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Evaluation of Parents and Hybrids for Yield and Quality characters in Bitter Gourd (*Momordica charantia* L.)

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A B S T R A C T

The experiment was conducted at AICRP on vegetable crops, OUAT, Bhubaneswar, India to study the performance of twenty eight bitter gourd hybrids along with eight genetically diverse parents. The analysis of variance for experimental design revealed that the differences among the mean square due to treatments were found highly significant for all the traits. Further variance due to parents and hybrids (within group) were also found significant for all the studied characters. Difference due to parents Vs hybrids were also found highly significant for all characters studied. The parents Phule Green Gold, Improved Katahi and Preethi were observed to be top performing parent for fruit yield per vine and Thusi for number of primary branches per vine and number of fruit per vine. The hybrids Phule Green Gold x Pusa Do Mausami, Phule Green Gold x Preethi and Preethi x Pusa Do Mausami were recorded to be three best performing F_1 hybrids for fruit yield per vine with an yield of 3.13, 3.00 and 2.75 kg, respectively. These top performing F_1 hybrids can be tested in different seasons over different locations for assessing their stability for high yield.

Introduction

Momordica charantia usually reffered to as bitter gourd may be a tropical and subtropical valuable commercial vegetable crop of the family Cucurbitaceae. Bitter gourd has been utilized in numerous herbal medicine systems for a long time because of its malady preventing and health promoting phyto chemical compounds like dietary fiber, minerals, vitamins, flavonoids and antioxidants. Consumption of its fruit juice is extremely helpful for diabetic patients due to its potent oxygen free radical scavenging activity (Sreejayan and Rao, 1991). Fruits and seeds of bitter gourd are consumed together at immature stage and both possess therapeutic properties such as anti-diabetes (Chen *et al.*, 2003), anti-carcinogenic and hypercholesterolemic (Ganguly *et al.*, 2000; Ahmed *et al.*, 2001), charantin (Yeh *et al.*, 2003), hypoglycemic compounds (Jayasooriya *et al.*, 2000), momorcharin (inactivating ribosome; Leung *et al.*, 1997), MAP30 (a momordica-HIV protein that suppress HIV activity; Lee-Huang *et al.*, 1995),

momordicoside A and B (tumour growth inhibitor; Okabe *et al.,* 1980). The fruits of bitter gourd additionally possess anti- fertility (Basch *et al.,* 2003), anti-microbial (Yesilada *et al.,* 1999), anti-viral (Nerurkar *et al.,* 2006), and anti-ulcerogenic (Gurbuz *et al.,* 2000), anti-tumour (Taylor, 2002) activities characterized in bitter gourd attributed to broad array of biologically active phytochemicals together with triterpenes and steroids (Grovar and Yadav, 2004). The seeds of bitter gourd contain pyrimidine nucleoside vicine (Dutta *et al.,* 1981 and Barron *et al.,* 1982). Throughout the past decade the anti-diabetic properties of the crop are studied broadly and a hypoglycaemic principle called charantin has been isolated. The bitterness of bitter gourd is due to the cucurbitacin like alkaloid momordicine and triterpene glycosides *viz*., momordicoside K and L (Jeffrey, 1980 and Okabe *et al*.,1982). Leading states cultivating bitter gourd in India are Tamil Nadu, Kerala, Maharashtra, Uttar Pradesh, Andhra Pradesh, Gujarat *etc.* and India produces about nine lakh metric tons of bitter gourd fruit from an area of 98,300 hectare (NHB database, 2015-16). Even though India is major producer of bitter gourd in the world, the normal productivity is extremely low and becomes static over the decades. Major constraints to productivity of bitter gourd are low genetic potential of improved varieties, lack of early and high yielding hybrids, and inaccessibility of quality seeds besides poor crop management, biotic and abiotic stresses. Hybrids in most of the vegetable crops offer opportunity of earliness, high yield, and quality improvement besides better capability to counteract biotic and abiotic stresses. The hybrid in bitter gourd may be constrained because of conventional practice of hand pollination, which requires lot of labour and time. There is a prime requiring for its enhancement and to create varieties or hybrids suited to particular agro ecological conditions. Hence, in the present investigation, parents and hybrids were evaluated to identify the best parents and hybrid combination.

