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Evaluation of growth, yield, and biochemical attributes of bitter gourd (*Momordica charantia* L.)

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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 F_1 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. In pooled, fruit yield per plant ranged from 752.12 to 2588.97 for parents and 336.89 to 2610.09 for hybrids. Parent NDBG-13 (2588.97) found to have highest fruit yield per plant among the parents which was followed by NDBG -25 (2348.75), NDBG- 35 (2238.33), NDBG-55 (1696.75). The best F1 hybrid for fruit yield per plant was NDBG-13 × PB-14 (2610.09) followed by NDBG-2 x PB-15 (2373.01), NDBG-25 x Pant Karela-1 (2356.08), NDBG-35 x Pant Karela-1 (2248.57).

Keywords: Bitter gourd, lines, yield, earliness, biochemical parameters

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 (Jeffrey, 1990 and Singh *et al*. 2013) [9, 20]. 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, Dhiman *et al*., 2012) [11, 8].

The name "*Momordica*" is derived from a Latin word, which means "to bite", referring to the ridged edges of its seed which appears as if it has been chewed. It is believed to be originated from Tropical Asia particularly Eastern India and South China. As it has been originated from old world tropics and disseminated over new world tropics, where it firstly arrived in Brazil through the slave traders of Africa and later on spread in Central America (Miniraj *et al*. 1993) [13]. The wild species *Momordica charantia* var. *abbreviata*, a native of Asia, is reported to be the progenitor of domesticated bitter gourd (Acharya *et al*. 2019). Bitter melon is largely distributed in China, Indo-Burman (center of origin), India, Malaysia, tropical Africa, North and South America (Miniraj *et al*. 1993) [13].

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) [3].

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) [14, 1]. Bitter gourd is well known for its high nutritive value particularly high ascorbic acid and iron content (Behera, 2004 and Bharathi and John, 2013) [5, 6]. The fruits of bitter gourd are commonly used as a vegetable and are well known for its medicinal properties (Robinson and Decker-Walters, 1997 and Kumari *et al*. 2018) [6, 12]. It also supplies health benefits against a range of diseases for a better life. It is a nutrient-rich vegetable contains diverse bioactive compounds such as alkaloids, phytochemicals, especially antioxidants, vitamins, and minerals.

These compounds have the ability to fight against cancer, diabetes, abdominal pain, kidney (stone), fever as well as scabies (Joseph and Jini, 2013; and Saeed *et al*. 2018) [10, 17].
Fruit yield is the most important component in crop improvement and is directly influenced by the other yield related variables. Desirable genotypes should be chosen based on yield as well as other yield related characteristics. Information on the yield and yield-related contributing factors is important for selection of the available genetic stocks in bitter gourd crop development program (Chinthan *et al.* 2021) [7]. The development and selection of material for earliness, high yield and quality are important aspects to be addressed to strengthen the breeding material of bitter gourd for future use and for commercialization.

Materials and Methods

The experimental plant material comprised of 30 F_1 hybrids and their 13 parents (10 lines and 3 testers) of bitter gourd. 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. All the recommended agronomic package of practices and protection measures were followed to raise good crops by 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 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

