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RESEARCH ARTICLE

Estimation of combining ability and nature of gene action for yield and quality traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] under salt affected soil

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Abstract

Present investigations were carried out in bottle gourd to assess the combining ability and nature of gene action for yield and quality traits in bottle gourd. About 27 bottle gourd hybrids generated by crossing 9 lines with 3 testers, along with their twelve parents evaluated in a randomized complete block design with three replication at the Main Experiment Station (salt affected soil), Department of Vegetable Science, ANDUA&T, Kumarganj, Ayodhya, during the of *Zaid* seasons of year 2020 and 2021. The pooled estimates of general combining ability over seasons revealed that parents, namely NDBG-13 and NDBG-Sel-1, in both the years and pooled, and Narendra Rashmi in Y2 and pooled, showed positive and significant gca effects in the desirable direction for total fruit yield per plant and other important characters. However, four crosses *viz*., Narendra Pooja × Pusa Naveen, NDBG-13 × Narendra Rashmi, NDBG-Sel × Narendra Rashmi and Narendra Kamna × Narendra Rashmi in both the years and pooled, NDBG-28 × Pusa Naveen and NDBG-105 × Narendra Prabha and NDBG-28 × Narendra Prabha were found as best specific combiners as they showed significant and positive sca effects in desirable directions. Overdominance was estimated for most of the traits studies, which reveals that the heterosis breeding approach will be more rewarding in bottle gourd.

Keywords: Combining ability, Gene action, Bottle gourd, Salt affected soil.

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Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is one of the popular cucurbit vegetable crop with 2n = 2x = 22. It is an important cultivated annual cucurbitaceous crop grown throughout the country. Being warm season vegetable crop it thrives well in warm and humid climate but at present it's off season cultivation has progressively stretched throughout the year in northern Indian plains. It is mainly grown for its fruits for culinary purposes and seeds which are good source of oil and protein. It is highly cross-pollinated crop due to its monoecious and andromonoecious nature. Bottle gourd is the largest produced cucurbitaceous vegetables in the world preferred in both urban and rural population. In India, the total area covered under bottle gourd is 0.117 million ha with production of 2.18 million tonnes and its productivity is 18.6 tonnes per ha. (Anonymous, 2018).

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. Keeping in view the above facts the present investigations were planned to find out the good general and specific combiner parents and nature of gene action under salt affected soil for twenty three fruit yield and quality attributing traits in bottle gourd.

Materials and Methods

The present research work was conducted during *Zaid* seasons of 2019-20 (Y_1) and 2020-21 (Y_2) to study combining ability, variance and their effect by using line × tester mating design at the Main Experiment Station (MES) of the Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) India. The soil of this station is salt-affected with a pH of more than 8. The observations were recorded on 23 quantitative characters. The experimental materials for the present investigation consisted of nine promising and diverse inbred lines/varieties with three testers of bottle gourd selected on the basis of genetic variability from the germplasm stock maintained in the Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), India. The selected parental lines *i.e.*; NDBG-28 (L_1), NDBG-13 (L_2), NDBG-15 (L_3), Narendra Pooja (L_4), NDBG-104 (L_5), NDBG-Sel-1 (L_6), Narendra Kamna (L_7), NDBG-21(L_8), NDBG-22 (L_9) were crossed with three testers *viz*. Pusa Naveen (T_1), Narendra Prabha (T_2), Narendra Rashmi (T_3) to get 27 F_1 seeds. Parental lines (9 lines and 3 testers) were also selfed/sibbed to get the true-to-type seeds. The present experiments were conducted in RBD with three replications to appraise the performance of 27 F_1 hybrids and their 12 parents (9 lines and 3 testers) for the study of general and specific combiner parents and nature of gene action under salt affected soil in bottle gourd for twenty three fruit yield and quality attributing traits. The crop was sown in rows spaced at 3 meters apart with a plant to plant spacing of 0.50 m. Sowing was done on 20 March, 2019-20 and 19 March, 2020-21. The estimation of combining ability variances and their effects was done as per the method suggested by Griffing (1956a**).**

Results and Discussion

General combining ability (GCA)

