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PERFORMANCE OF DIFFERENT BITTER GOURD GENOTYPES FOR GROWTH, YIELD AND QUALITY ATTRIBUTES IN KASHMIR'S NORTHERN HILLY REGION

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ABSTRACT

During the *Kharif* season of 2019, 33 genotypes of bitter gourd were evaluated for various growth, yield and quality attributes at the Vegetable Experimental Farm, SKUAST-K, Shalimar, Srinagar (J&K), India. The experiment was carried out using the RCBD model and treatments are replicated thrice. In the current study, analysis of variance revealed that genotypes differed significantly across all treatments for all fourteen variables. P-14, Phule Green Goal, B.G. Kantedar, NDBG-3, HABH-21 and B.G. Sagar produced the highest fruit yield per plant. These genotypes also performed well in terms of fruit yield per plant and fruit diameter. The earliest staminate flower anthesis occurs on NDBG-2, followed by Pant Karela-1, HABH-21, P-14, IIVR-BG-3, Hirkunt and others, and NDBG-4. NDBG-5, Pant Karela-1, P-14, IIVR-B.G-3, K.B.M, B.G Kantedar and NDBG-14 showed earlier pistillate flower development and are early fruit yielders. Based on the results, genotypes P-14, NDBG-4, and B.G. Kantedar may be chosen as parents in future breeding programmes to improve crop yield and earliness.

Key words: Evaluation, Yield, Quality, Number of fruits per plant, Vitamin-C, Chlorophyll content, Bitter gourd.

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the most important monoecious cucurbits grown throughout India. It is anesteemed vegetable among cucurbits due to its excellent nutritional properties, particularly ascorbic acid and iron (Behera *et al*., 2004). Charantin, a chemical found in bitter gourd, is used to treat diabetes by lowering blood sugar levels (Shetty *et al*., 2005). India, China, Japan, South East Asia, Tropical Africa and South America are all major producers of the crop. Bitter gourd is grown on 1.01 lakh hectares of land in India, with an annual production of 12 lakh tonnes and a productivity of 12.16 MT/ha. The top bitter gourd-producing states include Chhattisgarh, Telangana, Andhra Pradesh, Orissa, Madhya Pradesh, Uttar Pradesh and Bihar (NHB database, 2019-20).

Despite the crop's potential economic and therapeutic importance, a need-based crop enhancement plan did not receive adequate attention. It is urgently necessary to improve it and create varieties or hybrids that are appropriate for particular agroecological conditions. In regard to the significance of this crop, a good strategy for its improvement through evaluation of genetic variability and utilization of hybrid vigour has not yet been implemented. Bitter gourd can be used as the most effective crop for the commercial exploitation of heterosis owing to its vast diversity, monoecious nature, apparent and practical flower architecture for crossing and huge number of seeds per fruit. To identify the best genotypes that can be used as parents to take advantage of heterosis and boost the crop, genotypes were investigated in the current experiment.

Materials and Methods

The current study was conducted in *Kharif*, 2019, at

the Experimental Farm in Shalimar, Kashmir India. The location of the site is 34° N latitude and 74.89° E longitude. Shalimar is located in the temperate zone, which is distinguished by pleasant summers. The hottest months are June and July, while the coldest months are January and February. The months of March and April received the most rainfall. Bitter gourd genotypes representing 33 different treatments were assessed for yield and yield-related parameters. Three replications of the Randomized Complete Block Design (RCBD) were used to grow the genotypes. Table 1 contains a list of genotypes together with information about their source. The plots were limited to 2.4 × 1.8 m (4.32 m^2) in size, with 3 rows of each genotype in each replication, spaced 2.0 m from 2.5 m apart. Standard cultural and plant protection measures were followed to the experimental field in order to establish a healthy crop.Five plants were selected at random, and observations were made for each of the fourteen characters *viz*., days to anthesis of first staminate flower, days to anthesis of first pistillate flower node number to anthesis of first staminate flower, node number to anthesis of first pistillate flower, vine length (m), fruit diameter (cm), fruit length (cm), number of fruits per plant, average fruit weight (g) days of first fruit harvest, total chlorophyll content (mg/100g), vitamin-C content (mg/100g), dry matter content (%) and fruit yield per plant (kg).