Days to first staminate flower anthesis ranged from 52.22 to 65.12 days for parents and 52.06 to 69.27 days for hybrids. Parent NDBG-13 (52.22 days) showed earliest for days to first staminate flower anthesis which was followed by NDBG- 25 (54.18 days), NDBG- 35 (55.66 days) and NDBG- 8(58.31 days). The best F1 hybrids for days to first staminate flower anthesis were NDBG-13XPB-14 (52.10), NDBG-25xPant Karela-1 (53.83), NDBG-25xPB-15 (54.15) and NDBG-35x Pant Karela-1 (56.02). Averages over the parental mean (59.79 days) and averages over the F1 hybrid mean (59.80 days) were more or less of the same order. Study conducted by Priyadarshini *et al* (2018) [15] are in agreement with our study and conveyed that variation for number of days for anthesis of first male flower after seed sowing from 51.83 to 54.83 and it was minimum in genotype MCM-14 (51.83) and maximum in MCM-11 (54.83).
Days to first pistillate flower anthesis ranged from 58.70 to 69.12 days for parents and 58.52 to 73.72 days for hybrids. Parent NDBG-13 (58.70 days) showed earliest for days to first pistillate flower anthesis which was followed by NDBG- 25 (60.76 days), NDBG- 35 (61.79 days), NDBG-55 (63.75) and NDBG- 38(65.35 days). The best F1 hybrids for days to first pistillate flower anthesis were NDBG-13× PB-14 (58.52 days) followed by NDBG-13× Pant Karela-1 (58.55 days), NDBG-55xPant Karela-1 (60.40), NDBG-25× PB-15 (60.63 days) and NDBG-25× Pant Karela-1 (60.72)). Averages over the parental mean (65.71 days) and averages over the F1 hybrid mean (66.13 days) were more or less of the same order. Similarly, Saranyadevi *et al* (2017) [18] also recorded that the genotypes MCM-9 took maximum (41.83) days to produce first female flower whereas MC-6 took minimum (30.33) days to produce first female flower followed by MC-15 (30.35) and MC-19 (30.95).
Node number to first staminate flower appearance ranged from 1.87 to 3.27 nodes for parents and 1.65 to 7.00 nodes for hybrids. Parent NDBG-13 (1.87 nodes) showed earliest for node number to first staminate flower appearance which was followed by NDBG- 15 (1.96 nodes), NDBG- 25 (1.99), NDBG- 35 (2.11) and NDBG- 8(2.52 nodes). The best F1 hybrids for node number to first male flower appearance were NDBG-13× Pant karela-1 (1.65 nodes) followed by NDBG-13× PB-14 (1.75 nodes), NDBG-25× PB-15 (1.90 nodes), NDBG-25× Pant Karela-1 (1.91 nodes) and NDBG- 35 × Pant Karela-1 (2.00 nodes). Averages over the parental mean (2.90 nodes) and averages over the F1 hybrid mean (3.07 nodes) were more or less of the same order. Thakur *et al* 2018 also observed similar findings where morphological traits, node number to 1st staminate flower was lowest in the genotype P-14 (9.21) and highest observed in genotype Preeti (22.34) in bitter gourd.
Node number to first pistillate flower appearance ranged from 4.45 to 10.64 nodes for parents and 4.55 to 11.52 nodes for hybrids. Parent NDBG-15 (4.45 nodes) showed earliest for node number to first pistillate flower appearance which was followed by NDBG- 13 (4.72 nodes), NDBG- 25 (5.52 nodes), NDBG- 35 (6.33) and Pant Karela-1 (7.26 nodes). The best F1 hybrid for node number to first female flower appearance was NDBG- 13× PB-14 (4.55 nodes) followed by NDBG- 13× Pant Karela-1 (4.58 nodes), NDBG- 25× PB-15 (5.28 nodes), NDBG- 25× Pant Karela-1 (5.31 nodes) and NDBG-25 × PB-14 (6.42 nodes). Averages over the parental mean (7.74nodes) and averages over the F1 hybrid mean (7.72 nodes) were more or less of the same order. Similar observation was also reported by Thakur *et al* 2018 where morphological traits, node number 1st pistillate flower was lowest in the genotypes Solan Hara (11.57) and highest in the genotypes Preeti (25.53) variety of bitter gourd.
Vine length (cm) ranged from 210.68 to 360.71 (cm) for parents and 217.11 to 351.85 (cm) for hybrids. Parent NDBG-13 (360.71cm) found maximum vine length among the parents which was followed by NDBG-25 (350.64 cm), NDBG- 35 (345.66 cm), NDBG-12 (309.68 cm) and NDBG- 26 (2.81 cm). The best F1 hybrid for vine length (cm) was NDBG-13x Pant Karela-1 (351.85 cm) followed by NDBG-25× PB-15 (351.69 cm), NDBG-25 × Pant Karela-1 (351.35 cm), NDBG-13× PB-14 (350.66 cm) and NDBG-35 × Pant Karela-1 (345.73 cm). Averages over the parental mean (6.02 cm) and averages over the F1 hybrid mean (6.32 cm) were more or less of the same order. Adarsh *et al* (2019) [19] observed smallest in Pusa Rasdar (1.32 cm) and longest vine length for entry bitter kathi (294 cm).
Number of primary branches per plant ranged from 5.28 to 6.17 branches for parents and 5.23 to 6.21 branches for hybrids. Parent NDBG-25 (6.17 branches) found highest for primary branches per plant among the parents which was followed by NDBG-13 (6.13 branches), NDBG-35 (6.13 branches), NDBG- 26 (5.57) and NDBG- 55 (5.61

