

Combining ability analysis for fruit yield in bottle gourd [*Lagenariasiceraria* (Mol.) Standl.]

ABSTRACT: Present investigation was carried out during *Zaid* season 2019-2020 in (Y₁) and *Zaid* 2020-2021 in (Y₂) at the Main Experimental Station (MES), Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P) with 21 genotypes with six parental line and their fifteen F₁ hybrids of bottle gourd by using diallel (excluding reciprocal) mating fashion. Experiment was laid out in RBD (signification) include 3 replication having all experimental unit with rows space at 3 (m) apart with a plant to plant space of 0.50 (m). Significant variances over seasons were found for general as well as sca for all the 17 traits studied during over season pooled which suggested that both additive and non-additive gene action were most important in the expression of all the characters. Pooled combining ability analysis revealed that parents viz., P₄, P₆ and P₂ were good general combiner for fruit yield/plant. An attempt to identify desirable parents based on gca effect as well per se performance of the most of the character studied. Among the 15 F₁ crosses P₃ x P₄, P₂ x P₆ and P₂ x P₅ have found good specific combiners for total fruit yield per plant along with most of the other yield contributing characters follow days to 1st staminate and pistillate flower anthesis, fruit length and average fruit weight.

Key words: Bottle gourd, combining ability, GCA, SCA.

INTRODUCTION

Bottle gourd (*Lagenariasiceraria* (Mol.) Standl.), is an important bottle-like crop grown annually all over the word-country. As a vegetable crops for the warm season, it grows well in hot and humid climates. But now, off-season cultivation is gradually expanding year-round in the plains of northern India. Bottle is found in the wilds of South Africa and India as a vegetable in the rainy and summer months. It grows widely in warm regions of Africa, Ethiopia, Central America and other parts of the world. The total area of amber in India is 0.189 million hectares with a yield of 31.06 mt and a yield of 16434 tons/ha- (Anon., 2019-20).

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Bottle was found in uncultivated form in ~~South-~~ Africa and India. However, according to Cutler & Whitaker (1961) ~~of the view that most likely~~, it is original to tropical Africa on the base of variability in seed and fruit of bottle gourd. The wild species are originate to the northern part of Africa. The *L. breviflora* (Benth.) Naud. and *L. Siceraria* (Sond.) G. Roberty are observed in South Africa and Zimbabwe, respectively, (Jeffrey, 1967).

The analysis of combining ability aids in the evaluation of inbreds' genetic worth and the choice of the best parent for hybridization. This method also helps to identify the best scacombinations.

Put here, the interest of the study on the general and specific suitability for the species *Lagenariasiceraria*. What is its interest in the genetic improvement of the species? With references

You should put here the problematic, the general objective of this study as well as the specific objectives.

~~The crop bottle gourd is cross pollinated. It is popular with many people. It is easily absorbed is widely used as a vegetable. Due to their delicate and nutty aroma, bBottle gourd are widely used in many delicious recipes. The fruit is mainly used in desserts, pickles, petha, halva, eapokand, paratha, koftah and rayat. Bottle are a rich source of minerals and vitamins. Vitamins A, C, E, K, and B₆ are all present, along with dietary fibre folic acid, manganese, potassium, protein, thiamine, ribobblavin, pantothenic acid, magnesium, phosphorus, calcium, iron, and selenium. It also contains many nutrients, such as calories 22 Keal, carbohydrates 5.4 g, protein 0.9 g and sodium 347 mg (Anon, 2018). The fruit was rich in pectin, which provided a great opportunity to make jelly. A decoction of leaves is an excellent remedy for jaundice. The fruit has a cooling effect and has heart-strengthening and diuretic properties, so it is good for biliary diseases and for recovery to restore health after illness. Cellulose is excellent for overcoming constipation, coughing, blindness and an antidote to some toxins. The bottle gourd was one of the 1st-domesticated plants for human use, providing food, medicine and various tools and musical instruments from large, hard,~~

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peeled and ripe fruits. Dried fruit peels have been used to create a variety of universal products, including bowls, mesh bottle gourd and musical instruments.

~~The analysis of combining ability aids in the evaluation of inbreds' genetic worth and the choice of the best parent for hybridization. This method also helps to identify the best sea combinations.~~

MATERIAL AND METHODS

This chapter must be redone with a detailed description of the methodology used to obtain the results.

Present investigation was carried out during *Zaid* season 2019-2020 in (Y₁) and *Zaid* 2020-2021 in (Y₂) at the Main Experimental Station, Department of Vegetable Science, A.N.D.U.A.T. Kumarganj, Ayodhya (U.P.).

Plant material is constituted by twenty one diverse genotypes of bottle gourd include six parents and fifteen F₁ hybrids. ~~created parents served as the study's source of plant material.~~ The selected parental lines *i.e.* Narendra Pooja (P₁), Narendra Rashmi (P₂), Pusa Naveen (P₃), Narendra Prabha (P₄), NDBG-28 (P₅) and Narendra Jyoti (P₆), were crosses in all the possible combinations, excluding reciprocals.

