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RESEARCH ARTICLE

COMBINING ABILITY STUDIES IN BOTTLE GOURD (*LAGENARARIA SICERARIA* MOL. STANDL.) IN SUMMER SEASON

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ABSTRACT

Combining ability analysis was under taken in ten parental lines and their 45 F1 hybrids of bottle gourd obtained from half diallel for fruit yield and its contributing characters during summer season.. Data was recorded for nine quantitative characters. The mean squares due to GCA were significant for all the nine characters. The ratio of σ^2gca/ σ^2sca suggested that non additive gene action had greater role with inheritance of characters. Out of ten parents Bhagirathi was the best general combiner as it showed high gca effect in desirable direction for most of the traits. the best promising hybrids regarding SCA effects for yield and majority of yield traits were Samrat x Bhagirathi, PSPL X Pusa Naveen, Pusa Samrudhi x DBG-5, Pusa Samrudhi x Bhagirathi and PSPL X Bhagirathi Hence, these crosses can be utilized in further heterosis breeding for improvement in bottle gourd

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* Mol. Standl.) is one of the most important cucurbit grown throughout the country for its tender fruits. It is known for its rich genetic diversity is cultivated widely through out the warmer regions of the world. In recent, bottle gourd improvement programmes is focused on heterosis breeding. Indentification of suitable parents with good combining ability and derivation of best F_1 hybrids having better specific combining abiliy are prerequisite for exploitation of heterosis in desirable direction. Diallel mating design is most frequently used to determine nature and magnitude of gene action by estimating genetic components, GCA and SCA variances and their effects inself and cross pollinated crops. As similar reporded by Ray *et al.* (2015). Parvathi and Reddy (2015) reported that the ratio of GCA and SCA variance indicated non- additive genetic variances for days to first male flowering, node number of first female flowering, node number of first male flowering, fruits per vine, sex ratio and fruit weight. The selection of best parent for the production of F_1 hybrids has to be based on genetic information and knowledge of their combining ability. Keeping this view, the present study was undertaken to study combining ability and gene action through diallel mating design for earliness and yield components.

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MATERIALS AND METHODS

The experimental material comprised of 45 F_1s and 10 parents viz., Samrat, Pusa Summer Prolific Long (PSPL), Pusa Samrudhi, Pusa Naveen, NDBG-5006, NDBG-619, NDBG-129, PBOG-89, DBG-5and Bhagirathi. The complete set of 55 genotypes were evaluated in a randomized block design with three replications during summer season, 2013 at the AICVIP, Rahuri. The F_1s and parents comprised of five plants spaced at 5m apart in rows with plant to plant spacing of 1m were planted in each experimental plot. All the recommended cultural practices and plant protection measures were followed to grow a healthy crop.

Observations were recorded on 5 randomly selected plants for nine characters viz., days required for appearance of first female flower, node at which first female flower appeared, days to first harvest of fruit, length of vine (m), number of primary branches per vine, average weight of fruit (kg), length of fruit (cm), number of fruits per vine and fruit yield per plant (kg). The ANOVA for the experiment (RCBD) was estimated accordingly to Panse and Sukhatme (1967). The combining analysis was performed as per the Method II Model I of Griffing (1956), where parents and F_1's were included under the experiment excluding reciprocals

Table 1. Analysis of variance for combining ability in 10 x 10 diallel of bottle gourd

Source	Days to first female flower	Node to first female flower	Days to first harvest	Length of vine (m)	Number of primary branches/vine	Length of fruit (cm)	Average weight of fruit (kg)	Number of fruits/ plant	Fruit yield/plant (kg)
gca	46.63**	6.67**	40.00**	5.19**	43.52**	49.66**	0.01**	50.82**	48.84**
sca	26.18**	6.41**	21.02**	1.87**	22.63**	27.41**	0.02**	30.73**	27.87**
Error	0.91	0.51	0.98	0.34	0.97	2.03	0.003	0.20	0.23
σ^2gca	3.81	0.51	3.25	0.40	3.55	3.97	0.001	4.21	4.05
σ^2sca	25.26	5.89	20.04	1.52	21.66	25.38	0.02	30.53	27.64
σ^2gca/ σ^2sca	0.15	0.08	0.16	0.27	0.16	0.16	0.07	0.21	0.17

