**INDIAN JOURNAL OF ARID HORTICULTURE**
2011, Vol. 6 (1-2) : 31-34

# Combining ability analysis for quantitative traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

D. R. Sharma, M. R. Choudhary*, M. S. Fageria, B. R. Choudhary and Dhirendra Singh
Assoc. Professor, Department of Horticulture, S.K.N. College of Agriculture,
(S K Rajasthan Agricultural University), Jobner-303 329 (Jaipur)

**Abstract**

Combining ability analysis was carried through diallel mating design (excluding reciprocals) involving eight parents for fourteen characters. The analysis revealed highly significant differences among the genotypes for all the parameters studies. The variances due to sca were higher than the gca for vine length, days to first fruit harvest, harvest duration, fruit length, average weight of first three harvested fruits, number of marketable fruits, fruit yield per plant, size of seed cavity and flesh thickness indicating the predominance of non-additive gene effects. None of the parents was found good general combiner for all the characters consistently, however, parent Pusa Naveen, NDBG-104, NDBG-140, and Bharatpur Local showed higher combining ability for yield and yield attributing traits. The best specific cross for days to first female flower and days to first fruit harvest was Pusa Naveen x NDBG-132 and Pusa Naveen x RS-1, respectively. The crosses Pusa Naveen x NDBG-104 and Pusa Naveen x UL-6 were identified as best specific combiners for average weight of first three harvested fruits, number of marketable fruits and fruit yield per plant.

**Key words:** *Bottlegourd, Genotype, Combining ability, GCA effects, SCA effects, GCA variance, SCA variance*

## Introduction

Bottlegourd [*Lagenaria siceraria* (Mol.) Standl.] is one of the most important cucurbitaceous vegetables grown in warmer climatic regions of the world. Being a monoecious crop cross pollination is a general rule. A wide range of genetic variability is available in bottlegourd with respect to yield and its components, which may be exploited through heterosis breeding. Choice of parents is considered an important aspect in any breeding programme aimed improving yield and its related attributes. The analysis of combining ability helps in selecting suitable parents for hybridization and for characterizing the nature and magnitude of gene action. The selection of parents for production of $F_1$ hybrids has to be based on genetic information and knowledge of combining ability. Hence, the present investigation was undertaken to study combining ability for yield and other quantitative traits in selected genotypes.

## Materials and Methods

The experimental material comprised of eight elite inbred lines *viz.*, Pusa Naveen, RS-1, Pusa Summer Prolofic Long (PSPL), UL-6, NDBG 104, NDBG 132, NDBG 140 and Bharatpur Local and 28 hybrids derived from the diallel mating (excluding reciprocals). The parents and hybrids were evaluated in randomized block design with three replications at Horticulture Farm, SKN College of Agriculture, Jobner, Rajasthan. The experimental material was sown on 29th June, 2003 in rows of 2.5m apart with a spacing of 0.75m between plants. Observations were recorded on five competitive plants in each parents and hybrids for each treatment in each replication for fourteen quantitative traits. The combining ability variances and effects were worked out following the Model I and Method II of Griffing, 1956.

## Results and Discussion

The analysis of variance for combining ability revealed significant mean square due to general combining ability (gca) and specific combining ability (sca) for characters studied, indicating the additive and non-additive gene action for these traits. The analysis of variance for combining ability showed highly significant gca difference for all the characters under study (Table-1). The sca effects among hybrids were also significant for all the characters, which indicated the importance of both additive and non-additive gene action. Sirohi *et al.*, 1986; Sirohi *et al.*, 1988; Sreevani, 2005 and Dubey and Maurya, 2006 have reported almost similar results. The gca ($\sigma^2_g$) variances were higher than the sca ($\sigma^2_s$) variances for number of branches per plant, days to first female flower, severity of powdery mildew, severity of downy mildew and incidence of fruit fly. This indicated the limited scope of heterosis breeding for these characters and population improvement through selection should be adopted for exploiting the genetic variances (Kushwaha and Ram, 1996). Other characters *viz.*, vine length, days to first fruit harvest, harvest duration, fruit length, average weight of

*Corresponding author's e-mail: mrcrau@gmail.com

first three harvested fruits, number of marketable fruits, fruit yield per plant, size of seed cavity and flesh thickness where gca variances were lower than the sca variances may be improved through hybridization (heterosis) indicating the predominance of non-additive gene effects, these findings are in line with those of Sivakami *et al.*, 1987; Maurya and Singh, 1994; Dubey and Maurya, 2006 and Sit and Sirohi, 2008.