Perusal of Table 1 revealed that the significant and positive gca effects for fruit yield per plant were exhibited by NDBG-13 (1.58) and NDBG-Sel-1 (0.67) in Y_1. Whereas, NDBG-13 (1.55), NDBG-Sel-1 (0.83) and Narendra Rashmi (0.43) in Y_2 and NDBG-13 (1.57), NDBG-Sel-1 (0.75) and Narendra Rashmi (0.20) in pooled showed significant and positive gca effects for fruit yield per plant. On the basis of gca effects and mean performance; parents NDBG-Sel-1 was found good general combiner for days to first male flower anthesis, days to first female flower anthesis, node number to first male flower appearance, node number to first female flower appearance, length of pedicel of female flower, days to first harvest, picking duration, fruit yield per plant, non-reducing sugar and dry matter in both the years and pooled; parents NDBG-15 was found good general combiner for days to first female flower anthesis, reducing sugars and dry matter in both the years and pooled. Parents NDBG-104 was found good general combiner for node number to first female flower appearance and dry matter in both the years and pooled. Parents Narendra Kamna was found good general combiner for Length of pedicel of female flower in both the years and pooled. Parents NDBG-21 was found good general combiner for number of node per vine, internodal length and non-reducing sugar in both the years and pooled.

Among testers, parents, Pusa Naveen was found good general combiners for days to first male flower anthesis, days to first female flower anthesis, days to first harvest, primary branches per plant, vine length and peduncle length in both the years and pooled; parents, Narendra Prabha was found good general combiners for picking duration, fruit length , non-reducing sugar and dry matter in both the years and pooled and parents, Narendra Rashmi was found good general combiners for node number to first male flower appearance, node number to first female flower appearance, length of pedicel of male flower, non-reducing sugar and dry matter in both the years and pooled. Significant gca values indicated the importance of additive and additive × additive gene effect as earlier reported by Griffing (1956b). In view of this, these parents offered the best possibilities for the development of improved lines of bottle gourd through hybridization programme. It is, therefore, recommended that to improve yield one should breed for superior combining ability for the component traits with an ultimate objective to improve the pace of its genetic improvement.

Thus, lines NDBG-13 and NDBG-Sel-1 and tester Narendra Rashmi emerged as the most useful parent as these parents were found good general combiner for most of the characters studied. Hence, these parents may also be recommended for exploitation in hybridization programme aimed at improving the yield components for which they were good general combiner. These results corroborated with the findings of (Maurya *et al.* 2004; Gaykawad 2014; Mishra *et al.* 2019 and Patel and Mehta 2021).

Specific combining ability (SCA)

Perusal of Table 2 revealed that significant positive and negative sca effects were observed for different characters under study. Further, sca effects were found to vary in nature and magnitude for all the characters with the change of

Table 1: General combining ability effect of parents for different traits in bottle gourd over pooled

Traits *Lines*	*Days to first male flower anthesis*	*Days to first female flower anthesis*	*Node number to first male flower appearance*	*Node number to first female flower appearance*	*Length of pedicel of male flower*	*Length of pedicel of female flower*	*Days to first harvest*	*Primary branches per plant*	*Vine length*	*Number of node per vine*	*Internodal length*	*Picking duration*
	Pooled	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*
NDBG-28	-4.12**	-3.56**	1.45**	1.15**	0.19	-0.69**	-2.78**	-3.71**	-0.61**	-7.98**	-0.33	1.91**
NDBG-13	1.99**	1.33**	-1.22**	0.26	-2.53**	0.03	1.50**	2.74**	0.78**	11.30**	0.27	-2.81**
NDBG-15	-1.01**	-1.51**	-0.44**	0.98**	-1.86**	-0.97**	-0.94*	-2.88**	-0.88**	2.30	1.22**	-2.59**
Narendra Pooja	-0.68**	-0.67*	1.06**	-0.19	-0.36	-1.19**	-0.22	-0.38	0.37**	-6.03**	-1.08**	-1.19**
NDBG-104	1.65**	2.16**	-0.27	-0.85**	0.36	-0.69**	1.56**	-2.43**	0.24*	-1.25	-0.50**	-1.59**
NDBG-Sel-1	-2.79**	-3.12**	-1.33**	-2.07**	0.81**	1.19**	-2.78**	-3.82**	0.14	-16.92**	-1.97**	1.64**
Narendra Kamna	1.77**	1.94**	-0.11	0.43	1.19**	0.69**	1.72**	0.90**	-0.11	-3.25*	-0.29	1.91**
NDBG-21	1.32**	1.38**	0.62**	-0.07	1.14**	-0.14	0.78*	1.07**	-0.70**	8.41**	2.03**	-0.25
NDBG-22	1.88**	2.05**	0.23	0.37	1.03**	1.75**	1.17**	8.51**	0.77**	13.41**	0.66**	2.97**
SE (g_i) lines	0.25	0.32	0.15	0.27	0.31	0.21	0.37	0.30	0.07	1.36	0.17	0.34
SE($g_i - g_j$)	0.35	0.46	0.21	0.38	0.43	0.30	0.53	0.43	0.11	1.92	0.24	0.48
Tester												
Pusa Naveen	-1.90**	-1.78**	0.32**	0.67**	-0.01	0.11	-1.69**	2.99**	0.44**	-0.61	-0.52**	-1.33**
Narendra Prabha	0.78**	0.36	0.15	-0.33*	-0.67**	-0.34**	0.41	-2.59**	-0.18**	4.80**	0.74**	0.69**
Narendra Rashmi	1.12**	1.42**	-0.48**	-0.33*	0.68**	0.24	1.28 **	-0.39*	-0.26**	-4.19**	-0.22*	0.64**
SE (g_i) testers	0.14	0.19	0.09	0.16	0.18	0.12	0.22	0.17	0.04	0.79	0.10	0.20
SE (g_i-g_j)	0.20	0.27	0.12	0.22	0.25	0.18	0.30	0.25	0.06	1.11	0.14	0.28