The F₁ hybrids and parents were evaluated in RCBD with 3 replications for seventeen total fruit yield and yield component traits ~~viz.~~ days to 1st staminate and pistillate flower anthesis, node number to 1st staminate and pistillate flower appearance, days to 1st fruit harvest, vine length (meter), number of primary branches/plant, fruit length (cm), fruit circumference (cm), average fruit weight (kg), number of fruit/plant (kg), fruit yield/plant (kg), TSS, dry matter (g), reducing sugars (%), non-reducing sugar (%) and total sugars (%).

The seeds of the above said parents (6 parental lines) were sown in field separately in crossing blocks. Healthy and normal flower buds in a raceme preferably of the first flush, which were expected to open a day in afternoon (1.30pm–3pm). Pollination was done in just afternoon. After pollination, crossed flower buds were covered with an appropriated cotton bag and the fruits set was tagged. ~~After pollination crossed flower buds were covered with cotton the fruits set tagged.~~ Simultaneously, flower buds of parents were also selfed and it was ensured by covering flower buds with cotton bag just after pollination. Seeds were extracted from red hard shelled fruits by hand dried packed with appropriate label.

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Rows were set 3.0 inches apart. ~~P~~plant to plant ~~was~~ space ~~at~~ of 0.5 meter. Sowing was done on 20 March, 2019-20 and 22 April 2020-2021 for *Zaid* crops ~~respectively~~ for Year 1 (Y1) and Year 2 (Y2). To develop excellent crops, the entire suggested agronomic package of procedures and protection measures were implemented. ~~It was done to analyse each traits for~~ CA analysis different character was carried out by following the method 2 model 1 of Griffing (1956b), when the reciprocals were excluded but parents and F₁s were included. ~~At maturity, the red hard shelled fruits were harvested and the seeds were extracted by hand, dried and stored in appropriate label.~~

Comment [C6]: You should describe as clearly as possible the protocol implemented.

Comment [C7]: You should cite and show how the different parameters were measured.

RESULT AND DISCUSSION

~~Perusal of~~ Table-1 revealed that mean square ~~of the different parameters ant the interaction between them. The results of Analysis of variance (mean squares) for combining ability in 6 x 6 diallel cross of bottle gourd over seasons (pooled) showed ansignificant difference for every characteristic, excepted fruit length, fruit circumference and total soluble solids.nment,~~

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due to evidence that the mean square ~~due to environment~~ was observed ~~significant for every characteristic but except fruit length, fruit circumference and total soluble solids.~~ The mean square due to interaction effects of GCA vs. environments and SCA vs. environment was observed significant ~~(p-value?)~~ for the trait except days to first male and female flower anthesis and days to first fruit harvest, fruit circumference, fruit length and non-reducing sugar. Similar finding had also been reported by Singh *et al.* (2005), Gayakawad *et al.* (2016) and Adarsh *et al.* (2017) in bottle gourd ~~how???~~ What did they found?? Be explicite. ~~Variations in the gca and sca variations,~~ magnitudes were also noted which may have been influenced by the environment. ~~not clear~~

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GCA EFFECTS

GCA studies helps in the making selection of the parents and also helps in the isolation of appropriate germplasm for additional improvement. GCA is mostly a function of additive and additive × additive gene action. |

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~~Perusal of Table-2 showed that for each traits, gca impacts changed over the line of the season. The same variation in gca effects had been noted by Singh et al. (1999) and Yadav and Kumar (2012). according to (Auteur?) the variation of GCA over line is due to.....??. These results suggested that.....??.~~ ~~Perusal of Table 2 showed that each traits gea impacts changed over the line of the season. Additionally, variation in gea effects had been noted by Singh et al. (1999) and Yadav and Kumar (2012).~~ Parent, P₁ could be considered desirable for days to first pistillate flower anthesis and days to first fruit harvest. The earlier is

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desirable traits therefore, negative gca effects is desirable to days to 50% flowering. Parents, P₂, P₆ and P₅ exhibited best gca for number of fruit per plant while, the parents, P₄, P₆ and P₂ exhibited good general combiner for total fruit yield/plant. In attempt to identify most desirable parents based on the gca effects as well as *per se* performance the three superior parents were considered for the characters Table- 2. This indicated positive involvement between the two parameter (gca effects and *per se* performance). Thus, in parents P₁ was identified the good general combiner for earlier, node number to first staminate and pistillate flower appearance and days to first fruit harvest, P₆ exhibited superior general combiner for average fruit weight, no. of fruit/plant and total fruit yield/plant. Similar results have been observed by also Sreevani (2005), Yadav and Kumar (2012), Shinde *et al.* (2016), Mishra *et al.* (2019) on (species????). The gca includes both additive, additive × additive type of gene action (Sprague and Tatum, 1986) which is fixable in character. Practical important is given to additive parental effects as measured by the genotypes for the different traits were depicted in table.

