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Genetic diversity studies for improved horticultural traits in bitter gourd [*Momordica charantia* L.] genotypes

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Abstract

Twenty-seven bitter gourd genotypes were evaluated at Research farm of Department of Vegetable Science, CCS, Haryana Agricultural University, Hisar to find out suitable bitter gourd genotypes for future breeding programme. These genotypes were evaluated morphologically on leaf and fruit characters along with sixteen quantitative traits. In general, ample variation was observed for most of leaf and fruit characters, except for leaf pubescence. Analysis of variance exhibited highly significant variation among all genotypes for all the characters except nodes to first male and female flower and leaf length (cm). The maximum genotypic and phenotypic coefficients of variation (GCV and PCV) were recorded for number of primary branches (22.50 and 23.14) and number of fruits per vine (26.41 and 26.64). High heritability coupled with high genetic advance as percent of mean were observed for number of fruits per vine (95.18 and 53.96), number of primary branches (85.20 and 45.06), weight of 100 seeds (98.98 and 37.26) and fruit yield per vine (96.64 and 31.03) showing strong impact of additive gene effect. The following bitter gourd genotypes *viz*., IC 85624 and HK 113 were recorded best in terms of fruit yield.

Keywords: *Momordica charantia*, Diversity, Genetic Parameters, Heritability and Genetic advance

Introduction

Bitter gourd (*Momordica charantia* L.), belongs to Cucurbitaceae family, is grown for its tender and immature fruits, which showed a huge diversity in its fruit shape, colour, surface and level of cucurbitacin content. Its fruits are eaten either raw or in cooked form like boiled, curry, stuffed and fried. It is a rich source of Calcium, Phosphorus, Iron, vitamin A and C. Its fruit juice is used for curing several human ailments including diabetes, piles, blood and respiratory related and cholera as reported by (Kumar et al. 2017). In India, this crop is successfully grown mainly in states of Chhattisgarh, Telangana, Andhra Pradesh, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, Tamil Nadu and Haryana. The total cultivated area under this crop in India was around 101 thousand hectares with an annual production of 1214 thousand metric tonnes during 2019-20 (Anonymous 2019-20).

The formulation of an effective breeding plan totally relies on the assessment of genetic variability existing for any crop species. Most of the cultivars and hybrid developed in India have very low fruit yield potential due to genetic drift and advances of many new pathogen races. Phenotypic selection mainly based on the existing genetic variation and to choose the best genotypes for commercial utilization (Simmonds 1962). It is necessary to obtain adequate information on the magnitude and type of genetic variability and their consequent heritability. The role of genetic variability for crop improvement programme depends primarily on selection of potential parents for making the hybridization successful. Fruit yield is a complex trait which depends mainly on growth and yield related traits. The estimation of heritability has to be considered together with genetic advance and change in mean value among successive generation. The magnitude of such estimates also suggests the extent to which improvement is possible through selection. Keeping the above point under consideration, the present study was carried out with the objective to estimates the variability, heritability and genetic advance for different morphological and quantitative traits of bitter gourd genotypes.

Materials and Methods

Twenty-seven bitter gourd genotypes were evaluated in randomized complete block design with three replications during Spring Summer season 2018 at Research Farm of the Department of Vegetable Science, CCS Haryana

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Agricultural University, Hisar. The experimental materials comprised of 27 (16 Indigenous lines collected from NBPGR, New Delhi, 9 inbred lines developed by Department of Vegetable Science along with two commercial varieties *i.e*., Pusa Do Mausami and Pusa Vishesh) from IARI, New Delhi. Before sowing, the moist seeds of each genotype were treated with Captan @ 2.5-3.0 g per kg seed. The seeds were sown in a plot size of 2.7 x 3 m accommodating twelve plants per genotypes/ replication on 6th March 2018. A recommended dose of fertilizer @ 50: 25:25 Kg NPK/ ha was applied to the crop. A handful of well rotten Farm yard manure (FYM) along with full dose of phosphorus and potassium and half of nitrogen fertilizer were mixed thoroughly in the soil by spot placement method as basal dose. The remaining half dose of nitrogen fertilizer was top dressed after 45 and 60 DAS. After sowing a light irrigation was given in furrows up to half of height. The five selected and tagged plants from each replication were used for recording the observations based on sixteen quantitative parameters as described in Table 1. Similarly, the bitter gourd genotypes were also categorized morphologically on the following characters *i.e*., leaf shape & pubescence, fruit shape in longitudinal section, fruit neck & skin colour, shape of fruit at blossom and peduncle end as per the guidelines given by (Srivastava et al. 2011). All agronomic practices and plant protection measures were adopted for raising a successful healthy vegetable crop. The genotypic and phenotypic variances and coefficients of variation were estimated by implementing standard statistical procedures suggested by (Sheoran 2010)