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

Table-1: Contd….

Traits *Lines*	*Peduncle length*	*Fruit length*	*Average fruit circumference*	*Average fruit weight*	*Number of fruit per plant*	*Fruit yield per plant*	*Total soluble solids*	*Reducing sugars*	*Non-reducing sugar*	*Total sugars*	*Dry matter*
	Pooled	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*
NDBG-28	-2.82**	2.20	-1.46*	-0.02	-0.52**	-0.65**	-0.03	-0.01	0.01**	0.02	0.11*
NDBG-13	-0.54*	0.39	0.49	-0.04	1.43**	1.57**	0.08*	0.00	0.04**	0.06	0.31**
NDBG-15	0.02	0.01	0.14	0.03	0.02	-0.28*	-0.02	0.07**	-0.12**	-0.12**	0.21**
Narendra Pooja	-1.54**	3.28*	-0.13	-0.09*	-0.05	-0.44**	-0.11**	-0.11**	0.08**	0.04	-0.39**
NDBG-104	-0.65**	0.57	-2.87**	0.09**	-0.19	-0.30**	-0.03	-0.02	0.01	-0.01	0.45**
NDBG-Sel-1	0.74**	1.01	-0.54	0.06	-0.22	0.75**	-0.02	-0.08**	0.07**	0.05	0.51**
Narendra Kamna	0.57**	3.01*	-0.99	-0.05	-0.62**	-0.11	0.03	0.05*	-0.02**	0.00	-0.26**
NDBG-21	-0.26	1.39	2.22**	-0.01	-0.03	-0.05	-0.01	-0.14**	0.05**	-0.03	-0.50**
NDBG-22	4.46**	-11.85**	3.13**	0.02	0.18	-0.49**	0.11**	0.22**	-0.11**	-0.02	-0.44**
SE (g_i) lines	0.21	1.37	0.66	0.03	0.11	0.11	0.04	0.03	0.01	0.04	0.05
SE($g_i - g_j$)	0.30	1.94	0.94	0.05	0.16	0.15	0.05	0.04	0.01	0.05	0.07
Tester											
Pusa Naveen	0.87**	-0.59	0.77*	-0.02	0.04	-0.24**	0.04	0.07**	-0.05**	-0.03	-0.18**
Narendra Prabha	-0.35**	2.65**	-0.38	-0.03	0.15*	0.03	-0.02	-0.03	0.03**	0.03	0.08**
Narendra Rashmi	-0.52**	-2.06*	-0.39	0.06**	-0.19**	0.20**	-0.03	-0.04**	0.02**	0.00	0.09**
SE (g_i) testers	0.12	0.79	0.38	0.02	0.07	0.06	0.02	0.02	0.00	0.02	0.03
SE (g_i-g_j)	0.17	1.12	0.54	0.03	0.09	0.09	0.03	0.02	0.00	0.03	0.04

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

Table 2: Estimates of specific combining ability (SCA) effects of crosses for twenty three characters in bottle gourd over pooled