SPECIFIC COMBINING ABILITY EFFECTS

The sca effect of the crosses showing significant sca effects for total fruit yield and their association with additional yield components elements. Specific combining ability effect for all the 15 traits were shown in Table-3. F₁ hybrids with various features are shown the predominance of unfixable, non-additive gene activity, which is a key element that may be used in heterosis breeding. The sca effects is a dominance variance and additive, additive and dominant types of epistasis.

The three superior hybrids F₁ shown the maximum and significant desirable sca effects for total fruit yield/plant in order of merit were P₃ × P₄, P₂ × P₅ and P₂ × P₆ in over the season pooled. The top 3 crosses observed for highest sca effects for total fruit yield/plant also showed significant sca effects for some other component traits as well. The hybrids were and P₁ × P₂, P₃ × P₆ and P₁ × P₅ in pooled overcome highest negative sca effects for fruit yield/plant. The crosses with superior *per se* performance and sca effects involved in general low × low, low × high and high × high combiners. Similar results reported have also been reported by Singh *et al.* (2006a), Jayanthe *et al.* (2019).

The second most crucial factor in the evaluation of hybrids is the presence of linkage in the repulsion phase, which has been linked to the sca of hybrids and the combination of

favourable genes from several parents (Sarsaret *al.* 1986). The three promising hybrids are P₃ x P₄, P₂ x P₅ and P₂ x P₆ could be including for development of hybrid vigor in bottle gourd. However, before suggesting that these combination be used on a large, more testing is required.

In the discussion test, you should first present the results with figures. Then, you should explain these results based on your scientific knowledge and also on previous works.

The magnitude and direction of the significant effects for the SCA and SGA of perent could be used for results interpretation

The discussion needs to be taken up in full,

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CONCLUSION

Considering the findings ~~above it may be safely done that the~~ parents P₁ followed by P₂, P₆ and P₅ were found superior general combiner among six parental lines for fruit yield?? (indicate traits??). Theywere the best general combiners in crosses for the improvement of this traitas it show desirable effects of gea for mainly the fruit yield and ~~The~~crosses P₃ x P₄, P₂ x P₅ and P₂ x P₆show significant sca effect for total fruit yield per plant of bottle gourd.These genotypes ~~can be~~are used broadlyin a breeding programme for hybrids with analysis to increase the yield ~~inof~~ bottle gourd.These crosses could be used to take advantage of potential recombinant after multiple position testing for varietal development.

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UNDER PEER REVIEW

Table-1: Analysis of variance (mean squares) for combining ability in 6 x 6 diallel cross of bottle gourd over seasons (pooled)

| Source of Variation | d.f. | Days to first staminate flower anthesis | Days to first pistillate flower anthesis | Node number to first staminate flower appearance | Node number to first pistillate flower appearance | Days to first fruit harvest | Vine length | Number of primary branches per plant | Fruit length | Fruit circumference |
|---------------------|------|---|--|--|---|-----------------------------|-------------|--------------------------------------|--------------|---------------------|
| GCA | 5 | 15.10** | 19.07** | 1.20* | 0.98* | 16.56** | 0.83** | 0.94* | 24.28** | 6.22** |
| SCA | 15 | 3.23* | 2.86* | 0.97** | 0.79** | 3.14* | 0.53** | 2.62** | 21.94** | 3.38** |
| Environmets | 1 | 13.81** | 20.57** | 4.91** | 31.92** | 44.58** | 1.56** | 76.45** | 0.39 | 0.39 |
| GCA×Environments | 5 | 0.69 | 1.58 | 1.35* | 1.20** | 1.04 | 0.72** | 3.10** | 1.01 | 0.17 |
| SCA×Environments | 15 | 0.53 | 1.07 | 0.65* | 0.72** | 1.10 | 0.54** | 1.90** | 0.85 | 0.50 |
| Error | 80 | 1.12 | 1.38 | 0.29 | 0.22 | 1.36 | 0.04 | 0.26 | 0.62 | 0.49 |

| Source of Variation | d.f. | Average fruit weight | Number of fruits per plant | Fruit yield per plant | Total soluble solid (T.S.S.) | Dry matter content | Sugars | | |
|---------------------|------|----------------------|----------------------------|-----------------------|------------------------------|--------------------|-----------------|--------------------|--------------|
| | | | | | | | Reducing sugars | Non-reducing sugar | Total sugars |
| GCA | 5 | 0.03** | 0.97** | 0.79** | 0.04** | 0.07** | 0.16** | 0.02** | 0.08** |
| SCA | 15 | 0.02** | 0.84** | 0.89** | 0.05** | 0.28** | 0.16** | 0.01** | 0.12** |
| Environmets | 1 | 0.02** | 4.01** | 0.93** | 0.006 | 1.29** | 0.08** | 0.002** | 0.15** |
| GCA×Environments | 5 | 0.009** | 0.03 | 0.06* | 0.03* | 0.05* | 0.004* | 0.0003 | 0.002* |
| SCA×Environments | 15 | 0.004** | 0.22** | 0.08** | 0.02** | 0.10** | 0.01** | 0.0002 | 0.01** |
| Error | 80 | 0.001 | 0.03 | 0.02 | 0.006 | 0.01 | 0.001 | 0.0001 | 0.0008 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table-2. Estimates of G.C.A. effects of parents in 6 x 6diallel cross of bottle gourd during two seasons (Y₁, Y₂) and over seasons (pooled)

