



Combining ability studies in Bitter Gourd (*Momordica charantia* L.) for yield and it's contributing traits.

Ramesh Rajbhar¹, C. N. Ram², Ashwani Kumar³, Lav Kumar⁴, Ankur Kumar Pal⁵, Niranjan Kumar Chaurasia⁶, Priyanka Solanki⁷,

¹Ph.D. Scholar, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India.

²Professor & Head, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India.

³Ph.D. Scholar, Department of Vegetable Science, Sunrise university Alwar, Rajasthan.

⁴Assistant Professor (Horticulture) IAST, Shri Ramswaroop Memorial University, Lucknow.

⁵M.Sc. Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India.

⁶Assistant Professor, Department of Genetics and Plant Breeding, School of Agricultural Sciences, Nagaland University, Medziphema.

⁷Assistant Professor, Department of Social Science, College of Horticulture and Forestry, Jhalawar, AU, Kota.

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ABSTRACT

The present study was conducted 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 during the Zaid seasons of 2022-23 (Y1) and 2023-24 (Y2). Plant material consisted of 30 F1 hybrids and their 13 parents (10 lines and 3 testers) bitter gourd including 1 check namely Sagar (commercial check) in Randomized Block Design (RBD) with three replications in line x tester mating design. The crop was sown in rows spaced at 3 meters apart with a plant to plant spacing of 0.50 meter. Sowing was done on 22 February, 2022-23 and 19 February, 2023- 24. Evaluation was done for different yield and quality traits. On the basis of overall performance the three best crosses were, namely NDBG-35 × Pant Karela-1 (550.78) followed by NDBG-13 × PB-14 (468.86), NDBG-15× PB-15 (358.01), NDBG-26 × PB-14 (354.83) and NDBG-8 × PB-15 (344.58) were found in fruit yield per plant common over the seasons (pooled). Hence could be further evaluated in future breeding programme for their large-scale testing.

Keywords: Bitter gourd, Lines, Quality traits

INTRODUCTION

Bitter gourd, which is botanically known as “*Momordica charantia* L.”, belongs to the family “Cucurbitaceae”, and is a “tropical and subtropical” important commercial vegetable crop Singh *et al.* 2013. The crops belong to this family often called as "cucurbits". Hyde Bailey gave the word "cucurbits" for cultivated species of the Cucurbitaceae family. This family comprises about 130 genera and approximately 800 species almost uniformly spread between new and old-world tropics (Kocyan *et al.* 2007 and Dhiman *et al.*, 2012). Tropical and subtropical region are suitable for its growth. In India the total area under bitter gourd cultivation is 110, 000 ha, with a production of 1369, 000 MT (Anonymous, 2022). It is also known as bitter melon, balsam pear, maiden apple, casislla, karela, bitter cucumber and African cucumber (Morton, 1967 and Acharya *et al.* 2019). It is an extremely rich source of vitamin A and C, calcium, phosphate, iron, and protein. Because of the fruit juice's strong oxygen free radical scavenging properties, diabetic patients can also benefit greatly from consuming it. Cucurbitacin, also known as tetracyclin triterpenes, is the bitter glucoside that gives bitter gourd its bitter flavor and keeps cooked vegetables fresh for up to three days. Additionally, bitter gourd leaf extract has excellent mosquitocidal properties

Utilizing bitter gourd's hybrid vigor will significantly increase production and foster the emergence of new, promising cultivars. It is necessary to identify the genetically superior diversified parent. The primary aspect influencing the lines' potential use for hybrids and synthetics in the future is their inbred line's combining ability. In order to gather data on the estimations of general and particular combining ability, the current study was conducted in 10 genetically distinct bitter gourd lines.

MATERIALS AND METHODS

Thirteen parents (ten lines and three testers) of bitter gourd namely, NDBG-08 (L1), NDBG-12 (L2), NDBG-13 (L3), NDBG-15 (L4), NDBG-25 (L5), NDBG-26 (L6), NDBG-35 (L7), NDBG-38 (L8), NDBG-42 (L9), NDBG-55(10) and testers Pant Karela-1 (T1), Punjab Bitter gourd -14 (T2), Punjab Bitter gourd -15 (T3) were crossed in the all possible combination to get 30 F1 seed. These lines were evaluated in a Randomized Block Design (RBD) with three replications during Zaid seasons of 2022- 23 (Y1) and 2023-24 (Y2). The crop was sown in rows spaced at 3 meters apart with a plant to plant spacing of 0.50 meter. Sowing was done on 22 February, 2022-23 and 19 February, 2023-24. The data were collected on the anthesis of first male flower, anthesis of first female flower, node at which first male flower appear, node at which first female flower appear, vine length (cm), fruit weight, fruit length, fruit circumference, days to first fruit harvest, number of primary branches per plant, number of fruits per plant, fruit yield/plant, total soluble solids, ascorbic acid, reducing sugar, non-reducing sugar and dry matter content.

RESULTS AND DISCUSSION

Analysis of variances for combining ability revealed that the partitioning of variances due to crosses showed highly significant differences for all the eighteen characters in both Y1, Y2 and pooled. Variances due to lines $\times$ testers were highly significant for all the characters in both years and pooled, except for days to first staminate flower anthesis in Y1 and Y2, node number to first staminate flower appearance in Y1, vine length in Y1, number of primary branches in

Y1, fruit length in Y1 and Y2, fruit diameter in Y1, Y2 and pooled and average fruit weight in Y2. Similar findings were also reported by Kumar *et al.*, 2014; Ray *et al.*, 2015 and Janaranjani *et al.*, 2016.

Analysis of variances for combining ability in both the years (Y1, Y2 and pooled) revealed that the partitioning of variances due to crosses showed highly significant differences for all the eighteen characters in both Y1, Y2 and pooled. Variances due to lines $\times$ testers were highly significant for all the characters in both years and pooled, except for days to first staminate flower anthesis, except for days to first staminate flower anthesis in Y1 and Y2, node number to first staminate flower appearance in Y1, vine length in Y1, number of primary branches in Y1, fruit length in Y1 and Y2, fruit diameter in Y1, Y2 and pooled and average fruit weight in Y2. The mean squares due to interaction effects of GCA vs environments and SCA vs environments were found non-significant for all the traits. The estimates of highly significant gca and sca variances revealed that both additive and non-additive gene action were important in the expression of all eighteen traits studied in both the seasons.

The parents NDBG-25(22.48), NDBG-13 (21.51) NDBG-35 (12.62) and NDBG-8(3.93) exhibited significant and positive gca effects for fruit weight (g). NDBG-13 (6.94) exhibited significant and positive gca effects for number of fruits per plant followed by NDBG-25 (6.53), NDBG-26 (1.83) and NDBG-35 (1.41). NDBG-13 (967.97) followed by NDBG-25 (932.12) and NDBG- 35 (318.84) in fruit yield per plant in both the seasons and over seasons (pooled).

NDBG-13 (-5.67) exhibited significant and negative gca effects for days to first harvest also emerged as good general combiner for maturity traits (earliness). NDBG-25 (-2.05) followed by NDBG- 13(-0.84), NDBG-35(-0.51), NDBG-42(-0.28) exhibited significant and negative gca effects for node number to first pistillate flower appearance, significant and negative gca effects were observed for NDBG- 13(-4.46), NDBG- 25(-3.27) and NDBG-55(-2.13) in days to first female flower anthesis and NDBG-13 (0.44), NDBG-25 (0.35) exhibited significant and positive gca effects for number of primary branches per plant, whereas parents NDBG-13 (35.97), NDBG -26(13.25), NDBG-35 (10.66), NDBG-25(5.53) and NDBG-12(3.29) exhibited significant and positive gca effects for ascorbic acid (mg/100g fresh weight). Lines NDBG-13 (2.49) followed by NDBG -25(1.80), NDBG -35(0.34) exhibited significant and positive gca effects for reducing sugars (%). Lines NDBG-13 (2.86) followed by NDBG-38 (2.07), NDBG-35 (1.51), NDBG-55 (1.49), NDBG-42 (0.86) and NDBG-25 (0.35) exhibited significant and positive gca effects for non-reducing sugar (%). Lines NDBG-13 (2.86) followed by NDBG-25 (2.15), NDBG-35 (1.85), NDBG-38(1.12) and NDBG-55 (1.01) exhibited significant and positive gca effects for total sugar (%). lines NDBG-13 (1.21) followed by NDBG-25 (0.79), NDBG-42(0.25) and NDBG-55(0.12) exhibited significant and positive gca effects for dry matter content in fruit (g/100g).