*, ** Significant at 5 % and 1 % level, respectively

Table 2. Estimates of general combining ability effects for different characters in 10x10 half diallel of bottle gourd

Source	Days to first female flower	Node to first female flower	Days to first harvest	Length of vine (m)	Number of primary branches/vine	Sex ratio	Length of fruit (cm)	Average weight of fruit (kg)	Number of fruits/ plant	Fruit yield/ plant (kg)
Samrat	-0.29	-0.24	0.82**	-0.36*	-0.008	-0.65**	1.44**	0.024**	1.61**	1.70**
Pusa Summer Prolific Long	0.69**	0.48*	0.96**	-0.19	0.02	-1.16**	-1.57**	-0.023*	1.70**	1.05**
Pusa Samrudhi	-0.423	0.53**	-0.74**	0.72**	0.96**	-0.72**	0.72	0.019**	0.35**	0.44**
Pusa Naveen	0.03	-0.71**	-0.40	-0.10**	-1.95**	0.72**	-3.98**	-0.026**	-1.247**	-1.40**
NDBG 5006	-0.09	-0.17	-0.61*	-0.20	-0.56*	0.02	1.49**	0.005	-1.75**	-1.32**
NDBG 619	-1.64**	-0.36	-1.46**	0.45**	-0.15	0.42*	-0.40	-0.047**	-2.21**	-2.42**
NDBG 129	-0.68*	0.95**	-0.25	-0.11	1.20**	0.29	2.66**	-0.030**	-0.20	-0.76**
PBOG 89	5.18**	1.20**	4.53**	-0.62**	-4.00**	2.46**	-1.53**	0.014**	-3.10**	-2.38**
DBG 5	-0.91**	-0.89**	-0.88**	0.05	1.97**	0.31	-0.81*	-0.001	1.47**	1.19
Bhagirathi	-1.85**	-0.80**	-1.98**	1.26**	2.51**	-1.69**	1.99**	0.066**	3.28**	3.91**
S.E. (gi) ±	0.26	0.19	0.27	0.16	0.27	0.17	0.39	0.005	0.12	0.13
C.D.at 5%	0.51	0.38	0.53	0.31	0.53	0.34	0.77	0.01	0.24	0.26
C.D.at 1%	0.68	0.51	0.70	0.42	0.71	0.46	1.02	0.013	0.31	0.34

*, ** Significant at 5 % and 1 % level, respectively

RESULTS AND DISCUSSION

The analysis of varience showed significant differences due to treatments for all the characters. This indicates presence of sufficient amount of variation for all the traits and selection will be effective to improve them. The analysis of variance for combining ability (Table 1) indicated that mean square due to GCA and SCA were highly significant for all the traits. This indicated variation in parents and crosses and significant combination of additive and non additive effects in the expression of the characters. Sit and Sirohi (2008), Dubey and Maurya (2007) and Pandey (2004)*et al.* had also observed similar findings. The SCA variances were higher than GCA variances and ratio of σ^2gca/ σ^2sca was lesser than one for all for all characters, thereby indicating predominance of non-additive gene action for all these fruits. These results were confirming with the result of Sit and Sirohi (2008), Dubey and Maurya (2007) and Pandey (2004)*et al.* ,Wani *et al*. (2008), Ray *et al*. (2015) also reported significant gca and sca variances for yield and its components in bottle gourd.Information regarding gca effect of the parent is of prime importance as it helps in successful prediction of genetic potentionality of crosses. Estimates of general combining ability (GCA) effects of parents (Table 2) showed that the parent Bhagirathi was good general combiner for all the characters followed by DBG 5 and Pusa Samrudhi which were good general combiner for varying set of 5 characters each. The parents NDBG 619, NDBG 129, DBG 5 and Bhagirathi showed negative GCA effects for days required for appearance of first female flower. The parental lines Pusa Naveen, DBG-5 and Bhagirathi showed negative GCA effect for node to first female flower.