Materials and Methods

The study was taken up during summer season of 2016 at AICRP on vegetable crops, OUAT, Bhubaneswar. The experimental material consisted of eight genetically diverse inbred lines of bitter gourd *viz*., Phule Green Gold, Improved Katahi, Hirkani, CO-1, Nakhara Local, Thusi, Preethi and Pusa Do Mausami together with twenty eight F_1 hybrids obtained through half diallel mating among the selected parents. The crop was planted in rows spaced at 1.5 meters with plant to plant spacing of 1.0 meter in a randomised block design with three replications. Observations were recorded from four randomly selected plants on quantitative and qualititative traits *viz*., vine length (m), number of primary branches per vine, internodal length (cm), fruit length (cm), fruit diameter (cm), average fruit weight (g), number of fruits per vine, fruit yield per vine (kg), flesh thickness (mm), TSS (°Brix) and vitamin C content (mg/100 g). The mean data was subjected to statistical analysis as suggested by Panse and Sukathme (1957).

Results and Discussion

Analysis of variance for eight parents and twenty eight hybrids indicated powerful significant variability among them for all the characters (Table 1). This shows the existence of a noticeable amount of variability in the base material as well as in the generated materials, fulfilling the fundamental prerequisite for considering the genotypes further. Comparison of mean squares due to parents Vs hybrids was found to be significant for all traits. The mean values of F_1 hybrids were higher than those of parents (Table 2) for all the characters studied, which shown plentiful scope for the improvement of these characters. In any crop breeding programme, it

is fundamental to remove the undesirable types, which can be accomplished by studying the mean performance of parents and hybrids. *Per se* performance should be given an equal importance while judging the hybrid combinations for exploitation of heterosis.

Vine length is an essential yield component by which growth and vigour of plants are measured. In the present study vine length was high in the parents Preethi (4.40 m) followed by CO-1 (4.25 m) and Phule Green Gold (4.08 m) and the hybrids Phule Green Gold x Preethi shows highest vine length of (4.90 m) followed by Phule Green Gold x Pusa Do Mausami (4.86 m) and Preethi x Pusa Do Mausami (4.69 m) exhibited high vine length. The parent Thusi (2.94) and the hybrids Improved Katahi x Hirkani (3.12 m), Nakhara Local x Thusi (3.30 m) and CO-1 x Thusi (3.30 m) were shortest. The same patterns of results in their study were noted by Rajeswari (1998) and Sundaram (2006).

In the present study number of primary branches per vine was high in the parents, Thusi (16.75) and the hybrids, Thusi x Pusa Do Mausami (19.50), Hirkani x Thusi (19.00) appeared most noteworthy number of primary branches per vine, whereas the parent CO-1 (8.75) and the hybrid CO-1 x Nakhara Local (7.92) appeared least number of primary branches per vine. Lower intermodal length is the favorable trait in cucurbits. Within the present study the parents Pusa Do Mausami (4.25 cm), Thusi (4.43 cm) and Nakahara Local (4.50 cm), and the hybrid combinations Hirkani x Thusi (4.00 cm), Thusi x Pusa Do Mausami (4.04 cm) and Improved Katahi x Thusi (4.10 cm) had the lower intermodal length. The same pattern of results in their study was described by Rajeswari (1998), Sundaram (2006) and Rani *et al.,* (2014).

Fruit length and diameter are also imperative traits to decide yield besides market preference, purpose of use and means of handling. Longest fruit was found in parent, Phule Green Gold (18.04 cm), CO-1 (14.15 cm) and Preethi (13.34 cm) whereas, in hybrids Phule Green Gold x Pusa Do Mausami (22.68 cm), Phule Green Gold x CO-1 (19.50 cm) and Phule Green Gold x Preethi (19.00 cm) recorded higher fruit length, in this way it was evident that, the parents with longer fruits were effectively involved in producing hybrids with long fruits (Laxuman *et al.,* 2012). From point of view customer approval, the perfect fruit diameter should be between 4 to 5 cm. From this point of view 50 per cent of hybrids evaluated have sufficient fruit diameter. For trait fruit diameter, most noteworthy fruit diameter was found in parent Preethi (4.72 cm) and Improved Katahi (4.19 cm), although among hybrids Improved Katahi x Preethi had more fruit diameter of (5.20 cm) taken after by Preethi x Pusa Do Mausami (5.15 cm), Phule Green Gold x Preethi (5.00 cm).