S. No.	Crosses	*Days to first male flower anthesis*	*Days to first female flower anthesis*	*Node number to first male flower appearance*	*Node number to first female flower appearance*	*Length of pedicel of male flower*	*Length of pedicel of female flower*	*Days to first harvest*	*Primary branches per plant*	*Vine length*	*Number of node per vine*	*Internodal length*	*Picking duration*
		Pooled	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*
1	NDBG-28 × Pusa Naveen	3.12**	1.78**	-0.54*	1.11*	1.06*	0.56	1.46*	-3.88**	-0.85**	1.27	0.99**	-3.67**
2	NDBG-28 × Narendra Prabha	-0.56	-0.53	0.62*	0.28	1.23*	0.34	-0.29	3.21**	0.76**	-6.30**	-1.49**	2.31**
3	NDBG-28 × Narendra Rashmi	-2.56 **	-1.25*	-0.08	-1.39**	-2.29**	-0.90*	-1.17	0.67	0.09	5.03*	0.50	1.36*
4	NDBG-13 × Pusa Naveen	-2.15**	-1.27*	1.62**	-0.33	0.78	0.17	-0.82	4.51**	-0.28*	-14.51**	-1.11**	7.72**
5	NDBG-13 × Narendra Prabha	0.83	-0.25	0.79**	0.33	0.78	0.45	-0.57	-7.74**	0.68**	11.09**	0.29	-5.14**
6	NDBG-13 × Narendra Rashmi	1.33**	1.53**	-2.41**	0.00	-1.57**	-0.62	1.39*	3.23**	-0.41**	3.42	0.82**	-2.58**
7	NDBG-15 × Pusa Naveen	-1.32**	1.23*	-2.32**	-2.06**	-1.22*	0.34	1.29*	-2.38**	-0.23	13.83**	1.71**	-2.34**
8	NDBG-15 × Narendra Prabha	0.66	-1.42*	1.68**	0.78	1.62**	-0.05	-0.96	0.71	-0.76**	-9.41**	-0.06	-0.86
9	NDBG-15 × Narendra Rashmi	0.66	0.19	0.64*	1.28**	-0.40	-0.29	-0.33	1.67**	0.99**	-4.41	-1.65**	3.19**
10	Narendra Pooja × Pusa Naveen	-1.82**	-2.27**	0.18	-0.22	0.45	0.23	-2.09**	-2.55**	-0.54**	6.66**	1.26**	5.77**
11	Narendra Pooja × Narendra Prabha	2.49**	2.25**	-0.82**	-0.06	-1.88**	-0.83*	2.15**	0.71	-0.32*	-6.75**	-0.49	-3.25**
12	Narendra Pooja × Narendra Rashmi	-0.67	0.03	0.64*	0.28	1.43**	0.59	-0.06	1.84**	0.86**	0.09	-0.77*	-2.53**
13	NDBG-104 × Pusa Naveen	-3.15**	-4.27**	0.51	1.44**	-0.11	0.89*	-3.37**	6.34**	0.45**	22.22**	1.90**	0.16