The parents Pusa Samrudhi, NDBG 619, DBG 5 and Bhagirathi found to be with highly significant negative GCA effect for days to first harvest. The parent Pusa Samrudhi, NDBG 619 and Bhagirathi showed positive GCA effect for vine length while for number of primary branches per vine the parents Pusa Samrudhi, NDBG129, DBG5 and Bhagirathi showed significant positive GCA effects. For length of fruit and parents Samrat, Pusa Summer Prolific long, DBG 5 and Bhagirathi for number of fruits per vine and fruit yield per vine showed significant positive GCA effect. In general the parent DBG 5 and Bhagirathi were found good general combiner for yield and yield contributing characters which are worth considering in future breeding programme. These parents with good gca effect for a character also exhibits good per se performance. Similar findings for some characters were also reported by Islam *et al*. (2012) in Sponge gourd and Tewari *et al.* (2001) and singh *et al.* (2013) in bitter gourd.

The estimates of Specific combining ability (SCA) effects are givenin Table 3. The sixteen crosses exhibited desirable significant negative SCA for days required for appearance of first female flower and the crosses Samrat X Pusa Summer Prolific long, Pusa Summer Prolific long X Pusa Naveen, Samrat X NDBG129, Pusa Samrudhi X DBG 5 and Pusa Samrudhi X Bhagirathi showed highest negative SCA effect, for the node to first female flower. Out of 13 crosses, the crosses (NDBG129X PBOG 89), (Pusa Summer Prolific long X Pusa Samrudhi), (Pusa Summer Prolific long X Pusa Naveen) and (Samrat X NDBG 619) showed highest desirable significant SCA effects, for days to first harvest. Fifteen crosses showed significant negative SCA effects out of which (Samrat X Pusa Summer Prolific long), (Samrat X Bhagirathi),

Table 3 . Estimates of specific combining ability effects for various characters in 10 x 10 half diallel of bottle gourd

