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Original Research Article

Correlation and *Per se* Performance Studies in Various Lines of Bitter Gourd (*Momordica charantia* L.) under Garhwal Himalaya Region of Uttarakhand

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A B S T R A C T

The 20 bitter gourd genotypes collected from various places of India and conducted a research trial for evaluation. The various parameters were recorded *viz.*, vine length (cm), number of primary branches/vine, days taken to opening of first male and female flower, number of nodes bearing first male and female flower, percent of fruit setting, number of fruits/vine, weight of fruit (g), length of fruit (cm), diameter of fruit (cm), fruit yield/vine (kg), carbohydrate content (g/100g), ascorbic acid content (mg/ 100g), total soluble solids (^{0}Brix) and number of seeds/fruit was analyzed statistically. Among the lines, the lines HP-2, VRBTG-8, RAJ-2, VRBTG-2 and MN-1 showed yield per vine, carbohydrate content, ascorbic acid content, total soluble solids content and number of seeds per fruit showed highest mean values for various horticultural traits respectively. The correlation analysis revealed that yield per vine had highest significant positive association at genotypic level for length of vine, number of primary branches/vine, number of fruits/vine, length of fruit and weight of fruit. However, the ascorbic acid content showed negative association at genotypic level in different traits *viz.*, diameter of fruit and carbohydrate content.

Keywords

Bitter gourd, Evaluation, Correlation analysis, Carbohydrate and genotype

Introduction

Bitter gourd (*Momordica charantia* L.) one of the most popular and important cucurbitaceous crop grown all over India in different agro climatic conditions, due to their wide adoptability, nutritional and also medicinal properties. Bitter gourd uses as boiled, curried, stuffed or sliced and fried and can also be pickled, canned and dehydrated and also rich in medicinal properties like, purgative, carminative and anti-diabetic etc. (Singh *et. al.* 2016). The fruit acts as an anthelmintic, stomachic, antibilious and laxative. In fact, it is a tonic fruit, used in rheumatism, gout and also for diabetes. A decoction of the root extract is helpful in abortion, hemorrhoids and also in biliaesness (Khulakpam *et al*., 2015). India is blessed with wide range of variability in bitter gourd, mostly the bitter gourd show the variability in their vegetative and also their fruit traits. Selection of high yielding strains with desirable quality traits is very necessary to meet the increasing demands of quality yield. This crop have immense values in terms their medicinal, nutritional, antioxidants properties with high yielding capacity, but very little attention has been paid for its exploitation for above mention facts. So, it can be exploiting through various genetic improvement programmes. The first step of any breeding programme is evaluation of germplasm for the selection of

yield and yield related traits with all desirable quality traits. The correlation of yield and yield related traits at genotypic level is an ideal tool for selecting the desirable genotypes, such types of information is inadequate in the bitter gourd. It is very useful information for a breeder in developing a variety with market preference by determining the component traits on which selection can be exercised based on the improvement in yield and quality traits. Hence, the present study was undertaken with an objective of selecting high yielding bitter gourd strains to determine the interrelationship of quantitative and qualitative traits contributing to yield and quality parameters of bitter gourd.

Materials and Methods

The present investigation was conducted at Horticultural Research Centre, Department of Horticulture, H.N.B. Garhwal University Srinagar, Garhwal, Uttarakhand (India). The experimental materials comprised of 20 strains of bitter gourd *viz.*, GP-1, HP-1, HP-2, JP-1, KVS-7, MN-1, MP-1, PDM, PSPB-14, RAJ- 1, RAJ-2, VRBTG-1, VRBTG-2, VRBTG-3, VRBTG- 4, VRBTG-5, VRBTG-6, VRBTG-7, VRBTG-8 and VRBTG-9 collected from different parts of India. The details and source of genotypes has been given in the Table 1. The seeds were sown in the nursery bed on February 15th and transplanting was done in March 2015. These plants are raised in randomized block design (RBD) replicated thrice with twelve plants in each treatments following a spacing of 1.5 x .50 m. Recommended package of practices was followed to grow a successful crop. The observation were recorded on five randomly selected plants per treatment from each replication for sixteen growth, yield and quality characters *viz.*, length of vine (cm), number of primary branches per vine, days to opening of first male and female flower, number of nodes bearing first male and female flower, percent of fruit setting, number of fruit per vine, fruit length (cm), fruit diameter (cm), fruit weight (g), fruit yield per vine (kg), carbohydrate content (g/100g), ascorbic acid content (mg/100g), total soluble solids (^{o}Brix) and number of seeds per fruit. The data were subjected to statistical analysis to obtain information on the mean performance and to assess the association between yield and its components. Correlation analysis was done using GENRES package and genotypic correlation was worked out as per the methods suggested by (Grafius, 1956).