14	NDBG-104 × Narendra Prabha	-0.51	0.41	-1.82**	-2.56**	-1.61**	0.34	-0.13	-2.57**	-0.12	-14.19**	-1.45**	4.14**
15	NDBG-104 × Narendra Rashmi	3.66**	3.86**	1.31**	1.11*	1.71**	-1.24**	3.50**	-3.77**	-0.32*	-8.03**	-0.46	-4.30**
16	NDBG-Sel-1 × Pusa Naveen	1.29**	0.84	1.74**	0.83	-0.22	-0.66	0.29	-4.11**	-1.00**	-1.28	0.76*	-6.89**
17	NDBG-Sel-1 × Narendra Prabha	-1.56**	-0.98	0.74**	0.50	0.95	-1.38**	-0.13	2.49**	1.34**	-2.69	-1.38**	3.92**
18	NDBG-Sel-1 × Narendra Rashmi	0.27	0.14	-2.47**	-1.33*	-0.74	2.04**	-0.17	1.62**	-0.34*	3.98	0.62*	2.98**
19	Narendra Kamna × Pusa Naveen	-1.09*	-0.72	-3.15**	-2.67**	0.56	-1.16**	-0.87	-2.49**	-0.19	-5.62*	-0.42	4.83**
20	Narendra Kamna × Narendra Prabha	0.22	0.80	-0.65*	-0.17	0.06	1.12**	0.20	1.43**	-0.49**	-0.03	0.51	-5.36**
21	Narendra Kamna × Narendra Rashmi	0.88*	-0.09	3.81**	2.83**	-0.62	0.04	0.67	1.06*	0.68**	5.64*	-0.09	0.53
22	NDBG-21 × Pusa Naveen	4.51**	4.17**	1.46**	1.00*	-2.88**	1.34**	3.74**	3.01**	1.83**	-2.45	-2.49**	-5.67**
23	NDBG-21 × Narendra Prabha	-0.17	0.03	-1.21**	-0.5	-0.05	-1.05**	-0.35	-0.40	-0.76**	7.31**	1.80**	3.46**
24	NDBG-21 × Narendra Rashmi	-4.34**	-4.19**	-0.25	-1.00*	2.93**	-0.29	-3.39**	-2.61**	-1.07**	-4.86*	0.69*	2.19**
25	NDBG-22 × Pusa Naveen	0.62	0.51	0.51	0.89	1.56**	-1.72**	0.35	1.56**	0.81**	-20.12**	-2.59**	0.11
26	NDBG-22 × Narendra Prabha	-1.39**	-0.31	0.68*	0.89	-1.11*	1.06**	0.09	2.15*	-0.33*	20.98**	2.27**	0.75
27	NDBG-22 × Narendra Rashmi	0.77	-0.19	-1.19**	-1.78**	-0.46	0.65	-0.44	-3.72**	-0.48**	-0.86	0.32	-0.86
SE (S_{ij})		1.10	1.45	0.68	1.20	1.36	0.96	1.67	1.35	0.33	6.08	0.77	1.51
SE (S_{ij}-S_{kl})		0.60	0.79	0.37	0.66	0.75	0.52	0.91	0.74	0.18	3.33	0.42	0.83
CD 5%		0.85	1.11	0.52	0.92	1.05	0.74	1.28	1.03	0.26	4.67	0.59	1.16