SN	Crosses	Days to first female flower	Node to first female flower	Days to first harvest	Length of vine (m)	Number of primary branches /vine	Length of fruit (cm)	Average weight of fruit (kg)	Number of fruits /plant	Fruit yield/ plant (kg)
	1	2	3	4	5	6	7	8	9	10
1.	1 x 2	-9.26**	-1.05	-6.41**	0.35	3.31**	-4.49**	-0.012	5.75**	3.52**
2.	1 x 3	7.86**	2.34**	5.37**	-2.02**	-7.43**	1.67	-0.13**	-7.88**	-7.81**
3.	1 x 4	-1.47	3.53**	-2.42**	-0.61	-4.03**	-1.82	-0.09**	-3.11**	-3.93**
4.	1 x 5	7.70**	2.23**	6.64**	-0.39	-2.98**	10.43**	-0.003	-4.92**	-4.14**
5.	1 x 6	-3.13**	-3.43**	1.03	1.04	7.10**	7.42**	0.22**	6.53**	9.44**
6.	1 x 7	-6.73**	-3.06**	-4.09**	1.13*	3.43**	-4.52**	-0.08**	10.28**	5.15**
7.	1 x 8	-7.36**	0.96	-9.46**	-0.86	0.12	0.14	0.06**	-4.03**	-2.58**
8.	1 x 9	8.75**	-0.02	7.03**	0.46	-2.44**	-7.63**	-0.22**	-7.81**	-9.15**
9.	1 x 10	3.52**	-1.70*	1.53	1.41**	7.68**	5.07**	0.17**	2.74**	6.26**
10.	2 x 3	-4.92**	-3.90**	-5.63**	1.58**	-0.27	-5.85**	-0.09**	-7.15**	-6.69**
11.	2 x 4	-9.43**	-3.63**	-9.34**	1.04	6.39**	3.35*	0.04*	9.35**	7.26**
12.	2 x 5	7.08**	1.73**	5.48**	-1.30*	-3.79**	0.09	0.10**	-5.37**	-3.05**
13.	2 x 6	3.96**	5.20**	1.80	-1.66**	-4.28**	-3.31*	-0.03*	-3.82**	-3.45**
14.	2 x 7	0.15	2.05**	1.27	-1.89**	-3.90**	-8.61**	-0.12**	-6.08**	-6.10**
15.	2 x 8	2.59**	2.71**	1.73	-0.40	0.43	2.82*	-0.01	-2.89*	-2.36**
16.	2 x 9	-2.54**	2.00**	1.99*	0.30	-1.56	-7.46**	-0.21**	-8.95**	-9.48**
17.	2 x 10	-2.10	-2.45**	-0.94	1.75**	7.48**	14.10**	0.28**	3.09**	8.95**
18.	3 x 4	6.07**	0.27	5.73**	0.48	4.60**	5.40**	0.16**	-2.94**	-0.18**
19.	3 x 5	3.45**	-1.78**	5.60**	-0.52	0.08	-1.69	-0.04*	-2.92**	-2.80**
20.	3 x 6	-4.50**	-1.53*	-5.19**	-0.24	-6.66**	6.94**	0.12**	-1.91**	0.14
21.	3 x 7	-0.71	3.91**	-1.65	2.20**	6.67**	3.34*	0.18**	-1.06	2.17
22.	3 x 8	8.29**	-0.37	8.45**	-0.12	-1.661	-1.14	-0.14**	-0.86	-2.52
23.	3 x 9	-5.10**	1.34*	-5.45**	1.34*	5.40**	1.42	0.07**	6.36**	6.33**
24.	3 x 10	-6.98**	-2.70**	-5.28**	0.87	2.291*	-5.09**	-0.09**	6.97**	3.28**
25.	4 x 5	-0.35	0.58	-0.42	-1.43**	-4.59**	-5.84**	-0.15**	-1.93**	-3.33**
26.	4 x 6	-3.14**	-2.02**	-1.65	1.11*	3.84**	-2.35	0.06**	-0.39	0.48
27.	4 x 7	-2.58**	3.50**	-1.74	-0.44	-6.78**	-0.36	-0.02	-3.91**	-2.97**
28.	4 x 8	3.14**	1.83**	3.69**	-0.39	-3.16*	1.34	-0.03	0.55	0.18
29.	4 x 9	-1.17	-0.51	-1.64	-2.54**	-5.40**	-1.77	-0.17**	-5.27**	-6.26**
30	4 x 10	2.78**	-1.61*	2.90**	0.83	5.72**	0.27	-0.07**	-5.92**	-6.04**
	1	2	3	4	5	6	7	8	9	10
31.	5 x 6	-1.81	0.97	-2.82**	0.82	-2.39**	-0.26	0.08**	-1.23**	0.10
32.	5 x 7	-3.04**	1.37*	-2.72**	1.29*	6.45**	2.85*	0.12**	6.21**	7.03**
33.	5 x 8	-10.42**	0.70	-9.52**	1.98**	2.88*	-5.51**	0.06**	-0.74	0.16
34.	5 x 9	-4.55**	-1.96**	-4.11**	2.51**	3.14*	1.99	0.01	7.87**	5.96**
35.	5 x 10	-1.25	-2.37**	-1.64	0.17	1.24	2.07	0.03	5.70**	4.96**
36.	6 x 7	0.33	0.70	1.64	-0.33	5.66**	-2.14	-0.004	-1.57**	-1.16
37.	6 x 8	1.78*	1.86**	1.11	2.456**	-1.77	6.07**	-0.04*	3.74**	2.22
38.	6 x 9	2.20	2.79**	2.75**	-0.96	5.01**	4.42**	0.06**	-0.33	0.27
39.	6 x 10	-0.07	-1.41*	0.44	0.76	-7.65**	-3.43*	-0.22**	-3.29**	-6.33**
40.	7 x 8	1.92*	-4.05**	0.68	0.91	3.45*	2.52	-0.01	8.92**	6.56**
41.	7 x 9	-3.03**	-1.10	-4.04**	0.93	-0.38	8.16**	0.04*	4.93**	4.09**
42.	7 x 10	2.70**	3.84**	3.08**	-1.41**	-4.92**	2.44	0.02	-7.22**	-5.72**
43.	8 x 9	0.43	0.59	1.12	0.13	3.25*	5.30**	0.27**	-1.10	2.90**
44.	8 x 10	5.20**	1.23	4.93**	-1.60**	-6.29**	-1.95	0.03	-3.30**	-2.55**
45.	9 x 10	-2.09*	-1.01	-2.51**	-0.14	2.10*	-3.05*	-0.05	1.49**	-0.33
S.E. ±		0.87	0.66	0.91	0.54	0.91	1.32	0.02	0.41	0.44
C.D. 5 %		1.72	1.29	1.78	1.06	1.78	2.57	0.03	0.80	0.86
C.D. 1 %		2.27	1.70	2.35	1.39	2.35	3.38	0.05	1.06	1.14