Table 1 : List of genotypes of bitter gourd used in the experiment.

S. no.	Genotypes/varieties	Source
1	Pant Karela-1	GBPUA&T, Pantnagar
2	PBTH-52	GBPUA&T, Pantnagar
3	P-14	MPKV, Rahuri
4	Phule Green Goal	MPKV, Rahuri
5	Phule Ujwala	MPKV, Rahuri
6	IIVR-B.G-1	IIVR, Varanasi
7	IIVR-B.G-2	IIVR, Varanasi
8	IIVR-B.G-3	IIVR, Varanasi
9	IIVR-B.G-4	IIVR, Varanasi
10	Kashi Urvashi	IIVR, Varanasi
11	Hirkunt	IIVR, Varanasi
12	HABH-21	IIVR, Varanasi
13	MC-84	IIVR, Varanasi
14	K.B.M	IIVR, Varanasi
15	B.G. Kantedar	IGKV, Raipur
16	B.G. Sagar	IGKV, Raipur
17	NDBG-1	NDUA&T, Faizabad
18	NDBG-2	NDUA&T, Faizabad
19	NDBG-3	NDUA&T, Faizabad
20	NDBG-4	NDUA&T, Faizabad
21	NDBG-5	NDUA&T, Faizabad
22	NDBG-6	NDUA&T, Faizabad
23	NDBG-7	NDUA&T, Faizabad
24	NDBG-10	NDUA&T, Faizabad
25	NDBG-11	NDUA&T, Faizabad
26	NDBG-12	NDUA&T, Faizabad
27	NDBG-13	NDUA&T, Faizabad
28	NDBG-14	NDUA&T, Faizabad
29	NDBG-15	NDUA&T, Faizabad
30	NDBG-16	NDUA&T, Faizabad
31	NDBG-17	NDUA&T, Faizabad
32	Narendra Baramasi	NDUA&T, Faizabad
33	Local B.G. (Check)	SKUAST-Kashmir

Results and Discussion

Analysis of variance revealed that there is significant difference among the treatments for all the traits under investigation (Table 2). The mean performances of 33 genotypes for 14 characters (Growth, yield and quality) are given in Table 3a & 3b.

Growth and yield traits

Node number to anthesis of first staminate flower were lowest in NDBG-2 followed by Pant Karela-1, HABH-21 (5.33), P-14, IIVR-BG-3, Hirkunt, NDBG-4 (5.66), where the staminate flower appears at the earlier node which give the sufficient pollen for pistillate flower. Node number to anthesis of first pistillate flower appears on earlier node in NDBG-5 followed by Pant Karela-1 (5.66), P-14, IIVR-B.G-3, K.B.M, B.G Kantedar, NDBG-14 (6.00) showed earlier development of pistillate flower. This suggested that these genotypes were earlier in producing staminate flower anthesis and sufficient pollen corresponding to pistillate flowers, whereas in (Phule Green Goal), anthesis of first staminate flower was late (67.66 days) followed by NDBT-11, NDBG17 (67.00 days), B.G Kantedar (66.00 days) and Phule Ujwala (64.33 days).In these genotypes anthesis of first staminate flower was slightly later. Thus, the genotypes identified for first staminate flower anthesis as early and late may be selected based on objective of programme and could be exploited in suitable breeding programme. Similarly early days to anthesis of first pistillate flower occurred in (NDBG-3) (51.66 days) followed by HABH-21 (52.66) days, P-14 (55.00), Phule Green Goal, IIVR-B.G-3, NDBG-2, NDBG-6 (55.33 days) and B.G. Kantedar (55.66 days) categorized these genotypes as earlier. The results are in agree with the findings of Singh *et al*. (2017), Gupta *et al*. (2015) and Vandana *et al*. (2013) in bitter gourd.

