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Study the general and specific combining ability variances on the general and specific combining ability variances in bottle gourd

Vijay Bhadur Singh and SP Singh

Abstract
The present investigation entitled "Study the general and specific combining ability variances on the general and specific combining ability variances in Bottle gourd (*Lagenaria siceraria* Mol. Standl.)" using diallel cross analysis was undertaken to find out the genetic architecture of various quantitative traits, heterosis and combining ability, heritability and genetic advance. The experimental material of seven diverse parents and 42 F_1s including reciprocals was sown in Randomized Block Design with four replications during September 1999 at Students Instructional Farm, N.D.U.A.&T., Kumarganj, Faizabad. On the basis gca effects the parent Pusa Naveen was found good general combiner for days to anthesis of first male flower, days to anthesis of first female flower, node number of first male flower, fruit yield per plant, node number of first female flower, days to first harvest, fruit diameter, number of fruits per plant and internodal distance. On the basis of specific combining ability effects, good specific cross combinations were NDBG-202 x L-22, Pusa Naveen x NDBG-240 and NDBG-129 x NDBG-202 for fruit yield per plant. In general considerable heterosis over better parent and standard variety was observed for almost all the characters under study.

Keywords: Specific combining, variances, specific combining

Introduction
Among the cucurbits, bottle gourd or calabash gourd [*Lagenaria siceraria* (Mol.) Standl, 2n = 22] is the only plant that was known to mankind in both the new and old world from prehistoric times (Esquinas-Alcazar and Gulick, 1983). It is a cosmopolitan cucurbitaceous vegetable grown widely throughout the tropics and sub-tropics of the world. In addition to its use as vegetable, tender fruits are used for making sweets, *rayta, etc.* Shells of mature and dry fruits are used for making containers, floats, utensils and musical instruments. The bottle gourd thrives well in hot humid weather conditions, but it can be grown in adverse low temperature conditions also (Seshadri, 1986; Sirohi and Sivakami, 1991; Maurya *et al.*, 1993) [9, 10, 13, 8]. Under the North-Indian climatic conditions, it is cultivated both in spring summer (February-June) and rainy (July-November) seasons. The early maturing varieties sown by or before the middle of October can bear first edible fruit within 60 to 80 days (Maurya, 1991) [6]. There is also a common traditional practice among the villagers to grow few plants of bottle gourd near their residences, during rainy season (August), where growing plants are trained on thatches, huts or house roofs. These plants acquire sizable vegetative growth and start producing edible fruits in about 60 days (Singh, 1994) [8]. Farmers also plant the bottle gourd crop throughout the month of November as an inter-crop with potato in the plains or as pure crop in river bed (Seshadri, 1986) [9, 10] to fetch high price from early summer produce.
In India although a wide range of variability is available in vegetative and yield attributing characters in this crop, very little attention has been given in genetic improvement of this crop (Tyagi, 1973; Sharma *et al.* 1983; Seshadri, 1986; Jankiram and Sirohi, 1987, 1988; Sivakami *et al.*, 1987; Maurya and Singh, 1994) [9, 10, 12, 14, 11, 3, 4]. However, research work done during the recent years have resulted in the development of several improved varieties in this crop in different parts of the country.
Combining ability analysis helps in the evaluation of inbreds in terms of genetic value and in the selection of suitable parent for hybridization. The superior specific cross combinations are also identified by this technique. The existence of significant amount of non-additive gene action is a prerequisite for exploitation of heterosis. The specific combining ability variance

largely is the measure of dominance variance. If heterosis is high for specific cross and observations made are true for economic trait like yield, it is possible to utilize the cross as a commercial hybrid provided that the pollination system of the crop permits commercial seed production of hybrids or there exists a male sterility, fertility restoration system (Arunachalam, 1989) [1].

Material and Method

The experiment was conducted at the Students' Instructional Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar, Faizabad (U.P.) in September sown early winter crop during, 1999. Narendra Nagar is geographically situated at 26.47ºN latitude 82.12º E longitude, and at an altitude of 113m above the mean sea level. This area falls in subtropical climatic zone. The climate of district Faizabad is semi-arid with hot summer and cold winter.

The materials for the present investigation consisted of seven diverse parents Pusa Naveen, NDBG-129-B, NDBG-140, NDBG-202 LF, NDBG-208, L-22 and L-27. (Inbreeds /varieties of long fruited bottle gourd, their 21 F_1s and 21 reciprocals. The diverse parents/varieties were made available from the germplasm maintained in Department of Vegetable Science of the University. The experimental material comprising of 49 treatments i.e. 7 parents (including Pusa Naveen as standard check), their 21 F_1s and 21 reciprocals were grown in Randomized Block Design with four replications on 28th August, 1999. Each treatment was grown in three metre long and two meter wide experimental plots. The approximate distance of 50 cm between the plants and two m between rows to row was maintained. Recommended agronomic practices and plant protection measures were followed for raising a good crop.