Out of 30 the best five crosses combinations were NDBG-35 $\times$ Pant Karela-1 (550.78) followed by NDBG-13 $\times$ PB-14 (468.86), NDBG-15 $\times$ PB-15 (358.01), NDBG-26 $\times$ PB-14 (354.83) and NDBG-8 $\times$ PB-15 (344.58) were found in fruit yield per plant common over the seasons (pooled).

Proportional contribution of line $\times$ testers for different traits in pooled varied from total soluble solids (21.40%) to vine length (70.85%). Lines $\times$ testers component displayed greater contribution for vine length (70.85%) followed by node number to first staminate flower appearance (58.10%), node number to first pistillate flower appearance (54.43%), ascorbic acid

(49.05%), days to first harvest (48.05%), days to first staminate flower anthesis (50.86%), dry matter content in fruit (44.08%), fruit circumference (40.33%), days to first pistillate flower anthesis (56.71%), fruit length (39.16%), number of primary branches plant⁻¹ (35.22%), non-reducing sugar (31.73%), while, lines $\times$ testers component displayed lesser contribution for number of fruits plant⁻¹ (30.58%) followed by total sugars (26.91%), reducing sugars (23.29%), average fruit weight (22.95%), fruit yield plant⁻¹ (22.67%) and total soluble solids (21.40%).

In case of pooled, estimates of sca variances were higher than gca variances for days to first pistillate flower anthesis, node number to first staminate flower appearance, node number to first pistillate flower appearance, days to first harvest, vine length, fruit length, fruit circumference, number of fruits plant⁻¹, ascorbic acid, non-reducing sugar, and dry matter content in fruit while, gca variance (σ^2_g) were higher than sca variance (σ^2_s) for days to first staminate flower anthesis, number of primary branches per plant, fruit weight, total soluble solids, reducing sugar, total sugar and fruit yield per plant.

DISCUSSION

Bitter gourd (*Momordica charantia* L.) is one of the important members among the cultivated cucurbits. The present investigation was undertaken to evaluate 30 F1 hybrids and their 13 parents (10 lines and 3 testers) bitter gourd including 1 check namely Sagar (commercial check) of bitter gourd for horticultural and biochemical traits. On the basis of overall performance the three best crosses were, namely NDBG-35 $\times$ Pant Karela-1 (550.78) followed by NDBG-13 $\times$ PB-14 (468.86), NDBG-15 $\times$ PB-15 (358.01), NDBG-26 $\times$ PB-14 (354.83) and NDBG-8 $\times$ PB-15 (344.58) were found in fruit yield per plant common over the seasons (pooled). It can be concluded that, as a wide range of variation for almost all the economically important traits was present in this crop, so there is a vast scope for improvement through different breeding procedure.

Table- 1.1: Analysis of variance for combining ability following line $\times$ tester mating design for eighteen characters in bitter gourd over two years (Y1= 2023, Y2 = 2024) and pooled.

Source of variation	Years	Df	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 harvest	Vine length (cm)	Number of primary branches plant ⁻¹	Fruit length (cm)	Fruit circumference (cm)
Replications	Y1	2	3.36	32.26	0.35	1.04	46.84	1415.36*	0.12	1.669	0.008
	Y2	2	45.91	31.30	0.15	0.12	32.01	20.43	0.16	0.933	0.01
	Pooled	2	12.21	53.36*	0.47	0.79*	27.99	882.61*	0.00	0.068	0.01
Crosses	Y1	29	67.16**	54.64**	3.71**	8.20**	53.91**	5353.74**	0.33**	26.80**	8.81**
	Y2	29	73.70*	50.38**	2.91**	6.76**	43.64**	5291.69**	0.27*	29.216**	8.56**
	Pooled	29	114.00	94.03**	6.18**	14.04**	91.55**	10642.47**	0.50**	29.67 **	16.49**
Lines	Y1	9	73.17	79.23	2.52	8.69	63.29	4240.17	0.53	31.36	13.35
	Y2	9	145.26**	53.19	2.35	8.79	66.71	4170.00	0.51*	37.69	18.79**
	Pooled	9	186.83*	118.09	4.56	16.69	122.70	8408.10	0.92*	47.43*	30.45*
Testers	Y1	2	142.38	39.92	5.99	13.58	82.62	3694.68	0.38	8.46	3.62
	Y2	2	101.56	21.04	11.50*	5.43	60.67	3449.35	0.33	49.23	2.61
	Pooled	2	236.80*	58.80	16.97	17.68	137.37	7141.24	0.57	48.36	5.61
Lines $\times$ Testers	Y1	18	55.80**	43.97**	4.05**	7.36**	46.02	6094.87**	0.23	26.55 **	7.11**
	Y2	18	34.82	52.23**	2.24**	5.90**	30.21	6057.24**	0.14	22.75 **	4.10**
	Pooled	18	63.94**	85.92**	5.78**	12.32**	70.88**	12148.68**	0.28*	18.72**	10.71**
Error	Y1	58	12.39	12.87	0.11	0.34	25.84	327.67	0.14	0.757	0.092
	Y2	58	40.92	14.69	0.21	0.08	18.51	60.49	0.14	0.575	0.060
	Pooled	116	26.65	13.78	0.16	0.21	22.17	194.08	0.14	0.666	0.076
Total	Y1	89	30.03	26.91	1.29	2.91	35.46	1989.82	0.20	9.263	2.931
	Y2	89	51.71	26.69	1.09	2.26	27.00	1764.14	0.18	9.915	2.828
	Pooled	179	41.11	26.70	1.18	2.57	31.06	1866.57	0.19	9.743	2.873

Table- 1.1. Contd....

Source of variation	Years	Df	Average fruit weight(g)	Number of fruits plant ⁻¹	Total soluble solids (°B)	Ascorbic acid (mg/100g)	Reducing sugars (%)	Non- reducing sugar (%)	Total sugars (%)	Dry matter content in fruit (g/100g)	Fruit yield plant ⁻¹
Replications	Y1	2	15.96	19.73*	0.00	2.71	0.00	0.00	0.00	0.03	6567.21
	Y2	2	18.53	4.50	0.00	0.47	0.00	0.00	0.01	0.010	30901.7*
	Pooled	2	12.03	4.05	0.00	0.46	0.00	0.00	0.00	0.03	4946.40
Crosses	Y1	29	744.77**	82.05**	2.33**	3407.67**	5.72**	13.62**	26.34**	2.45**	1326566.00**
	Y2	29	1150.7**	66.32**	2.06**	2739.30**	5.92**	10.91**	15.08**	1.82**	1164921.00**
	Pooled	29	1768.11**	144.17**	4.34**	6021.86**	11.34**	21.76**	38.32**	4.16**	2439772.00**
Lines	Y1	9	1771.01**	178.69**	5.88**	2787.04	11.33**	25.88*	47.46*	4.29*	3154067.00**
	Y2	9	2573.9**	143.25**	4.86**	3063.59	14.84**	20.36*	33.37**	2.99	2791069.00**
	Pooled	9	4277.35 **	316.19**	10.67**	5726.63	25.81**	44.22**	79.32**	7.09	5871786.00**
Testers	Y1	2	81.00	21.63	0.93	9899.86	5.27	16.04	39.42	1.25	536005.40
	Y2	2	543.32	11.11	0.51	8888.02*	4.86	4.08	13.48	0.68	400910.20
	Pooled	2	504.54	28.20	1.42	18710.19*	10.04	16.44	49.12	1.86	930519.90
Lines × Testers	Y1	18	305.40**	40.44**	0.71**	2996.63**	2.97**	7.22**	14.32**	1.65**	500656.00**
	Y2	18	506.66**	33.99**	0.83**	1893.96**	1.57**	6.94**	6.11**	1.36**	436737.00**
	Pooled	18	653.88**	71.05**	1.49**	4759.66**	4.25**	11.12**	16.62**	2.96**	891459.60**
Error	Y1	58	6.34	5.48	0.01	6.54	0.00	0.01	0.01	0.02	5228.77
	Y2	58	12.43	1.97	0.00	6.16	0.00	0.00	0.01	0.02	6370.99
	Pooled	116	9.39	3.73	0.00	6.35	0.00	0.00	0.01	0.02	5799.88
Total	Y1	89	247.17	30.75	0.76	1114.68	1.86	4.44	8.59	0.81	435807.10
	Y2	89	383.48	23.00	0.67	896.61	1.93	3.56	4.92	0.61	384427.30
	Pooled	179	316.56	27.30	0.71	1001.73	1.90	4.00	6.78	0.71	411451.40