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

Table 2: Contd….

S. No.	Crosses	*Peduncle length*	*Fruit length*	*Average fruit circumference*	*Average fruit weight*	*Number of fruit per plant*	*Fruit yield per plant*	*Total soluble solids*	*Reducing sugars*	*Non-reducing sugar*	*Total sugars*	*Dry matter*
		Pooled	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*
1	NDBG-28 × Pusa Naveen	0.35	0.37	-0.08	0.09	0.24	0.31	0.01	-0.04	0.06**	0.06	-0.04
2	NDBG-28 × Narendra Prabha	-0.93*	-2.61	-0.53	-0.08	0.52*	0.55**	-0.06	0.07	-0.07**	-0.07	0.54**
3	NDBG-28 × Narendra Rashmi	0.57	2.25	0.61	-0.02	-0.75**	-0.87**	0.04	-0.03	0.02*	0.00	-0.49**
4	NDBG-13 × Pusa Naveen	-5.09**	1.53	-2.17	0.07	-1.23**	-1.17**	-0.18**	-0.20**	0.13**	0.05	-0.32**
5	NDBG-13 × Narendra Prabha	1.46**	1.66	1.26	0.03	0.05	0.22	0.23**	0.07	-0.08**	-0.05	-0.18*
6	NDBG-13 × Narendra Rashmi	3.63**	-3.19	0.91	-0.10	1.18**	0.94**	-0.05	0.13**	-0.06**	-0.01	0.50**
7	NDBG-15 × Pusa Naveen	0.52	-0.85	-1.53	0.06	-0.33	-0.22	0.14*	-0.08	-0.06**	-0.13	0.26**
8	NDBG-15 × Narendra Prabha	0.07	0.59	0.78	0.01	-0.33	0.20	-0.07	-0.28**	0.24**	0.15*	-0.54**
9	NDBG-15 × Narendra Rashmi	-0.59	0.25	0.75	-0.07	0.66**	0.02	-0.07	0.36**	-0.18**	-0.03	0.28**
10	Narendra Pooja × Pusa Naveen	2.24**	2.87	0.15	0.00	-0.00	0.89**	0.04	0.05	0.03**	0.07	-0.00
11	Narendra Pooja × Narendra Prabha	-2.70**	-3.26	-0.18	0.04	1.04**	0.18	-0.06	0.01	-0.06**	-0.08	0.22**
12	Narendra Pooja × Narendra Rashmi	0.46	0.39	0.03	-0.04	-1.03**	-1.08**	0.02	-0.06	0.03**	0.01	-0.22*
13	NDBG-104 × Pusa Naveen	-4.65**	2.13	-0.05	-0.05	0.43*	0.24	-0.01	-0.01	-0.00	-0.01	-0.17*
14	NDBG-104 × Narendra Prabha	0.91*	-0.87	1.36	0.04	-0.67**	0.31	0.09	0.24**	-0.11**	-0.01	0.48**
15	NDBG-104 × Narendra Rashmi	3.74**	-1.26	-1.31	0.01	0.24	-0.55**	-0.08	-0.23**	0.12**	0.02	-0.31**
16	NDBG-Sel-1 × Pusa Naveen	1.63**	-1.57	-1.63	0.06	-0.74**	0.40*	0.02	0.03	0.00	0.02	0.13
17	NDBG-Sel-1 × Narendra Prabha	-1.15**	-0.46	1.76	-0.05	0.51*	-0.96**	0.02	0.15**	-0.05**	0.02	-0.19*
18	NDBG-Sel-1 × Narendra Rashmi	-0.48	2.03	-0.13	-0.02	0.23	0.56**	-0.05	-0.18**	0.05**	-0.04	0.07
19	Narendra Kamna × Pusa Naveen	-2.54**	-2.19	-0.44	-0.07	-0.26	-0.61**	-0.05	0.17**	-0.07**	0.00	0.01
20	Narendra Kamna × Narendra Prabha	2.35**	0.24	-0.14	-0.06	-0.02	-0.48**	-0.07	-0.27**	0.13**	0.02	-0.09
21	Narendra Kamna × Narendra Rashmi	0.19	1.95	0.58	0.13*	0.27	1.09**	0.11	0.09*	-0.06**	-0.02	0.08
22	NDBG-21 × Pusa Naveen	-0.04	-1.75	5.65**	-0.12*	1.67**	0.02	0.17*	0.22**	-0.15**	-0.09	0.01
23	NDBG-21 × Narendra Prabha	2.85**	6.37**	-4.03**	0.09	-1.35**	0.09	-0.09	-0.12**	0.07**	0.02	-0.13
24	NDBG-21 × Narendra Rashmi	-2.82**	-4.62	-1.62	0.03	-0.32	-0.10	-0.07	-0.09*	0.09**	0.07	0.12
25	NDBG-22 × Pusa Naveen	7.57**	-0.54	0.11	-0.04	0.23	0.12	-0.14*	-0.14**	0.08**	0.02	0.12
26	NDBG-22 × Narendra Prabha	-2.87**	-1.66	-0.29	-0.03	0.24	-0.11	-0.0	0.13**	-0.07**	-0.01	-0.09
27	NDBG-22 × Narendra Rashmi	-4.70**	2.20	0.18	0.8	-0.47*	-0.01	0.14*	0.01	-0.01	-0.01	-0.02
SE (S_{ij})		0.94	6.13	2.96	0.15	0.51	0.47	0.17	0.12	0.02	0.17	0.22
SE (S_{ij}-S_{kl})		0.52	3.36	1.62	0.08	0.28	0.26	0.09	0.07	0.01	0.09	0.12
CD 5%		0.73	4.71	2.27	0.12	0.39	0.36	0.19	0.09	0.02	0.13	0.17

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

Table 3: Components of genetic variance, average degree of dominance, predictability ratio for twenty three characters in bottle gourd over pooled