Table1: Analysis of variance for different characters in bitter gourd genotypes

Characters	Mean sum of square		
	Replications (df=2)	Genotypes (df=26)	Error (df=52)
Days to 50% germination	1.293	0.755**	0.227
Number of primary branches	0.203	13.826**	0.756
Days to first male flower opening	3.308	4.254**	1.244
Days to first female flower opening	0.753	14.100**	3.624
Node to first male flower	1.186	0.654	0.34
Node to first female flower	1.170	0.595	0.252
Leaf length (cm)	0.057	1.247	0.154
Leaf width (cm)	0.099	1.434**	0.216
Leaf blade	0.266	0.542**	0.07
Days to first fruit harvest	2.487	29.333**	1.613
Length of fruit (cm)	1.174	7.983**	1.509
Diameter of fruit (cm)	0.05	0.240**	0.038
Vine length (m)	0.009	0.081**	0.019
Weight of 100 seeds (g)	1.942	34.255**	0.116
Number of fruits per vine	0.566	68.564**	1.137
Fruit yield per vine (kg)	0.0005	0.040**	0.0004

Results and Discussion

The analysis of variance for 27 different genotypes of bitter gourd for sixteen quantitative characters carried out during the study designated significantly higher amount of variability among the genotypes for all the thirteen quantitative characters studied except nodes to first male and female flower and leaf length (cm) (Table 1). The present results of diversity study of bitter gourd genotypes, which recorded the maximum diversity are in consultation with the findings of (Kumari et al. 2018) in bitter gourd. All the 27 genotypes of bitter gourd were studied for seven morphological characters differed significantly for most of the characters except leaf pubescence. On the basis of leaf shape and leaf pubescence the bitter gourd genotypes were classified into three groups (14, 12 and 1) of genotypes having cordate, reniform and oblong leaf shape, whereas, the total genotypes exhibited soft leaf pubescence. Enough variation was observed for fruit shape (longitudinal) and neck (11, 10, 5 and 1) genotypes, which exhibited elongate straight, elongate curved, round and cylindrical fruit shape, whereas, the maximum genotyped (17 and 10) possessed straight and crooked neck. On the basis of fruit skin colour the maximum genotypes were categorized into three group (10, 9, 8) possessing green, mottle green and light green colour, whereas based on fruit shape at blossom end, the genotypes were grouped into four categories (14, 6, 5, 2) having acute, blunt, semi blunt and semi acute fruit shape, respectively. With regard to the fruit shape at peduncle end (12, 9 and 6) genotypes demonstrated flat, round and depressed fruit shape, respectively. Ssignificantly differences were noted among the different bitter gourd genotypes with regard to different growth and flowering traits. The mean performance of different growth and flowering parameters was depicted in (Table 2). The difference observed for different growth parameters might have been due to their own genetic makeup, seed vigour and environmental factor confirming to the results of Sharma and Sengupta (2013) in bottle gourd and (Hanchinamani et al. 2008) in cucumber germplasm.

The data pertaining to fruit yield and its related parameters *i.e*. fruit length, fruit diameter, number of fruits per vine and fruit yield per vine were 13.29 cm, 3.61 cm, 2.06 m, 18.62 m, 17.95 and 0.76 kg as recorded in the present germplasm of bitter gourd. It ranged from 9.33 to 16.53 cm, 3.13 to 4.28 cm, 1.59 to 2.29 m, 10.20 to 27.37 and 0.43 to 0.91 kg /vine for fruit length, fruit diameter, weight of 100 seeds, number of fruits per vine and fruit yield per vine. On the basis of mean performance of fruit yield and its related traits, it was revealed that IC 85624 followed by HK 113, IC 85610

Table 2: Components of variation and estimates of genetic parameters for various characters in bitter gourd