Table. 1.2 Estimates of general combining ability (gca) effects of parents (lines and testers) for eighteen characters in bitter gourd over two years (Y1= 2023, Y2 = 2024) and 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		
Lines		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8	2.16	-4.01 *	-0.92	2.84*	1.43	2.14*	-0.27*	-0.29*	-0.28**	0.42	1.19**	0.81**
2.	NDBG-12	1.78	3.54	2.66*	2.02	-0.42	0.80	-0.00	-0.09	-0.04	0.74**	0.56**	0.65**
3.	NDBG-13	4.13**	-5.03**	-4.58**	-6.04**	-2.88*	-4.46**	0.54**	0.24	0.39**	-0.75**	-0.93**	-0.84**
4.	NDBG-15	0.19	1.98	1.09	1.31	0.09	0.70	-0.28**	-0.42**	-0.35**	1.17**	1.33**	1.25**
5.	NDBG-25	-3.48**	-5.12**	-4.30**	-2.82*	-3.72**	-3.27**	-1.09**	-1.08**	-1.08**	-2.14**	-1.96**	-2.05**
6.	NDBG-26	-2.03	0.87	-0.58	0.65	0.64	0.64	0.40**	0.17	0.28**	0.40	0.07	0.243*
7.	NDBG-35	0.052	-1.19	-0.57	0.52	3.40**	1.96*	-0.35**	-0.07	-0.21*	-0.40	-0.63**	-0.51**
8.	NDBG-38	4.95**	6.87**	5.91**	3.88**	3.54**	3.71**	0.70**	0.48**	0.59**	0.37	-0.03	0.17
9.	NDBG-42	2.14	3.20	2.67*	-0.16	-0.04	-0.10	0.26*	0.40**	0.33**	-0.58*	0.01	-0.28*
10.	NDBG-55	-1.65	-1.12	-1.39	-2.22	-2.04	-2.13*	0.10	0.65**	0.37**	0.75**	0.36**	0.56**
	SE (gi) lines	1.09	1.79	1.21	1.20	1.15	0.87	0.10	0.12	0.09	0.27	0.11	0.10
	SE (gi-gj)	1.54	2.54	1.72	1.70	1.63	1.23	0.14	0.18	0.13	0.38	0.16	0.15
1.	Pant Karela-1	-2.06**	-2.02 *	-2.04**	-1.22	-0.94	-1.08*	-0.32**	-0.51**	-0.41**	-0.70**	-0.35**	-0.53**
2.	Punjab Bitter Gourd-14	-0.22	0.45	0.11	1.07	0.63	0.85	-0.18**	-0.17*	-0.17***	0.06	-0.11	-0.02
3.	Punjab Bitter Gourd-15	2.28**	1.57	1.92**	0.14	0.31	0.22	0.51**	0.68**	0.59**	0.63**	0.47**	0.55**
	SE (gi) testers	0.59	0.98	0.66	0.66	0.63	0.47	0.05	0.07	0.05	0.14	0.06	0.05
	SE (gi-gj)	0.84	1.39	0.94	0.93	0.89	0.67	0.08	0.10	0.07	0.21	0.09	0.08

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Traits		Days to first harvest			Vine length (cm)			Number of primary branches plant ⁻¹			Fruit length (cm)		
Lines		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8	0.72	0.99	0.85	-19.90**	-19.52**	-19.71**	-0.13	-0.09	-0.11	-0.94**	-0.22	-0.58**
2.	NDBG-12	1.68	1.40	1.54	-12.33*	-11.55*	-11.94**	-0.25*	0.00	-0.12	0.01	-2.29**	-1.13**
3.	NDBG-13	-6.00**	-5.35**	-5.67**	16.95**	16.58**	16.77**	0.42**	0.46**	0.44**	2.28**	3.54**	2.91**
4.	NDBG-15	1.35	1.88	1.61	5.94	6.47	6.209	-0.27*	-0.06	-0.16	-0.27	-2.34**	-1.30**
5.	NDBG-25	-0.15	-3.53*	-1.84	38.46**	38.34**	38.40**	0.35**	0.34**	0.35**	1.61**	2.42**	2.01**
6.	NDBG-26	-0.57	-0.07	-0.32	-7.15	-6.51	-6.83*	0.02	-0.27*	0.12	-2.66**	-1.88**	-2.27**
7.	NDBG-35	0.57	0.36	0.46	27.14**	25.93**	26.53**	0.10	0.12	0.11	-0.26	1.51**	0.62**
8.	NDBG-38	4.334**	4.33**	4.33**	-14.15*	-14.65**	-14.40**	-0.09	-0.13	-0.11	1.06**	-1.33**	-0.13
9.	NDBG-42	-0.37	0.26	-0.05	-29.53**	-30.24**	-29.89**	-0.21	-0.18	-0.19*	2.22**	-0.25	0.98**
10.	NDBG-55	-1.56	-0.28	-0.92	-5.43	-4.83	-5.13	0.05	-0.19	-0.08	-3.05**	0.84**	-1.10**
	SE (gi) lines	1.59	1.32	1.11	5.71	5.31	3.28	0.11	0.11	0.08	0.29	0.28	0.19
	SE (gi-gj)	2.25	1.87	1.56	8.08	7.51	4.64	0.169	0.15	0.12	0.41	0.39	0.27
1.	Pant Karela-1	-1.91*	-1.53*	-1.72**	12.54**	12.07**	12.30**	0.06	0.12	0.09	0.58**	1.47**	1.03**
2.	Punjab Bitter Gourd-14	0.93	1.27	1.10	-8.52**	-8.42**	-8.47***	-0.13*	-0.07	-0.10*	-0.45**	-0.75**	-0.60**
3.	Punjab Bitter Gourd-15	0.97	0.25	0.61	-4.01	-3.65	-3.83*	0.06	-0.05	0.00	-0.13	-0.72**	-0.43**
SE (gi) testers		0.87	0.72	0.60	3.13	2.91	1.79	0.06	0.06	0.04	0.16	0.15	0.10
SE (gi-gj)		1.22	1.02	0.85	4.42	4.11	2.54	0.09	0.08	0.06	0.22	0.21	0.14

Conti....