Minimum days taken for first fruit harvest recorded in NDBG-14 (66.00 days) followed by NDBG-1 (67.00

Table 2 : Analysis of variance for growth, yield and quality traits in bitter gourd.

S. no.	Character	Mean sum of squares		
		Replication	Treatment	Error
d. f		2	32	64
1.	Days to anthesis of first male flower	0.41	136.016**	2.60
2.	Days to anthesis of first female flower	4.74	156.729**	3.22
3.	Node no. to anthesis of first male flower	1.73	2.377**	0.64
4.	Node no. to anthesis of first female flower	5.34	25.156**	0.78
5.	Vine length (m)	0.08	1.190**	0.01
6.	Fruit diameter (cm)	0.23	1.003**	0.05
7.	Fruit length (cm)	3.69	27.424**	0.41
8.	No. of fruits plant^{-1}	4.47	32.116**	0.67
9.	Average fruit weight (g)	5.80	201.425**	7.30
10.	Days to first fruit harvest	0.84	143.643**	1.94
11.	Total chlorophyll content (mg/100g)	0.87	145.21**	1.28
12.	Vitamin C content (mg/100g)	6.24	26.61**	0.88
13.	Dry matter content (%)	0.17	0.27**	0.01
14.	Fruit yield plant^{-1} (kg)	0.044	0.524**	0.01

days), Kashi Urvashi (67.33 days), Pant Kerala-1 (71.33 days), IIVR-B.G-1 (73.33 days), IIVR-B.G-4 (74.00 days), NDBG-4 (74.33 days) and NDBG-4 (74.66 days). These genotypes seems to be early in days to first marketable fruit harvest and may be considered promising genotype for early harvest of fruits, whereas, Phule Ujwala (88.00 days) followed by P-14 (87.66 days) and NDBG-6 (86.33 days) took maximum days to first marketable fruit harvest. The genotypes for both early and late harvesting of fruits were identified in case of fruit length in bitter gourd; medium long fruits were generally preferred with high market value. Hence the genotypes with fruit length near to population mean were desired. Similar results are obtained by Sagar *et al*. (2022).

Hirkunt had longest vine length (2.37 m) followed by HABH-21 (2.36 m), IIVR-B.G-3 (2.34 m), Narendra Baramasi (2.33 m) and NDBG-3 (2.32 m). While, shortest vine length was recorded in (Kashi Urvashi) (1.27 m). The genotypes with medium vine length close to general mean (1.98m); Pant Kerala-1, P-14, Phule Ujwala and NDBG-2 were more desirable in case of vine length.The highest and lowest fruit diameter was recorded in Kashi Urvashi (2.46 cm) and IIVR-B.G-4 (4.50 cm). In bitter gourd medium and low fruit diameter had more consumer preference for cooking purpose. On above basis promising phenotypes identified for fruit length in present investigation were NDBG-10 (18.50 cm) followed by B.G.Sagar (18.00 cm), NDBG-4 (17.00 cm), NDBG-17 (16.62 cm), NDBG-11 (16.50 cm), NDBG-3 (16.43 cm) and NDBG-14 (16.00 cm). The mean fruit lengths of these genotypes of the population mean (12.80 cm). These genotypes were identified as most promising genotypes for fruit length. Highest mean performance for average fruit weight was recorded in (NDBG-6) (77.76 g) followed by NDBG-17 (75.63 g), NDBG-11 (75.29 g), Phule Green Goal (74.87 g), NDBG-10 (74.00 g), NDBG-5 (73.11 g), NDBG-4 (73.06 g) and P-14 (73.00). The lowest mean performance of average fruit weight was observed in NDBG-12 (52.96 g), NDBG-7 (54.70 g), NDBG-14 (54.87 g), MC-84 (59.72 g) and IIVR-B.G-3 (60.09 g), whereas its general mean was 67.46 g. The above results are in similar with the findings of Rani *et al*. (2014) and Talukdar *et al*. (2018).