Characters	General Mean	Range of mean		Components of variance		Coefficient of variation		h^2 (%)	Genetic advance as % of mean
		Minimum	Maximum	Genotypic	Phenotypic	Genotypic %	Phenotypic %		
Days to 50% germination	12.56	11.53	13.63	0.18	0.25	3.34	4.00	43.60	5.75
Number of primary branches	9.28	5.90	13.73	4.36	4.61	22.50	23.14	85.20	45.06
Days to first male flower opening	36.02	33.67	38.33	1.00	1.42	2.78	3.31	44.63	4.82
Days to first female flower opening	44.36	41.00	48.67	3.49	4.70	4.21	4.89	49.07	7.48
Node to first male flower	7.09	6.29	8.09	0.11	0.22	4.57	6.59	23.55	6.52
Node to first female flower	13.72	12.83	14.83	0.11	0.20	2.47	3.25	31.18	3.85
Leaf length (cm)	7.31	4.61	8.09	0.36	0.42	8.26	8.82	70.17	15.92
Leaf width (cm)	9.36	8.01	10.69	0.41	0.48	6.81	7.39	65.24	12.92
Leaf blade	6.45	5.66	7.04	0.16	0.18	6.15	6.59	68.91	11.80
Days to first fruit harvest	57.89	52.80	64.20	9.24	9.78	5.25	5.40	85.13	10.51
Length of fruit (cm)	13.29	9.33	16.53	2.16	2.66	11.05	12.27	58.85	20.50
Diameter of fruit (cm)	3.61	3.13	4.28	0.07	0.08	7.20	7.85	63.75	13.60
Vine length (m)	2.06	1.59	2.29	0.02	0.03	7.01	8.01	52.24	12.65
Weight of 100 seeds (g)	18.62	13.79	26.93	11.38	11.42	18.12	18.15	98.98	37.26
Number of fruits per vine	17.95	10.20	27.37	22.48	22.86	26.41	26.64	95.18	53.96
Fruit yield per vine (kg)	0.76	0.43	0.91	0.01	0.01	15.15	15.24	96.64	31.03

and IC 85605 genotypes should have grown for getting the maximum fruit yield of bitter gourd and these genotypes could be further utilized for future breeding programmes (Table 3). The number of fruits per vine and it size and other fruits yield related traits are the major factors, which decide the total fruit yield of the crop. The variation for these traits might have been due to sex ratio, fruit set percentage, genetic nature and their response to varying environmental conditions. These fruit yield related traits clearly indicate that fruit yield is governed mainly due to genetic mechanism of genotypes and it differs from one genotype to the other in bitter gourd. The results are in close conformity with the findings of Mangala et al. (2015) in bottle gourd.

The values for phenotypic coefficient of variability were reported higher than the genotypic coefficients of variability demonstrating the control of environment on these traits. High estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for the characters number of fruits/vine (26.41 and 26.64) and number of primary branches (22.50 and 23.14) indicating greater extent of genetic variability present for the above characters whereas moderate GCV and PCV were estimated for the traits namely weight of 100 seeds (18.12 and 18.15), fruit yield/vine in kg (15.15 and 15.24) and length of fruit (11.05 and 12.27) representing moderate amount of genetic variability present in these characters, which in turn contributed to average scale for selection. The characters like leaf length (8.26 and 8.82), vine length at the time of final harvest (7.01 and 8.01) and other such traits like diameter of fruit, leaf width, leaf blade,

Table 3: Five promising genotypes selected on the basis of mean performance for growth, flowering and fruit yield parameters in bitter gourd

Characters	Superior genotypes
Days to 50% germination	HK 132, HK 161, Pusa Do Mausami, HK 113 and HK 121
Number of primary branches	IC 85605, HK 121, HK 113, IC 85615 and IC 85624
Days to first male flower opening	HK 121, HK 161, HK 160, IC 85624 and Pusa Do Mausami
Days to first female flower opening	IC 85605, IC 85615, HK 157, HK 121 and HK 113
Node to first male flower	IC 85620, IC 85612, IC 85617, HK 106 and IC 85622
Node to first female flower	IC 85609, IC 85612, HK 160, IC 85617 and IC 85622
Leaf length (cm)	Pusa Vishesh, HK 106, IC 85615, HK 132 and IC 85610
Leaf width (cm)	IC 85609, HK 132, HK 113, IC 85614 and IC 85610
Leaf Blade	HK 157, HK 106, HK 132, HK 113 and IC 85605
Days to first fruit harvest	IC 85605, HK 157, HK 121, IC 85615 and IC 85624
Length of fruit (cm)	IC 85622, HK 121, IC 85615, HK 113 and IC 85624
Diameter of fruit (cm)	HK 107, IC 85622, HK 113, IC 85624 and IC 85605
Vine length (m)	HK 161, IC 85609, IC 85624, IC 85617 and IC 85612
Weight of 100 seeds (g)	IC 85616, HK 121, IC 85618, IC 85613 and IC 85614
Number of fruits per vine	HK 157, HK 121, IC 85615, HK 113 and IC 85624
Fruit yield per vine (kg)	IC 85614, HK 121, IC 85615, HK 113 and IC 85624
Yield per hectare (q/ha)	HK 157, HK 121, IC 85615, HK 113 and IC 85624

days to first fruit harvest, nodes to first male flower, days to first female flower opening, days to 50% germination, days to first male flower opening and nodes to first female flower had lower GCV and PCV depicting restricted extent of improvement for these traits (Table 2). The above results were in agreement with (Singh et al. 2017) in bitter gourd, who reported high magnitude of PCV than GCV suggesting very low role of environment in expression of characters promoting phenotypic selections. Similarly, in bitter gourd (Maurya et al. 2018), who described high GCV and PCV for number of fruits per vine.