| Traits | Days to first staminate flower anthesis | | | Days to first pistillate flower anthesis | | | Node number to first staminate flower appearance | | | Node number to first pistillate flower appearance | | | Days to first fruit harvest | | |
|---|---|----------------|---------|--|----------------|---------|--|----------------|--------|---|----------------|--------|-----------------------------|----------------|---------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P₁ | -1.97** | -1.61** | -1.79** | -2.13** | -1.43** | -1.78** | -0.55* | -0.26 | -0.40* | -0.27 | -0.25 | -0.26* | -1.88** | -1.54** | -1.71** |
| P₂ | -0.097 | -0.27 | -0.18 | -0.51 | -0.68 | -0.59* | 0.40* | -0.32 | 0.04 | 0.08 | -0.39* | -0.15 | -0.38 | -0.58 | -0.48 |
| P₃ | 0.52 | 0.68 | 0.60* | 0.73 | 0.86* | 0.79* | 0.03 | 0.82** | 0.43** | 0.07 | 0.65** | 0.36* | 0.61 | 0.75* | 0.68* |
| P₄ | 0.44 | 0.43 | 0.43 | 0.31 | 0.73 | 0.52 | -0.09 | 0.21 | 0.061 | 0.019 | 0.16 | 0.09 | 0.15 | 0.70 | 0.43 |
| P₅ | -0.22 | 0.18 | -0.02 | -0.18 | -0.13 | -0.16 | -0.11 | -0.15 | -0.13 | 0.19 | -0.60** | -0.20 | -0.09 | -0.04 | -0.06 |
| P₆ | 1.31** | 0.59 | 0.95** | 1.77** | 0.65 | 1.21** | 0.31 | -0.29 | 0.00 | -0.09 | 0.43* | 0.16 | 1.61** | 0.70 | 1.16** |
| SE (g_i) | 0.33 | 0.35 | 0.24 | 0.38 | 0.37 | 0.26 | 0.16 | 0.18 | 0.12 | 0.13 | 0.16 | 0.10 | 0.39 | 0.36 | 0.26 |
| SE (g_r-g_j) | 0.51 | 0.54 | 0.37 | 0.59 | 0.58 | 0.41 | 0.25 | 0.28 | 0.19 | 0.21 | 0.25 | 0.16 | 0.60 | 0.56 | 0.41 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table-2. Contd...

| Traits | Vine length | | | Number of primary branches per plant | | | Fruit length | | | Fruit circumference | | | Average fruit weight | | |
|--------------------------------------|----------------|----------------|---------|--------------------------------------|----------------|--------|----------------|----------------|---------|---------------------|----------------|---------|----------------------|----------------|---------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P ₁ | 0.26** | -0.05 | 0.10* | 0.80** | -0.24 | 0.28* | -1.52** | -2.26** | -1.89** | -1.01** | -0.66* | -0.84** | -0.01 | -0.03** | -0.02** |
| P ₂ | -0.44** | -0.20* | -0.32** | 0.09 | -0.05 | 0.02 | -0.65* | -0.80* | -0.72** | -0.59* | -0.54* | -0.56** | -0.07** | -0.04** | -0.05** |
| P ₃ | 0.62** | -0.02 | 0.30** | -0.31 | -0.05 | -0.18 | -0.27 | -0.47* | -0.37* | 0.44* | 0.45 | 0.45* | 0.01 | 0.01 | 0.01 |
| P ₄ | -0.18* | -0.25** | -0.22** | 0.74** | -0.18 | 0.28* | 0.34 | 0.94** | 0.64** | 0.73** | 0.75* | 0.74** | 0.09** | 0.007 | 0.05** |
| P ₅ | -0.17* | 0.31** | 0.06 | -0.67** | 0.48* | -0.09 | 0.63* | 1.19** | 0.91** | -0.05 | -0.25 | -0.15 | -0.04* | -0.009 | -0.02* |
| P ₆ | -0.08 | 0.21* | 0.06 | -0.65** | 0.04 | -0.30* | 1.47** | 1.40** | 1.43** | 0.48* | 0.25 | 0.36* | 0.02* | 0.06** | 0.04** |
| SE (g _i) | 0.06 | 0.06 | 0.04 | 0.16 | 0.16 | 0.11 | 0.27 | 0.23 | 0.18 | 0.20 | 0.24 | 0.16 | 0.01 | 0.009 | 0.001 |
| SE (g _r -g _j) | 0.10 | 0.10 | 0.07 | 0.26 | 0.25 | 0.18 | 0.42 | 0.36 | 0.28 | 0.31 | 0.38 | 0.24 | 0.01 | 0.01 | 0.01 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table 2.Contd..