Traits		Fruit circumference (cm)			Average fruit weight (g)			Number of fruits plant ⁻¹			Total soluble solids (°B)		
Lines		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8	0.69**	0.80**	0.74**	1.29	6.58 **	3.93**	-4.09**	-2.09**	-3.09**	0.78**	0.55**	0.66**
2.	NDBG-12	-0.16	-0.08	-0.12	-18.19**	-19.82**	-19.00**	-4.22**	-4.61**	-4.42**	0.95**	0.78**	0.86**
3.	NDBG-13	1.77**	2.38**	2.08**	19.62**	23.40**	21.51**	6.66**	7.21**	6.94**	-1.33**	-1.31**	-1.32**
4.	NDBG-15	-1.97**	-1.77**	-1.87**	-17.21**	-24.40**	-20.81**	-5.82**	-4.56**	-5.19**	0.67**	0.69**	0.68**
5.	NDBG-25	1.42**	2.01**	1.72**	22.13**	22.83**	22.48**	6.94**	6.11**	6.53**	-1.21**	-1.08**	-1.15**
6.	NDBG-26	-0.93**	-1.58**	-1.25**	-3.66**	-1.92	-2.79**	2.52**	1.14**	1.83**	0.50**	0.44**	0.47**
7.	NDBG-35	0.34	0.72**	0.53**	11.02**	14.22**	12.62**	2.02**	0.81*	1.418**	-0.52**	-0.43**	-0.47**
8.	NDBG-38	0.39	-0.78**	-0.19**	-0.33	-0.76	-0.55	-1.57*	-1.36**	-1.46**	0.17**	0.35**	0.26**
9.	NDBG-42	-1.61**	-1.13**	-1.37**	-3.91**	-4.40**	-4.15**	-0.34	-1.25**	-0.79	0.21**	0.14**	0.17**
10.	NDBG-55	0.06	-0.56*	-0.25**	-10.76**	-15.71**	-13.23**	-2.10**	-1.39**	-1.74**	-0.22**	-0.15**	-0.19**
	SE (gi) lines	0.24	0.23	0.06	1.14	1.07	0.72	0.74	0.40	0.45	0.03	0.02	0.02
	SE (gi-gj)	0.35	0.32	0.09	1.62	1.51	1.02	1.05	0.57	0.64	0.04	0.03	0.03
1.	Pant Karela-1	0.35*	0.33**	0.34**	1.75**	4.91**	3.33**	0.95*	0.42	0.69**	-0.20**	-0.15**	-0.17**
2.	Punjab Bitter Gourd-14	-0.34*	-0.13	-0.23**	-0.24	-2.51**	-1.37**	-0.66	-0.69**	-0.67**	0.11**	0.07**	0.09**
3.	Punjab Bitter Gourd-15	-0.01	-0.20	-0.10*	-1.50*	-2.39**	-1.95**	-0.29	0.27	-0.01	0.08**	0.07**	0.07**
SE (gi) testers		0.13	0.12	0.03	0.62	0.58	0.39	0.40	0.22	0.24	0.01	0.01	0.01
SE (gi-gj)		0.19	0.17	0.05	0.88	0.83	0.55	0.57	0.31	0.35	0.03	0.02	0.01

Conti....

Traits		Ascorbic acid (mg/100g)			Reducing sugars (%)			Non-Reducing sugar (%)			Total sugars (%)		
Lines		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8	-19.88**	-14.85**	-17.37**	-0.16**	-0.53**	-0.34**	-2.39**	-2.38**	-2.38**	-2.55**	-2.91**	-2.73**
2.	NDBG-12	5.13**	1.45	3.29**	-0.65**	-0.83**	-0.74**	-1.62**	-1.23**	-1.43**	-2.28**	-2.06**	-2.17**
3.	NDBG-13	36.28**	35.66**	35.97**	2.24**	2.74**	2.49**	1.06**	-0.33**	0.36**	3.31**	2.41**	2.86**
4.	NDBG-15	-11.85**	-16.29**	-14.07**	-0.72**	-0.73**	-0.72**	-1.43**	-0.46**	-0.94**	-2.15**	-1.19**	-1.67**
5.	NDBG-25	-0.60	11.67**	5.53**	1.83**	1.76**	1.80**	0.67**	0.03	0.35**	2.50**	1.80**	2.15**
6.	NDBG-26	13.00**	13.51**	13.25**	-0.72**	-0.39**	-0.56**	-2.11**	-1.69**	-1.90**	-2.83**	-2.09**	-2.46**
7.	NDBG-35	11.01**	8.99**	10.00**	0.17**	0.50**	0.34**	1.74**	1.28**	1.51**	1.92**	1.79**	1.85**
8.	NDBG-38	0.35	1.32	0.84	-0.86**	-1.03**	-0.95**	2.03**	2.12**	2.07**	1.16**	1.08**	1.12**
9.	NDBG-42	-22.07**	-25.31**	-23.69**	-0.70**	-0.95**	-0.82**	0.76**	0.96**	0.86**	0.06	0.01	0.03
10.	NDBG-55	-11.38**	-16.15**	-13.77**	-0.42**	-0.52**	-0.47**	1.28**	1.69**	1.49**	0.86**	1.16**	1.01**
	SE (gi) lines	0.80	0.83	0.59	0.02	0.02	0.01	0.03	0.02	0.02	0.05	0.04	0.02
	SE (gi-gj)	1.13	1.17	0.84	0.03	0.03	0.02	0.04	0.03	0.03	0.07	0.06	0.04
1.	Pant Karela-1	20.66**	19.84**	20.25**	0.48**	0.44**	0.46**	0.83**	0.30**	0.57**	1.32**	0.75**	1.03**
2.	Punjab Bitter Gourd-14	-13.44**	-10.86**	-12.15**	-0.26**	-0.32**	-0.29**	-0.33**	0.10**	-0.11**	-0.60**	-0.22**	-0.41**
3.	Punjab Bitter Gourd-15	-7.22**	-8.97**	-8.10**	-0.21**	-0.12**	-0.16**	-0.50**	-0.41**	-0.45**	-0.71**	-0.53**	-0.62**
	SE (gi) testers	0.43	0.45	0.32	0.01	0.01	0.008	0.01	0.01	0.01	0.02	0.02	0.01
	SE (gi-gj)	0.62	0.64	0.46	0.01	0.01	0.01	0.02	0.01	0.01	0.04	0.03	0.02

Conti....

Traits		Dry matter content in fruit (g/100g)			Fruit yield plant ⁻¹ (g)		
Lines		Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8	-0.65**	-0.79**	-0.72**	-370.87**	-98.2***	-234.55**
2.	NDBG-12	-0.75**	-0.42**	-0.58**	-577.01**	-610.92**	-593.97**
3.	NDBG-13	1.31**	1.12**	1.21**	950.11**	985.83**	967.97**
4.	NDBG-15	-0.12*	-0.12*	-0.12**	-644.09**	-679.34**	-661.72**
5.	NDBG-25	0.83**	0.74**	0.79**	1006.92**	857.31**	932.12**
6.	NDBG-26	-0.70**	-0.41**	-0.55**	28.13	-60.11*	-15.99
7.	NDBG-35	-0.05	0.07	0.00	362.51**	275.16**	318.84**
8.	NDBG-38	-0.40**	-0.40**	-0.40**	-263.07**	-145.15**	-204.11**
9.	NDBG-42	0.43**	0.07	0.25**	-125.18**	-231.93**	-178.56**
10.	NDBG-55	0.10	0.14*	0.12**	-367.43**	-292.61**	-330.02**
	SE (gi) lines	0.05	0.05	0.03	24.45	25.62	17.95
	SE (gi-gj)	0.07	0.07	0.05	34.58	36.23	25.38
1.	Pant Karela-1	0.21**	0.17**	0.19**	153.36**	133.41**	143.39**
2.	Punjab Bitter Gourd-14	-0.19**	-0.10**	-0.14**	-61.63**	-62.96**	-62.30**
3.	Punjab Bitter Gourd-15	-0.02	-0.06*	-0.04*	-91.73**	-70.44**	-81.08**
SE (gi) testers		0.02	0.02	0.02	13.39	14.03	9.83
SE (gi-gj)		0.04	0.04	0.03	18.94	19.84	13.90

