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RESEARCH ARTICLE

COMBINING ABILITY STUDIES FOR EARLINESS AND YIELD IN BOTTLE GOURD (*LAGENARARIA SICERARIA* MOL. STANDL.) IN *KHARIF* SEASON

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ABSTRACT

Gene action, Combining ability varience derived by crossing ten diverse bottle gourd parents were studied through half diallel analysis including 45 F_1 hybrids for earliness and yield components. 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 Pusa Summer Prolific Long X Pusa Naveen, Samrat X NDBG 619, Samrat X Bhagirathi , Pusa Summer Prolific Long X Bhagirathi, NDBG 5006X NDBG 129, and NDBG 129 X PBOG-89 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 cucurbits grown throughout the country for its tender fruits. Due to it's delicate and nutty flavor, bottle gourds are widely used for preparing many detectable recipes. It is known for its rich genetic diversity is cultivated widely throughout the warmer regions of the world. In recent, bottle gourd improvement programme is focused on heterosis breeding. Indentification of suitable parents with good combining ability and derivation of best F_1 hybrids having better specific combining ability 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. At present main emphasis is being given to develop F_1 hybrids in bottle gourd. The identification and selection of potential parents based on their combining ability is very essential for hybrid development. Keeping this view, the present studies were undertaken to identify the genetic architecture of characters related to 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-5 and Bhagirathi. The complete set of 55 genotypes were evaluated in a randomized block design with three replications during *kharif* 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, 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 Griffing (1956), Method II Model I.), where parents and F_1's were included under the experiment excluding reciprocals

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.

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	64.21**	9.48**	72.35**	4.65**	65.71**	61.20**	0.01**	46.98**	46.20**
sca	25.78**	5.87**	27.71**	1.61**	55.11**	44.69**	0.02**	26.31**	25.28**
Error	0.92	0.49	0.88	0.45	2.15	1.58	0.005	0.13	0.19
σ^2gca	5.27	0.75	5.96	0.35	5.30	4.97	0.001	3.90	3.83
σ^2sca	24.87	5.38	26.83	1.16	52.96	43.11	0.02	26.18	25.08
σ^2gca/ ^{2}sca	0.21	0.14	0.22	0.30	0.10	0.12	0.02	0.09	0.06

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

Table 2. Estimates of general combining ability effects for different characters in 10x10 diallel without reciprocals 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)
Samrat	0.10	0.09	0.13	-0.27	1.61**	0.52	0.020*	1.65**	1.72**
Pusa Summer Prolific Long	0.64*	1.10**	0.49	0.30	-1.11**	-1.12**	0.027**	0.72**	0.99**
Pusa Samrudhi	1.47**	0.68**	1.37**	1.03**	4.12**	0.11	0.002	0.32**	0.24*
Pusa Naveen	-0.47	0.75**	-0.48	-0.74**	0.33	-4.16**	-0.057**	-0.87**	-1.58**
NDBG 5006	0.99**	0.04	0.89**	0.13	-1.38**	1.90**	0.005	-0.35**	-0.35**
NDBG 619	-1.41**	-0.62**	-1.65**	-0.70**	-0.30	0.03	-0.013*	-2.29**	-2.01**
NDBG 129	-1.14**	0.22	-1.14**	-0.14	0.18	3.00**	-0.023*	-0.19	-0.52**
PBOG 89	5.16**	1.39**	5.71**	-0.58**	-3.97**	-2.05**	-0.004	-3.78**	-3.29**
DBG 5	-2.26**	-1.40**	-2.24**	0.05	-1.64**	-1.12**	-0.017*	2.34**	1.57**
Bhagirathi	-3.07**	-0.75**	-3.08**	0.93**	2.82**	2.96**	0.062*	2.45**	3.23**
S.E. (gi) ±	0.26	0.19	0.26	0.18	0.40	0.34	0.006	0.10	0.11
C.D.at 5%	0.52	0.38	0.51	0.36	0.79	0.68	0.01	0.19	0.23
C.D.at 1%	0.69	0.50	0.67	0.48	1.05	0.90	0.02	0.25	0.31