| Traits | Number of fruits per plant | | | Fruit yield per plant | | | Total soluble solid (T.S.S.) | | | Dry matter content | | |
|------------------------|----------------------------|----------------|---------|-----------------------|----------------|---------|------------------------------|----------------|--------|--------------------|----------------|--------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P ₁ | -0.31** | -0.41** | -0.36** | -0.28** | -0.48** | -0.38** | 0.03 | -0.02 | 0.01 | -0.16** | -0.01 | -0.09* |
| P ₂ | 0.26** | 0.16* | 0.21** | 0.11* | 0.04 | 0.08* | -0.03 | -0.05* | -0.04* | 0.09* | -0.06 | 0.01 |
| P ₃ | -0.21* | -0.21** | -0.21** | -0.17* | -0.11* | -0.14** | -0.03 | -0.05* | -0.04* | -0.01 | -0.01 | -0.01 |
| P ₄ | -0.11 | 0.04 | -0.03 | 0.17* | 0.14* | 0.16** | -0.06* | 0.01 | -0.03 | 0.10* | -0.00 | 0.04 |
| P ₅ | 0.17* | 0.16* | 0.17** | 0.02 | 0.16** | 0.09* | -0.04 | 0.08** | 0.02 | 0.08* | 0.10* | 0.09** |
| P ₆ | 0.19* | 0.26** | 0.22** | 0.14* | 0.24** | 0.19** | 0.14** | 0.02 | 0.08** | -0.10* | 0.01 | -0.05 |
| SE (g _i) | 0.06 | 0.04 | 0.04 | 0.05 | 0.04 | 0.03 | 0.03 | 0.02 | 0.01 | 0.03 | 0.04 | 0.02 |
| SE (g-g _j) | 0.09 | 0.07 | 0.06 | 0.07 | 0.07 | 0.05 | 0.04 | 0.03 | 0.02 | 0.04 | 0.06 | 0.04 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

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| Parents \ Traits | Reducing sugars | | | Non-reducing sugar | | | Total Sugars | | |
|--------------------------------------|-----------------|----------------|---------|--------------------|----------------|---------|----------------|----------------|---------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P ₁ | 0.008 | -0.005 | 0.002 | -0.02 | -0.008 | -0.006* | -0.01* | -0.01 | -0.01* |
| P ₂ | -0.11** | -0.09** | -0.10** | 0.01** | 0.02** | 0.02** | -0.08** | -0.07** | -0.08** |
| P ₃ | -0.05* | -0.05** | -0.05** | 0.02** | 0.003 | 0.01** | -0.02* | -0.03* | -0.02** |
| P ₄ | 0.09** | 0.14** | 0.12** | 0.03 | 0.003 | 0.01 | 0.10** | 0.14** | 0.12** |
| P ₅ | -0.07** | -0.09** | -0.08** | 0.03** | 0.04** | 0.03** | -0.03** | -0.04** | -0.04** |
| P ₆ | 0.13** | 0.10** | 0.12** | -0.06** | -0.07** | -0.07** | 0.05** | 0.02* | 0.04** |
| SE (g _i) | 0.01 | 0.006 | 0.008 | 0.003 | 0.004 | 0.003 | 0.007 | 0.01 | 0.006 |
| SE (g _r -g _i) | 0.02 | 0.01 | 0.01 | 0.005 | 0.007 | 0.004 | 0.01 | 0.01 | 0.01 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table-3. Estimates of SCA effects of F₁ hybrids in 6 x 6diallelcross of bottle gourd over two seasons (Y₁, Y₂) and pooled