Table- 1.3: Estimates of specific combining ability (sca) effects of crosses for eighteen characters in bitter melon over two years (Y1 = 2023, Y2 = 2024) and pooled

S.No.	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		
		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8xPant Karela-1	5.08**	-6.75*	-0.83	5.82**	7.24**	6.53**	0.75**	0.51*	0.63**	0.05	1.08**	0.30
2.	NDBG-8xPB-14	-4.48*	1.43	-1.52	-3.97	-3.73	-3.85*	-0.38*	0.05	-0.16	0.05	-1.52***	-0.73**
3.	NDBG-8XPB-15	-0.60	5.31	2.35	-1.84	-3.51	-2.67	-0.36*	-0.57*	-0.46**	-0.11	0.44*	0.16
4.	NDBG-12XPant Karela-1	-2.19	0.02	-1.08	-0.23	-0.47	-0.35	-0.19	-0.07	-0.13	-0.19	-0.26	-0.22
5.	NDBG-12xPB-14	2.76	0.21	1.48	-0.54	-0.54	-0.54	0.94**	0.46*	0.70**	0.02	0.91**	0.46*
6.	NDBG-12XPB-15	-0.57	-0.23	-0.40	0.77	1.03	0.89	-0.75**	-0.39	-0.57	0.16	-0.64**	-0.23
7.	NDBG-13XPant Karela -1	-2.28	0.05	-1.11	-1.06	-3.00	-2.03	-1.68	-1.09**	-1.39**	-1.71**	1.82**	-1.77**
8.	NDBG-13xPB-14	-4.07*	-2.39	-3.23	-3.38	-4.63*	-4.00*	-1.73**	-1.34**	-1.54**	-2.58**	-2.02**	-2.30**
9.	NDBG-13XPB-15	6.36*	2.33	4.35*	4.44*	7.63**	6.04*	3.42**	2.44**	2.93**	4.30**	3.85**	4.08**
10.	NDBG-15XPant Karela-1	-1.76	-0.08	-0.92	1.56	-0.97	0.29	0.13	0.26	0.19	0.97*	0.28	0.62*
11.	NDBG-15xPB-14	0.70	0.44	0.57	-1.49	1.65	0.07	-0.00	-0.37	-0.18	1.06*	0.56**	0.81**
12.	NDBG-15XPB-15	1.06	-0.35	0.35	-0.06	-0.67	-0.37	-0.13	0.10	-0.01	-2.03**	-0.85**	-1.44**
13.	NDBG-25XPant Karela-1	-0.37	1.47	0.36	-2.04	-0.05	-1.05	0.17	0.51*	0.34	0.14	0.19	0.17
14.	NDBG-25xPB-14	5.04**	0.76	2.90	5.69**	1.32	3.51**	0.49**	0.18	0.33*	0.95*	0.58**	0.77***
15.	NDBG-25XPB-15	-4.30*	-2.24	-3.27	-3.65	-1.26	-2.45	-0.66*	-0.70**	-0.68**	-1.10**	-0.78**	-0.94**
16.	NDBG-26XPant Karela-1	0.96	0.69	0.82	1.40	2.26	1.83	-0.31	-0.54*	-0.42*	0.68	0.54*	0.61**
17.	NDBG-26xPB-14	1.27	2.55	1.91	-0.22	1.45	0.61	0.34	0.03	0.19	1.08*	0.66**	0.87***
18.	NDBG-26XPB-15	2.23	3.24	-2.73	-1.17	-3.71	-2.44	-0.03	0.50*	0.23	0.39	0.12	0.26
19.	NDBG-35XPant Karela-1	-2.52	0.18	-1.17	-5.43*	-2.55	-3.99**	-0.4**	-0.37	-0.43**	-0.51	-0.32	-0.41*
20.	NDBG-35xPB-14	-1.65	-0.15	-0.90	3.63	1.13	2.38	0.23	0.44*	0.34*	0.23	0.22	0.22
21.	NDBG-35XPB-15	4.10*	-0.03	2.07	1.79	1.41	1.60	0.26	-0.07	0.09	0.27	0.10	0.19
22.	NDBG-38XPant Karela-1	-5.27**	-4.30	-4.78*	-3.05	-6.65**	-4.85**	0.92**	0.40	0.66**	-0.39	0.28	-0.05
23.	NDBG-38xPB-14	3.77	2.54	3.16	1.20	4.55*	2.87	0.35	-0.10	0.15	1.55**	0.88**	1.18**
24.	NDBG-38XPB-15	1.49	1.76	1.62	1.85	2.10	1.97	-1.28**	-0.29	-0.79**	-1.15*	-1.10**	-1.13**
25.	NDBG-42X Pant Karela-1	7.09**	6.03	6.56**	5.61**	4.65*	5.13**	0.26	0.31	0.29	0.11	-0.50*	-0.19
26.	NDBG-42xPB-14	-4.18*	-4.12	-4.15	-3.12	-2.73	-2.93	0.01	-0.09	-0.03	-0.18	0.31	0.06
27.	NDBG-42xPB-15	-2.91	-1.90	-2.40	-2.49	-1.91	-2.20	-0.28	-0.22	-0.25	0.06	0.18	0.12
28.	NDBG-55xPant Karela-1	1.63	2.69	2.16	-2.57	0.44	-1.51	0.43*	0.07	0.25	0.83	0.52*	0.68**
29.	NDBG-55xPB-14	0.83	-1.28	-0.22	2.21	1.52	1.86	-0.27	0.72**	0.22	-0.04	0.80**	0.38*
30.	NDBG-55xPB-15	2.47	-1.40	-1.93	0.36	-1.07	-0.35	-0.16	0.79**	-0.47**	-0.79	-1.33**	-1.06**
	SE (Sij)	2.67	4.40	2.98	2.96	2.83	2.14	0.25	0.31	0.23	0.66	0.28	0.26
	SE (Sij-Skl)	5.12	8.43	5.70	5.66	5.42	4.10	0.49	0.60	0.44	1.27	0.55	0.51
	CD@ 5%	3.78	6.23	4.17	4.18	4.00	3.00	0.36	0.44	0.32	0.94	0.40	0.37

Conti....