branches). The best F1 hybrid for number of primary branches per plant was NDBG-25× PB-15 (6.21 branches) followed by NDBG-13× PB-14 (6.20), NDBG-25× Pant Karela-1 (6.19), NDBG-35× Pant Karela-1 (6.19 branches) and NDBG-13× Pant Karela-1 (6.16). Averages over the parental mean (16.88 branches) and averages over the F1 hybrid mean (17.50 branches) were more or less of the same order.

Fruit length (cm) ranged from 8.54 to 16.56 (cm) for parents and 7.02 to 15.73 (cm) for hybrids. Parent NDBG- 13 (16.56 cm) exhibited maximum fruit length among the parents which was followed by NDBG- 25 (14.55 cm), NDBG-26 (14.40 cm), NDBG- 35 (14.14 cm) and NDBG- 55 (13.78 cm). The best F1 hybrid for fruit length was NDBG-13× PB-14 (15.73 cm) followed by NDBG-13× Pant Karela-1 (15.70 cm), NDBG-25× PB-15 (14.68 cm), NDBG-25× Pant Karela-1 (14.63 cm) and NDBG-35× Pant Karela-1 (14.43 cm). Averages over the parental mean (3.19 cm) and averages over the F1 hybrid mean (32.54 cm) were more or less of the same order. Thakur et al (2018) did similar work and reported the range for fruit length varied from 18.0 cm to 19.27 cm. In entry Solan Hara it was 19.27 cm and in Charu 18.0 cm.

Fruit circumference (cm) ranged from 8.01 to 12.45 (cm) for parents and 6.64 to 12.64 (cm) for hybrids. Parent NDBG-13 (12.45 cm) found maximum fruit circumference among the parents which was followed by NDBG-25 (11.55 cm), NDBG-35 (11.15), NDBG-26 (10.24) and NDBG-12 (10.01 cm). The best F1 hybrids for fruit circumference were NDBG-13× PB-14 (12.64cm) followed by NDBG-13× Pant Karela -1 (12.50 cm), NDBG-25× PB-15 (11.80 cm) and NDBG-25× Pant Karela -1 (11.64 cm). Averages over the parental mean (25.05 cm) and averages over the F1 hybrid mean (25.95 cm) were more or less of the same order.

Average fruit weight (kg) varied from 44.62 to 93.15 (kg) for parents and 25.63 to 93.60 (kg) for hybrids. The parent NDBG-13 (93.15 g) produced heaviest average fruit weight among the parents which was followed by NDBG- 25 (87.27 g), NDBG- 35 (84.31 g), NDBG- 15 (72.50 g) and NDBG- 55 (69.16 g). Among the hybrids, the highest fruit weight was exhibited by NDBG- 13× PB-14 (93.60 g) followed by NDBG- 13× Pant Karela-1 (93.49 g), NDBG-25× PB-15 (87.65 g), NDBG- 25× Pant Karela-1 (87.38 g) and NDBG- 35× Pant Karela-1 (84.40 g), in descending order. Averages over the parental mean (0.88 g) and averages over the F1 hybrid mean (0.90 g) were more or less of the same order. Saranyadevi et al (2017) [18] also found similar results where the lowest was observed in MCM-5 (2.35 g) and highest individual fruit weight was noted in MCM-20 (24.10 g).