| Traits Crosses | Days to first staminate flower anthesis | | | Days to first pistillate flower anthesis | | | Node number to first staminate flower appearance | | | Node number to first pistillate flower appearance | | | Days to first fruit harvest | | |
|--|---|----------------|--------|--|----------------|--------|--|----------------|--------|---|----------------|--------|-----------------------------|----------------|--------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P ₁ × P ₂ | -0.75 | -1.33 | -1.04 | 1.16 | -0.57 | 0.29 | -0.04 | -0.30 | -0.17 | 0.47 | 0.51 | 0.49 | 1.54 | 0.07 | 0.81 |
| P ₁ × P ₃ | -0.04 | -0.62 | -0.33 | -1.42 | -0.78 | -1.10 | -0.48 | -1.04 | -0.76* | 0.92* | -1.37* | -0.22 | -2.11 | -0.92 | -1.52* |
| P ₁ × P ₄ | 1.03 | 0.95 | 0.99 | -0.67 | 0.67 | 0.003 | -0.21 | -0.96 | -0.59 | 0.34 | -0.28 | 0.03 | -1.66 | 0.45 | -0.60 |
| P ₁ × P ₅ | 1.03 | -0.12 | 0.45 | 0.49 | -0.44 | 0.02 | 0.20 | 0.90 | 0.55 | 1.64** | 0.62 | 1.13** | -0.07 | -0.46 | -0.27 |
| P ₁ × P ₆ | 1.16 | 1.79 | 1.47* | 0.86 | 2.09 | 1.48* | 0.37 | 0.53 | 0.45 | -0.94* | 0.02 | -0.46 | 1.54 | 2.11 | 1.83* |
| P ₂ × P ₃ | 2.74* | 1.37 | 2.06* | 0.95 | 2.80* | 1.87* | -0.70 | 0.57 | -0.06 | -1.33* | 0.20 | -0.56 | 0.04 | 2.45* | 1.25 |
| P ₂ × P ₄ | -0.17 | 1.29 | 0.56 | 0.03 | 0.59 | 0.31 | -0.30 | -1.34* | -0.82* | -0.25 | 1.12* | 0.43 | 0.83 | 0.49 | 0.66 |
| P ₂ × P ₅ | -0.83 | -0.45 | -0.64 | -1.46 | 0.13 | -0.66 | 0.71 | 0.96 | 0.83* | 0.67 | -0.26 | 0.20 | -0.91 | 0.24 | -0.33 |
| P ₂ × P ₆ | 0.28 | -0.87 | -0.29 | -0.42 | 0.34 | -0.03 | 0.28 | -0.66 | -0.19 | 0.12 | -0.43 | -0.15 | -0.95 | 0.49 | -0.22 |
| P ₃ × P ₄ | 0.86 | 0.00 | 0.43 | 1.11 | 0.72 | 0.92 | 0.32 | 0.21 | 0.26 | -1.00* | 0.70 | -0.14 | 1.50 | 0.82 | 1.16 |
| P ₃ × P ₅ | -0.79 | -0.41 | -0.60 | 1.28 | -0.73 | 0.27 | 1.14* | 0.54 | 0.84* | 0.65 | 1.08* | 0.86* | 1.75 | -0.75 | 0.50 |
| P ₃ × P ₆ | -0.33 | 0.83 | 0.24 | -1.33 | 0.13 | -0.60 | 0.45 | -1.41* | -0.48 | 0.00 | -0.05 | -0.02 | -1.28 | -0.50 | -0.89 |
| P ₄ × P ₅ | 2.28* | 2.16* | 2.22* | 2.03 | 2.72* | 2.37* | 1.04* | 0.42 | 0.73* | 0.17 | 0.20 | 0.19 | 1.88 | 2.28* | 2.08* |
| P ₄ × P ₆ | 0.74 | -0.25 | 0.24 | 1.07 | -1.07 | 0.003 | 0.51 | -0.63 | -0.06 | 0.56 | 0.13 | 0.34 | 0.83 | -0.46 | 0.18 |
| P ₅ × P ₆ | -0.25 | 1.33 | 0.53 | -0.08 | 1.13 | 0.52 | -1.99** | -0.29 | -1.14* | -0.04 | 0.87 | 0.41 | 0.42 | 1.28 | 0.85 |
| SE (s _{ij}) | 0.91 | 0.96 | 0.54 | 1.05 | 1.03 | 0.60 | 0.46 | 0.50 | 0.28 | 0.37 | 0.45 | 0.24 | 1.07 | 0.99 | 0.60 |
| SE (s _{ij} -s _{ik}) | 1.35 | 1.44 | 0.99 | 1.57 | 1.54 | 1.10 | 0.68 | 0.75 | 0.50 | 0.56 | 0.68 | 0.44 | 1.59 | 1.48 | 1.09 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table-3. Cont....