Results and Discussion

The development of high yielding varieties of bitter gourd crops requires information about the nature and magnitude of variability present in the available strains and depends on judicious assessment of available data on the phenotypic traits that are connected with yield. Hence, 20 bitter gourd strains were evaluated for growth, yield and quality attributes (Table 2 and 3). Among the bitter gourd strains, the vine length is an important trait that's indirectly influence the yield, as maximum vine length provide the opportunity to produce the highest number of primary branches, number of nodes, number of male and female flower, which eventually increases the yield. The length of vine was recorded maximum (351.50 cm) in RAJ-2 and minimum (163.44 cm) in PDM. The maximum (11.33) number of primary branches per vine was observed in JP-1, while (6.02) minimum in VRBTG-2.

The lowest number of nodes bearing first male and female flower is one of the key traits, that's directly correlated to yield, because nodes is the main site of flower emergence. If the nodes are appeared at

lowest nodes, then there is chance to produces high number of flower and fruits per plant. The lowest (6.65) number of nodes bearing first male flower was recorded in PDM and highest in VRBTG-8 (10.49). The minimum number of nodes bearing first female flower was observed in KVS-7 (10.77), while maximum in VRBTG-9 (16.38). These finding are in corroboration with work of Laxuman (2005), Mohan (2005), Islam *et. al.* (2014) & Singh *et. al.* (2016) in bitter gourd. Early flowering is one of the most important traits, which decides who early the fruits reach to market, so for, earliness is concern this characters is very necessary. The minimum (53.83 days) days taken to opening of first male flower were noticed in VRBTG-6, while maximum (72.90) in RAJ-1.The minimum (58.01 days) days taken to opening of first female flower was noticed in VRBTG-2, while maximum in RAJ-1 (77.33 days). The above results are found in conformity with the findings of Mohan (2006), Islam *et. al.* (2014) & Singh *et. al.* (2016) in bitter gourd. High percent of fruit setting directly related to high number of fruits per plant, while minimum days to first fruit harvest provide opportunity to enhance the harvesting duration of crop that directly influenced the crop yield in bitter gourd. The maximum (92.28%) percent of fruit setting was recorded in VRBTG-8 and minimum in VRBTG-1 (76.48%). The maximum number of fruits per vine was reported in (49.61) VRBTG-6, while minimum fruit was recorded in VRBTG-1 (29.60). The genotype HP-2 had maximum (3.64 kg) total fruit yield per vine and VRBTG-1 exhibited minimum (1.15 kg).

Table.1 Genotypes of bitter gourd with their sources

Sl. No.	Genotypes	Sources
1.	GP-1	Gorakhpur, Uttar Pradesh
2.	HP-1	Mandi, Himachal Pradesh
3.	HP-2	Mandi, Himachal Pradesh
4.	JP-1	Jaunpur, Uttar Pradesh
5.	KVS-7	Pauri, Uttarakhand
6.	MN-1	Khurai, Manipur
7.	MP-1	Jabalpur,Madhya Pradesh
8.	PDM	IIVR, Varanasi
9.	PSPB-14	Imphal, Manipur
10.	RAJ-1	Jaipur, Rajasthan
11.	RAJ-2	Jaipur, Rajasthan
12.	VRBTG-1	IIVR, Varanasi
13.	VRBTG-2	IIVR, Varanasi
14.	VRBTG-3	IIVR, Varanasi
15.	VRBTG-4	IIVR, Varanasi
16.	VRBTG-5	IIVR, Varanasi
17.	VRBTG-6	IIVR, Varanasi
18.	VRBTG-7	IIVR, Varanasi
19.	VRBTG-8	IIVR, Varanasi
20.	VRBTG-9	IIVR, Varanasi