The gca effects of parents were significant for most of the characters studied which indicated the existence of variability among the parents selected for hybridization (Table-2). The information regarding gca effect of the parent is of prime importance as it helps in successful prediction of genetic potentiality of crosses. Estimate of gca effect showed that it is difficult to pick up good general combiner for all the characters. The parent Pusa Naveen was the best general combiner as it has shown significant gca effects in desirable direction for most of the traits except vine length, fruit length, average weight of first three harvested fruits and harvest duration indicating its superiority over the rest of the parents and suitability in using such parent in bottlegourd breeding programme to improve yield potential. The parent Bharatpur Local exhibited significant positive gca effect for vine length (0.61) followed by RS-1 (0.25). For days to first female flower and days to first fruit harvest Pusa Naveen, PSPL and NDBG-104 expressed significant negative gca effects indicating their good general combining ability for early fruiting. PSPL (2.83), Bharatpur Local (2.35) and RS-1(1.10) were good general combiners for fruit length. Similarly NDBG-104 (0.06), NDBG-140 (0.05) and Bharatpur Local (0.03) for average weight of first three harvested fruits and NDBG-104 (0.98) and Bharatpur Local (0.44) for harvest duration recorded significant positive gca effects indicating good general combining ability for these traits. It was also observed that parents which showed high gca effects for fruit yield and its attributes were also found to produce high *per se* yield and yield components. Such parents can be exploited through heterosis breeding for developing high yielding hybrids. The results are in close conformity with the findings of Sirohi *et al.*, 1986; Janakiram and Sirohi, 1987; Sivakami *et al.*, 1987; Janakiram, 1988; Sirohi *et al.*, 1988; Janakiram and Sirohi, 1991; Maurya *et al.*, 1993; Maurya and Singh, 1994; Singh *et al.*, 1996; Kumar *et al.*, 1998; Maurya *et al.*, 1998; Sreevani, 2005 and Dubey and Maurya, 2006.

In the present study, the magnitudes of non-additive variances were also higher for most of the traits. The *per se* performance may not be real indicative for their gca effects. The estimates of sca effects were higher and significant (Table-3). The cross combinations Pusa Naveen x NDBG-132 (-3.29), UL-6 x NDBG-132 (-2.60), NDBG-104 x NDBG-140 (-2.52), PSPL x Bharatpur Local (-2.30) and RS-1 x UL-6 (-1.74) for days to first female flower, Pusa Naveen x RS-1 (-5.27), UL-6 x NDBG-132 (-3.14), RS-1 x UL-6 (-3.12), PSPL x Bharatpur Local (-2.93), Pusa Naveen x NDBG-132 (-2.44), NDBG-104 x NDBG-140 (-1.90) and PSPL x NDBG-104 (-1.75) for days to first fruit harvest, UL-6 x NDBG-132 (-3.19), Pusa Naveen x NDBG-104 (-2.36), NDBG-104 x NDBG-140 (-2.06) and Pusa Nusa Naveen x Bharatpur Local (-1.08) for severity of powdery mildew, RS-1 x NDBG-140 (-2.10), Pusa Naveen x RS-1 (-1.89), UL-6 x Bharatpur Local (-1.36), NDBG-104 x Bharatpur Local (-1.13) and PSPL x NDBG-104 (-1.02) for severity of downy mildew and RS-1 x Bharatpur Local (-3.39), PSPL x Bharatpur Local (-3.05), UL-6 x NDBG-132 (-2.59), UL-6 x NDBG-104 (-2.05) and RS-1 x NDBG-140 (-1.16) for incidence of fruit fly were found to exhibit negative sca effects.