Result and Discussion

Among parents the days to anthesis of first male flower ranged from 41.40 days (Pusa Naveen) to 46.05 days (NDBG-208). Among the crosses the range varied from 40.97 days (Pusa Naveen x NDBG-140) to 46.13 days (NDBG-208 x L-22).

In case of reciprocals, the range was observed from 41.25 days (NDBG-140 x Pusa Naveen) to 47.20 days (L-27 x NDBG-202). Parents NDBG-140, NDBG-129, crosses Pusa Naveen x NDBG-129, Pusa Naveen x NDBG-202 and reciprocal crosses NDBG-129 x Pusa Naveen and L-22 x NDBG-140 showed early male flowering.

Days to anthesis of first female flower varied from 41.28 (Pusa Naveen) to 48.30 days (NDBG-202) for different parental lines. Among crosses it ranged from 40.60 days (Pusa Naveen x NDBG-140) to 50.35 days (NDBG-129 x NDBG-208). In case of reciprocals the range was observed from 40.30 (NDBG-140 x Pusa Naveen) to 50.75 days (NDBG-202 x NDBG-140). Parents NDBG-140, NDBG-129, crosses Pusa Naveen x NDBG-202, Pusa Naveen x NDBG-208 and reciprocal crosses NDBG-129 x Pusa Naveen and L-27 x NDBG-140 exhibited early female flowering.

The node number of first female flower ranged from 8.94 (Pusa Naveen) to 15.53 (L-22) in parents, among crosses from 8.94 (Pusa Naveen x NDBG-208) to 14.09 (L-22 x L-27) and among reciprocal crosses from 9.89 (NDBG-129 x Pusa Naveen) to 15.14 (L-27 x L-22). Parents NDBG-129, NDBG-140, crosses Pusa Naveen x NDBG-140, Pusa Naveen x NDBG-129 and reciprocal crosses NDBG-208 x Pusa Naveen and NBG-202 x Pusa Naveen exhibited earlier female flowering at lower node numbers. While parents L-27, NDBG-208, crosses NDBG-202 x L-22, NDBG-129 x NDBG-140 and reciprocal crosses L-27 x NDBG-202 and L-22 x NDBG-202 showed flowering at higher node numbers.

The range of days to first harvest varied from 51.75 days (Pusa Naveen) to 63 days (L-22) among parents. In case of crosses from 51.75 days (Pusa Naveen x NDBG-129) to 60.50 days (L-22 x L-27) and among reciprocal crosses from 53 days (NDBG-140 x Pusa Naveen) to 63 days (NDBG-208 x NDBG-202). Lesser days for first harvest were recorded in parents NDBG-140, NDBG-129, in F_1s (Pusa Naveen x NDBG-140, Pusa Naveen x NDBG-202) and in reciprocal crosses (NDBG-140 x Pusa Naveen) and (NDBG-129 x Pusa Naveen). Days for first harvest was more (late fruiting) in parents NDBG-202, L-27, in crosses (Pusa Naveen x L-22, NDBG-208 x L-22, NDBG-202 x L-27) and in reciprocal crosses (L-27 x NDBG-202 and L-27 x L-22).

The range of fruit diameter for parents varied from 7.11 cm (NDBG-129) to 8.85 cm (NDBG-208), in crosses from 6.74 cm (NDBG-208 x L-22) to 8.09 cm (Pusa Naveen x NDBG-208) and reciprocal crosses from 6.82 cm (L-27 x NDBG-129) to 7.99 cm (NDBG-208 x Pusa Naveen). Parents NDBG-140, L-27; crosses NDBG-129 x NDBG-202 and reciprocals L-27 x Pusa Naveen and NDBG-202 x NDBG-140 showed lower fruit diameter, while parent Pusa Naveen; cross Pusa Naveen x NDBG-129 and reciprocal cross NDBG-208 x L-27 exhibited higher values of fruit diameter.

Number of fruits per plant ranged from 2.69 fruits (NDBG-202) to 4.39 (Pusa Naveen) in parents, in crosses from 2.38 (NDBG-202 x NDBG-208) to 5.26 fruits (Pusa Naveen x NDBG-140) and in reciprocals from 2.59 (NDBG-202 x NDBG-14) to 5.19 fruits (NDBG-140 x Pusa Naveen).

