

Genetic evaluation of bitter gourd for yield parameter under tarai region of Uttarakhand

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Bitter Gourd (*Momordica charantia* L., $2n=2x=22$) is one of the most important members the family Cucurbitaceae. Among the cucurbits, bitter gourd is considered a prized vegetable because of its high nutritive value especially having ascorbic acid and iron. It has been used in various Asian traditional medicines for the treatment of cholera, bronchitis, anemia, blood diseases, ulcer, diarrhea, dysentery, gonorrhoea rheumatism, gout, worms, colic, disease of liver and spleen, cancer and diabetes etc (Basch *et al.*, 2003). Among the cultivated cucurbits, bitter gourd has been identified as one of the potent vegetables for export by APEEDA. One of the possible approaches for achieving the targeted production is to identify and develop suitable hybrids with high yield and good quality. Hence, in present investigation assessment of yield and quality traits has been undertaken for identification of best genotypes and hybrids.

The investigation was carried out at the Vegetable Research Centre, G.B.Pant University of Agriculture and Technology, Pantnagar, U.S.Nagar, during spring-summer seasons of 2014-15. The location lies on 29° North latitude, 79.3° East longitude and at an altitude of 243.83 meters above mean sea level and comes under the Tarai belt of Shivalik ranges of Himalayas. The climate of Pantnagar is broadly humid and subtropical in nature with hot summers and cool winters. The soil of experimental field was calcareous and of miscellaneous type and it is generally 1.0 to 1.5 meter deep with good drainage and nearly neutral reaction (pH 6.0-7.5), high rainfall is generally received from June to September. Eight Genotypes of bitter gourd were utilized for developing crossing in half diallel mating design for the production Twenty eight F_1 's hybrids were developed by involving eight genotypes of in open field conditions during mid July 2013 to October 2013. Twenty eight F_1 crosses along with parents were evaluated during rainy season 2014 from mid July 2014 to October 2014 and mid February 2015 to May 2015 in open field conditions in a Randomized Block Design with three replications for

assessment of different quantitative parameters. The observations were recorded on five plant basis and the average was computed for the following 18 morphological characters viz., days to 1st male flower anthesis, days to anthesis of 1st female flower, node no. of 1st male & female flower, main vine length, internodal length, no. of primary branches, average fruit weight, leaf length, leaf width, petiole length, leaf area, fruit diameter, fruit length, L/D ratio, number of fruits/plant, yield/plant and fruit yield/ha. The data was statistically analysed following the standard procedure as applicable to a typical randomized block design. Treatments were tested by 'F-test' (Snedecor and Cochran, 1967).

The mean values of 36 bitter gourd genotypes (8 parents and 28 F_1 s) for 12 characters along with standard error of mean, coefficient of variation and critical difference are presented in table 1. The mean performance of genotypes in season I showed that there was not a very wide range of variation for days to first male flower, which ranged from 34 (VNR 28) to 47.4 (US 33), whereas days to first female flower ranged from 36.6 (MC 84 × PBIG 2) to 50.2 (US 33). It was found that most of the hybrids were early in flowering as compared to parents. Hybrid MC 84 × PBIG 2 was found early for female flowering (36.6) while for male flowering parent VNR 28 showed the minimum days (34). Node no. to first male flower showed a wide range of variation ranging from 6.8 (VNR 28) to 16.1 (PDM × Pant karela 3). The node no. for first female flower representing earliness, were found in between 12.2 (VNR 28 × VNR 22) to 33.2 (US 33). Main vine length lied between 1.05m (US 33) to 4.5m (MC 84 × PBIG 4) while intermodal length showed a range of 4.2cm (VNR 28 × Pant karela 1, MC 84 × US 33) to 7.2cm (VNR 28 × VNR 22, VNR 22 × US 33). No. of primary branches per plant showed a significant amount of variation ranging from 7.2 (Pant karela 1 × US 33) to 20.2 (MC 84 × US 33). Internodal length ranged from 4.20 (VNR 28 × Pant karela 1, MC 84 × US 33) to (VNR 28 × VNR 22, VNR 22 × US 33). Leaf length varied from

Table 1: Average performance of parents and hybrids for various yield related traits