Table.2 Mean performance of bitter gourd genotypes for growth and yield parameters

Genotypes	Length of vine (cm)	Number of primary branches per vine	Days taken to opening of first male flower	Number of nodes bearing first male flower	Days taken to opening of first female flower	Number of nodes bearing first female flower	Percent of fruit setting	Number of fruits per vine
GP-1	322.18	9.90	58.76	8.61	63.21	13.53	90.46	42.45
HP-1	320.44	8.16	60.23	10.35	65.74	14.48	89.24	35.31
HP-2	319.47	10.44	62.70	10.01	66.02	15.74	86.40	39.23
JP-1	220.78	11.33	70.72	10.26	73.42	12.84	91.42	44.81
KVS-7	296.32	8.78	59.71	7.82	62.80	10.77	83.41	42.36
MN-1	312.52	8.56	71.41	9.52	77.28	12.37	89.24	41.63
MP-1	339.20	7.55	60.18	8.09	64.67	13.46	79.48	34.61
PDM	163.44	6.79	63.83	6.65	70.52	10.95	80.95	35.63
PSPB-14	260.47	9.53	59.10	8.27	63.89	12.36	84.95	43.40
RAJ-1	307.17	9.53	72.90	8.77	77.33	13.98	86.37	40.33
RAJ-2	351.50	8.66	72.54	7.70	76.65	14.85	80.45	46.26
VRBTG-1	260.50	6.02	66.88	7.87	72.57	13.19	76.48	29.60
VRBTG-2	227.88	7.55	55.38	8.44	58.01	12.49	82.63	39.34
VRBTG-3	211.30	8.67	61.39	7.32	66.09	11.15	83.33	42.62
VRBTG-4	310.60	9.54	56.98	8.79	61.81	15.25	77.33	45.54
VRBTG-5	274.81	8.50	58.22	8.72	60.13	14.55	85.40	40.54
VRBTG-6	261.65	10.43	54.83	8.56	58.64	13.20	89.82	49.61
VRBTG-7	283.44	9.63	67.91	8.30	74.07	14.51	90.51	39.41
VRBTG-8	301.31	7.43	55.66	10.49	60.55	14.13	92.28	35.23
VRBTG-9	340.82	6.68	55.51	9.78	61.09	16.38	78.61	37.55
Range Max.	351.50	11.33	72.90	10.49	77.33	92.28	49.61	5.53
Min.	163.44	6.02	54.83	6.65	58.01	76.48	29.60	2.25
Mean	**284.29**	**8.68**	**62.24**	**8.71**	**66.72**	**13.51**	**84.94**	**40.27**
S.Em±	0.61	0.17	0.36	0.27	0.36	0.26	0.40	0.07
C.D @5%	1.75	0.51	1.04	0.78	1.04	0.75	1.15	0.22

Table.3 Mean performance of bitter gourd genotypes for yield and quality seed parameters

