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Combining Ability Studies for Yield and Plant Characters in Bitter Gourd (*Momordica charantia* L.)

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A B S T R A C T

The present investigation was carried out involving thirty hybrids which were derived by crossing ten lines with three testers. These hybrids were evaluated along with their parents in randomized block design (RBD) with three replications. The recorded data was subjected to Line × Tester analysis. The analysis of variance for combining ability revealed that the mean sum of squares due to parents and hybrids were highly significant for almost all the characters except for days required to 50% pistillate flowering, vine length, number of primary branches per plant and internodal length. The lines IC-085612, OBGCS-4 and Katehi were found to be good general combiners for earliness characters as well as for fruit yield. Among the hybrids, the crosses OBGCS-4 × Preethi, IC-085612 × Katheri, Katehi × Meghna and Jaunpuri Green × Meghna exhibited high SCA effects for earliness in flowering with first female at lowest node. These hybrids should be further evaluated and can be exploited for commercial cultivation.

Introduction

Bitter gourd (*Momordica charantia* L.) having the chromosome number of 2n=2x=22, is a tropical and subtropical important commercial vegetable crop belonging to family Cucurbitaceae, genus *Momordica*. It has been used in various herbal medicine systems for a long time because of its disease preventing and health promoting phyto-chemical compounds like dietary fibres, minerals, vitamins, flavonoids and antioxidants. Its extracts traditionally used as vegetable insulin or "charantin" possess hypoglycemic and anti-diabetic properties that are useful in the treatment of diabetes

(Behera *et al.,* 2008). It is a highly crosspollinated crop and its monoecious nature has resulted in wider variation. Information about combining ability is vitally important to a breeding program aiming to develop hybrids and composite varieties having high yield and quality. Combining ability studies aiming to identify inbred lines with good GCA and SCA effects involved in a breeding program. GCA enabled breeders to exploit the existing variability in the population, to identify individual genotypes having desirable attributes and to distinguish relatedness among genotypes. While SCA determines the heterotic pattern among populations or inbred lines, to identify promising single crosses and to assign inbred lines into heterotic groups.Therefore, this study was conducted to get information about general and specific combining ability effects for different economic characters in a Line × Tester crossing system using ten lines and three testers.

Materials and Methods

The present investigation was carried out at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the *kharif* season of 2017-2018.The experimental material consists of 13 diverse genotypes of bitter gourd *viz.* Katehi,IC-085612, BGCV-2, OBGCS-4, OBGCS-2, OBGCS-3, Jaunpuri Green, Shaktigopal Local, OBGCS-1, IC-085611, Katheri, Preethi and Meghna. A total of 30 F_1 hybrids were developed using Line × Tester mating design. The experiment was laid out in Randomized Block Design (RBD) with three replications. The observations were recorded on five randomly selected plants and the average was computed for the following 8 morphological characters, *viz*. days to 50% staminate flowering, days to 50% pistillate flowering, node at which first staminate flower appears, node at which first flower pistillate appears, vine length (m), number of primary branches per plant, intermodal length (cm), fruit yield (q/ha).The combining ability estimation for different traits was calculated according to model suggested by Kempthrone (1957) and the statistical analysis was done according to Panse and Sukhatme (1967).

Results and Discussion

Analysis of variance (ANOVA) for combining ability

The analysis of variance for combining ability is presented in Table 1. The mean sum of squares due to parents and hybrids were highly significant for almost all the characters except for days required to 50% pistillate flowering, vine length, number of primary branches per plant and internodal length for which male parents showed no significant differences. Similarly female parents also showed significant differences for all the traits except for internodal length. This indicates the existence of wider genetic differences among the parents and crosses. Higher value of SCA as compared to GCA for all the characters under study indicated that these characters were governed by non-additive gene action and hence heterosis breeding is suitable for all the characters.

Khattra *et al.,* (2000); and Jadhav *et al.,* (2010) also reported that non-additive gene action played significant role in the inheritance of all the yield related characters in bitter gourd. However, Matoria and Khandelwal (1999) observed that both additive and non-additive gene action were involved in the expression of yield related characters in bitter gourd. Whereas, Singh and Joshi (1980) observed that additive gene action was dominant for number of primary branches per plant and fruit yield per vine.