S.No.	Crosses	Days to first harvest			Vine length (cm)			Number of primary branches plant-1			Fruit length (cm)		
		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8XPant Karela 1	5.47	5.12*	5.30**	-22.59*	-23.69*	-23.14**	-0.08	-0.04	-0.06	-0.47	-1.51**	-0.99**
2.	NDBG-8xPB-14	-3.38	-3.78	-3.58	18.63	9.67*	19.15**	0.04	0.21	0.12	1.22*	-0.10	0.56
3.	NDBG-8XPB-15	-2.09	-1.34	-1.72	3.96	4.02	3.99	0.04	-0.16	0.06	-0.75	1.62**	0.43
4.	NDBG-12XPant Karela-1	-0.06	0.05	-0.00	39.95**	41.34**	40.64**	-0.23	-0.20	-0.21	2.10**	-1.16*	0.47
5.	NDBG-12xPB-14	-0.24	0.01	-0.11	52.54**	-53.09**	-52.82**	0.13	0.10	0.12	-0.20	1.31**	0.55
6.	NDBG-12XPB-15	0.31	-0.07	0.12	12.59	11.75	12.17*	0.10	0.09	0.09	-1.90**	-0.15	-1.03**
7.	NDBG-13XPant Karela -1	-0.69	-0.39	-0.54	31.66**	33.20**	32.43**	0.08	0.00	0.04	0.84	-0.10	0.36
8.	NDBG-13xPB-14	-4.53	-4.20	-4.36*	53.03**	51.00**	52.01**	0.29	0.24	0.27	1.89**	2.17**	2.03**
9.	NDBG-13XPB-15	5.22	4.59	4.91*	-84.70**	-84.20**	-84.45**	-0.37	-0.24	-0.31*	-2.73**	-2.06**	-2.40**
10.	NDBG-15XPant Karela-1	2.85	1.14	2.00	12.97	13.01	12.99*	-0.04	-0.07	-0.06	3.48**	-4.44**	-0.48
11.	NDBG-15xPB-14	-0.90	-0.59	-0.75	28.75**	28.78**	28.76**	0.05	-0.07	-0.01	-4.47**	-0.43	-2.45**
12.	NDBG-15XPB-15	-1.94	-0.55	-1.25	-41.72**	-41.79**	-41.76**	-0.00	0.15	0.07	0.98	4.87**	2.93**
13.	NDBG-25XPant Karela-1	-4.63	-1.15	-2.89	9.15	11.44	10.30	0.25	0.06	0.15	0.51	-0.13	0.19
14.	NDBG-25xPB-14	2.16	3.74	2.95	-36.77**	-37.38**	-37.08**	-0.52*	-0.32	-0.42**	-1.75**	-2.04**	-1.89**
15.	NDBG-25XPB-15	2.47	-2.59	-0.06	27.62**	25.94**	26.78**	0.26	0.26	0.26	1.24*	2.17**	1.70**
16.	NDBG-26XPant Karela-1	2.08	0.40	1.24	-66.15**	-65.68**	-65.92**	-0.18	0.07	-0.05	-1.99**	-1.54**	-1.76**
17.	NDBG-26xPB-14	0.03	0.27	0.15	38.84**	38.97**	38.91**	0.21	-0.07	0.07	1.80**	-0.02	0.88**
18.	NDBG-26XPB-15	-2.11	-0.67	-1.39	27.31**	26.70**	27.01**	-0.03	0.00	-0.01	0.19	1.56**	0.87**
19.	NDBG-35XPant Karela-1	-5.36	-4.14	-4.75*	16.48	16.59	16.54**	0.53*	0.25	0.39*	2.54**	0.22	1.38**
20.	NDBG-35xPB-14	4.20	3.16	3.68	-3.41	-3.55	-3.48	-0.27	-0.22	-0.24	-0.88	0.37	-0.25
21.	NDBG-35XPB-15	1.16	0.97	1.06	-13.07	-13.03	-13.05*	-0.26	-0.03	-0.14	-1.66**	-0.60	-1.13**
22.	NDBG-38XPant Karela-1	-3.11	-2.09	-2.60	36.65**	33.51**	35.08**	-0.19	0.05	-0.07	-0.63	0.31	-0.16
23.	NDBG-38xPB-14	1.02	-0.25	0.38	-17.08	-16.19	-16.63**	0.06	0.18	0.12	-3.01**	0.67	-1.17**
24.	NDBG-38XPB-15	2.09	2.34	2.21	-19.56	-17.32	-18.44**	0.13	-0.24	-0.05	3.64**	-0.98*	1.33**
25.	NDBG-42X Pant Karela-1	5.58*	3.75	4.66*	-36.546**	-38.22**	-37.38**	-0.10	0.09	-0.00	-5.93**	4.71**	-0.60
26.	NDBG-42xPB-14	-1.28	-1.11	-1.20	-13.47	-12.30	-12.88*	0.12	-0.24	-0.05	3.56**	-1.82**	0.87*
27.	NDBG-42xPB-15	-4.30	-2.63	-3.46	50.02**	50.52**	50.27**	-0.02	0.15	0.06	2.36**	-2.89**	-0.26
28.	NDBG-55XPant Karela-1	-2.12	-2.70	-2.41	-21.58*	-21.50*	-21.54**	-0.03	-0.21	-0.12	-0.46	3.65**	1.59**
29.	NDBG-55xPB-14	2.92	2.74	2.83	-15.97	-15.90	-15.94*	-0.13	0.18	0.02	1.83**	-0.10	0.86*
30.	NDBG-55xPB-15	-0.79	-0.04	-0.42	37.55**	37.41**	37.48**	0.17	0.03	0.10	-1.37**	-3.54**	-2.45**
	SE (Sij)	3.90	3.25	2.71	14.00	13.02	8.04	0.28	0.27	0.22	0.77	0.69	0.47
	SE (Sij-Skl)	7.47	6.22	5.20	26.82	24.93	15.40	0.55	0.52	0.42	1.38	1.32	0.90
	CD@ 5%	5.52	4.60	3.80	19.82	18.43	11.26	0.41	0.38	0.30	1.02	0.98	0.66

Conti....

S.No.	Crosses	Fruit circumference (cm)			Average fruit weight (g)			Number of fruits plant ⁻¹			Total soluble solids (°B)		
		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8XPant Karela 1	-0.60	-0.62	-0.61**	-2.37	-6.12**	-4.24**	0.16	-0.81	-0.32	-0.05	0.55**	-0.01
2.	NDBG-8xPB-14	0.72	0.58	0.65**	2.95	4.08*	3.52**	-2.54	-3.99**	-3.27**	0.04	0.78**	-0.01
3.	NDBG-8XPB-15	-0.11	0.04	-0.03	-0.58	2.03	0.72	2.38	4.81**	3.59**	0.01	-1.31**	0.02
4.	NDBG-12XPant Karela-1	0.01	0.27	0.14	5.66**	6.05**	5.86**	0.95	2.03**	1.49	0.19**	0.69**	0.06
5.	NDBG-12xPB-14	-0.59	-0.73	-0.66**	-12.14**	-1.82	-6.98**	0.27	-0.78	-0.25	-0.20**	-1.08**	-0.08*
6.	NDBG-12XPB-15	0.57	0.46	0.52**	6.47**	-4.23*	1.12	-1.23	-1.24	-1.24	0.01	0.44**	0.02
7.	NDBG-13XPant Karela -1	1.42**	0.91*	1.17**	7.16**	6.40**	6.78**	1.38	0.88	1.13	-0.21**	-0.43**	-0.24**
8.	NDBG-13xPB-14	2.16**	1.61**	1.89**	9.28**	13.93**	11.60**	3.08*	2.09**	2.58**	-0.56**	0.35**	-0.54**
9.	NDBG-13XPB-15	-3.59**	-2.53**	-3.06**	-16.45**	-20.34**	-18.39**	-4.47**	-2.97**	-3.72**	77**	0.14**	0.78**
10.	NDBG-15XPant Karela-1	-0.64	-0.17	-0.40**	-17.47**	-20.01**	-18.74**	-1.38	-1.63*	-1.50	0.05	-0.15**	0.18**
11.	NDBG-15xPB-14	0.15	-0.45	-0.15	6.68**	-12.47**	-2.89*	1.17	1.53*	1.35	-0.17**	-0.15**	-0.14**
12.	NDBG-15XPB-15	0.48	0.62	0.55**	10.79**	32.48**	21.64**	0.20	0.09	0.15	0.12*	0.07**	-0.04
13.	NDBG-25XPant Karela-1	0.82	0.52	0.67**	0.79	-1.39	-0.30	0.73	0.62	0.68	-0.16**	0.07**	-0.22**
14.	NDBG-25xPB-14	-2.11**	-1.80**	-1.95**	-5.02*	-4.89*	-4.95**	-2.84*	-1.50*	-2.17**	0.61**	0.05	0.69**
15.	NDBG-25XPB-15	1.28**	1.27**	1.28**	4.23*	6.28**	5.26**	2.10	0.88	1.49	-0.45**	0.03	-0.47**
16.	NDBG-26XPant Karela-1	-1.34**	-1.06**	-1.20**	5.68**	2.42	4.05**	-6.79**	-5.21**	-6.00**	0.52**	0.54	0.61**
17.	NDBG-26xPB-14	0.94*	0.79	0.87**	1.33	-0.00	0.66	5.82**	5.44**	5.63**	0.21**	0.01	0.12**
18.	NDBG-26XPB-15	0.39	0.26	0.33**	-7.01**	-2.41	-4.71**	0.96	-0.23	0.36	-0.74**	0.13	-0.74**
19.	NDBG-35XPant Karela-1	1.50**	1.38**	1.44**	8.16**	5.01**	6.58**	5.19**	.76**	5.48**	-0.59**	0.27	-0.57**
20.	NDBG-35xPB-14	-0.37	-0.51	-0.44**	-3.50	0.02	-1.74	-3.46**	-2.91**	-3.18**	0.21**	0.00	0.21**
21.	NDBG-35XPB-15	-1.13*	-0.87*	-1.00**	-4.65*	-5.03**	-4.84**	-1.73	-2.85**	-2.29**	0.38**	0.27	0.36**
22.	NDBG-38XPant Karela-1	-1.54**	-1.10**	-1.32**	5.35**	10.98**	8.16**	3.81**	2.74**	3.27**	-0.55**	0.27	-0.59**
23.	NDBG-38xPB-14	-0.34	0.58	0.12	-12.15**	-6.43**	-9.29**	-0.07	-0.93	-0.50	0.18**	1.00	0.19**
24.	NDBG-38XPB-15	1.88**	0.52	1.20**	6.80**	-4.55*	1.12	-3.73**	-1.80*	-2.77**	0.36**	0.99	0.40**
25.	NDBG-42X Pant Karela-1	0.78	0.43	0.61**	-10.05**	-9.34**	-9.69**	-2.92*	-1.76*	-2.34**	0.61**	0.55	0.64**
26.	NDBG-42xPB-14	-0.66	-0.31	-0.49**	3.90	13.39**	8.65**	-0.90	-0.13	-0.52	-0.17**	1.10	-0.29**
27.	NDBG-42XPB-15	-0.11	-0.11	-0.11	6.14**	-4.05*	1.04	3.82**	1.89**	2.86**	-0.44**	0.50	-0.35**
28.	NDBG-55XPant Karela-1	-0.41	-0.55	-0.48**	-2.91	5.98**	1.53	-1.15	-2.62**	-1.89*	0.18*	1.41	0.13**
29.	NDBG-55xPB-14	0.09	0.24	0.16	8.67**	-5.81**	1.43	-0.53	1.19	0.32	-0.15*	0.55	-0.14**
30.	NDBG-55xPB-15	0.31	0.31	0.31**	-5.75**	-0.17	-2.96*	1.69	1.43*	1.56	-0.03	49.83	0.00
	SE (Sij)	0.61	0.56	0.15	2.80	2.63	1.76	1.82	0.99	1.11	0.08	0.06	0.05
	SE (Sij-Skl)	1.17	1.08	0.30	5.37	5.03	3.38	3.49	1.90	2.13	0.15	0.12	0.10
	CD@ 5%	0.86	0.80	0.22	3.97	3.72	2.47	2.58	1.40	1.56	0.11	0.76	0.07