Genotypes		Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	Fruit yield per vine (kg)	Carbohydrate (g/100g)	Vit. C (mg/ 100g)	T.S.S (^{0}Brix)	No. of seeds/ fruit
GP-1		52.74	5.27	21.60	1.24	5.77	95.50	4.44	15.17
HP-1		95.82	3.05	18.75	3.37	5.17	84.58	5.30	14.90
HP-2		92.65	4.27	18.20	3.64	5.29	86.82	5.30	11.76
JP-1		49.81	5.33	21.75	2.23	4.72	95.09	5.79	18.47
KVS-7		79.54	5.53	23.55	3.36	5.33	62.24	5.15	13.23
MN-1		89.20	3.01	20.55	2.70	6.37	84.20	5.15	22.03
MP-1		90.25	4.87	19.66	3.11	4.64	86.15	5.55	15.76
PDM		40.22	3.42	10.51	1.45	5.36	85.09	4.82	12.78
PSPB-14		100.28	5.23	22.86	3.34	9.47	93.39	5.75	14.60
RAJ-1		89.89	4.15	19.84	2.63	5.10	86.63	5.66	20.45
RAJ-2		90.68	3.96	12.64	3.17	4.15	100.32	5.27	19.52
VRBTG-1		38.74	4.36	7.53	1.15	5.95	85.29	5.68	10.52
VRBTG-2		52.82	4.36	12.57	2.08	8.17	88.41	6.01	15.58
VRBTG-3		80.46	2.25	11.65	3.46	7.43	79.56	5.10	16.58
VRBTG-4		79.97	4.64	15.66	1.63	8.10	89.47	5.49	14.616
VRBTG-5		66.04	4.07	16.54	2.65	9.30	91.51	5.77	18.54
VRBTG-6		72.35	3.50	20.66	3.58	6.51	84.44	5.30	13.55
VRBTG-7		53.17	5.32	19.79	2.09	4.41	92.87	5.41	18.73
VRBTG-8		62.86	2.76	16.74	1.19	9.55	96.25	5.67	13.36
VRBTG-9		89.29	3.03	14.74	3.34	7.31	66.81	5.06	19.49
Range	**Max.**	100.28	3.64	3.64	23.55	9.55	100.32	6.01	22.03
	Min.	38.74	1.15	1.15	7.53	4.15	62.24	4.44	10.52
Mean		**73.34**	**4.12**	**17.29**	**2.57**	**6.40**	**86.73**	**5.38**	**15.98**
S.Em±		0.17	0.04	0.09	0.01	0.04	0.81	0.21	0.30
C.D @5%		0.50	0.12	0.28	0.02	0.12	2.32	0.61	0.87

Table.4 Genotypic correlation between growth, yield and quality parameters in bitter gourd (*Momordica charantia L.*)

Sl. No.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.047	0.020	0.425**	0.020	0.685**	-0.018	0.009	0.320*	0.599**	0.075	-0.173	-0.017	-0.153	0.262*	0.254*
2	**X**	0.189	0.264*	0.093	0.079	0.573**	0.760**	0.678**	0.186	0.414**	-0.186	0.308*	-0.036	0.175	0.269*
3		X	-0.097	0.984**	-0.073	0.089	0.014	-0.012	-0.012	0.119	-0.631**	0.262*	0.031	0.478**	-0.042
4			X	-0.128	0.576**	0.540**	-0.049	0.393**	0.251	-0.154	0.148	0.112	0.274*	0.163	0.068
5				X	-0.074	0.057	-0.068	-0.061	-0.019	0.047	-0.630**	0.232	-0.079	0.446**	-0.091
6					X	-0.038	-0.053	-0.024	0.293*	-0.052	0.008	0.221	0.102	0.196	0.068
7						X	0.255*	0.621**	-0.063	-0.006	-0.027	0.335*	-0.044	0.195	-0.002
8							X	0.429**	0.256*	0.166	0.042	0.143	-0.125	0.311*	0.355**
9								X	0.374**	0.462**	-0.108	-0.018	-0.052	0.213	0.328*
10									X	-0.187	0.033	-0.219	-0.006	0.288*	0.776***
11										X	-0.263*	0.171	0.191	-0.116	-0.155
12											X	0.052	0.413**	-0.121	-0.129
13												X	0.329*	0.094	-0.408**
14													X	0.041	-0.020
15														X	0.209
16															X

*, ** significant at 5 and 1 percent respectively

1. Length of vine (cm) **2. No. of primary branch/ vine** **3. Days to opening of first male flower** **4. No. of nodes bearing first male flower** **5. Days to opening of first female flower**

6. No. of nodes bearing first female flower **7. percent of fruit setting** **8. No. of fruit per vine** **9. Length of fruit (cm)** **10. Weight of fruit (g)**

11. Diameter of fruit (cm) **12. Carbohydrate (g/100g)** **13. Vit. C (mg/100g)** **14. T.S.S (^{0}Brix)** **15. Number of seeds/ fruit**