| Traits | Vine length | | | Number of primary branches per plant | | | Fruit length | | | Fruit circumference | | | Average fruit weight | | |
|--|----------------|----------------|---------|--------------------------------------|----------------|---------|----------------|----------------|---------|---------------------|----------------|---------|----------------------|----------------|---------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P ₁ × P ₂ | -0.19 | -0.43* | -0.31* | -0.80 | -0.98* | -0.89* | -1.61 | -3.23** | -2.42** | 0.69 | -0.55 | 0.06 | -0.10* | -0.08* | -0.09** |
| P ₁ × P ₃ | -0.61* | 0.03 | -0.29* | 1.03* | -0.25 | 0.39 | -1.65* | -2.23* | -1.94** | 0.64 | 0.44 | 0.54 | -0.08* | -0.04 | -0.06* |
| P ₁ × P ₄ | -0.22 | -0.15 | -0.19 | -1.12* | -1.05* | -1.08* | -1.28 | -0.98 | -1.13* | -0.64 | -0.17 | -0.41 | -0.15** | -0.02 | -0.09** |
| P ₁ × P ₅ | 0.15 | 2.00** | 1.07** | 1.13* | 2.87** | 2.00** | -2.23* | -2.56* | -2.40** | -0.18 | -0.51 | -0.34 | -0.11* | -0.05* | -0.08** |
| P ₁ × P ₆ | -0.17 | -0.47* | -0.32* | -1.22* | -1.01* | -1.11** | 1.59 | 1.89* | 1.74** | -0.72 | -0.34 | -0.53 | -0.03 | 0.01 | -0.007 |
| P ₂ × P ₃ | -0.87** | 0.88** | 0.005 | 0.41 | 2.96** | 1.68** | 3.47** | 4.31** | 3.89** | 0.56 | 1.32 | 0.94* | 0.00 | 0.02 | 0.01 |
| P ₂ × P ₄ | -0.52* | -1.01** | -0.76** | 0.08 | -0.23 | -0.07 | 2.84* | 2.89** | 2.86** | -2.06* | -1.30 | -1.68** | -0.07* | 0.01 | -0.02 |
| P ₂ × P ₅ | 0.50* | -0.53* | -0.01 | -0.42 | -1.27* | -0.85* | 1.88* | 2.64** | 2.26** | -1.93* | -0.97 | -1.45* | 0.03 | 0.02 | 0.02 |
| P ₂ × P ₆ | -0.02 | -0.55* | -0.29* | -2.07** | 1.20* | -0.43 | -4.94** | -5.89** | -5.42** | 1.52* | -1.13 | 0.19 | -0.007 | -0.05* | -0.03 |
| P ₃ × P ₄ | -0.77** | -0.04 | -0.41* | -0.70 | 0.42 | -0.14 | 4.13** | 2.89** | 3.51** | -1.76* | -2.30* | -2.03** | 0.12* | 0.20** | 0.16** |
| P ₃ × P ₅ | -0.29 | -0.45* | -0.37* | 0.14 | -2.11** | -0.98* | 1.51 | 1.31 | 1.41* | -1.31* | -0.97 | -1.14* | 0.005 | 0.01 | 0.008 |
| P ₃ × P ₆ | 0.001 | 0.22 | 0.11 | -1.67* | 1.59* | -0.03 | -3.65** | -4.89** | -4.27** | -0.51 | -0.47 | -0.49 | -0.16** | -0.16** | -0.16** |
| P ₄ × P ₅ | -0.02 | -0.56* | -0.29* | -1.31* | -1.48* | -1.39** | 1.22 | 4.22** | 2.72** | -0.93 | -0.92 | -0.93* | -0.11* | -0.003 | -0.05* |
| P ₄ × P ₆ | 0.64* | -0.34 | 0.14 | 0.63 | -0.56 | 0.03 | 0.05 | 0.68 | 0.36 | 0.85 | 1.23 | 1.04* | -0.15** | -0.10* | -0.12** |
| P ₅ × P ₆ | 0.16 | -0.47* | -0.15 | -0.67 | -1.10* | -0.89* | 1.09 | 0.43 | 0.76 | 1.98* | 1.23 | 1.61** | -0.04 | -0.09* | -0.07* |
| SE (s _{ij}) | 0.18 | 0.18 | 0.10 | 0.46 | 0.45 | 0.26 | 0.76 | 0.63 | 0.41 | 0.55 | 0.68 | 0.36 | 0.03 | 0.02 | 0.01 |
| SE (s _{ij} -s _{ik}) | 0.27 | 0.27 | 0.19 | 0.69 | 0.68 | 0.48 | 1.13 | 0.95 | 0.74 | 0.82 | 1.01 | 0.65 | 0.05 | 0.03 | 0.03 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table -3: Cont....