Seven most promising genotypes for number of fruits per plant were Phule Green Goal (19.33), Phule Ujwala (18.00), IIVR-BG-2 (16.66), P-14 (16.00), IIVR-BG-1 (15.66), NDBG-16 (15.33) and NDBG-1 (15.00). The highest fruit yield per plant was obtained in P-14 and constituted the top significant group for high fruit yield per plant. Among the high yielding genotypes five most promising genotypes identified in order of merit were Phule Green Goal, B.G. Kantedar, NDBG-3, HABH-21 and B.G.Sagar exhibited average mean performance for number of fruit per plant also.These genotypes had significantly more number of fruits per plant and identified as most desirable genotypes for this trait. Similar results are obtained by Saho (2015).

Quality traits

Total chlorophyll content (mg/100g) was highest in P-14 (561.8) followed by IIVR-B.G-2 (501.3), Phule Green Goal (478.4), IIVR-B.G-3 (470.4), NDBG-2 (416.4) and NDBG-1 (387.08) produced significantly higher chlorophyll content. Whereas, seven genotypes *viz*., Pant Kerala-1 (184.55), K.B.M (192.80), NDBG-15 (194.18), NDBG-16 (195.43), Local B.G (0196.16)

Table 3a : Mean performance of various genotypes for growth and yield traits in bitter gourd.

S. no.	Genotype	Days to anthesis of first male flower	Days to anthesis of first female flower	Node No. to anthesis of first male flower	Node No. to anthesis of first female flower	Vine length (m)	Fruit diameter (cm)	Fruit length (cm)
1.	Pant Karela-1	53.00	59.00	5.33	5.66	2.01	4.33	12.46
2.	PBTH-52	47.00	72.33	8.00	11.33	1.71	4.31	14.00
3.	P-14	66.00	55.00	5.66	6.00	2.20	3.49	12.53
4.	Phule Green Goal	67.66	55.33	6.00	7.66	1.57	3.53	8.33
5.	Phule Ujwala	64.33	72.33	7.33	9.66	1.99	4.10	12.50
6.	IIVR-B.G-1	54.00	66.66	7.33	9.00	1.59	4.33	12.33
7.	IIVR-B.G-2	61.66	61.00	7.00	13.00	2.23	3.18	11.50
8.	IIVR-B.G-3	54.00	55.33	5.66	6.00	2.34	3.24	11.76
9.	IIVR-B.G-4	58.33	67.66	7.33	11.00	2.20	4.50	11.66
10.	Kashi Urvashi	46.00	72.33	8.33	11.33	1.27	2.46	10.83
11.	Hirkunt	57.33	56.66	5.66	6.66	2.37	2.66	14.17
12.	HABH-21	57.00	52.66	5.33	6.66	2.36	3.56	11.55
13.	MC-84	57.33	70.00	6.66	13.00	2.14	3.96	13.50
14.	K.B.M	46.33	57.00	6.66	6.00	1.74	3.83	12.60
15.	B.G. Kantedar	66.00	55.66	6.00	6.00	1.59	3.63	15.00
16.	B.G. Sagar	57.33	61.66	7.33	12.00	2.21	3.19	18.00
17.	NDBG-1	52.00	74.33	7.33	12.33	2.23	3.95	12.66
18.	NDBG-2	48.66	55.33	5.00	5.33	1.82	3.46	13.90
19.	NDBG-3	47.00	51.66	6.66	12.33	2.32	4.03	16.43
20.	NDBG-4	44.00	61.00	5.66	11.33	2.07	4.33	17.00
21.	NDBG-5	52.33	67.33	6.66	5.00	2.17	4.16	14.43
22.	NDBG-6	54.66	55.33	6.66	13.00	2.25	3.36	14.66
23.	NDBG-7	54.66	62.66	6.33	11.00	1.35	3.36	11.83
24.	NDBG-10	48.00	66.66	7.66	10.66	2.14	2.60	18.50
25.	NDBG-11	67.00	56.00	6.33	6.33	2.17	3.80	16.50
26.	NDBG-12	47.00	64.33	6.00	11.66	2.20	3.96	15.30
27.	NDBG-13	51.66	70.33	6.33	12.00	2.23	4.33	12.66
28.	NDBG-14	52.00	67.66	7.66	6.00	1.65	3.20	16.00
29.	NDBG-15	47.00	69.38	6.66	12.00	2.23	4.02	11.82
30.	NDBG-16	54.00	74.66	7.66	12.33	2.23	3.95	12.66
31.	NDBG-17	67.00	59.38	6.66	6.33	2.19	3.92	16.62
32.	Narendra Baramasi	52.66	74.33	6.00	12.33	2.33	4.03	14.16
33.	Local B.G. (Check)	53.33	65.66	6.33	7.66	1.64	2.67	11.32
Mean		**54.71**	**62.95**	**6.60**	**9.41**	**1.98**	**3.73**	**12.80**
C.V.		**2.95**	**2.85**	**12.13**	**9.39**	**6.05**	**6.40**	**4.91**
C.D. 5		**2.63**	**2.93**	**1.30**	**1.44**	**0.21**	**0.39**	**1.05**
C.D. 1%		**3.51**	**3.90**	**1.74**	**1.92**	**0.28**	**0.52**	**1.39**