Combining ability effects

Information regarding GCA effect of the parent is essential as it helps in selection of suitable parents for breeding programme. The estimates of general combining ability (GCA) of the parents for various characters have been shown in Table 2. Among the thirteen parental lines five parents showed significant and desirable GCA effects for days to 50% staminate flowering, six fordays to 50% pistillate flowering, four for node at which first staminate and pistillate flower appears, one for vine length, two for number of primary branches per plant, three for internodal length and six for fruit yield per hectare. In bitter gourd, earliness in flowering is a desirable trait. Hence, parents with negative value of GCA effects were taken into consideration.

Parent OBGCS-4, OBGCS-1 and IC-085612exhibited significant negative GCA effects, thus presumed as good combiner for days to 50% staminate flowering. Whereas, for days to 50% pistillate flowering the line IC-085612 followed by OBGCS-4 and Katehi showed the best results. Regarding the node bearing first staminate flower, the parent Katehi was observed as good combiner followed by OBGCS-2 and Shaktigopal Local while, in case of node bearing first pistillate flower, the lines IC-085612, Katehi and OBGCS-1 were found to be most promising ones. Similar results of significant GCA effects for earliness was reported by Khattra *et al.,* (2000); Yadav *et al.,* (2008); Kumara *et al.,* (2011); and Thangamani *et al.,* (2011)in bitter gourd.

As regards to the vegetative growth of vine, the line Katehi was observed as good combiner as it exhibited significant and positive GCA effect. Similarly, the parent Jaunpuri Green and Meghna observed as very good combiner for number of primary branches per plant due to their significant positive GCA effects. In case of internodal length, the lines Shaktigopal Local, OBGCS-3 and OBGCS-2 appeared as very good combiners showing significantly negative GCA effects. Similar findings have been reported by Yadav *et al.,* (2008) and Singh *et al.,* (2013) for these traits.

For fruit yield the parents, Jaunpuri Green followed by IC-085612 and IC-085611 were identified as best genotypes for improvement of yield combiner. Significant GCA effects for fruit yield per hectare was also reported by Singh and Joshi (1980); Thangamani*et al.,* (2011); and Sundharaiya and Venkatesan (2016) in bitter gourd.

Estimation of specific combining ability effects are given in Table 3. Among the 30 hybrids, eight hybrids exhibited significant SCA effect in desired direction for days to 50% staminate flowering. The highest and significant negative SCA effects was observed in hybrid IC-085611 ×Meghna followed by BGCV-2 ×Katheri and OBGCS-4 × Preethi for this trait. Regarding the days to 50% pistillate flowering, eleven out of 30 hybrids showed negative SCA effect and the highest value of negative SCA were reported by the crosses OBGCS-3 ×Preethi followed by Katehi×Meghna and OBGCS-4 × Preethi. For node at which first staminate flower appears, the highest and significant SCA effects in desired (negative) direction were observed in crosses BGCV-2 ×Meghna followed by Katehi×Katheri and OBGCS-2 × Meghna. The top hybrids exhibiting negative and significant SCA values with first pistillate flower at lowest node observed in BGCV-2 ×Meghna followed by Jaunpuri Green ×Meghna and IC-085611 × Katheri. Significant SCA effects for earliness traits was also reported by Singh and Joshi (1980); Thangamani *et al.,* (2011); and Radharani *et al.,* (2013) in bitter gourd.

Table.1 Analysis of variance for combining ability for yield and plant characters in bitter gourd

Source of Variations	d.f.	Mean sum of square							
		Days to 50% staminate flowering	Days to 50% pistillate flowering	Node at which first staminate flower appears	Node at which first pistillate flower appears	Vine length (m)	Number of primary branches per plant	Internodal length (cm)	Fruit yield (q/ha)
Replicates	2	2.47	0.05	0.15	0.21	0.10	1.20	0.13	116.51
Line Effect	9	38.87 *	38.13**	4.93**	10.65**	1.68**	5.52 **	5.32	6660.59 *
Tester Effect	2	10.47**	8.06	7.48**	8.92**	0.62	4.06	0.47	3459.93**
Line × Tester Eff.	18	13.07 **	19.61 **	3.78 **	7.39 **	1.25 **	6.19 **	7.82 **	2295.97 **
Error	58	0.83	1.09	0.66	0.59	0.39	1.29	1.39	51.82
σ^2**gca**		1.22	1.13	0.29	0.47	0.04	0.18	0.09	256.84
σ^2**sca**		4.05	6.21	1.06	2.28	0.29	1.66	2.23	748.05
σ^2gca/σ^2**sca**		0.30	0.18	0.27	0.21	0.14	0.11	0.04	0.34
***Significant at p=0.05, **Significant at p=0.01**									