Numbers of fruits and fruit weight specifically decide bitter gourd yield (Dey *et al.,* 2005). Among the parents average fruit weight was highest in Preethi (83.98 g), Phule Green Gold (71.35 gm) and CO-1 (63.48 g) and among the hybrids Phule Green Gold x Pusa Do Mausami (103.53 g), Phule Green Gold x Preethi (102.40 g) and Preethi x Pusa Do Mausami (99.62 g) recorded higher fruit weight. Based on the mean performance, the hybrids Thusi x Pusa Do Mausami (41.92), Hirkani x Thusi (39.83) and Improved Katahi x Thusi (35.75) were producing higher number of fruits per vine. The parents Thusi (36.17), Hirkani (30.25) and Improved Katahi (29.42) were found to be the best for this character. The same trend of results was recorded by Devadas (1993). The more number of fruits in Thusi might be ascribed due to more number of primary branches. These traits possibly boost the number of leaves and subsequently the photosynthetic efficiency. Comparative results were recorded by Harika *et al.,* (2012) in bottle gourd.

Table.1 Analysis of variance (Mean squares) for various characters in bitter gourd during summer season -2016

Source	d.f	Vine length (m)	Number of primary branches per vine	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Number of fruits per vine	Fruit yield per vine (kg)
Replications	2	0.05	0.58	0.01	3.72	0.01	7.34	3.16	0.06
Treatments	35	0.89**	22.97**	3.79**	34.11**	0.87**	1358.05**	96.28**	1.35**
Parents	7	1.04**	20.80**	2.14**	44.83**	0.69**	1303.22**	104.36**	0.45**
Hybrids	27	0.84**	23.21**	4.11**	30.40**	0.90**	1342.89**	95.41**	1.47**
Parents Vs Hybrids	1	1.30**	31.72**	6.84**	59.33**	1.42**	2151.15**	63.51**	4.41**
Error	70	0.03	1.55	0.04	1.25	0.03	9.34	5.27	0.02

*, ** significant at 5% and 1% level, respectively

Table 1. contd….

Source	d.f	Flesh thickness (mm)	TSS (^{o}Brix)	Vitamin C (mg/100g)
Replications	2	0.02	0.06	43.79
Treatments	35	9.81**	1.17**	843.08**
Parents	7	6.45**	0.85**	343.63**
Hybrids	27	10.35**	1.24**	959.67**
Parents Vs Hybrids	1	18.73**	1.38**	1191.47**
Error	70	0.05	0.06	61.38

*, ** significant at 5% and 1% level, respectively

Table.2 Mean performance of parents and hybrids for yield and its contributing traits during summer season - 2016

Hybrid	Vine length (m)	Number of primary branches per vine	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)
Phule Green Gold x Improved Katahi	4.31	12.50	5.46	15.15	4.42	80.00
Phule Green Gold x Hirkani	3.62	11.92	5.41	13.21	3.75	53.92
Phule Green Gold x CO-1	4.57	12.50	7.58	19.50	4.32	89.20
Phule Green Gold x Nakhara Local	4.28	15.50	6.45	16.00	4.13	71.60
Phule Green Gold x Thusi	3.79	17.25	5.78	14.16	3.90	62.00
Phule Green Gold x Preethi	4.90	14.50	7.75	19.00	5.00	102.40
Phule Green Gold x Pusa Do Mausami	4.86	16.83	5.24	22.68	4.85	103.53
Improved Katahi x Hirkani	3.12	11.42	5.89	10.81	3.36	40.60
Improved Katahi x CO-1	4.30	12.00	7.26	16.00	4.35	76.21
Improved Katahi x Nakhara Local	3.60	14.83	4.53	10.06	3.58	41.30
Improved Katahi x Thusi	3.65	16.33	4.10	11.55	3.85	50.00
Improved Katahi x Preethi	4.51	14.33	6.80	15.65	5.20	92.30
Improved Katahi x Pusa Do Mausami	4.09	14.83	4.98	15.26	4.65	83.53
Hirkani x CO-1	3.38	9.00	7.17	14.60	4.06	64.50
Hirkani x Nakhara Local	3.60	14.67	6.33	11.86	3.69	49.30
Hirkani x Thusi	3.63	19.00	4.00	11.18	3.80	45.05
Hirkani x Preethi	4.56	14.08	7.55	15.46	4.78	84.13
Hirkani x Pusa Do Mausami	3.46	13.58	5.75	11.09	3.45	41.85
CO-1 x Nakhara Local	3.37	7.92	6.28	10.20	3.39	40.10
CO-1 x Thusi	3.30	11.92	5.50	12.02	3.84	49.05
CO-1 x Preethi	4.60	11.75	7.90	15.90	4.95	90.01
CO-1 x Pusa Do Mausami	3.61	10.00	6.38	12.55	3.79	58.67