*, ** Significant at 5 % and 1 % level, respectively

(Pusa Summer Prolific long X Pusa Naveen), (Pusa Samrudhi X DBG 5),(Pusa Samrudhi X Bhagirathi) and (NDBG 5006 X PBOG 89) showed highest values. For the length of vine 11 crosses showed positive significant SCA effects and the crosses (Pusa Samrudhi X NDBG129), (NDBG 5006 X DBG 5) and (NDBG 619X NDBG129) showed highest significant sca effects. The 20 crosses showed significant positive effect for number of primary branches per vine and the crosses (Samrat X NDBG 619), (Samrat X Bhagirathi), (Pusa Summer Prolific long X Pusa Naveen), (Pusa Summer Prolific long X Bhagirathi), (Pusa Samrudhi X NDBG129) and (NDBG 5006 X NDBG 129) showed highest effects. For the length of fruit, 14 crosses recorded significant positive SCA effects and the crosses (Samrat X NDBG 5006), (Pusa Summer Prolific long X Bhagirathi) and (NDBG129 X DBG 5) showed highest significant effects. The 14 crosses showed positive significant SCA effects for average weight of fruit and the crosses (Samrat X NDBG 619), (Samrat X Bhagirathi), (Pusa Summer Prolific long X Bhagirathi), (Pusa Samrudhi X Pusa Naveen) and (PBOG 89X DBG 5) showed highest significant effects. The 15 crosses recorded significant positive effects for number of fruits per vine, out of which the crosses (Samrat x NDBG 619), (Samrat X NDBG129), (Pusa Summer Prolific long X Pusa Naveen), (Pusa Samrudhi X DBG 5), (Pusa Samrudhi X Bhagirathi) and (DBG 5 X NDBG129) showed highest significant effect. However, for fruit yield per plant, 14 crosses showed positive significant SCA effects among which the crosses (Samrat X NDBG 619), (Samrat X NDBG129), (Pusa

Summer Prolific long X Pusa Naveen), (Pusa Summer Prolific long X Bhagirathi), (Pusa Samrudhi X DBG 5) and (NDBG 5006 X NDBG129) showed highest positive significant effect. These croses involved parents wih high x low, high x high and lowx low general combining ability effects indicating presence of dominance, additive and epiststis gene action controlling these characters. Similar results were reported by Sharma etal (2002)in bottle gourd ; Laxuman et al (2012) and singh etal (2013) in bitter gourd. High x low general combiningability combinations can be considered for developing superior variants through pedigree method. the present study indicated that cross combinations (Pusa Summer Prolific long X Pusa Naveen), (Pusa Samrudhi X DBG 5), (Pusa Samrudhi X Bhagirathi), (Samrat X Bhagirathi) and (Pusa Summer Prolific long X Bhagirathi) having high SCA effects for yield and majority traits and hence are useful to derive high performing hybrids. The results need to be futher strengthened for GXE interaction of these best cross combinations over different season and or location.

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