and Narendra Baramasi (197.23) had significantly lower chlorophyll content than general mean 291.41g. Vitamin-C content (mg/100g) was highest in Narendra Baramasi (42.65) followed by NDBG-16 (42.46), K.B.M (42.00), NDBG-11 (41.73) and NDBG-3 (40.66) produced significantly higher vitamin-C content. Whereas, four genotype *viz*., IIVR-B.G-3 (28.00), IIVR-B.G-2 (28.66), NDBG-5 (29.96) and IIVR-B.G-4 (29.66) had significantly lower vitamin-C content than general mean (291.41).Dry matter content (%) was found to be highest in NDBG-12 (12.81) followed by NDBG-1 (12.76), IIVR-B.G-1 (12.59), B.G.Sagar (12.48) followed by

Table 3b : Mean performance of various genotypes for yield and quality traits in bitter gourd.

S. no.	Genotype	No. of fruits per plant	Average fruit weight (g)	Days to first fruit harvest	Chlorophyll content (mg/100g)	Vitamin-C content (mg/100g)	Dry matter content (%)	Fruit yield (kg)
1.	Pant Karela-1	11.66	62.60	71.33	184.55	27.66	7.06	1.17
2.	PBTH-52	12.66	67.50	79.00	361.75	40.33	9.59	0.80
3.	P-14	16.00	73.00	87.66	561.866	32.66	11.16	1.54
4.	Phule Green Goal	19.33	74.87	75.33	478.45	34.66	11.85	1.52
5.	Phule Ujwala	18.00	61.53	88.00	316.45	37.16	11.44	0.68
6.	IIVR-B.G-1	15.66	62.40	73.33	299.29	35.66	12.59	0.64
7.	IIVR-B.G-2	16.66	62.37	97.33	510.33	28.66	10.33	0.81
8.	IIVR-B.G-3	13.66	60.09	77.33	470.42	28.00	9.88	0.60
9.	IIVR-B.G-4	13.00	69.39	74.00	251.33	29.66	12.16	1.48
10.	Kashi Urvashi	14.66	66.86	67.33	207.60	35.33	12.15	0.70
11.	Hirkunt	10.00	64.33	80.33	256.70	33.33	12.41	0.50
12.	HABH-21	9.33	61.71	81.33	219.09	39.33	12.33	1.28
13.	MC-84	7.00	69.72	75.33	179.09	38.66	11.32	1.05
14.	K.B.M	11.00	66.86	84.33	192.80	42.00	12.41	0.85
15.	B.G. Kantedar	11.00	61.44	87.66	258.08	36.66	11.44	1.51
16.	B.G. Sagar	7.66	72.43	77.66	299.16	37.66	12.48	1.26
17.	NDBG-1	15.00	71.43	67.00	387.08	31.66	12.76	0.62
18.	NDBG-2	12.66	70.78	76.33	416.43	35.66	12.38	0.57
19.	NDBG-3	13.66	69.41	73.33	369.75	40.66	11.60	1.48
20.	NDBG-4	11.66	73.06	74.33	284.42	37.00	10.37	0.75
21.	NDBG-5	13.66	73.11	74.66	243.78	29.96	8.66	1.10
22.	NDBG-6	14.66	77.76	86.33	266.06	30.33	8.65	0.76