| Traits | Number of fruits per plant | | | Fruit yield per plant | | | Total soluble solid (T.S.S.) | | | Dry matter content | | |
|--|----------------------------|----------------|--------|-----------------------|----------------|---------|------------------------------|----------------|---------|--------------------|----------------|---------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| P ₁ × P ₂ | -0.02 | -0.13 | -0.08 | -0.64** | -0.52** | -0.58** | 0.14 | 0.03 | 0.09 | -0.51** | -0.42* | -0.46** |
| P ₁ × P ₃ | 0.38* | -0.18 | 0.09 | -0.10 | -0.35* | -0.23* | 0.06 | 0.04 | 0.05 | -0.41** | -0.39* | -0.40** |
| P ₁ × P ₄ | 0.11 | 0.15 | 0.13 | -0.48* | -0.04 | -0.26* | 0.11 | -0.02 | 0.04 | -0.46** | -0.25* | -0.36** |
| P ₁ × P ₅ | 0.39* | -0.13 | 0.12 | -0.24 | -0.38* | -0.31* | 0.07 | -0.09 | -0.007 | 0.49** | -0.10 | 0.19* |
| P ₁ × P ₆ | 0.95** | 0.03 | 0.49** | 0.76** | 0.34* | 0.55** | 0.04 | -0.09 | -0.02 | 0.64** | 0.56** | 0.60** |
| P ₂ × P ₃ | 0.42* | 0.27 | 0.35* | 0.25 | 0.27* | 0.26* | -0.08 | -0.12 | -0.10* | -0.48** | 0.25* | -0.11 |
| P ₂ × P ₄ | 0.42* | 0.61** | 0.52** | 0.02 | 0.48* | 0.25* | -0.27* | 0.02 | -0.12* | -0.43** | -0.11 | -0.27** |
| P ₂ × P ₅ | 0.54* | 0.75** | 0.65** | 0.65** | 0.65** | 0.65** | -0.001 | 0.25* | 0.12* | -0.52** | 0.07 | -0.22* |
| P ₂ × P ₆ | 0.52* | 0.62** | 0.57** | 0.72** | 0.58** | 0.65** | 0.37** | -0.04 | 0.16* | 0.65** | -0.10 | 0.27** |
| P ₃ × P ₄ | 1.00** | 0.69** | 0.85** | 1.63** | 1.59** | 1.61** | 0.13 | 0.14* | 0.14* | 0.54** | 0.42* | 0.48** |
| P ₃ × P ₅ | 0.12 | -0.16 | -0.02 | 0.34* | -0.15 | 0.09 | -0.15 | -0.22* | -0.19** | -0.47** | -0.07 | -0.27** |
| P ₃ × P ₆ | 0.30 | -0.19 | 0.05 | -0.25 | -0.56** | -0.41** | 0.01 | 0.09 | 0.05 | -0.27* | -0.11 | -0.19* |
| P ₄ × P ₅ | -0.01 | -0.12 | -0.06 | -0.43* | -0.20 | -0.31* | 0.45** | 0.28** | 0.37** | -0.12 | -0.10 | -0.11 |
| P ₄ × P ₆ | 0.90** | -0.08 | 0.41** | 0.43* | -0.25 | 0.09 | -0.36** | -0.20* | -0.28** | -0.36** | -0.33* | -0.34** |
| P ₅ × P ₆ | 0.48* | 0.42* | 0.45** | 0.32* | 0.26 | 0.29* | -0.14 | 0.17* | 0.01 | -0.29* | -0.22 | -0.25** |
| SE (s _{ij}) | 0.17 | 0.13 | 0.09 | 0.13 | 0.12 | 0.07 | 0.08 | 0.06 | 0.04 | 0.08 | 0.11 | 0.06 |
| SE (s _{ij} -s _{ik}) | 0.26 | 0.20 | 0.16 | 0.20 | 0.18 | 0.13 | 0.12 | 0.09 | 0.07 | 0.12 | 0.17 | 0.10 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively

Table -3: Cont....

| Traits | Reducing sugars | | | Non-reducing sugar | | | Total Sugars | | |
|--|-----------------|----------------|---------|--------------------|----------------|---------|----------------|----------------|---------|
| | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled | Y ₁ | Y ₂ | Pooled |
| Crosses | | | | | | | | | |
| P ₁ × P ₂ | -0.31** | -0.19** | -0.25** | 0.002 | 0.004 | 0.003 | -0.29** | -0.19** | -0.24** |
| P ₁ × P ₃ | 0.34** | 0.43** | 0.39** | -0.14** | -0.12** | -0.13** | 0.21** | 0.28** | 0.25** |
| P ₁ × P ₄ | -0.20** | -0.22** | -0.21** | 0.06** | 0.06** | 0.06** | -0.11** | -0.13** | -0.12** |
| P ₁ × P ₅ | -0.11* | 0.05* | -0.02 | 0.002 | 0.03* | 0.01* | -0.09** | 0.07* | -0.01 |
| P ₁ × P ₆ | 0.39** | 0.17** | 0.28** | -0.05** | -0.07** | -0.06** | 0.17** | 0.09* | 0.13** |
| P ₂ × P ₃ | -0.15* | -0.16** | -0.15** | -0.05** | -0.04* | -0.04** | -0.21** | -0.21** | -0.21** |
| P ₂ × P ₄ | 0.31** | 0.28** | 0.30** | -0.02* | -0.04* | -0.03** | 0.29** | 0.23** | 0.26** |
| P ₂ × P ₅ | 0.01 | 0.21** | 0.11** | 0.04* | 0.01 | 0.03** | 0.05* | 0.19** | 0.12** |
| P ₂ × P ₆ | 0.30** | 0.36** | 0.33** | 0.05** | 0.05* | 0.05** | 0.37** | 0.45** | 0.41** |
| P ₃ × P ₄ | 0.29** | 0.26** | 0.27** | -0.004 | 0.01 | 0.007 | 0.28** | 0.26** | 0.27** |
| P ₃ × P ₅ | -0.21** | -0.16** | -0.19** | -0.05** | -0.05** | -0.05** | -0.28** | -0.15** | -0.21** |
| P ₃ × P ₆ | -0.45** | -0.45** | -0.45** | 0.07** | 0.10** | 0.09** | -0.35** | -0.35** | -0.35** |
| P ₄ × P ₅ | 0.27** | 0.16** | 0.22** | 0.04* | 0.03* | 0.03** | 0.31** | 0.20** | 0.25** |
| P ₄ × P ₆ | -0.13* | 0.32** | 0.09** | -0.10** | -0.08** | -0.09** | -0.22** | 0.21** | -0.003 |
| P ₅ × P ₆ | 0.34** | 0.02 | 0.18** | -0.12** | -0.12** | -0.12** | 0.24** | -0.10* | 0.07** |
| SE (s _{ij}) | 0.04 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 |
| SE (s _{ij} -s _{ik}) | 0.06 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.02 |

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.