Conti....

S.No.	Crosses	Ascorbic acid (mg/100g)			Reducing sugars (%)			Non-reducing sugar (%)			Total sugars (%)		
		Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8XPant Karela 1	21.89**	13.51**	17.70**	0.73**	0.14**	0.44**	-0.23**	-0.38**	-0.31**	0.50**	-0.24**	0.12*
2.	NDBG-8xPB-14	-7.11**	-9.82**	-8.46**	-0.94**	-0.47**	-0.70**	0.50**	0.34**	0.42**	-0.44**	-0.12	-0.28**
3.	NDBG-8XPB-15	-14.77**	-3.69*	-9.23**	0.20**	0.32**	0.26**	-0.26**	0.04	0.11*	-0.06	0.37**	0.15**
4.	NDBG-12XPant Karela-1	-4.24**	-4.27**	-4.25**	-0.41**	-0.36**	-0.39**	0.92**	1.24**	1.08**	0.50**	0.88**	0.69**
5.	NDBG-12xPB-14	27.98**	25.69**	26.83**	0.07	0.15**	0.11**	-0.58**	-0.97**	-0.77**	-0.51**	-0.82**	-0.66**
6.	NDBG-12XPB-15	-23.73**	-21.42**	-22.57**	0.34**	0.20**	0.27**	-0.34**	-0.27**	-0.30**	0.00	-0.06	-0.03
7.	NDBG-13XPant Karela -1	-10.78**	-10.84**	-10.81**	0.41**	0.03	0.22**	0.55**	0.08	0.31**	0.96**	0.11	0.53**
8.	NDBG-13xPB-14	23.36**	20.07**	21.71**	1.17**	0.84**	1.01**	1.76**	0.27**	1.02**	2.94**	1.12**	2.03**
9.	NDBG-13XPB-15	-12.57**	-9.22**	-10.90**	-1.58**	-0.88**	-1.23**	-2.32**	-0.35**	-1.33**	-3.90**	-1.23**	-2.57**
10.	NDBG-15XPant Karela-1	8.30**	14.41**	11.35**	-0.54**	-0.32**	-0.43**	1.61**	3.23**	2.42**	1.06**	2.90**	1.98**
11.	NDBG-15xPB-14	-30.03**	-25.05**	-27.54**	0.36**	0.31**	0.34**	-0.71**	-1.61**	1.16**	-0.34**	-1.29**	-0.82**
12.	NDBG-15XPB-15	21.73**	10.64**	16.18**	0.18**	0.01	0.09**	-0.90**	-1.61**	-1.25**	-0.71**	-1.60**	-1.16**
13.	NDBG-25XPant Karela-1	21.10**	8.15**	14.62**	0.38**	0.33**	0.36**	0.87**	-0.41**	0.22**	1.25**	-0.07	0.58**
14.	NDBG-25xPB-14	-70.14**	-45.42**	-57.78**	-1.51**	-1.34**	-1.42**	-3.11**	0.02	1.54**	4.62**	-1.32**	-2.97**
15.	NDBG-25XPB-15	49.04**	37.27**	43.15**	1.13**	1.00**	1.06**	2.24**	0.39**	1.31**	3.37**	1.39**	2.38**
16.	NDBG-26XPant Karela-1	-34.94**	-30.77**	-32.86**	-0.54**	-0.08*	-0.31**	0.23**	-0.60**	-0.18**	-0.31**	-0.69**	-0.50**
17.	NDBG-26xPB-14	17.54**	11.23**	14.39**	0.56**	0.34**	0.45**	-0.52**	0.14**	-0.19**	0.03	0.48**	0.26**
18.	NDBG-26XPB-15	17.39**	19.53**	18.46**	-0.01	-0.25**	-0.13**	0.29**	0.46**	0.37**	0.27**	0.20*	0.24**
19.	NDBG-35XPant Karela-1	7.53**	7.02**	7.27**	1.83**	1.39**	1.61**	-0.60**	-1.77**	-1.19**	1.23**	-0.37**	0.43**
20.	NDBG-35xPB-14	1.59	3.09*	2.34*	-0.98**	-0.24**	-0.61**	-0.76**	-1.07**	-0.92**	-1.75**	-1.31**	-1.53**
21.	NDBG-35XPB-15	-9.12**	-10.11**	-9.62**	-0.84**	-1.15**	-1.00**	1.37**	2.85**	2.11**	0.52**	1.69**	1.10**
22.	NDBG-38XPant Karela-1	-26.36**	-22.22**	-24.29**	-0.82**	-0.45**	-0.64**	-0.66**	-0.25**	-0.46**	-1.49**	-0.70**	-1.10**
23.	NDBG-38xPB-14	2.38	-3.45*	-0.53	0.60**	0.26**	0.43**	0.32**	-0.39**	-0.03	0.93**	-0.12	0.40**
24.	NDBG-38XPB-15	23.98**	25.67**	24.82**	0.22**	0.18**	0.20**	0.34**	0.64**	0.49**	0.56**	0.83**	0.69**
25.	NDBG-42X Pant Karela-1	21.01**	21.96**	21.48**	-0.57**	-0.37**	-0.47**	-1.92**	-0.25**	-1.09**	-2.49**	-0.63**	-1.56**
26.	NDBG-42xPB-14	8.12**	4.15**	6.13**	0.15**	0.14**	0.14**	1.80**	1.19**	1.49**	1.95**	1.33**	1.64**
27.	NDBG-42xPB-15	-29.14**	-26.11**	-27.62**	0.42**	0.22**	0.32**	0.12*	-0.93**	-0.40**	0.54**	-0.70**	-0.08
28.	NDBG-55xPant Karela-1	-3.50*	3.06*	-0.21	-0.46**	-0.30**	-0.38**	-0.76**	-0.86**	-0.81**	-1.22**	-1.17**	-1.20**
29.	NDBG-55xPB-14	26.31**	19.49**	22.90**	0.51**	-0.01	0.24**	1.30**	2.08**	1.69**	1.82**	2.06**	1.94**
30.	NDBG-55xPB-15	-22.81**	-22.5**	-22.68**	-0.05	0.32**	0.13**	-0.54**	-1.219**	-0.88**	-0.59**	-0.88**	-0.74**
	SE (Sij)	1.96	2.04	1.45	0.05	0.05	0.03	0.07	0.06	0.05	0.12	0.11	0.07
	SE (Sij-Skl)	3.76	3.90	2.76	0.11	0.11	0.06	0.15	0.11	0.10	0.24	0.21	0.19
	CD@ 5%	2.78	2.88	2.03	0.08	0.08	0.05	0.11	0.08	0.07	0.18	0.15	0.10