High heritability estimates specified the inner strength of the characters to transfer from one generation to next, therefore these traits as observed are most helpful in selection of the promising genotypes for breeding purpose. High heritability values (>60%) ranged from 63.75% to 98.98% and were observed for weight of 100 seeds, fruit yield per vine, number of fruits per vine, number of primary branches, days to first fruit harvest, leaf length, leaf blade, leaf width and diameter of fruit which indicate that these characters were less influenced by the environment (Table 2). However, the characters like length of fruit, vine length at the time of final harvest, days to first female flower opening, days to first male flower opening, days to 50% germination and nodes to first female flower possessed moderate heritability estimates (30-60%) and ranged from 31.18% to 58.85%. While only one character namely nodes to first male flower had low heritability estimates (<30%) and denotes that the selection based on this trait will be ineffective as it will be modified by the environment. These results are in agreement with (Deepthi et al. 2016) in bottle gourd, who revealed high heritability for fruit yield per vine and number of fruits/vine.

High genetic advance as per cent of mean was reported for number of fruits/vine (53.96%), number of primary branches, weight of 100 seeds, fruit yield/vine in kg and length of fruit (20.50%). The moderate values were found for the traits namely leaf length (15.92%), diameter of fruit, leaf width, vine length at the time of final harvest, leaf blade and days to first fruit harvest (10.51%). However low genetic advance estimates were recorded for days to first female flower opening (7.48%), nodes to first male flower, days to 50% germination, days to first male flower opening and nodes to first female flower (3.85%). The high, moderate and low genetic advance were also reported by previous researcher like Sharma and Sengupta (2013) who reported high GA for fruit length in bottle gourd, while (Tiwari et al. 2018) recorded low GA in bitter gourd. The high heritability together with high GA values as percentage of mean is more valuable for selection breeding approaches as it passes light on the nature of gene action involved in transfer process of a particular traits from one generation to the other. High heritability coupled with genetic advance was found in case of number of fruits/vine, number of primary branches, weight of 100 seeds, fruit yield/vine. High heritability together with high genetic advance showed greater share of additive gene effect, therefore, these characters encourage direct selection for further utilization in yield improvement of bitter gourd. These results confirm the findings of Devmore et al. (2010) and Chakraborty et al. (2013), they noticed high heritability in combination with high genetic advance for number of primary branches and fruit yield/vine in bitter gourd. Among the different bitter gourd genotypes evaluated in the present study, it can be concluded that IC 85624, HK 113 and IC 85610 and IC 85605 were high yielding genotypes of bitter gourd. These could be utilized further for future breeding programme.

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सारांश

करेले के कुल 27 प्रभेदों में उन्नत औद्यानिक लक्षणों को जानने के लिए इनकी अनुवांशिक विविधता का मूल्यांकन वर्ष–2018 के मौसम (वसंत–गर्मी) के दौरान चौधरी चरण सिंह हरियाणा कृषि विश्वविद्यालय, हिसार (हरियाणा) के सब्जी विज्ञान विभाग के अनुसंधान प्रक्षेत्र में किया गया। इस प्रयोग से उन्नत करेले के प्रभेदों को भविष्य में इस फसल की नस्ल सुधार के कार्यक्रम में शामिल किया जायेगा। करेले के प्रभेदों का मूल्यांकन इस फसल के बाह्यदृश्य प्रारूप लक्षणों जैसे–पत्तों और फलों से संबंधित गुणों और इसमें सम्मिलित अन्य उपयोगी 16 मात्रात्मक गुणों के आधार पर किया गया। आंकड़ों के परिणाम से स्पष्ट हुआ कि अध्यान में सम्मिलित सभी 16 लक्षणों के लिए विभिन्न करेला प्रभेदों के पत्तियों और फलों से संबंधित गुणों के बीच में काफी अंतर पाया गया और पत्तियों के ऊपर स्थित मुलायम कांटों के गुण में ऐसा नही पाया गया। विभिन्नता विश्लेषण के आधार पर प्रमुख प्रभेदों में काफी भिन्नता प्रदर्शित पायी गयी लेकिन पार्श्व गांठ पर स्थित नर व मादा फूलों फूलों और पत्तों की लम्बाई में आपसी भिन्नता नही पायी गयी। भिन्नता के अधिकतम मात्रात्मक और पितृात्मक विचरण गुणांक प्राथमिक शाखाओं की संख्या में 22.50 एवं 23.14 और प्रति लता की संख्या (26.41 एवं 26.64) में पाया गया। प्रति लता फलों की संख्या (95.18 एवं 53.96) प्राथमिक शाखाओं की संख्या (85.20 एवं 45.06), 100 बीजों का भार (98.98 एवं 37.26) और प्रति लता फल की उपज (96.64 एवं 312.03) के लिए उच्च आनुवांशिक मूल्य के साथ उच्च आनुवंशिकता का प्रतिशत पाया गया। फलों की उपज के लिए कुछ विशेष करेले के प्रभेदों–आईसी 85624 और एच.के.–113 उत्कृष्ट व्यवहार के आधार पर चयन किया गया।