Number of fruits per plant varied from 10.91 to 27.80 fruits for parents and 12.00 to 27.90 fruits for hybrids. The parent NDBG- 13 (27.80 fruits) produced maximum number of fruits per plant among the parents which was followed by NDBG- 25 (26.90 fruits), NDBG- 35 (26.55 fruits), NDBG-55 (24.50 fruits) and NDBG- 42 (20.67 fruits). Among the hybrids, the maximum number of fruits was exhibited by NDBG- 13× PB-14 (27.90 fruits) followed by NDBG- 13× Pant Karela-1 (27.82 fruits), NDBG- 25× PB-15 (27.06 fruits), NDBG- 25× Pant Karela-1 (26.95 fruits) and NDBG-35× Pant Karela-1 (26.64 fruits) in descending order. Averages over the parental mean (5.91 fruits per plant) and averages over the F1 hybrid mean (6.82 fruits per plant) were more or less of the same order**.** Similar results were observed by Priyadarshini *et al* (2018) [15] where the genotypes MCM-15 (22.15) was found minimum and MCM-23 (89.67) was found maximum number of fruits.

Days to first harvest ranged from 68.06 to 82.16 days for parents and 65.92 to 81.69 days for hybrids. Parent NDBG-13 (68.06 days) found earliest for days to first harvest among the parents which was followed by NDBG- 35 (68.50 days), NDBG- 25 (69.32 days), NDBG- 38(70.32 days) and NDBG- 8(70.44 days). The best F1 hybrid for days to first harvest was NDBG- 13× PB-14 (65.92 days) followed by NDBG- 13× Pant Karela-1 (66.91 days), NDBG- 25× Pant Karela-1 (68.39 days), NDBG- 35× Pant Karela-1 (68.84 days) and NDBG- 55× Pant Karela-1 (70.24). Averages over the parental mean (61.25 days) and averages over the F1 hybrid mean (60.24 days) were more or less of the same order.

The total sugars (%) varied from 2.14 to 9.63 (%) for parents and 1.76 to 9.71 (%) for hybrids. The mean values over the parental lines and F1 hybrids were 3.23 and 3.32 (%), respectively. The parent NDBG- 13 (9.63%) recorded highest total sugars followed by NDBG-25 (8.85 %), NDBG- 35 (8.48), NDBG- 42 (7.36 %) and NDBG- 8(6.18 %). Among the hybrids, highest total sugars content was exhibited by NDBG- 13× PB-14 (9.71 %) followed by NDBG- 13× Pant Karela-1 (9.76 %), NDBG- 25× PB-15 (9.14 %), NDBG- 25× Pant Karela-1 (9.01 %) NDBG- 55× PB-15 (7.77) and NDBG- 25× PB-15 (7.65 %). Similar results were recorded by Adarsh *et al* (2019) [19] where lowest in the genotype Bitter Kathi (0.22 g/100 g) and highest total sugar was observed in Gangajalee small (0.96 g/100 g) variety of bitter gourd.

Ascorbic acid ranged from 140.75 to 55.52 for parents and 141.02 to 31.08 for hybrids. Parent NDBG-13 (140.75) found to have highest ascorbic acid content which was followed by NDBG- 25 (135.76), NDBG- 35 (132.97) and NDBG-55 (120.35). The best F1 hybrids for ascorbic acid content were NDBG-13XPB-14 (141.02), NDBG-13xPant Karela-1 (140.90), NDBG-25xPB-15 (136.07) and NDBG-35x Pant Karela-1 (133.03). Averages over the parental mean (59.79 days) and averages over the F1 hybrid mean (59.80 days) were more or less of the same order. Similar results have been noted by Behera and Kaur (2006) [4] where the highest amount of ascorbic acid was found in genotype DBTG-3 (122.07 mg) followed by DBTG-8 (120.53 mg), DBTG-6 (115.13 mg), DBTG-9 (108.43 mg), DBTG-7 (100.67 mg) and DBTG-4 (92.15 mg).