S.No.	Characters / Parameters	*gca variance* (σ^2g)	*sca variance* (σ^2s)	*Average degree of dominance*	*Predictability ratio*	σ^2A	σ^2D
		Pooled	*Pooled*	*Pooled*	*Pooled*	*Pooled*	*Pooled*
1	Days to first male flower anthesis	3.32	6.59	1.20	0.50	13.26	26.35
2	Days to first female flower anthesis	3.24	5.58	1.12	0.54	12.96	22.34
3	Node number to first male flower appearance	0.35	4	2.91	0.15	1.38	16.01
4	Node number to first female flower appearance	0.46	2.57	2.03	0.26	1.82	10.27
5	Length of pedicel of male flower (cm)	0.75	2.85	1.66	0.35	3.01	11.41
6	Length of pedicel of female flower (cm)	0.31	1.25	1.73	0.33	1.22	5.00
7	Days to first harvest	2.48	3.91	1.07	0.56	9.93	15.62
8	Primary branches per plant	9.8	16.52	1.11	0.54	39.20	66.08
9	Vine length (m)	0.2	0.91	1.80	0.31	0.82	3.63
10	Number of node per vine	38.91	155.49	1.71	0.33	155.64	621.98
11	Internodal length (cm)	0.67	2.69	1.71	0.33	2.68	10.79
12	Picking duration	2.1	24.03	2.89	0.15	8.41	96.14
13	Peduncle length (cm)	1.4	13.13	2.61	0.18	5.62	52.50
14	Fruit length (cm)	8.69	2.27	0.52	0.84	34.79	13.06
15	Average fruit circumference (cm)	0.95	3.19	1.57	0.37	3.78	12.77
16	Average fruit weight (kg)	0	0	1.13	0.53	0.01	0.01
17	Number of fruit per plant	0.1	0.79	2.37	0.21	0.41	3.17
18	Fruit yield per plant (kg)	0.16	0.54	1.58	0.37	0.63	2.17
19	Total soluble solids (%)	0	0.01	2.56	0.18	0.01	0.05
20	Reducing sugars (%)	0.01	0.04	2.38	0.20	0.02	0.16
21	Non- reducing sugar (%)	0	0.01	1.98	0.27	0.01	0.06
22	Total sugars (%)	0	0	1.15	0.52	0.00	0.00

seasons. This varying magnitude of sca effects over seasons may be due to environmental effects and genotypes, respectively. Out of 27 crosses studied, some crosses showed significant and positive sca effects for fruit yield per plant as well as some other yield component traits in both years and in pooled. For fruit yield per plant, among twenty seven crosses the top five cross combinations with significant and positive sca effects were Narendra Pooja × Pusa Naveen, NDBG-13 × Narendra Rashmi, NDBG-104 × Narendra Prabha, NDBG-28 × Pusa Naveen, and Narendra Kamna × Narendra Rashmi in Y_1, Narendra Kamna × Narendra Rashmi, NDBG-28 × Narendra Prabha, NDBG-13 × Narendra Rashmi, NDBG-104 × Pusa Naveen and Narendra Pooja × Pusa Naveen in Y_2 and Narendra Kamna × Narendra Rashmi, NDBG-13 × Narendra Rashmi, Narendra Pooja × Pusa Naveen, NDBG-Sel-1 × Narendra Rashmi and NDBG-28 × Narendra Prabha in pooled. Amongst these, the four crosses *viz.* Narendra Pooja × Pusa Naveen, NDBG-13 × Narendra Rashmi, NDBG-Sel-1 × Narendra Rashmi and Narendra Kamna × Narendra Rashmi showed significant and positive sca effects in both years and over pooled. Out of these top crosses for significant positive sca effects over season and pooled, the cross Narendra Pooja × Pusa Naveen was found most promising hybrid as it had highly significant sca effect for total fruit yield per plant along with internodal length, picking duration, peduncle length and dry matter; likewise cross NDBG-13 × Narendra Rashmi for node number to first male flower appearance, primary branches per plant, peduncle length, reducing sugars dry matter in both the years and pooled; NDBG-Sel-1 × Narendra Rashmi for node number to first male flower appearance, length of pedicel of female flower, picking duration and non reducing sugars in both the years and pooled; Narendra Kamna × Narendra Rashmi for vine length in both the years and pooled. These four crosses mentioned above for significant positive sca effects for yield along with traits in both the years and pooled may be considered for utilization in a breeding programme to enhance the fruit yield.

In general, the crosses showing significant and desirable sca effects were associated with better *per se* performance for respective characters. However, the crosses having high sca effects in desirable direction did not always have high mean performance for the characters in question. Thus, the sca effect of the crosses may not be directly related to their performance *per se*. This may be attributed to the fact that, per se, performance is a realized value, whereas sca effect is an estimated value of F_1's performance over parental one. Therefore, both *per se* performance along with sca effects should be considered for evaluating the superiority of a cross, although the former may be more important if the development of F_1 hybrids is the ultimate goal. The analytical examination of results revealed that the crosses exhibiting highly significant and desirable sca effects for different characters involved parents having all types of combinations of gca effects such as high × high (H × H), high × average (H × A), high × low (H × L), average × average (A × A), average × low (A × L) and low × low (L × L). The foregoing observations clearly indicated that there was no particular relationship between positive and significant sca effects of crosses with gca effects of their parents for the characters under study and also approve the finding of previous workers in bottle gourd (Wani *et al.,* 2009; Shinde *et al.,* 2016; Jaynath *et al.,* 2019, Quamruzzaman *et al.,* 2019, Balat *et al.,* 2021, and Patel and Mehta, 2021).