Table.2 Estimates of general combining ability effects of parents for various yield and plant characters in bitter gourd

Genotypes	Days to 50% staminate flowering	Days to 50% pistillate flowering	Node at which first staminate flower appears	Node at which first pistillate flower appears	Vine length (m)	Number of primary branches per plant	Internodal length (cm)	Fruit yield (q/ha)
LINES								
Katehi	-0.92 **	-1.76 **	-1.12 **	-1.25 **	0.78 **	0.22	0.24	12.90 **
IC-085612	-1.45 **	-2.23 **	-0.45	-1.28 **	0.37	0.26	1.27 **	25.82 **
BGCV-2	-0.29	-0.38	0.68 *	0.07	-0.20	-1.41 **	0.10	3.27
OBGCS-4	-2.83 **	-2.05 **	0.56 *	1.40 **	-0.43 *	-0.25	-0.49	10.95 **
OBGCS-2	2.77 **	1.90 **	-0.70 **	0.18	-0.03	-1.14 **	-0.72 *	-26.41 **
OBGCS-3	1.42 **	0.68 *	0.32	-0.24	-0.32	-0.11	-0.82 *	-39.02 **
Jaunpuri Green	-0.54	-1.25 **	-0.42	-0.46	-0.37	1.21 **	0.97 **	35.42 **
Shaktigopal Local	2.55 **	3.88 **	-0.56 *	0.58 *	-0.49 *	0.65	-0.91 *	-43.19 **
OBGCS-1	-2.72 **	-0.85 *	1.17 **	-0.98 **	0.35	0.27	0.62	1.45
IC-085611	2.00 **	2.06 **	0.51	1.98 **	0.34	0.30	-0.25	18.83 **
CD (95%)	0.63	0.66	0.51	0.49	0.41	0.73	0.71	4.80
TESTERS								
Katheri	0.34	0.28	-0.52 **	-0.58 **	0.16	-0.10	0.04	-0.67
Preethi	-0.68 **	-0.60 **	0.48 **	0.08	-0.11	-0.31	-0.14	-10.39 **
Meghna	0.34	0.32	0.04	0.50 **	-0.05	0.41 *	0.10	11.06 **
CD (95%)	0.35	0.36	0.28	0.26	0.22	0.40	0.39	2.63
***Significant at p=0.05, **Significant at p=0.01**								

Table.3 Estimates of specific combining ability effects of crosses for various yield and plant characters in bitter gourd

CROSSES	Days to 50% staminate flowering	Days to 50% pistillate flowering	Node at which first staminate flower appears	Node at which first pistillate flower appears
Katehi× Katheri	1.46 **	2.30 **	-1.26 **	-1.31 **
Katehi ×Preethi	0.55	0.24	0.09	0.06
Katehi ×Meghna	-2.01 **	-2.54 **	1.18 *	1.25 **
IC-085612 ×Katheri	0.33	-1.76 **	-0.72	-1.26 **
IC-085612 ×Preethi	-1.25 *	1.84 **	-0.87	-0.86 *
IC-085612 ×Meghna	0.92	-0.08	1.60 **	2.13 **
BGCV-2 ×Katheri	-2.49 **	-1.88 **	1.54 **	1.04 *
BGCV-2 ×Preethi	1.39 *	1.26 *	-0.12	0.94 *
BGCV-2 ×Meghna	1.10 *	0.61	-1.42 **	-1.98 **
OBGCS-4 ×Katheri	0.04	-0.28	-0.85	-1.16 **
OBGCS-4 ×Preethi	-2.41 **	-2.54 **	-0.49	-0.17
OBGCS-4 ×Meghna	2.37 **	2.81 **	1.34 **	1.33 **
OBGCS-2 ×Katheri	-0.43	-1.70 **	-0.32	-0.70
OBGCS-2 × Preethi	-0.34	3.91 **	1.31 **	0.34
OBGCS-2 ×Meghna	0.77	-2.21 **	-0.99 *	0.36
OBGCS-3 ×Katheri	-0.94	-0.08	-0.08	-0.27
OBGCS-3 ×Preethi	-0.92	-2.94 **	-0.26	-0.74
OBGCS-3 ×Meghna	1.86 **	3.01 **	0.34	1.01 *
Jaunpuri Green ×Katheri	3.02 **	3.46 **	0.36	1.10 *
Jaunpuri Green ×Preethi	-1.10 *	-1.34 *	0.67	0.54
Jaunpuri Green ×Meghna	-1.92 **	-2.12 **	-1.03	-1.64 **
Shaktigopal Local ×Katheri	0.93	0.79	1.06 *	2.31 **
Shaktigopal Local ×Preethi	1.15 *	-0.34	-0.37	-1.29 **
Shaktigopal Local ×Meghna	-2.08 **	-0.46	-0.69	-1.03 *
OBGCS-1 ×Katheri	-1.07	-2.48 **	0.93 *	1.63 **
OBGCS-1 ×Preethi	-0.45	-0.27	-0.69	-0.88 *
OBGCS-1 ×Meghna	1.52 **	2.74 **	-0.24	-0.76
IC-085611 ×Katheri	-0.85	1.61 **	-0.65	-1.38 **
IC-085611 ×Preethi	3.37 **	0.15	0.73	2.06 **
IC-085611 ×Meghna	-2.52 **	-1.77 **	-0.08	-0.67
CD (95%)	1.10	1.15	0.89	0.85