Reducing sugar ranged from 1.44 to 5.20 for parents and 0.70 to 5.26 for hybrids. Parent NDBG-13 (5.20) found to have highest reducing sugar content which was followed by NDBG- 25 (4.60), NDBG- 35 (4.45) and NDBG-12 (3.28). The best F1 hybrids for reducing sugar content were NDBG-13XPB-14 (5.26), NDBG-13xPant Karela-1 (5.23), NDBG-25xPB-15 (4.75) and NDBG-25x Pant Karela-1 (4.68). Averages over the parental mean (59.79 days) and averages over the F1 hybrid mean (59.80 days) were more or less of the same order.

Non-reducing sugar ranged from 0.34 to 4.84 for parents and 0.22 to 6.35 for hybrids. Parent NDBG-42 (4.84) found to have highest non-reducing sugar content which was followed by NDBG- 13 (4.43), NDBG- 25 (4.25) and NDBG-35 (4.03). The best F1 hybrids for non-reducing sugar content were NDBG-35XPB-14 (6.35), NDBG-55xPB-14 (6.25), NDBG-42xPB-14 (5.42) and NDBG-38x PB-15 (5.29). Averages over the parental mean (59.79 days)

and averages over the F1 hybrid mean (59.80 days) were more or less of the same order. Similar results were recorded by Sidhu et al (2017) where the lowest non-reducing sugar in the genotype PBBG-7 (0.6) and PBBG-6 showed highest (2.35) with the grand mean was 1.60.

Dry matter ranged from 7.05 to 9.70 for parents and 7.11 to 9.76 for hybrids. Parent NDBG-13 (9.70) found to have highest dry matter content which was followed by NDBG-25 (9.50), NDBG- 35 (9.15) and NDBG-26 (8.89). The best F1 hybrids for dry matter content were NDBG-13XPB-14 (9.76), NDBG-25xPB-15 (9.57), NDBG-25xPant Karela-1(9.55) and NDBG-35x Pant Karela-1(9.18). Averages over the parental mean (59.79 days) and averages over the F1 hybrid mean (59.80 days) were more or less of the same order.

Total soluble solids ranged from 2.04 to 5.28 for parents and 1.94 to 4.68 for hybrids. Parent Punjab Bitter Gourd-15 (5.28) found to have highest total soluble solids content among the parents which was followed by Punjab Bitter Gourd -14 (5.17), NDBG-55 (4.26), NDBG- 26 (3.50). The best F1 hybrids for total soluble solids content were NDBG-12xPB-15 (4.68), NDBG-26xPant Karela-1(4.62), NDBG-12xPB-14 (4.59) and NDBG-8x PB-15 (4.48). Averages over the parental mean (59.79 days) and averages over the F1 hybrid mean (59.80 days) were more or less of the same order.

Fruit yield per plant ranged from 752.12 to 2588.97 for parents and 336.89 to 2610.09 for hybrids. Parent NDBG-13 (2588.97) found to have highest fruit yield per plant among the parents which was followed by NDBG -25 (2348.75), NDBG- 35 (2238.33), NDBG-55 (1696.75). The best F1 hybrid for fruit yield per plant was NDBG-13× PB-14 (2610.09) followed by NDBG-25x PB-15 (2373.01), NDBG-25xPant Karela-1 (2356.08), NDBG-35XPantKarela-1 (2248.57). Averages over the parental mean (59.98 days) and averages over the F1 hybrid mean (60.31 days) were more or less of the same order.

Table 1: Mean performance of genotypes for different agronomic and quality traits based on pooled data of 2023 and 2024