Crosses	1st Male Flower Anthesis (days)	1st Female Flower Anthesis (days)	Node No. of 1st Male Flower	Node No. of 1st Female Flower	Main Vine Length cm	Primary Branche s/Plant	Internodal Length cm	Leaf Length cm	Leaf Width cm	Petiole Length cm	Leaf Area cm ²	Fruit Length cm	Fruit Dia cm	Length/Dia ratio	Average Fruit Weight	Fruits/Plant	Fruit Yield/Plant gm	Fruit Yield/hac	
PDM×VNR-28	34.74	38.10	14.50	19.44	2.15	11.60	6.10	9.36	7.85	4.30	73.65	13.44	4.15	3.24	59.29	29.75	1756.84	73.21	
PDM×VNR-22	39.81	42.28	15.21	20.05	3.45	11.80	6.45	11.61	8.52	6.50	98.84	17.08	3.78	4.52	41.57	33.47	1391.43	57.98	
PDM×MC-84	38.26	41.13	13.48	20.88	3.20	11.60	5.45	6.73	7.37	2.93	49.60	14.46	4.61	3.14	64.53	27.76	1776.40	74.02	
PDM×PK1	37.09	41.06	13.28	20.24	2.70	10.20	5.35	11.28	9.44	5.52	106.40	17.66	3.93	4.50	48.77	33.29	1623.56	67.65	
PDM×US-33	41.55	44.36	14.78	24.38	3.40	12.30	6.15	8.05	7.45	3.91	59.95	16.15	4.67	3.46	58.84	33.03	1944.68	81.04	
PDM×PK3	38.19	44.32	17.10	25.04	3.15	14.10	5.45	9.45	6.22	4.56	58.83	16.36	4.56	3.60	43.56	31.41	1341.37	55.90	
PDM×PBIG-2	41.30	43.97	13.94	19.96	3.52	16.30	5.90	7.50	4.53	2.32	33.98	16.06	4.20	3.69	57.95	23.75	1353.27	56.39	
VNR-28×VNR-22	41.12	43.97	10.03	16.93	3.20	11.80	7.30	9.45	6.85	4.43	64.66	11.17	3.99	2.80	33.67	40.53	1362.43	56.77	
VNR-28×PK1	35.50	39.10	9.03	14.18	2.65	12.00	6.45	11.75	8.81	7.39	103.55	8.70	4.16	2.10	26.74	59.79	1494.52	62.28	
VNR-28×US-33	38.54	40.41	9.13	17.19	2.53	11.60	4.30	12.59	8.75	5.89	110.37	6.54	3.94	1.69	29.20	54.61	1510.36	62.94	
VNR-28×PK3	37.49	40.19	10.00	14.22	2.53	12.40	5.95	7.70	6.32	4.33	48.60	11.86	4.17	2.85	49.17	33.75	1627.38	67.81	
VNR-28×PBIG-2	33.23	42.28	8.03	15.91	2.78	11.90	6.10	9.91	7.38	6.03	73.13	9.54	3.99	2.42	24.45	68.55	1627.19	67.81	
VNR-28×MC-84	38.10	42.78	7.90	15.81	3.25	14.70	5.35	11.56	8.62	4.78	99.48	11.06	5.20	2.13	30.95	47.23	1459.34	60.81	
VNR-22×PK1	37.52	45.71	12.72	21.71	2.72	14.50	6.95	10.52	8.97	5.48	96.58	12.30	3.87	3.18	23.84	60.58	1444.58	60.20	
VNR-22×US-33	35.59	42.54	13.67	20.76	3.75	14.80	6.55	8.50	7.56	5.10	64.28	14.63	4.07	3.60	46.57	41.15	1902.84	79.85	
VNR-22×PBIG-2	38.06	48.22	13.76	24.82	3.20	12.40	7.10	6.50	7.70	5.51	50.01	19.72	4.11	4.80	59.51	32.31	1923.78	80.17	
VNR-22×PK3	37.21	46.07	11.56	21.87	4.00	12.10	7.05	7.05	8.00	5.30	56.41	20.34	3.95	5.16	40.77	31.98	1303.73	54.33	
VNR-22×PBIG-2	39.92	42.28	11.86	20.05	3.32	10.40	6.25	9.06	6.55	2.92	59.34	16.30	3.92	4.16	37.76	34.30	1295.71	53.99	