CROSSES	Vine length (m)	Number of primary branches per plant	Internodal length (cm)	Fruit yield (q/ha)
Katehi× Katheri	-0.29	-1.89 **	-1.91 **	-21.49 **
Katehi ×Preethi	-0.31	0.40	-0.05	5.71
Katehi ×Meghna	0.61	1.49 *	1.97 **	15.78 **
IC-085612 ×Katheri	0.82 *	1.36 *	2.12 **	13.65 **
IC-085612 ×Preethi	-0.87 *	-0.62	-1.92 **	-22.51 **
IC-085612 ×Meghna	0.04	-0.75	-0.21	8.86 *
BGCV-2 ×Katheri	0.53	0.38	1.21	35.22 **
BGCV-2 ×Preethi	-0.46	0.41	-0.42	-15.79 **
BGCV-2 ×Meghna	-0.07	-0.79	-0.79	-19.43**
OBGCS-4 ×Katheri	0.20	0.58	0.13	-12.44 **
OBGCS-4 ×Preethi	0.20	-0.48	0.55	5.13
OBGCS-4 ×Meghna	-0.41	-0.10	-0.68	7.32
OBGCS-2 ×Katheri	0.21	0.33	0.27	10.18 *
OBGCS-2 × Preethi	-0.23	0.77	-0.26	-1.15
OBGCS-2 ×Meghna	0.03	-1.10	-0.01	-9.04 *
OBGCS-3 ×Katheri	-0.34	-0.16	0.55	-6.64
OBGCS-3 ×Preethi	0.89 *	0.24	1.14	2.71
OBGCS-3 ×Meghna	-0.54	-0.08	-1.69 **	3.93
Jaunpuri Green ×Katheri	-0.61	-1.97 **	-2.29 **	-39.91 **
Jaunpuri Green ×Preethi	0.60	0.77	1.71 **	20.70 **
Jaunpuri Green ×Meghna	0.00	1.21	0.58	19.21 **
Shaktigopal Local ×Katheri	0.44	0.26	0.44	-6.38
Shaktigopal Local ×Preethi	-0.18	-0.30	-0.12	19.68 **
Shaktigopal Local ×Meghna	-0.26	0.04	-0.32	-13.30 **
OBGCS-1 ×Katheri	0.03	1.84 **	0.41	42.18 **
OBGCS-1 ×Preethi	0.41	0.54	1.11	9.98 *
OBGCS-1 ×Meghna	-0.44	-2.37 **	-1.52 *	-52.15 **
IC-085611 ×Katheri	-0.99 **	-0.73	-0.93	-14.37 **
IC-085611 ×Preethi	-0.05	-1.72 **	-1.74 **	-24.46 **
IC-085611 ×Meghna	1.04 **	2.45 **	2.67 **	38.83 **
CD (95%)	0.71	1.27	1.23	8.32

For growth parameters like vine length, the best combinations were IC-085611 × Meghna, OBGCS-3 × Preethi and IC-085612 × Katherias it exhibited highest and positive SCA effects whereas the hybrids IC-085611 × Meghna, OBGCS-1 × Katheri and Katehi × Meghna showed good specific combining ability for number of primary branches per plant. For internodal length, the crosses Jaunpuri Green ×Katheri, IC-085612 ×Preethi and Katehi×Katheri appeared as good specific combiners showing significantly negative SCA effects. Similar findings for vine length and number of primary branches per plant have been also reported by Yadav *et al.*, (2008); Patil *et al.,* (2012); and Singh *et al.*, (2013).