S. No.	Genotypes Crosses	Days to first pistillate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower appearance	Node number to first pistillate flower appearance	Vine length (cm)	Number of primary branches per plant	Fruit length (cm)	Fruit Circumference (cm)
1	NDBG-8 x Pant Karela-1	56.00	73.72	3.00	8.57	259.79	5.50	10.83	9.38
2	NDBG-8xPB-14	57.47	65.2	2.44	7.78	281.31	5.50	10.76	10.06
3	NDBG-8XPB-15	63.16	65.8	2.91	9.25	270.78	5.42	10.80	9.51
4	NDBG-1xPant Karela-1	59.34	65.50	2.47	7.62	331.36	5.34	11.75	9.27
5	NDBG-12xPB-14	64.07	67.25	3.55	8.82	217.11	5.48	10.20	7.88
6	NDBG-12xPB-15	63.99	68.06	3.05	8.70	286.74	5.56	8.78	9.19
7	NDBG-13xPant Karela-1	52.06	58.55	1.65	4.58	351.85	6.16	15.70	12.50
8	NDBG-13xPB-14	52.10	58.52	1.75	4.55	350.66	6.20	15.73	12.64
9	NDBG-13xPB-15	61.5	67.94	7.00	11.52	218.83	5.72	11.47	7.81
10	NDBG-15xPant Karela-1	57.93	66.05	2.5	9.07	321.86	5.45	10.63	6.97
11	NDBG-15xPB-14	61.58	67.77	2.35	9.77	316.84	5.30	7.02	6.64
12	NDBG-15xPB-15	63.17	66.70	3.30	8.09	250.96	5.50	12.58	7.48
13	NDBG-25xPant Karela-1	53.83	60.72	1.91	5.31	351.35	6.19	14.63	11.64
14	NDBG-25xPB-14	58.52	67.22	2.14	6.42	283.19	5.41	10.90	8.43
15	NDBG-25xPB-15	54.15	60.63	1.90	5.28	351.69	6.21	14.68	11.80
16	NDBG-26xPant Karela-1	58.00	67.53	2.51	8.05	229.90	5.50	8.38	6.78
17	NDBG-26xPB-14	61.25	68.25	3.37	7.07	313.94	5.43	9.39	8.28
18	NDBG-26xPB-15	58.41	64.56	4.19	8.78	306.69	5.45	9.56	7.87
19	NDBG-35xPant Karela-1	56.02	63.02	2.00	6.26	345.73	6.19	14.43	11.23
20	NDBG-35xPB-14	58.44	71.34	3.02	7.41	304.92	5.35	11.15	8.76
21	NDBG-35xPB-15	63.23	69.93	3.55	7.95	299.99	5.56	10.45	8.33
22	NDBG-38xPant Karela-1	58.89	63.91	3.91	7.31	323.33	5.50	12.12	7.73
23	NDBG-38xPB-14	69.00	73.58	3.61	9.06	250.82	5.50	9.48	8.59
24	NDBG-38xPB-15	69.27	72.05	3.47	7.32	253.66	5.42	12.15	9.80
25	NDBG-42xPant Karela-1	67	70.08	3.28	6.72	235.38	5.48	12.80	8.48
26	NDBG-42xPB-14	58.43	63.95	3.19	7.48	239.09	5.23	12.64	6.80
27	NDBG-42xPB-15	61.99	64.05	3.75	8.12	306.89	5.46	11.68	7.30
28	NDBG-55xPant Karela-1	58.53	61.40	3.28	8.44	275.98	5.49	12.90	8.51
29	NDBG-55xPB-14	58.30	66.72	3.50	8.64	260.80	5.44	10.54	8.58
30	NDBG-55xPB-15	58.40	63.87	3.57	7.77	318.86	5.62	7.39	8.86
	F1 Hybrid mean	59.8	66.13	3.07	7.72	290.34	5.58	11.38	8.90
	Line								
1	NDBG-8	58.31	67.28	2.52	7.67	252.98	5.42	12.41	9.17
2	NDBG-12	59.58	65.65	2.61	7.96	309.68	5.47	10.38	10.01
3	NDBG-13	52.22	58.70	1.87	4.72	360.71	6.13	16.56	12.45
4	NDBG-15	61.75	66.94	1.96	4.45	220.73	5.45	11.89	8.19
5	NDBG-25	54.18	60.76	1.99	5.54	350.64	6.17	14.55	11.55
6	NDBG-26	59.68	65.06	2.8	8.64	281.13	5.70	14.40	10.24
7	NDBG-35	55.66	61.79	2.1	6.33	345.66	6.13	14.14	11.15
8	NDBG-38	59.69	65.35	2.75	10.37	259.82	5.53	9.82	8.05
9	NDBG-42	65.12	67.28	2.30	10.64	245.86	5.37	12.67	9.59
10	NDBG-55	64.53	63.75	2.39	8.88	210.97	5.61	13.78	8.16