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

Table 3. Estimates of specific combining ability effects for various characters in 10 x 10 diallel without reciprocals 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	-8.73**	-2.14**	-9.09**	-0.95	-4.29**	-1.35	-0.11**	6.93**	3.01**
2	1 x 3	1.74	1.11	2.27**	0.27	-5.14**	-3.69**	-0.19**	-5.52**	-7.06**
3	1 x 4	-0.52	3.13**	-0.71	-0.81	-6.93**	-1.08	-0.11**	-3.98**	-4.78**
4	1 x 5	5.25**	1.14	5.00**	-1.29*	-10.28**	5.49**	0.17**	-6.28**	-3.42**
5	1 x 6	-6.74**	-3.09**	-6.68**	1.06	2.16	16.87**	0.18**	6.84**	9.16**
6	1 x 7	-7.34**	-3.20**	-6.96**	0.57	14.62**	-9.20**	-0.05**	7.71**	4.75**
7	1 x 8	0.10	-0.44	-0.001	-0.38	0.28	-5.50**	0.10**	-3.60**	-2.06
8	1 x 9	9.14**	-1.44*	8.28**	-1.27*	-2.10	-4.10**	-0.26**	-8.13**	-9.85**
9	1 x 10	1.59	5.85**	1.75	0.73	7.99**	11.74**	0.22**	0.96	5.39**
10	2 x 3	-7.73**	-1.68*	-7.71**	0.93	-7.24**	-6.61**	-0.09**	-5.85**	-5.91**
11	2 x 4	-4.15**	-3.62**	-4.50**	2.76**	14.83**	1.98	-0.01	9.85**	7.38**
12	2 x 5	6.38**	0.17	6.42**	-1.18	-7.20**	0.83	0.01	-4.84**	-3.96**

…… *Continued*

13	2 x 6	1.59	2.80**	2.53**	-0.96	-5.76**	-8.60**	-0.11**	-2.92**	-3.94**
14	2 x 7	7.43**	0.18	6.78**	-1.37*	-9.21**	-7.86**	-0.24**	-5.71**	-7.40**
15	2 x 8	1.94*	2.53**	1.46	-0.18	1.07	5.15**	0.22**	-0.28	2.47
16	2 x 9	0.09	1.76**	0.001	-0.84	-5.23**	-7.81**	0.10**	-6.70**	-4.43**
17	2 x 10	-3.39**	-2.32**	-3.75**	-1.07	4.74**	15.49**	0.26**	1.79	6.92**
18	3 x 4	2.03*	-0.06	2.01*	0.04	-2.91	0.93	0.18**	-2.41	0.36
19	3 x 5	3.46**	-1.76*	4.69**	0.15	15.22**	7.56**	0.08**	-5.19**	-3.36
20	3 x 6	-5.45**	-1.77**	-5.39**	-1.47*	-3.73**	-0.76	0.01	-1.66	-1.38
21	3 x 7	-0.37	4.13**	0.64	2.33**	13.48**	12.06**	0.11**	1.77	3.21**
22	3 x 8	6.23**	-1.37*	5.11**	-0.75	-7.21**	1.72	-0.14**	-1.73	-2.92**
23	3 x 9	-4.25**	-0.01	-4.65**	-0.06	10.72**	-2.87*	0.02	5.27**	4.63**
24	3 x 10	-7.34**	-3.20**	-7.72**	0.48	1.81	-4.06**	-0.06**	7.41**	4.73**
25	4 x 5	-1.98*	0.19	-1.86	-0.66	-1.96	-5.96**	-0.11**	-0.15	-1.68
26	4 x 6	-6.11**	-1.56*	-6.50**	-0.02	0.96	7.76**	0.17**	0.05	2.10
27	4 x 7	4.39**	2.45**	4.70**	-1.09	-10.66**	-0.86	-0.07**	-3.94**	-3.82**
28	4 x 8	-0.43	1.61*	-0.48	-0.13	1.28	-2.31*	-0.11**	-0.29	-1.22
29	4 x 9	0.06	0.89	-0.60	-1.48*	-1.53	-3.61**	-0.10**	-6.79**	-6.42**
30	4 x 10	3.95**	-0.27	4.88**	-0.19	-2.28	-7.37**	-0.17**	-1.80	-4.55**
31	5 x 6	0.60	0.58	0.45	1.68**	11.92**	-1.72	0.02	0.37	0.46
32	5 x 7	-9.40**	2.25**	-9.21**	-0.09	-8.45**	4.50**	0.12**	5.32**	6.60**
33	5 x 8	-1.88*	2.63**	-2.88**	0.71	-3.91**	-6.00**	-0.18**	0.04	-1.94**
34	5 x 9	-7.85**	-2.23**	-8.80**	3.37**	3.53**	1.53	0.03*	6.51**	5.85**
35	5 x 10	-4.66**	-3.47**	-5.16**	0.06	-5.63**	2.31*	-0.03	5.59**	4.15**
36	6 x 7	5.50**	1.62*	5.44**	1.72**	5.31**	-2.33*	-0.05**	0.36	-0.60
37	6 x 8	1.04	2.72**	1.42	1.06	5.42**	5.15**	0.13**	2.04**	3.23**
38	6 x 9	2.96**	2.04**	2.46**	-0.84	-3.52**	0.21	-0.01	1.01	0.46
39	6 x 10	-2.52**	-2.23**	-2.90**	-1.41*	-2.72*	-3.97**	-0.22**	-5.33**	-7.45**
40	7 x 8	-4.87**	-4.68**	-5.63**	0.04	2.34	0.08	-0.02	7.64**	5.71**
41	7 x 9	-2.66**	-0.40	-3.21**	0.53	0.02	9.45**	0.08**	4.66**	5.23**
42	7 x 10	3.15**	1.72**	4.67**	-1.92**	-8.77**	3.17**	0.08**	-7.62**	-6.04**
43	8 x 9	-2.05*	1.85**	3.46**	-0.07	3.70**	8.30**	0.11**	-3.40**	-1.39
44	8 x 10	5.87**	0.14	6.82**	-0.82	-1.82	-1.93	-0.05	-5.84**	-5.86**
45	9 x 10	-2.62**	-1.38*	-3.22**	1.95**	8.25**	-0.55	-0.10**	3.76**	0.68
S.E. ±		0.88	0.65	0.86	0.61	1.35	1.16	0.02	0.33	0.40
C.D. 5 %		1.74	1.27	1.69	1.20	2.65	2.27	0.04	0.64	0.79
C.D. 1 %		2.27	1.68	2.23	1.57	3.48	2.99	0.05	0.85	1.03

