3xT_3	49.11	13.89	23.66	11.66	153.99	34.72	18.89	442.78
	*2.67**	*2.07**	*0.69*	*1.55**	*29.04**	*3.05**	*-3.13*	*-51.94*
L_4xT_1	50.99	15.89	15.32	15.66	197.55	63.41	61.11	950.55
	*1.13**	*0.01*	*-1.18**	*-0.65**	*11.87**	*-0.35*	*2.12*	*16.28*
L_4xT_2	53.89	16.11	14.11	18.11	230.44	73.33	57.77	817.77
	-0.56	*0.41*	*0.19*	*1.85**	*36.32**	*10.11**	*0.83*	*-17.29*
L_4xT_3	50.55	16.22	14.78	15.88	154.33	55.99	57.22	887.77
	-0.56	*-0.41*	*0.99**	*-1.19**	*-48.19**	*-9.76**	*-2.95*	*1.01*
L_5xT_1	41.88	10.44	34.78	13.05	98.27	30.72	18.99	663.99
	-0.94	*-0.18*	*4.94**	*-3.13**	*13.17**	*8.26**	*0.71*	*18.28**
L_5xT_2	46.44	10.66	25.11	8.22	89.55	18.11	19.44	451.11
	-0.98	0.22	-2.15*	-1.65*	-3.99	-3.79*	3.20	4.59
L_5xT_3	45.99	11.33	24.33	9.22	92.77	19.98	15.55	375.33
	*1.03**	*-0.04*	*-2.79**	*-1.47**	*-9.18**	*-4.47**	*-3.91**	*-128.87**
SE (L x T)	1.406	0.723	0.988	0.519	7.960	2.610	4.008	76.175
CD(*P=0.05*)	0.198	0.102	0.139	0.078	1.126	0.360	0.566	10.772
SE (*sca*)	*1.148*	*0.591*	*0.807*	*0.424*	*6.501*	*2.134*	*3.272*	*62.200*

*Significant at 5% **Specific combining ability values are in italics

alleles for different components of yield. Therefore, high general combining ability of the parents seems to be a reliable criterion for prediction of specific combining ability (Brar and Sidhu, 1977). The negative estimates of *gca* for days to first female flowering and days to fruit maturity registered by lines L_5, L_3 and T_1 indicate that these can be utilized in hybridization programmes for developing earliness in bitter gourd it being monoecious with earliness as an important trait (Pal *et al*, 1983). The lines L_1 and L_2 expressing higher *per se* and *gca* for most of the yield attributing characters can be successfully utilized for developing superior hybrids where heterosis in the cross involving low x high combiners may be due to dominant x additive type of interaction, which is partially fixable and crosses involving both poor combining parents showing high sca might be due to intra - and inter- allelic interactions.

Among the 15 F_1 hybrids, L_1 x T_3, L_2 x T_2 and L_1 x T_1 recorded higher *per se* performance for fruit length, fruit size index, cavity size index, individual fruit weight and yield per vine. The cross L_5 x T_1 proved to be the best *per se* performer for days to first female flowering and number of fruits per vine. Results indicated the crosses L_1 x T_3 and L_2 x T_2 to be products of high x low combination, and, L_1 x T_1 and L_5 x T_1 to be products of high x high combination, suggesting the role of additive x dominance and additive x additive type of interactions, respectively. It is evident that the best performance of hybrids for specific characters may be due to either one or both parents having high *gca* for the respective character (Choudhury, 1987). The same hybrids also exhibited higher specific combining ability effects for individual fruit weight and yield per vine. L_1 x T_3 was a product of good x good combiner for individual fruit weight.

This mean that *per se* performance was reflected in their respective *sca* effects (Munshi, and Sirohi, 1991). The hybrid L_5 x T_1 was the best specific combiner for number of fruits per vine, days to fruit maturity and days to first female flower. The cross was a product of good x good combiner for the respective traits. Higher *gca* effect of the parent involved in a cross also confirms superiority of the cross. The above results suggest that crosses with high *sca* effects for particular traits generally involved one of the parents which had either good or medium combining ability. Similar result was also reported by Arora *et al* (1996) in summer squash. Perusal of the data on *sca* effects shows that no specific hybrid combination had significant *sca* effect for all the characters studied. Of the 15 F_1 hybrid combinations, four hybrids recorded significant positive sca for yield per vine. Highest *sca* for yield per vine showed by the crosses L_1 x T_3 and L_2 x T_2 could be exploited for hybrid vigour in bitter gourd. However, this needs further testing before these combinations can be recommended for large scale commercial exploitation.

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(MS Received 24 April 2007, Revised 27 June 2007)