Gene action

The estimates of general combining ability (gca) and specific combining ability (sca) variances, average degree of dominance, predictability ratio, additive and dominance variances for Y_1, Y_2 and pooled have been presented in Table- 3. The combining ability analysis elucidated higher magnitude of variance due to sca (σ^2s) than variance due to gca (σ^2g) indicating preponderance of non-additive gene action for all the characters except total sugar which are almost similar to each other. Similar finding had also been reported previously by Parvathi and Reddy, (2005); Singh *et al.,*(2005a; Masud *et al*, 2006; Pandey *et al.,* 2011; Vaged *et al.,* 2011; Adarsh *et al*., 2015 and Janarnjani *et al.,* 2016). Average degree of dominance were more than unity (1) for all the characters under study, except for fruit length in both the years and pooled which indicated existence of over dominance and controlled by a preponderance of non-additive gene effects suggesting thereby scope of development of F_1's . The predictability ratio was lesser than (<1) for all the characters under study in both the years and pooled. The importance of non-additive gene effects in inheritance of fruit yield and yield components of bottle gourd has also been reported by earlier workers (Pandey *et al*., 2004; Singh *et al*., 2005b; Rehana and Sharma; 2007; Wani *et al*., 2008; Dubey and Ram, 2008; Kumar *et al*., 2014; Gautam and Yadav, 2017; Jha *et al.,* 2017; Niva *et al.,* 2017 and Kumar *et al.,* 2018; Singh *et al* . 2025; Keshari *et al.* 2024; Patel *et al.* 2023). The predominance of non-additive gene effects representing non-fixable dominance and epistatic components of genetic variance indicated that maintenance of heterozygosity would be highly fruitful for improving the characters.

Conclusion

On basis of above result and discussion it might be very safely concluded that parents namely NDBG-13, NDBG-Sel-1 and Narendra Rashmi were found as good general combiner, while crosses *viz*., Narendra Pooja × Pusa Naveen, NDBG-13 × Narendra Rashmi, NDBG-Sel × Narendra Rashmi and Narendra Kamna × Narendra Rashmi were found as best specific combiners and could be exploit in future breeding programme of bottle gourd improvement. Overdominance was estimated for most of the traits studies, which reveals

that the heterosis breeding approach will be more rewarding in bottle gourd.

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सारांश

लौकी [लजिनेरिया सिसेरिया (मोल) स्टैंडल] में उपज और गुणवत्ता के लिए संयोजन क्षमता" नामक शीर्षक पर मुख्य प्रयोग केंद्र, सब्जी विज्ञान विभाग, आचार्य नरेंद्र देव कृषि और प्रौद्योगिक विश्वविद्यालय, नरेंद्र नगर (कुमारगंज), अयोध्या (यूपी) में जायद 2019-2020, और 2020-2021 के दौरान परीक्षण निष्पादित किया गया। पितृ, L_2, L_6 और T_3 ने प्रति पौधे फल उपज के लिए अच्छे सामान्य संयोजन का प्रदर्शन किया। इसी प्रकार, पितृ में L_2 ने प्रति पौधे फल की संख्या, बेल की लंबाई और प्रति बेल गांठ की संख्या के लिए अच्छे सामान्य संयोजन का प्रदर्शन किया। दोनो वर्षों के औसत में $L_7 \times T_1$, $L_2 \times T_3$, $L_4 \times T_1$, $L_6 \times T_2$ और $L_1 \times T_2$ संकरों ने सबसे अधिक सकारात्मक विशिष्ट संयोजन प्रभाव पाये गये। प्रति पौधा फल उपज के साथ साथ अधिकांश लक्षणों के लिए पितृ में प्रभावी जीन क्रिया की प्रबलता से पता चलता है कि चयन की तुलना में संकर प्रजनन दृष्टिकोण अधिक फायदेमंद हो सकता है।