	Tester								
1	Pant Karela-1	60.27	64.04	3.27	7.26	225.82	5.28	9.66	8.44
2	Punjab Bitter Gourd-14	63.08	69.12	2.73	8.79	230.74	5.44	8.65	7.77
3	Punjab Bitter Gourd-15	64.33	67.80	3.15	9.02	210.68	5.28	8.54	8.01
	Grand mean	59.88	64.88	2.49	7.71	283.33	5.59	11.58	9.04
	C.D @ 5%	59.79	65.71	2.90	7.74	16.75	0.40	2.51	0.86
	C.V.	5.064	4.05	0.48	0.84	5.19	6.31	19.03	8.32
	S.E. m±	7.442	5.41	14.51	9.54	6.01	0.14	0.90	0.31

S. No.	Genotypes Crosses	Fruit weight (g)	Number of fruits per plant	Days to first harvest	Total Sugar	Ascorbic acid	Reducing sugar	Non reducing sugar	Dry matter	Total Soluble Solids	Fruit yield per plant (g)
1	NDBG-8 x Pant Karela1	64.88	15.80	79.29	3.66	116.07	2.6	1.05	7.47	4.19	1060.90
2	NDBG-8xPB-14	67.94	11.50	73.24	1.79	57.49	0.70	1.10	7.11	4.46	677.61
3	NDBG-8 x PB-15	64.56	21.28	74.61	2.02	60.78	1.80	0.22	7.26	4.48	1264.49
4	NDBG-12xPant Karela-1	52.04	16.13	74.67	4.78	114.77	1.38	3.40	7.31	4.47	875.69
5	NDBG-12xPB-14	34.49	12.20	77.39	1.97	113.46	1.12	0.85	7.59	4.59	470.16
6	NDBG-12xPB-15	42.02	12.70	77.14	2.40	68.09	1.41	0.98	7.36	4.68	578.91
7	NDBG-13xPant Karela-1	93.49	26.82	66.91	9.67	140.90	5.23	4.43	9.73	1.97	2599.53
8	NDBG-13xPB-14	93.60	26.90	65.92	9.71	141.02	5.26	4.45	9.76	1.94	2610.09
9	NDBG-13xPB-15	63.02	22.80	74.70	4.89	112.46	3.14	1.75	8.16	3.25	1400.97
10	NDBG-15xPant Karela-1	25.63	12.53	76.75	6.57	113.02	1.35	5.22	7.17	4.40	336.89
11	NDBG-15xPB-14	36.77	14.57	76.83	2.31	41.71	1.36	0.95	8.27	4.35	533.85
12	NDBG-15xPB-15	60.73	14.10	75.84	1.76	89.50	1.25	0.51	8.21	4.43	850.77
13	NDBG-25xPant Karela-1	87.38	25.45	68.39	9.01	135.90	4.68	4.33	9.55	2.15	2356.08
14	NDBG-25xPB-14	78.01	22.20	77.07	3.99	31.08	2.12	1.87	7.28	3.35	1773.95
15	NDBG-25xPB-15	87.65	25.56	73.56	9.14	136.07	4.75	4.39	9.57	2.16	2373.01
16	NDBG-26xPant Karela-1	66.45	14.65	74.05	3.30	96.14	1.64	1.66	7.45	4.62	1035.72
17	NDBG-26xPB-14	58.35	24.18	75.79	2.61	110.98	1.64	0.97	7.48	4.41	1512.10
18	NDBG-26xPB-15	52.39	19.48	73.75	2.38	119.11	1.19	1.19	7.41	3.51	1110.88
19	NDBG-35xPant Karela-1	84.40	25.30	68.84	8.55	133.03	4.47	4.08	9.18	2.48	2248.57
20	NDBG-35xPB-14	71.36	15.50	80.11	5.13	95.68	1.48	3.66	7.43	3.54	1184.03
21	NDBG-35xPB-15	67.69	16.52	77.01	7.56	87.77	1.22	6.35	7.43	3.68	1230.59
22	NDBG-38xPant Karela-1	72.81	20.10	74.86	6.29	92.28	0.92	5.36	7.44	3.20	1565.47
23	NDBG-38xPB-14	50.63	15.30	80.68	6.34	83.64	1.23	5.11	7.27	4.27	830.53