A total of six crosses out of 28 crosses exhibited significant sca effect for number of marketable fruits. The combinations Pusa Naveen x NDBG-104 (1.90), Pusa Naveen x UL-6 (1.85), Pusa Naveen x NDBG-140 (1.29), RS-1 x Bharatpur Local (1.16), NDBG-104 x NDBG-132 (1.01), RS-1 x NDBG-140 (0.82), PSPL x NDBG-140 (0.63) RS-1 x UL-6 (0.61) and PSPL x NDBG-104 (0.57) and were found to register significant positive sca effects for fruit yield per plant, indicating the presence of dominance and epistatic (non-additive) type of gene actions. Ten crosses for vine length, five crosses for number of branches per plant, twelve for fruit length, eight for average weight of first three harvested fruits, five for harvest duration and three for flesh thickness depicted significant positive estimates of specific combining ability effects. None of the cross combination showed significant sca effects in desirable direction. Similar results were reported by Sirohi *et al.*, 1986; Sivakami *et al.*, 1987; Janakiram and Sirohi, 1991; Maurya *et al.*, 1993; Maurya *et al.*, 1994; Singh *et al.*, 1996; Kumar *et al.*, 1998); Sreevani, 2005 and Dubey and Maurya, 2006. These combinations can be advanced in further generations for selecting superior segregants.

Most of the crosses included high x high and high x medium type of general combiners. The desirable cross combinations with medium x medium and poor x poor type of general combiners were also obtained which may be due to complimentary gene effects. The crosses involving parents with good gca effect can be exploited effectively by conventional breeding producer like pedigree method. However, the crosses involving one good general combiner and other medium and poor combiner could produce desirable transgressive segregants if additive genetic system was operating in good combining parents and epistatic effect also act in the same direction. Non-additive gene action was however pre-ponderant for all the traits studied, indicating the need for heterosis breeding for improvement of the traits. The pre-dominant role played by non-additive gene action in bottle gourd for fruit yield and yield component characters has also been reported by Sirohi *et al.*, 1986; Sivakami *et al.*, 1987; Janakiram and Sirohi, 1988; Kumar *et al.*, 1988; Sirohi *et al.*, 1988; Janakiram and Sirohi, 1991; Maurya *et al.*, 1993; Singh *et al.*, 1996; Maurya and Singh, 1998; Dubey and Maurya, 2006 and Sit and Sirohi, 2008.

It is apparent from the foregoing discussion that in almost all the hybrids, which showed the best results, at least one of the outstanding parental lines namely Pusa Naveen, NDBG-104, NDBG-140 and Bharatpur Local, were involved. These lines have high gca effects for one or

more of the characters contributing towards yield. This indicated that there was a strong tendency of higher gain to be transmitted from parents to off spring. In the present study almost all the characters are governed by non-additive gene action thus it can be concluded that improvement in bottle gourd for yield and its contributing traits may be brought out either by exploiting heterosis or recurrent selection in the succeeding generations.

Table 1: Analysis of variance for combining ability in bottlegourd (pool of two years).