MC-84×PK1	38.78	46.82	10.66	17.01	3.33	12.10	6.25	8.00	6.41	3.48	51.20	11.60	4.11	2.83	54.24	25.03	1350.63	56.28	
MC-84×US-33	44.33	47.31	13.02	19.29	3.78	17.80	4.30	8.65	7.04	5.12	62.94	11.45	4.43	2.59	48.81	40.19	1957.49	81.57	
MC-84×PK3	39.19	45.33	10.52	18.57	4.15	12.70	5.45	7.25	6.26	5.17	45.38	17.12	4.02	4.25	63.52	30.28	1922.14	80.10	
MC-84×PBIG-2	38.65	44.24	10.69	14.93	2.40	10.40	6.40	7.61	6.56	5.46	49.93	18.54	4.36	4.25	38.57	35.29	1359.59	56.65	
PK1×US-33	39.28	46.20	10.44	25.32	2.55	10.60	6.30	9.50	6.53	4.84	62.08	16.20	4.03	4.02	62.88	22.23	1394.65	58.12	
PK1×PK3	37.88	45.32	8.64	22.47	3.25	16.20	7.25	9.45	7.01	3.98	66.62	16.33	3.84	4.25	35.15	43.45	1527.58	63.65	
PK1×PBIG-2	37.55	42.72	24.25	21.43	2.68	14.40	6.75	9.18	8.60	5.89	78.34	12.16	3.95	3.08	40.91	31.79	1301.41	54.23	
US-33×PK3	42.54	49.42	13.77	29.89	3.70	17.40	5.95	9.21	8.61	5.65	79.33	12.68	4.51	2.81	58.90	35.24	2075.77	86.50	
US-33×PBIG-2	41.58	49.29	11.21	30.23	2.75	13.20	5.85	8.94	8.09	5.70	72.30	11.70	4.42	2.65	62.82	28.10	1768.45	73.69	
PK3×PBIG-2	40.59	47.94	9.81	21.07	3.03	18.20	6.35	10.02	7.91	3.23	79.11	14.72	4.39	3.35	58.20	23.70	1379.21	57.47	
PDM	38.50	41.12	16.33	21.31	3.08	11.60	5.90	9.73	6.78	4.58	65.83	14.08	3.92	3.59	85.09	24.53	2074.57	86.45	
VNR-28	34.20	37.30	6.83	11.90	2.90	13.40	5.55	9.84	7.32	4.38	72.43	6.16	4.75	1.30	35.85	53.13	1902.44	79.27	
VNR-22	43.30	44.66	13.72	22.90	3.30	10.60	5.60	7.53	6.92	3.64	52.12	18.34	3.54	5.18	41.31	40.38	1668.23	69.51	
MC-84	41.42	45.04	10.70	16.64	3.55	9.50	6.30	5.53	4.53	2.32	25.06	14.52	4.66	3.11	60.74	31.42	1907.27	79.48	
PBIG-3	34.53	43.30	9.11	23.10	2.50	13.90	6.30	11.00	9.04	5.72	100.28	15.66	3.55	4.41	61.67	27.60	1701.92	70.92	
US-33	47.40	50.24	14.45	32.23	2.05	11.80	6.45	18.00	11.91	8.66	214.68	12.64	4.46	2.83	56.28	27.91	1570.95	65.46	
PBIG-4	40.80	50.10	9.32	22.40	2.78	13.00	5.75	5.53	4.33	3.04	23.98	20.41	4.23	4.83	61.09	26.31	1604.87	66.88	
PBIG-2	37.40	45.12	7.71	15.32	2.50	11.60	5.35	14.51	9.10	8.42	131.56	11.54	4.39	2.62	44.18	35.98	1590.09	66.26	
Mean	38.92	44.23	11.98	20.54	3.05	12.91	6.08	9.39	7.50	4.90	73.36	14.14	4.19	3.42	48.54	36.11	1616.57	67.38	
C.V.	6.92	5.93	25.86	8.18	16.89	17.55	2.73	8.91	7.09	21.40	14.36	6.99	5.07	8.09	7.65	12.05	5.21	5.26	5.45
S.E.	1.10	1.07	1.26	0.69	0.21	0.93	0.07	0.34	0.22	0.43	4.30	0.40	0.09	0.11	1.52	1.78	34.35	1.45	1.45
C.D. 5%	3.07	2.99	3.53	1.92	0.59	2.58	0.19	0.95	0.61	1.20	12.01	1.13	0.24	0.31	4.23	4.96	95.88	4.04	4.04
C.D. 1%	4.05	3.94	4.66	2.53	0.77	3.41	0.25	1.26	0.80	1.58	15.84	1.49	0.32	0.42	5.58	6.54	126.52	5.33	5.33