The range for internodal distance among parents varied from 11.89 in (Pusa Naveen) to 16.42 cm (NBG-208), among crosses from 11.39 cm (NDBG-129 x NDBG-140) to 17.91 cm (NDBG-202 x L-27) and among reciprocal crosses from 12.86 cm (L-27 x NDBG-140) to 16.39 cm (NDBG-202 x NDBG-140). Parents NDBG-202, NDBG-129, crosses Pusa Naveen x NDBG-204, Pusa Naveen x NDBG-140 and reciprocals L-22 x NDBG-140 and NDBG-208 x Pusa Naveen exhibited lower values of intermodal distance while parent L-27, cross NDBG-208 x L-22 and reciprocal cross NDBG-208 x NDBG-140 showed higher intermodal distance.

Table 1: Estimates of general combining ability (GCA) effects of parents for 14 characters in 7x7 diallel cross of bottle gourd

Parental lines	Days to anthesis of Ist male flower	Days to anthesis of first female flower	Node number of Ist male flower	Fruit yield per plant (kg)	Node number of Ist female flower	Days to first harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	No. of fruits per plant	No. of branches per plant	No. of nodes per plant	Inter-nodal distance (cm)	Vine length (m)
1. Pusa Naveen	-0.87**	-1.75**	-0.74**	0.39**	-1.18**	-1.51**	-1.89**	0.15*	0.01	0.48**	0.69	-0.86	-0.96**	-0.50**
2. NDBG-129	-0.31	-0.05	-0.24	-0.17*	-0.10	-0.58	1.24*	-0.12	-0.01	-0.16**	-0.46	-0.31	0.08	-0.01
3. NDBG-140	-0.02	0.73*	0.04	0.03	0.32	0.29	1.24*	-0.16*	0.01	-0.02*	-0.07	0.43	0.43	0.28*
4. NDBG-202	-0.10	-0.14	0.04	0.09	-0.21	0.28	-0.24	-0.01	0.00	0.10**	1.12*	-0.59	0.12	-0.09
5. NDBG-208	0.04	-0.55	0.17	-0.01	-0.55	-1.05*	-2.18**	0.23**	-0.02	0.11**	-0.29	0.10	-0.04	-0.04
6. L-22	0.30	0.75*	0.23	-0.22**	0.73*	1.24*	1.61**	-0.05	0.01	-0.34**	-0.64	0.40	0.15	0.12
7. L-27	0.96*	1.02*	0.50**	-0.11	0.99**	1.33*	0.22	-0.02	0.01	-0.18**	-0.34	0.83	0.23	0.24*
SE (g_i)	0.267	0.438	0.156	0.0684	0.331	0.576	0.604	0.063	0.0079	0.010	0.385	0.522	0.227	0.112

*,** significant at 5% and 1% probability levels, respectively.

Table 2: Estimates of specific combining ability (SCA) effects of the crosses for 14 characters in 7x7 diallel cross of bottle gourd