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S.No.	Crosses	Dry matter content in fruit (g/100g)			Fruit yield plant ⁻¹ (g)		
		Y1	Y2	Pooled	Y1	Y2	Pooled
1.	NDBG-8XPant Karela 1	0.05	-0.06	-0.00	8.81	-175.79**	-83.48**
2.	NDBG-8xPB-14	-0.03	-0.00	-0.02	-293.24**	-228.94**	-261.09**
3.	NDBG-8XPB-15	-0.01	0.06	0.02	284.42**	404.73**	344.58**
4.	NDBG-12XPant Karela-1	-0.32*	-0.28**	-0.30**	52.14	129.27**	90.71**
5.	NDBG-12xPB-14	0.32**	0.30**	0.31**	-155.37**	-62.87	-109.12**
6.	NDBG-12XPB-15	-0.00	-0.02	-0.01	103.22*	-66.40	18.41
7.	NDBG-13XPant Karela -1	0.31**	0.32**	0.32**	256.11**	249.11**	252.61**
8.	NDBG-13xPB-14	0.77**	0.61**	0.69**	481.94**	455.77**	468.86**
9.	NDBG-13XPB-15	-1.08**	-0.93**	-1.01**	-738.05**	-704.88**	-721.47**
10.	NDBG-15XPant Karela-1	-0.87**	-0.95**	-0.91**	-389.45**	-371.21**	-380.33**
11.	NDBG-15xPB-14	0.51**	0.54**	0.53**	175.69**	-131.06**	22.31
12.	NDBG-15XPB-15	0.35**	0.40**	0.37**	213.76**	502.27**	358.01**
13.	NDBG-25XPant Karela-1	0.53**	0.57**	0.55**	55.09	34.92	45.01
14.	NDBG-25xPB-14	-1.33**	-1.40**	-1.36**	-370.43**	-292.42**	-331.43**
15.	NDBG-25XPB-15	0.79**	0.83**	0.81**	315.33**	257.50**	286.41**
16.	NDBG-26XPant Karela-1	-0.26**	-0.12	-0.19**	-365.82**	-288.65**	-327.23**
17.	NDBG-26xPB-14	0.20*	0.15	0.18**	415.85**	293.82**	354.83**
18.	NDBG-26XPB-15	0.05	-0.03	0.01	-50.03	-5.17	-27.60
19.	NDBG-35XPant Karela-1	1.08**	0.85**	0.96**	553.38**	548.18**	550.78**
20.	NDBG-35xPB-14	-0.53**	-0.33**	-0.43**	-342.25**	-273.88**	-308.06**
21.	NDBG-35XPB-15	-0.54**	-0.52**	-0.53**	-211.13**	-274.29**	-242.71**
22.	NDBG-38XPant Karela-1	-0.58**	-0.13	-0.38**	432.32**	348.94**	390.63**
23.	NDBG-38xPB-14	-0.15	-0.22*	-0.19**	-81.01	-196.20**	-138.60**
24.	NDBG-38XPB-15	0.73**	0.35**	0.54**	-351.31**	-152.74**	-252.02**
25.	NDBG-42X Pant Karela-1	-0.41**	-0.36**	-0.38**	-424.95**	-271.57**	-348.26**
26.	NDBG-42xPB-14	-0.04	-0.10	-0.07	24.73	198.54**	111.64**
27.	NDBG-42xPB-15	0.45**	0.46**	0.45**	400.21**	73.02	236.62**
28.	NDBG-55xPant Karela-1	0.46**	0.16	0.31**	-177.65**	-203.22**	-190.44**
29.	NDBG-55xPB-14	0.28**	0.41**	0.35**	144.09**	237.25**	190.67**
30.	NDBG-55xPB-15	-0.74**	-0.59**	-0.67**	33.56	-34.02	-0.22
	SE (Sij)	0.13	0.13	0.09	59.89	62.76	43.96
	SE (Sij-Skl)	0.25	0.25	0.16	114.69	120.19	84.19
	CD@ 5%	0.18	0.18	0.13	84.77	88.84	61.57

References

- Acharya, S. K., Kaushik, R. A., Ameta, K. D., Dubey, R. B., & Upadhya, B. 2019. Heterosis and combining ability in bitter gourd (*Momordica charantia* L.). *J. of Pharm and Phyto.*, 8(1S), 537-544
- Anonymous, 2021-2022. Area, production and productivity of bitter gourd (*Momordica charantia* L.) in India, Department of agriculture, Government of India.
- Dhiman K, Gupta A, Sharma DK, Gill NS, Goyal A. 2012. A Review on the Medicinally Important Plants of the Family Cucurbitaceae. *Asian J. of Cli. Nutrition.* 4(1):16-26.
- Janaranjani, K.G., Kanthaswamy, V. and Kumar, R.S. 2016. Heterosis, combining ability, and character association in bottle gourd for yield attributes. *Int. J. Veg. Sci.* 22(5): 490-515.
- Kocyan, A., Zhang, L. B., Schaefer, H. and Renner, S. S. 2007. A multilocus Chloroplast phylogeny for the Cucurbitaceae and its implications for character evolution and classification. *Mol. Phylogen Evol.* 44: 533-577.
- Kumar, A., Yadav, G.C., Prasad, R., Singh, A.K. and Pandey, V. 2014. Influence of gene action in diallel crossing on bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] hybrids. *Bioscan.* 9(2): 783-787.
- Morton, J.F. 1967. The balsam pear an edible medicinal and toxic plant. *Economic Botany.* 212: 57-68.
- Ray, P.K., Yadav, G.C., Baranwal, D.K. and Singh, H.K. 2015. Genetic estimates and gene action for obtaining promising heterotic hybrids in bottle gourd [*(Lagenaria siceraria* (Mol.) Standl.)]. *The Bioscan.* 10(2): 801-806.
- Singh, A. K. Pan, R. S., and Bhavana, P. 2013. Heterosis and combining ability analysis in bitter gourd (*Momordica charantia* L.). *The Bioscan*, 8(4): 1533-1536.