Eleven out of 30 hybrid exhibited significant SCA effects in desirable direction for fruit yield (q/ha). The top three hybrids exhibiting maximum and significant SCA effect for this trait were OBGCS-1 × Katheri followed by IC-085611 × Meghna and BGCV-2 × Katheri. Significant SCA effects for fruit yield per hectare was also reported by Matoria and Khandelwal (1999); Kumar *et al.,* (2016); and Sundharaiya and Venkatesan (2016) in bitter gourd.

It is concluded in terms of better general combiners, the lines IC-085612, OBGCS-4 and Katehiand among crosses based on SCA effects, IC-085612 × Katheri, OBGSC-1 × Katheri and IC-085611 × Meghnawere found superior. It is therefore, suggested that these promising parents and crosses may be exploited for further amelioration of yield and yield components in bittergourd. The selected crosses can be directly utilized as promising hybrids.

References

Behera, T. K., Staub, J. E., Behera, S. and Simon, P. W. 2008. Bitter gourd and human health. Medicinal and Aromatic Plant Science and Biotechnology, 1: 224-226.

Jadhav, K. A., Garad, B. V., Kshirsagar, D. B., Dhumal, S. S. and Patil, B. T. 2010. Combining ability studies in bitter gourd (*Momordica charantia* L.). Journal of Maharashtra Agricultural Universities, 35(2): 203-206.

Kempthorne, O. 1957. An introduction to genetic statistics. John Wiley and Sons, Inc.; New York. pp. 545.

Khattra, A. S., Raghbir, S. and Thakur, J. C. 2000. Combining ability studies in bitter gourd in relation to line × tester crossing system. Vegetable Science, 27(2): 148-151.

Kumar, A., Singh, B. K., Singh, A. K. and Anand, P. K. 2016. Combining ability analysis for yield and yield contributing traits in bitter gourd. Indian Journal of Agriculture and Allied Sciences, 2(1): 50-54.

Kumara, B. S., Puttaraju, T. B., Shivanand, H., Prakash, K., Jainag, K.and Sudheesh, N. K. 2011. Combining ability studies in bitter gourd (*Momordica charantia* L.) for quantitative characters. Asian Journal of Horticulture, 6(1): 135-140.

Matoria, G. R. and Khandelwal, R. C. 1999. Combining ability and stability analysis in bitter gourd (*Momordica charantia* L.). Journal of Applied Horticulture, 1(2): 139-141.

Panse,V. G., Sukhatme, P. V. 1967. Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi. 695p.

Patil, S. A., Salimath, P. M., Dharmatti, P. R., Byadgi, A. S.and Nirmala, Y. 2012. Heterosis and combining ability analysis for productivity traits in bitter gourd (*Momordica charantia* L.). Karnataka Journal of Agricultural

Sciences, 25(1): 9-13.

Radharani, K., Reddy, K.and Raju, C. 2013. Heterosis and combining ability for quantitative traits in bitter gourd (*Momordica charantia* L.). Current Advances in Agricultural Sciences (An International Journal), 5(2): 184-188.

Singh, A. K. Pan, R. S., and Bhavana, P. 2013. Heterosis and combining ability analysis in bittergourd (*Momordica charantia* L.). The Bioscan, 8(4): 1533-1536.

Singh, B.and Joshi, S. 1980. Heterosis and combining ability in bitter gourd. Indian Journal of Agricultural Sciences, 50(7): 558-561.

Sundharaiya, K.and Venkatesan, K. 2016. Studies on combining ability in bitter gourd (*Momordica charantia* L.). Journal of Horticultural Science, 2(1): 63-66.

Thangamani, C., Pugalendhi, L., Sumathi, T., Kavitha, C.and Rajashree, V. 2011. Estimation of combining ability and heterosis for yield and quality characters in bitter gourd (*Momordica charantia* L.). Electronic Journal of Plant Breeding, 2(1): 62-66.

Yadav, M., Chaudhary, R.and Singh, D. B. 2008. Combining ability in bitter gourd. Indian Journal of Horticulture, 65(2): 163-166.

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