Nakhara Local x Thusi	3.30	15.83	4.87	10.50	3.64	42.20
Nakhara Local x Preethi	3.77	11.25	6.67	11.52	3.82	50.21
Nakhara Local x Pusa Do Mausami	3.70	16.33	4.85	14.68	4.01	66.10
Thusi x Preethi	3.58	15.25	4.90	9.36	3.91	45.01
Thusi x Pusa Do Mausami	3.70	19.50	4.04	11.95	4.00	51.00
Preethi x Pusa Do Mausami	4.69	14.58	7.12	16.33	5.15	99.62
Phule Green Gold	4.08	11.83	5.85	18.04	3.86	71.35
Improved Katahi	3.51	11.25	5.50	12.62	4.19	60.01
Hirkani	3.97	14.17	5.63	12.15	3.83	46.00
CO-1	4.25	8.75	6.35	14.15	3.78	63.48
Nakhara Local	3.12	14.17	4.50	9.29	3.32	33.58
Thusi	2.94	16.75	4.43	4.66	3.18	19.04
Preethi	4.40	9.92	6.28	13.34	4.72	83.98
Pusa Do Mausami	3.01	14.00	4.25	12.40	3.94	57.65
Mean	**3.87**	**13.62**	**5.81**	**13.47**	**4.07**	**62.74**
C.V (%)	4.16	9.15	3.33	8.31	4.15	4.87
S.Em±	0.09	0.72	0.11	0.65	0.10	1.76
C.D at 5%	0.27	2.03	0.32	1.82	0.28	4.98
Range	2.94-4.90	7.92-19.50	4.00-7.90	4.66-22.68	3.18-5.20	19.04-103.53

Table 2 contd….

Hybrid	Number of fruits per vine	Fruit yield per vine (kg)	Flesh thickness (mm)	TSS (°Brix)	Vitamin C (mg/100g)
Phule Green Gold x Improved Katahi	29.50	2.33	11.68	3.75	122.04

Phule Green Gold x Hirkani	24.00	1.16	9.16	3.37	102.04
Phule Green Gold x CO-1	28.33	2.44	11.27	4.28	115.47
Phule Green Gold x Nakhara Local	32.00	2.23	10.40	4.00	125.10
Phule Green Gold x Thusi	32.42	1.98	10.08	2.75	120.37
Phule Green Gold x Preethi	30.00	3.00	13.93	4.10	138.05
Phule Green Gold x Pusa Do Mausami	31.00	3.13	12.43	4.20	141.28
Improved Katahi x Hirkani	23.50	0.93	8.40	3.39	90.42
Improved Katahi x CO-1	27.92	2.09	11.35	2.43	102.15
Improved Katahi x Nakhara Local	32.50	1.23	9.14	3.60	93.02
Improved Katahi x Thusi	35.75	1.70	9.80	2.27	110.15
Improved Katahi x Preethi	29.17	2.62	14.92	3.11	125.73
Improved Katahi x Pusa Do Mausami	31.58	2.54	12.21	4.07	125.00
Hirkani x CO-1	19.17	1.32	10.28	3.66	85.02
Hirkani x Nakhara Local	25.83	1.20	9.20	4.05	97.02
Hirkani x Thusi	39.83	1.71	9.35	2.81	100.00
Hirkani x Preethi	31.00	2.40	12.34	2.52	117.00
Hirkani x Pusa Do Mausami	26.00	1.01	8.74	3.77	97.41
CO-1 x Nakhara Local	18.83	0.75	8.50	4.32	79.07
CO-1 x Thusi	25.08	1.15	9.70	3.77	80.40
CO-1 x Preethi	24.50	2.15	13.28	3.34	116.43
CO-1 x Pusa Do Mausami	17.25	0.94	9.35	4.22	97.17
Nakhara Local x Thusi	28.17	1.15	9.03	3.37	86.35
Nakhara Local x Preethi	24.25	1.12	9.27	3.33	94.05
Nakhara Local x Pusa Do Mausami	28.83	1.79	10.34	4.60	95.43
Thusi x Preethi	24.25	1.03	9.96	3.44	92.00
Thusi x Pusa Do Mausami	41.92	2.12	10.10	3.51	126.80
Preethi x Pusa Do Mausami	28.00	2.75	14.64	4.75	132.55
Phule Green Gold	27.33	1.87	9.70	3.50	113.25
Improved Katahi	29.42	1.65	10.63	2.65	105.70