References

Anonymous (2019-20) Area and production of horticulture crops-All India. Ministry of Agriculture and Farmers Welfare, Government of India. (In: Vegetable category, Bitter gourd) https:// www. indiastat.com/ table/agriculture-data/2/bitter-gourd/962145/962234/data.aspx.

Chakraborty L, Acharya P and Raychaudhuri S (2013) Diversity analysis of (*Momordica charantia* L.) accessions from Eastern and North Eastern India based on morphological, yield related traits and molecular marker. In: Proceedings of International Symposium on Quality Management of Fruits and Vegetable for Human Health of FVHH held on 5-8 August 2013 at Thailand, pp 179-193.

Deepthi B, Reddy PSS, Kumar AS and Reddy AR (2016) Studies on PCV, GCV, heritability and genetic advance in bottle gourd genotypes for yield and yield components. Plant Arch 16(2): 597-601.

Devmore JP, Dhonukshe BL, Thaware BL, Bendale VW, Jadhav BB and Thirathy TN (2010) Genetic variability and heritability studies in bitter gourd (*Momordica charantia* L.). J Maharashtra Agric Univ 35(1):163-165.

Hanchinamani CN, Patil MG, Dharmatti PR and Mokashi AN (2008) Studies on variability in cucumber (*Cucumis sativus*). Crop Res 36(1-3): 273-276.

Kumar GS, Shathirapathiy G, Jainraj R and Paul Y (2017) Immediate effect of bitter gourd, ash gourd, Knol-khol juices on blood sugar levels of patients with type 2 diabetes mellitus: A pilot study. J Tradit Complement Med **7** (4): 526-531.

Kumari M, Kumar J, Kumari A, Singh VK, Rani N and Kumar A (2018) Genetic variability, correlation and path coefficient analysis for yield and yield attributing traits in bitter gourd (*Momordica charantia* L.). Curr J App Sci Technol 31(4): 1-8.

Mangala T, Mandal J, Dhangrah VK (2015) Studies on genetic variability and trait inter-relationship in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. HortFlora Res Spec 4(1): 34-38.

Maurya D, Singh VB, Yadav GC and Kumar V (2018) Studies on genetic variability, heritability and genetic advance in bitter gourd (*Momordica charantia* L.). J Pharmacogn Phytochem **7**(5): 1925-1928.

Sharma A and Sengupta SK (2013) Genetic diversity, heritability and morphological characterization in bottle gourd [*Lagenaria siceraria* (Molina.) Standl.]. The Bioscan 8(4): 1461-1465.

Sheoran OP (2010) Online Statistical Analysis (OPSTAT) A software developed by Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India. http:// www.hau.ernet.in/opstat.html.

Simmonds NW (1962) Variability in crop plants, its use and conservation. Biol Rev 37: 314-318.

Singh R, Kumar A, Singh ML, Maurya SK and Pandey KD (2017) Microbial diversity in the rhizosphere of *Momordica charantia* L. (Bitter gourd). Int J Curr Microbial Appl Sci 6(2): 67-76.

Srivastava U, Mahajan RK, Gangopadhyay KK, Singh M. and Dhillon, BS (2011) Minimal descriptors of Agri-horticultural Crops-Part III Fruit crop. NBPGR, Pusa Campus, New Delhi 110012.

Tiwari NK, Pandey AK, Singh UN and Singh VB (2018) Genetic variability, heritability in narrow sense and genetic advance as percent of mean in bitter gourd (*Momordica charantia* L.). J Pharmacogn Phytochem **7**(2): 2608-2610.