23.	NDBG-7	8.66	54.70	82.00	286.19	38.33	7.66	0.72
24.	NDBG-10	12.00	74.00	81.33	285.09	38.66	8.29	0.69
25.	NDBG-11	12.33	75.29	81.66	288.45	41.73	10.26	0.57
26.	NDBG-12	7.00	52.96	76.00	281.03	38.60	12.81	0.66
27.	NDBG-13	7.33	74.83	78.00	276.46	36.53	12.00	1.10
28.	NDBG-14	8.00	54.87	66.00	225.36	34.93	12.08	0.71
29.	NDBG-15	8.33	65.63	82.32	194.18	39.96	10.27	0.51
30.	NDBG-16	15.33	71.43	82.33	195.43	42.46	11.16	1.17
31.	NDBG-17	12.33	75.63	82.33	196.50	39.33	11.95	0.80
32.	Narendra Baramasi	12.66	74.03	83.66	197.23	42.65	12.04	1.18
33.	Local B.G. (Check)	7.03	61.43	81.33	196.16	42.66	12.10	0.48
Mean		**12.38**	**67.46**	**78.45**	**291.41**	**36.31**	**11.09**	**0.97**
C.V.		**6.62**	**3.74**	**1.77**	**23.43**	**16.52**	**12.91**	**13.34**
C.D. 5		**1.34**	**4.41**	**2.28**	**111.38**	**9.78**	**2.33**	**0.21**
C.D. 1%		**1.78**	**5.87**	**3.03**	**148.02**	**13.00**	**3.10**	**0.281**

Hirkunt and K.B.M (12.41) produced significantly higher Dry matter content (%). Whereas, four genotypes *viz*., NDBG-7(7.66), NDBG-10 (8.29), NDBG-6 (8.65) and NDBG-5 (8.66) had significantly lower dry matter content than general mean (11.09). Similar results obtained by researchers like Talukder *et al*. (2018), Mounica *et al*. (2019) and Sagar *et al*.(2022).

Conclusion

The five most promising genotypes among the high yielding genotypes were Phule Green Goal, B.G. Kantedar, NDBG-3, HABH-21 and B.G. Sagar. These genotypes also exhibited average mean performance for number of fruits per plant. Node number to anthesis of first staminate flower were lowest in NDBG-2 followed by Pant Karela-

1, HABH-21, P-14, IIVR-BG-3, Hirkunt, NDBG-4, where the staminate flower appears at the earlier node which give the sufficient pollen for pistillate flower. Node number to anthesis of first pistillate flower appears on earlier node in NDBG-5 followed by Pant Karela-1, P-14, IIVR-B.G-3, K.B.M, B.G Kantedar, NDBG-14 showed earlier development of pistillate flower.P-14, NDGB-4 and B.G. Sagar outperformed the other genotypes in terms of growth, yield, and yield-attributing characters.

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