| Characters | Source of variation | | | Model I | | |
|---|---|---|---|---|---|---|
| | gca | sca | Error | $\sigma^2_g$ | $\sigma^2_s$ | $\sigma^2_g/\sigma^2_s$ |
| d.f. | 7 | 28 | 70 | | | |
| Vine length (m) | 0.827** | 0.208** | 0.005 | 0.082 | 0.203 | 0.404 |
| Branches/plant | 0.961** | 0.149** | 0.038 | 0.923 | 0.111 | 8.31 |
| Days to 1st female flower | 23.943** | 2.580** | 0.760 | 2.318 | 1.82 | 0.498 |
| Days to 1st fruit harvest | 27.356** | 3.979** | 0.805 | 2.655 | 3.174 | 0.836 |
| Harvest duration (days) | 3.207** | 2.431** | 0.472 | 0.273 | 1.959 | 0.139 |
| Fruit length (cm) | 33.520** | 10.272** | 0.378 | 3.314 | 10.23 | 0.323 |
| Marketable fruits/plant | 1.198** | 0.406** | 0.060 | 0.114 | 0.346 | 0.329 |
| Avg. wt. of 1st three harvested fruits (kg) | 0.018** | 0.013** | 0.001 | 0.0017 | 0.012 | 0.142 |
| Yield/plant (kg) | 1.994** | 0.882** | 0.083 | 0.191 | 0.799 | 0.239 |
| Size of seed cavity (cm) | 0.319** | 0.060* | 0.031 | 0.028 | 0.029 | 0.965 |
| Flesh thickness (cm) | 0.036** | 0.001** | 0.001 | 0.0035 | 1.000 | 0.0035 |
| Severity of powdery mildew (%) | 56.729** | 1.622** | 0.182 | 5.695 | 1.44 | 3.904 |
| Severity of downy mildew (%) | 99.942** | 2.182** | 0.301 | 9.964 | 1.881 | 5.297 |
| Incidence of fruit fly (%) | 93.074** | 2.621** | 0.152 | 9.292 | 2.469 | 3.763 |

* Significant at 5% probability level
** Significant at 1% probability level

Table 2: Estimate of general combining ability (gca) effects of parents in diallel population (pool of two years).

| Parents | Vine length (m) | Branches/ plant | Days to 1st female flower | Days to 1st fruit harvest | Fruit length (cm) | Avg. wt. of 1st three harvested fruits (kg) | Marketable fruits/plant | Yield/ plant (kg) | Harvest duration (days) | Size of seed cavity (cm) | Flesh thickness (cm) | Severity of powdery mildew (%) | Severity of downy mildew (%) | Incidence of fruit fly (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pusa Naveen | -0.04* | 0.41** | -1.94** | -2.85** | -1.70** | -0.02* | 0.36** | 0.28** | 0.33 | -0.28** | 0.06** | -1.63** | -1.19** | -1.39** |
| RS-1 | 0.25** | -0.21** | 1.15** | 0.43 | 1.10** | -0.04** | -0.32** | -0.46** | -0.58** | -0.04 | -0.07** | 2.61** | 3.97** | 3.66** |
| PSPL | -0.20** | -0.15** | -1.52** | -1.27** | 2.83** | 0.01 | -0.11 | -0.09 | -0.20 | 0.01 | -0.00 | -0.67** | -1.03** | 2.84** |
| UL-6 | -0.20** | -0.23** | 1.00** | 1.53** | -1.77** | -0.05** | -0.14 | -0.38** | -0.65** | 0.06 | -0.08** | 4.03** | 5.81** | 2.53** |
| NDBG-104 | -0.15** | 0.00 | -1.68** | -1.13** | -0.73** | 0.06** | 0.10 | 0.43** | 0.98** | 0.01 | 0.08** | 0.60** | -2.00** | -0.26* |
| NDBG-132 | -0.08** | 0.06 | 0.77** | 1.06** | -0.90** | -0.03** | 0.15* | -0.05 | 0.07 | -0.02 | 0.01 | -0.64** | -0.31 | -1.75** |
| NDBG-140 | -0.19** | 0.49** | 0.00 | 0.12 | -1.16** | 0.05** | 0.50** | 0.74** | -0.40 | -0.09 | 0.05** | -0.84** | -2.43** | 0.03 |
| Bharatpur Local | 0.61** | -0.37** | 2.22** | 2.11** | 2.35** | 0.03** | -0.54** | -0.47** | 0.44* | 0.36** | -0.05** | -3.47** | -2.82** | -5.67** |
| S.E. ($g_i$)± | 0.02 | 0.06 | 0.26 | 0.27 | 0.18 | 0.01 | 0.07 | 0.09 | 0.20 | 0.05 | 0.01 | 0.13 | 0.16 | 0.12 |
| S.E. ($g_i - g_j$)± | 0.03 | 0.09 | 0.39 | 0.40 | 0.28 | 0.01 | 0.11 | 0.13 | 0.31 | 0.08 | 0.01 | 0.19 | 0.25 | 0.17 |