Crosses (F_1s)	Days to anthesis of Ist male flower	Days to anthesis of first female flower	Node number of Ist male flower	Fruit yield per plant (kg)	Node number of Ist female flower	Days to first harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	No. of fruits per plant	No. of branches per plant	No. of nodes per plant	Inter-nodal distance (cm)	Vine length (m)
1.Pusa Naveen x NDBG-129	-0.92	-0.33	0.47	-0.13	1.30	-1.01	0.48	0.05	0.01	-0.22	1.97*	3.10*	-0.41	0.21
2. Pusa Naveen x NDBG-140	-0.35	-1.41	-0.61	0.74**	-0.71	-0.01	-0.70	0.10	0.00	0.87**	0.11	-0.81	-0.17	-0.21
3. Pusa Naveen x NDBG-202	0.85	1.02	1.05**	-0.04	1.01	0.39	2.69*	-0.47**	0.03	-0.17	-0.52	2.08	0.71	0.59*
4. Pusa Naveen x NDBG-208	-0.18	-0.61	-0.26	0.33*	-1.19	-0.67	-2.03	0.26	0.01	0.32	0.15	-0.59	-0.02	-0.10
5. Pusa Naveen x L-22	0.71	0.44	-0.03	-0.32*	0.07	0.92	1.86	-0.06	0.02	-0.48*	-0.76	1.82	-0.05	0.23
6. Pusa Naveen x L-27	00.95	1.24	-0.10	-0.12	0.58	2.83*	0.87	0.01	-0.01	-0.08	-0.47	0.03	0.60	0.22
7. NDBG-129 x NDBG-140	0.98	1.13	0.55	-0.33*	0.70	0.56	-0.37	0.02	-0.02	-0.38	1.69*	0.50	-0.03	0.04
8. NDBG-129 x NDBG-202	1.58**	0.66	-0.08	0.31*	-0.10	0.08	-2.94*	0.40**	0.02	0.31	-1.44	-1.43	0.58	0.06
9. NDBG-129 x NDBG-208	0.16	0.95	-0.86*	0.12	-0.07	0.78	3.93**	-0.25	-0.01	0.30	-0.38	-0.84	-0.05	-0.11
10. NDBG-129 x L-22	-0.43	-0.72	-0.12	0.18	-0.75	0.49	0.87	-0.19	0.05	0.05	-0.11	-0.16	1.12	0.41
11. NDBG-129 x L-27	-0.25	-0.50	-0.01	-0.13	-0.26	0.15	-0.74	0.02	-0.01	-0.14	-0.19	0.55	-0.26	0.00
12. NDBG-140 x NDBG-202	0.09	0.73	1.08**	-0.31*	1.13	0.96	3.68*	0.02	0.03	-0.54*	-1.64	1.18	0.18	0.29
13. NDBG-140 x NDBG-208	-0.80	-0.51	-0.96	-0.15	-0.11	0.53	0.75	-0.32*	0.07	-0.48*	1.18	0.28	-0.73	-0.20
14. NDBG-140 x L-22	1.05	3.06**	0.57	-0.26	0.37	-0.51	-2.07	0.10	-0.03	-0.23	-0.09	0.20	0.31	0.13
15. NDBG-140 x L-27	0.93	1.50	0.01	0.15	-1.16	2.53	0.62	-0.05	0.01	0.12	1.47	1.32	1.40*	0.78**
16. NDBG-202 x NDBG-208	-1.58**	-2.77**	-0.44	0.08	-0.58	-1.83	3.41*	-0.35*	-0.02	0.20	-0.61	-0.29	-0.14	-0.30
17. NDBG-202 x L-22	-1.12	-2.06*	0.04	0.97**	-1.95*	-1.24	-2.50	0.20	0.02	1.19	0.58	-5.29**	0.44	-0.57*
18. NDBG-202 x L-27	-0.40	-1.03	-1.42**	0.17	-0.44	-2.08	-2.01	0.19	0.01	0.19	0.42	0.97	-0.59	-0.07
19. NDBG-208 x L-22	0.12	-0.35	-0.57	-0.13	0.93	-2.04	2.84*	-0.24	0.02	-0.31	0.02	2.24	-0.47	0.11
20. NDBG-208 x L-27	0.50	-0.02	1.35**	0.12	-0.13	-0.13	-0.32	-0.08	0.02	0.02	0.63	-0.55	-0.63	-0.31
21. L-22 x L-27	-0.65	-1.31	0.01	-0.08	-1.92	-1.92	0.54	0.02	-0.03	0.02	0.28	0.60	-1.00*	-0.34
SE (S_{iy})	0.664	1.087	0.386	0.170	0.822	1.432	1.501	0.158	0.019	0.253	0.955	1.295	0.563	0.278

Specific combining ability is a function of non-additive gene action, where the crosses showing high sca effects involved parents of good general combining ability effects, they could be exploited in future breeding programme. Darrah and Hallaur (1972) pointed out that poor inbreds though lacked the additive effects of good inbred were highly responsive to heterozygosity in the way of non-additive effects.

The present study indicated that specific good combiners for fruit yield per plant were NDBG-202 x L-22, Pusa Naveen x NDBG-140 and NDBG-129 x NDBG-202. NDBG-202 x NDBG-208 was good specific combiner for days to anthesis of first male flower and days to anthesis of first female flower for node number of first male flower NDBG-202 x L-27 was observed as good specific combiner whereas NDBG-202 x L-22 was good specific combiner for node number of first female flower. Pusa Naveen x L-27 showed good specific combining ability and recommended for late harvesting conditions. For number of fruits per plant good GCA effect was exhibited by Pusa Naveen x NDBG-140.

The present study of reciprocal crosses indicated that good specific cross combinations was NDBG-208 x NDBG-140 for fruit yield per plant and number of fruit per plant.

Similar findings on GCA and sca were reported by Shivakami *et al.* (1987), Janakiram and Sirohi (1988) [3], Singh *et al.* (1989), Singh and Singh (1998) [7] and Kishwaha and Ram (1997-98) [5] for various quantitative characters in bottle gourd.

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