5.54 (VNR 22, US 33) to 19.50 (US 33). Leaf width and petiole length ranged from 4.54 and 2.32 (PDM × PBIG 2) to 12.12 and 8.80 (US 33). Leaf area was found to be varying from 25.21 (MC 84) to 236.34 (US 33). Fruit length, fruit diameter and L/D ratio had range varying from 6.54, 3.50 and 1.27 (VNR 28 × Pant karela 1, VNR 28 × PBIG 2 and VNR 28) to 21.34, 5.20 and 5.27 (VNR 22 × Pant karela 3, VNR 28 × PBIG 2 and Pant karela 1), respectively. Average fruit weight was found maximum in 78.57 (g) (PDM) and lowest 19.25 in VNR 28 × MC 84. Fruits/plant, fruit yield/plant and yield /ha was lowest in 23.33 (Pant karela 1 × US 33), 1245.13(g) and 51.88(q) (VNR 22 × PBIG 2) and was found highest (83.33) in VNR 28 × Pant karela 3, 2119.83 (g) and 88.33 (q) in US 33 × Pant karela 3.

The mean values for season II showed significant variation in 1st male flower anthesis, 1st female flower anthesis, node no. of first male flower and node no. of first female flower ranging from 31.56 (VNR 28 × PBIG 4) to 47.40 (US 33), 37.80 (VNR 28) to 53.60 (PBIG 4), 6.86 (VNR 28) to 40.50 (PK1 × PBIG 2) and 11.40 (VNR 28) to 31.26 (US 33), respectively. For main vine length maximum value (4.50 m) was given by US 33 × PBIG 4 whereas cross VNR 28 × PBIG 3 accounted for lowest value (2.25 m). No. of primary branches per plant and internodal length ranged from 9.60 (VNR 28 × MC 84) and 4.40 cm (VNR 28 × PK1, MC 84 × US 33) to 21.20 (US 33 × PBIG 4) and 7.80 cm (VNR 22 × US 33). Leaf length, leaf width, petiole length and leaf area showed variation from 5.52 cm to 16.50 cm (MC 84; US 33), 4.08 cm to 11.70 cm (PBIG 4; US 33), 2.11 to 8.88 (MC 84; US 33 × PBIG 2) and 24.92 cm² to 193.03 cm² (MC 84 × PBIG 4), respectively. Maximum L/D ratio of 5.27 was observed in VNR 22 while minimum value was given by VNR 28 (1.33). Heaviest fruits were found that of PDM while least average fruit weight was observed in hybrid (VNR 22 × MC 84). No. of fruits/plant, fruit yield/plant and fruit yield /ha was found maximum in VNR 22 × MC 84 (60.55), PDM (2068.72 g) and PDM (86.20 q/ha) while minimum (20.33) in PDM × PBIG 2 and (1218.94 g and 50.79 q/ha) PK1 × PBIG 2.

Pooled data of two seasons i.e. rainy and spring summer showed a range of variation for 1st male flower anthesis, 1st female flower anthesis, node no. of first male flower and node no. of first female flower from 33.23 (VNR 28 × PK3) to 47.40 (US 33), 37.30 (VNR 28) to 50.24 (US 33), 6.83 (VNR 28) to 24.25 (PK1 × PBIG 2) and 11.90 (VNR 28) to 32.23 (US 33), respectively. Value for main length was found maximum (4.15 m) in cross MC 84 × PBIG 4, whereas minimum (2.05 m) in US 33. Number of primary branches per plant ranged from 9.50

(MC 84) to 18.20 (PBIG 4 × PBIG 2). Internodal length was least (4.30 cm) in hybrids VNR 28 × PBIG 3 and MC 84 × US 33, while it was recorded highest (7.30 cm) in cross VNR 28 × VNR 22. Leaf area and L/D ratio varied from 23.98 cm² (PK3), 1.30 (VNR 28) to 214.69 cm² (US 33), 5.18 (VNR 22). Average fruit weight, number of fruits per plant, fruit yield per plant and yield /ha ranged from 30.95 (g), 22.23, 1301.41 (g) and 54.23 (q) in genotypes VNR 28 × PBIG 2, PK1 × US 33 and PK1 × PBIG 2 to 85.09 (g), 68.55, 2075.77 (g) and 86.50 (q) in PDM, VNR 28 × PK3 and US 33 × PK3.

These results are in consonance with the findings of Aksel & Johnson (1963), Bahera *et al.* (2006, 2007) and Tiwari *et al.* (1998). The variations among yield and yield attributes among parental lines and crosses can be explained on the basis that genotypes differ in their morphological and physiological basis. Out of 36 genotypes maximum yield was recorded for parental line PDM and cross US 33 × Pant karela 3. The above results it can be concluded that genotypes PDM and US 33 × Pant karela 3 recorded highly significant yield and related traits. Hence, they may be selected further for breeding new genotypes with desirable horticultural traits.

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