Hirkani	30.25	1.34	9.63	3.37	98.05
CO-1	20.50	1.21	9.40	3.71	94.30
Nakhara Local	27.83	0.93	8.38	3.18	84.35
Thusi	36.17	0.73	7.44	2.50	86.04
Preethi	20.17	1.57	12.39	3.67	103.18
Pusa Do Mausami	19.50	1.07	9.80	4.04	110.51
Mean	**27.83**	**1.68**	**10.45**	**3.54**	**105.64**
C.V (%)	8.25	8.32	2.15	7.11	7.42
S.Em±	1.32	0.08	0.13	0.15	4.52
C.D at 5%	3.74	0.23	0.37	0.41	12.76
Range	17.25-41.92	0.73-3.13	7.44-14.92	2.27-4.75	79.07-141.28

Fruit yield per vine is the extreme and the foremost vital trait for any variety or hybrid. For fruit yield per vine the parents, Phule Green Gold (1.87 kg), Improved Katahi (1.65 kg) and Preethi (1.57 kg) and the hybrids Phule Green Gold x Pusa Do Mausami (3.13 kg), Phule Green Gold x Preethi (3.00 kg) and Preethi x Pusa Do Mausami (2.75 kg) registered higher mean values. Similar results were reported by Jadhav *et al.,* (2009), Rani *et al.,* (2014) and Kumara *et al.,* (2017) in bitter gourd.

With respect to flesh thickness it should be as high as possible. In the present study the parents, Preethi (12.39 mm) and Improved Katahi (10.63 mm) recorded maximum pulp thickness whereas among hybrids Improved Katahi x Preethi (14.92 mm), Preethi x Pusa Do Mausami (14.64 mm) and Phule Green Gold x Preethi (13.93 mm) recorded higher flesh thickness. Similar results were reported by Rani *et al.,* (2014). Among parents, Pusa Do Mausami (4.04°brix), CO-1 (3.71°brix) and Preethi (3.67°brix) recorded maximum TSS content in fruits. Among all the hybrids, it was observed that Preethi x Pusa Do Mausami (4.75°brix), Nakahara Local x Pusa Do Mausami (4.60°brix) and CO-1 x Nakahara Local (4.32°brix) recorded higher TSS content in fruits. Ascorbic acid is a nutritionally important character and the parents Phule Green Gold (113.25 mg), Pusa Do Mausami (110.51 mg) and Improved Katahi (105.70 mg) and the hybrids Phule Green Gold x Pusa Do Mausami (141.28 mg), Phule Green Gold x Preethi (138.05 mg) and Preethi x Pusa Do Mausami (132.55 mg) registered higher magnitudes of ascorbic acid content. These results are in similarity with the results of Rajeswari (1998) and Thangamani and Pugalendhi (2013)..

From the present investigation, it is concluded that parents Phule Green Gold for fruit length, fruit yield per vine and vitamin C content, Preethi for vine length, fruit diameter and average fruit weight; Thusi for number of primary branches per vine and number of fruits per vine, were found superior among all the parents. Improved Katahi recorded second position for fruit yield per vine. These may well be utilized in as one of the parent to produce high yielding and superior quality hybrids, as well as in varietal improvement programmes. Further, the best cross combinations (Phule Green Gold x Pusa Do Mausami, Phule Green Gold x Preethi and Preethi x Pusa Do Mausami) may be exploited as commercial hybrids after their stability test as they are not as it high yielder but also possessed good quality characters as per present market demand. Therefore, it is proposed that hybrid breeding approaches may well be more fulfilling since hybrids advocate increased yield and other related traits in comparison with parents.

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