16. Fruit yield/ vine (kg)

The results of present studies are in line with Shah *et. al.* (2016) in cucumber and Singh *et. al.* (2016) in bitter gourd. Yield is a collective efforts of fruit length, fruit diameter and fruit weight, hence these the traits directly manipulate the total yield of a crop. The maximum fruit length (23.55 cm) was recorded in KVS-7, while minimum was recorded in VRBTG-1 (7.53 cm). The maximum (100.28 g) weight of fruit was recorded in PSPB-14 and minimum in VRBTG-1 (38.74 g). The genotype JP-1 recorded (5.33 cm) maximum fruit diameter and the genotypes VRBTG-3 and KVS-7 and VRBTG-3 recorded minimum (2.25 cm) fruit diameter. Similar results were recorded by Mohan (2005), Islam *et. al.* (2014) & Singh *et. al.* (2016) in bitter gourd. The maximum carbohydrate (9.55 g/100g) content was recorded in VRBTG-8 and minimum (4.15 g/100g) in RAJ-2. The (6.01 ^{0}Brix) maximum T.S.S was recorded in VRBTG-2 and minimum (4.44 ^{0}Brix) in GP-1. The vitamin C was found maximum (100.32 mg/100g) in RAJ-2 and minimum in KVS-7 (86.73 mg/100g). Similar findings were also reported by Shah *et. al.* (2016) cucumber and Singh *et. al.* (2016) in bitter gourd. The maximum (20.30) number of seeds per fruit was exhibited by MN-1, while minimum (10.52) by VRBTG-1. The results are in similarly with Mohan (2005) & Singh *et. al.* (2016) in bitter gourd.

Correlation analysis

Yield being a complex character, is influenced by many yield and yield related traits. The knowledge on the impact of various components on yield is essential before selection of desirable strains. In this context, correlation analysis will indicate possible association between the yield and yield attributes of bitter gourd strains. Estimation of correlation is a simple tool to select bitter gourd lines suitable for further crop improvement programme. The genotypic correlation coefficients among the yield and yield attributes in bitter gourd are presented in Table 4. Doku (1970) suggested that inter correlation among the yield components need to be estimated because one component influences the other related components. The results in the present experiment, revealed that yield per vine had significant positive association at genotypic levels for vine length, number of primary branches per vine, number of fruit per vine, fruit length and fruit weight. Similar results were also observed by Miah *et. al.* (2000), Dey *et. al.* (2005) & Singh *et. al.* (2014) in bitter gourd and Fayeun *et. al.* (2012) in fluted pumpkin also reported that fruit yield positively correlated with number of number of fruit per plant, fruit length and fruit weight in bitter gourd. Ascorbic acid showed negative association at genotypic levels in some traits *viz.*, fruit diameter and carbohydrate content, while the least negative correlation was reported at genotypic levels in the traits like, days taken to opening of first male and female flower, percent of fruit setting and total soluble solid. Similar observations were also reported by Rao *et. al.* (2002) in ridge gourd; Sanwal *et. al.* (2007) in sweet gourd and Selvi *et. al.* (2012) in pumpkin. It is suggested that vigorous plant with profuse growth, high number of primary branches per vine produce high yield per vine. A very strong positive and significant correlation was observed between yield and average weight of fruit, whereas the number of fruit per vine and fruit length also reported the good association with yield. The days taken to opening of first male and female flower, percent of fruit setting and total soluble solid showed negligible negative effect on fruit yield per vine. It indicates that number of fruit per vine, fruit length and average fruit weight in bitter gourd plays important role in selection of higher yielding genotypes.

Bhave *et. al*. (2003), Dey *et. al*. (2005), Ram *et. al.* (2006) and Islam *et. al*. (2009) in bitter gourd also reported similar association of fruit yield with number of fruits per vine. Bhave *et. al*. (2003) and Sundaram (2010) in bitter gourd reported similar association of fruits per vine with vine length. It suggests that these traits are most valuable for yield, so more priority should be given to these characters in bitter gourd improvement programme.

In conclusion, selection of parents with the earliness, high fruit yield and quality is the primary objective of all breeders in any hybrid development programme. Based on the present research work, among the twenty bitter gourd lines, the strain HP-2 recorded the highest mean value of fruit yield per vine followed by VRBTG-6 and VRBTG-3. Further these genotypes viz., HP-2, VRBTG-6 and VRBTG-3 could be adjudged as the ideal donor for yield as it proved its potential to serve as the best parents for earliness and fruit yield vine.

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