* Significant at 5% probability level
** Significant at 1% probability level

Table 3: Estimate of specific combining ability (sca) effects of 28 $F_1$ crosses of bottle gourd (pool of to years).

| Crosses | Vine length (m) | Branches/ plant | Days to 1st female flower | Days to 1st fruit harvest | Fruit length (cm) | Avg. wt. of 1st three harvested fruits (kg) | Marketable fruits/plant | Yield/ plant (kg) | Harvest duration (days) | Size of seed cavity (cm) | Flesh thickness (cm) | Severity of powdery mildew (%) | Severity of downy mildew (%) | Incidence of fruit fly (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pusa Naveen x RS-1 | 0.12 | 0.39* | 1.33 | -5.27** | 2.33** | -0.06* | 0.12 | -0.27 | -1.32* | -0.15 | -0.03 | -0.16 | -1.89** | -1.91** |
| Pusa Naveen x PSPL | 1.00** | -0.01 | 0.47 | 0.10 | 5.30** | -0.07* | -0.55* | -0.85** | -0.10 | -0.06 | -0.03 | -0.08 | 0.19 | 0.38 |
| Pusa Naveen x UL-6 | -0.15* | 0.53** | -1.32 | 0.22 | 2.54** | 0.24** | 0.74** | 1.85** | 1.98** | -0.00 | 0.11** | 0.54 | 1.74** | 3.08** |
| Pusa Naveen x NDBG-104 | 0.29** | 0.23 | 0.96 | 1.16 | 3.50** | 0.18** | 0.97** | 1.90** | -0.62 | 0.03 | 0.00 | -2.36** | -0.78 | -0.71* |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pusa Naveen x NDBG-132 | -0.17** | -0.15 | -3.29** | -2.44** | -2.74** | -0.03 | -0.68** | -0.82** | -1.44* | -0.18 | 0.04 | 0.71 | -0.05 | -0.24 |
| Pusa Naveen x NDBG-140 | -0.41** | 0.08 | 1.14 | 1.37 | -1.08 | -0.03 | 1.63** | 1.29** | -2.44** | 0.15 | 0.03 | -0.22 | 0.91 | -0.35 |
| Pusa Naveen x Bharatpur Local | -0.26** | 0.21 | -0.54 | -0.36 | -0.92 | -0.03 | -0.32 | -0.28 | 2.18** | 0.19 | -0.02 | -1.08** | -0.22 | 1.97** |
| RS-1 x PSPL | -0.59** | -0.05 | -0.09 | 0.96 | 1.20* | 0.00 | 0.05 | 0.02 | 0.01 | -0.10 | 0.01 | 0.11 | -0.24 | 1.20** |
| RS-1 x UL-6 | 0.11 | -0.17 | -1.74* | -3.12** | -1.27* | 0.08** | 0.41 | 0.61* | 0.13 | 0.01 | -0.01 | -0.31 | -0.07 | 0.72* |
| RS-1 x NDBG-104 | 0.38** | 0.26 | -0.94 | -0.52 | 2.56** | 0.04 | -0.02 | 0.02 | -0.77 | 0.01 | -0.00 | -0.55 | 4.51** | 1.52** |
| RS-1 x NDBG-132 | 0.06 | 0.07 | 0.62 | 1.42 | 1.86** | -0.01 | 0.13 | 0.03 | 1.27* | 0.74** | -0.01 | 0.08 | -0.91 | 1.06** |
| RS-1 x NDBG-140 | 0.01 | 0.24 | 0.05 | 0.83 | 3.79** | 0.17** | 0.11 | 0.82** | 0.74 | -0.19 | 0.01 | 1.89** | -2.10** | -1.16** |
| RS-1 x Bharatpur Local | 0.35** | -0.10 | -0.64 | 0.37 | 2.75** | 0.05 | 0.95** | 1.16** | 1.97** | -0.04 | 0.02 | 1.48** | 0.81 | -3.39** |
| PSPL x UL-6 | -0.74** | 0.03 | -0.94 | -0.42 | 6.27** | -0.04 | 0.14 | -0.06 | -0.98 | -0.15 | 0.03 | 0.08 | 2.06** | -0.14 |
| PSPL x NDBG-104 | -0.60** | -0.00 | -0.93 | -1.75* | -1.04 | 0.07** | 0.31 | 0.57* | -0.35 | -0.12 | 0.04 | 0.58 | -1.02* | -0.05 |
| PSPL x NDBG-132 | 0.21** | 0.01 | 1.29 | 1.26 | 1.13* | -0.08** | 0.45* | 0.03 | 0.29 | 0.73** | -0.01 | -0.25 | -0.70 | -0.40 |
| PSPL x NDBG-140 | -0.40** | 0.18 | 0.39 | 0.13 | -3.08** | 0.14** | -0.03 | 0.63* | -0.64 | -0.14 | -0.02 | 0.20 | -0.09 | -0.94* |
| PSPL x Bharatpur Local | 0.60** | 0.17 | -2.30** | -2.93** | -1.92** | -0.10** | 0.48* | 0.10 | 0.52 | -0.00 | -0.00 | 1.21** | 0.00 | -3.05** |