24	NDBG-38xPB-15	60.48	15.40	82.02	6.43	113.05	1.14	5.29	8.11	4.46	698.32
25	NDBG-42xPant Karela-1	51.33	15.70	77.74	4.74	113.53	1.22	3.52	8.07	4.36	852.12
26	NDBG-42xPB-14	64.97	16.20	74.70	6.49	65.77	1.07	5.42	8.04	3.69	1106.33
27	NDBG-42xPB-15	56.79	19.20	71.95	4.56	36.06	1.38	3.18	8.67	3.61	1212.53
28	NDBG-55xPant Karela-1	53.48	14.70	69.79	6.08	101.75	1.66	4.42	8.64	3.48	858.48
29	NDBG-55xPB-14	48.67	17.40	77.87	7.77	92.46	1.52	6.25	8.34	3.48	1033.90
30	NDBG-55xPB-15	43.70	18.60	74.12	4.87	50.92	1.54	3.33	7.41	3.60	824.22
	F1 Hybrid mean	61.85	18.29	74.85	5.22	95.48	2.04	3.17	8.00	3.70	1235.55
	Line										
1	NDBG-8	61.25	11.23	70.44	6.18	64.91	2.45	3.74	7.65	3.20	752.12
2	NDBG-12	65.80	13.41	74.79	5.01	94.93	3.28	1.74	8.43	3.42	882.64
3	NDBG-13	93.15	27.80	68.06	9.63	140.75	5.20	4.43	9.70	2.04	2588.97
4	NDBG-15	72.50	17.91	72.07	3.46	95.47	2.06	1.40	7.35	2.82	1298.38
5	NDBG-25	87.27	26.90	69.32	8.85	135.76	4.60	4.25	9.50	2.26	2348.75
6	NDBG-26	67.71	14.85	77.61	4.02	59.02	2.66	1.36	8.89	3.50	1005.70
7	NDBG-35	84.31	26.55	68.50	8.48	132.97	4.45	4.03	9.15	2.43	2238.33
8	NDBG-38	53.95	17.30	70.32	3.45	78.64	2.64	0.81	7.45	3.18	933.06
9	NDBG-42	60.93	20.67	82.16	7.36	77.24	2.53	4.84	7.33	3.49	1098.97
10	NDBG-55	69.16	24.50	71.93	5.22	120.35	2.43	2.79	7.44	4.26	1696.75
	Tester										
1	Pant Karela-1	59.75	14.78	73.39	3.53	55.52	1.44	2.09	7.10	4.63	886.00
2	Punjab Bitter Gourd-14	44.62	10.91	73.78	2.14	55.93	1.79	0.34	7.15	5.17	484.69
3	Punjab Bitter Gourd-15	63.33	11.71	76.29	2.77	63.95	2.21	0.56	7.05	5.28	739.84
	Grand mean	63.86	19.03	74.28	5.27	94.75	2.29	2.98	8.01	3.66	1269.97
	C.D @ 5%	6.13	2.08	4.57	0.98	5.45	0.33	0.86	0.26	0.14	129.19
	C.V.	8.44	9.62	5.41	16.34	5.06	12.82	25.34	2.86	3.42	8.94
	S.E. m±	2.20	0.75	1.64	0.35	1.96	0.12	0.31	0.09	0.05	46.35

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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. The genotypes viz. Parent NDBG-13 (2588.97) found to have highest fruit yield per plant among the parents which was followed by NDBG -25 (2348.75), NDBG- 35 (2238.33), NDBG-55 (1696.75). The best F1 hybrid for fruit yield per plant was NDBG-13× PB-14 (2610.09) followed by NDBG-25 x PB-15 (2373.01), NDBG-25 x Pant Karela-1 (2356.08), NDBG-35 x Pant Karela-1 (2248.57) in terms of marketable fruit yield. 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.

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