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

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, which 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) 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 characters the followed by DBG 5 and NDBG 129 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 NDBG 619, DBG 5, Bhagirathi showed negative GCA effect for node to first female flower. The parents NDBG 129, NDBG 619, DBG 5, Bhagirathi found to be with highly significant negative GCA effect for days to first harvest. The parent Pusa Samrudhi, Bhagirathi showed positive GCA effect for vine length while for number of primary branches per vine the parents Pusa Samrudhi, Samrat, Bhagirathi showed significant positive GCA effects. For length of fruit, the parents NDBG 5006, NDBG 129, Bhagirathi showed significant positive GCA effect. For number of fruits per vine and fruit yield per vine the parent Samrat, Pusa Summer Prolific Long, Pusa Samrudhi, DBG 5 and Bhagirathi showed significant positive GCA effect.

In general the parent DBG 5, Bhagirathi and NDBG 129 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 Tiwari *et al*. (2001) in bitter gourd. The estimates of Specific combining ability (SCA) effects are given in Table 3. The twenty crosses exhibited desirable significant negative SCA for days required for appearance of first female flower and the crosses Samrat X Pusa Summer Prolific Long, Samrat X NDBG 619, Samrat X NDBG 129), Pusa Summer Prolific Long X Pusa Samrudhi, Pusa Samrudhi X DBG 5 and Pusa Samrudhi X Bhagirathi showed highest negative SCA effect, for the node to first female flower out of 17 crosses the crosses NDBG 129X 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 19 crosses showed significant negative SCA effects out of which Samrat X Pusa Summer Prolific Long, Samrat X NDBG 619, Samrat X NDBG 129, Pusa Summer Prolific Long X Pusa Samrudhi, Pusa Samrudhi X Bhagirathi, NDBG 5006 X NDBG 129 and NDBG 5006X DBG 5 showed highest values. For the length of vine 6 crosses showed positive significant SCA effects and the crosses Pusa Summer Prolific Long X Pusa Naveen, and Pusa Samrudhi X NDBG 129 showed highest significant sca effects. The 13 crosses showed significant positive effect for number of primary branches per vine and the crosses (Samrat X NDBG 129), (Pusa Summer Prolific Long X Pusa Naveen, Pusa Samrudhi X NDBG 5006 and Pusa Samrudhi X NDBG 129 showed highest effects. For the length of fruit 14 crosses recorded significant positive SCA effects and the crosses Samrat X NDBG 619, Samrat X Bhagirathi, Pusa Summer Prolific Long X Bhagirathi and Pusa Samrudhi X NDBG 129 showed highest significant effects.

The 16 crosses showed positive significant SCA effects for average weight of fruit and the crosses Samrat X Bhagirathi, Pusa Summer Prolific Long X Bhagirathi and Pusa Summer Prolific Long X PBOG-89) showed highest significant effects. The 13 crosses recorded significant positive effects for number of fruits per vine out of which the crosses Samrat x Pusa Summer Prolific Long, Samrat X NDBG 129, Samrat X NDBG 129, Pusa Summer Prolific Long X Pusa Naveen, Pusa Samrudhi X DBG 5, Pusa Samrudhi X Bhagirathi, NDBG 5006X NDBG 129), NDBG 5006X DBG 5, NDBG 5006X Bhagirathi and NDBG 129X PBOG-89 showed highest highest significant effect while for fruit yield per plant the 15crosses showed positive significant SCA effects and the crosses Samrat X NDBG 619, Pusa Summer Prolific Long X Pusa Naveen, Samrat X Bhagirathi, Pusa Summer Prolific Long X Bhagirathi, NDBG 5006X NDBG 129, and NDBG 5006X DBG 5 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 epistatis gene action controlling these characters. Similar results were reported by Sharma *et al* (2002) in bottle gourd; Laxuman *et al.,* (2012) and singh *et al* (2013) in bitter gourd.

High x low general combining ability 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, Samrat X NDBG 619, Samrat X Bhagirathi, Pusa Summer Prolific Long X Bhagirathi, NDBG 5006X NDBG 129, and NDBG 129X PBOG-89 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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