* Significant at 5% probability level
** Significant at 1% probability level

## References


Dubey, S. K. and Maurya, I. B. 2006. Combining ability studies in bottle gourd [*Lagenaria siceraria* (L.) (Molina) Standl.]. *Indian J. Hort.*, 63 (2):178-181.

Griffing, J.B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.*, 9 : 463-493.

Janakiram, T and Sirohi, P. S. 1987. Gene action in round fruited bottle gourd. *Veg. Sci.*, 14 : 26-32.

Janakiram, T and Sirohi, P.S. 1988. Combining ability of quantitative characters in 10 x 10 diallel cross of round fruited bottle gourd. *Ann. Agric. Res.*, 9 (2) : 207-214.

Kumar, S., Singh, S. P. and Singh, S. K. 1998. Line x Tester analysis for combining ability and heterosis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Veg. Sci.*, 25 : 78-90.

Kushwaha, M. L. and Ram, H. 1996. A note on components of genetic variation in bottle gourd for fruit diameter and length. *Veg. Sci.*, 23 : 108-110.

Maurya, I.B., Singh, S.P. and Singh, N.K. 1993. Heterosis and combining ability in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Veg. Sci.*, 20 (11) : 77-81.

Maurya, I.B. and Singh, S.P. 1994. Studies on gene action in long fruited bottle gourd [*Lageraria siceraria* (Mol.) Standl.]. *Crop Res.*, 8 (1) : 100-104.

Maurya, I.B. and Singh, S.P, 1998. Combining ability analysis in relation to different season in bottle gourd. *PKV Res. J.*, 22 (2) : 181-191.

Singh, K.P., Choudhary, D.N., Singh, V.K. and Mandal, G. 1996. Combining ability analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *J. Res. Birsa Agril. Univ.*, 8 (1) : 39-43.

Sirohi, P.S., Sivakami, N. and Chowdhary, B. 1988. Genetic studies in bottle gourd. *Ann. Agric. Res.*, 9 :1-5.

Sit, A.K. and Sirohi, P.S. 2008. Genetic architecture of yield and yield attributing characters of bottle gourd. *Indian J. Hort.*, 65 (2):243-244.

Sivakami, N., Sirohi, P.S. and Chowdhary, B. 1987. Combining ability analysis in long fruited bottle gourd. *Indian J. Hort.*, 44 (3-4) : 213-219.

Sreevani, P.G. 2005. Combining ability analysis for yield and its components in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Veg. Sci.*, 32 (2): 140-142.