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Assessment of Genotypic Variability, Heritability and Genetic advance for Growh, Yield and Quality Related Traits in Bitter Gourd (*Momordica charantia* L.) Genotypes

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ABSTRACT: Bitter gourd (*Momordica charantia* L.) is an important nutritious vegetable crop belonging to the genera momordica with diploid chromosome number 2n=22 and is cultivated for immature tuberculate fruits which containing a unique bitter taste. The characteristic bitter taste is due to the presence of 'momordicine' chemical. Genetic variability is a pre requisite for a plant breeder to develop a high yielding with good quality variety. It is important because it helps to maintain the health of population by including alleles that may be valuable in resisting diseases and nutraceutical values. The present investigation was undertaken to compute the genotypic variability, heritability and genetic advance for growth and yield parameters among fifty genotypes of bitter gourd (*Momordica charantia* L.). In a randomized block design with two replications during *kharif* 2022 at KRCCH, Arabhavi. Analysis of variance exhibited maximal significant differences among the genotypes were observed for all the traits under study. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits. High (> 20 %) genotypic coefficient of variation (GCV) and phenotypic coefficient variation (PCV) were observed for number of primary branches per plant, vine length, node number at which first female flower appearance, fruit length, L:D ratio, sex ratio, ascorbic acid, average fruit weight, fruit yield per vine, fruit yield per hectare, beta carotene. It indicated the existence of broad genetic base, which would be amenable for further selection. High heritability (> 60 %) coupled with high genetic advance as per cent over mean (> 20 %) were recorded for the characters such as, number of primary branches per plant, days to first male flowering, node number at which first male flower opening, sex ratio, node number at which first female flower opening, vine length, fruit yield per vine, fruit length, average fruit weight, ascorbic acid, fruit yield per hectare, beta carotene and exocarp thickness this due to the prevalence of additive gene action. Hence, there is a huge scope for improving these traits through direct selection.

Keywords: Bitter gourd genotypes, heritability, variability, genetic advance, genotypic and phenotypic coefficient of variation.

INTRODUCTION

Bitter gourd (*Momordica charantia* L.) is an important nutritious vegetable crop belonging to the genera momordica with diploid chromosome number 2n=22 and is cultivated for immature tuberculate fruits which containing a unique bitter taste. The characteristic bitter taste is due to the presence of 'momordicine' chemical. Bitter gourd is the old world origin and is native of Tropical Asia, particularly in Indo-Burma region and secondary centre of origin is China. It is extensively cultivated in India, Indonesia, Malaysia, China and Tropical Africa. In India the crop is mainly grown in Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Kerala. Concerning the popularity of bitter gourd in the Asian Tropics and the release of superior F_1 hybrid

cultivars, its popularity in Africa is expected to increase. Since, the results with bitter gourd against the diabetes are still contradictory, more research needs to be finished on its hypoglycaemic activity. Several compounds from bitter gourd show interesting pharmacological activities, e.g. antitumour, immunotoxic and anti-HIV. So, further research may have potential in the development of future medicines. Traditionally, the characterization and evaluation of bitter gourd genotypes are most important for selection of desirable parent for development of superior variety or hybrid in breeding programme and also helps in improvement of productivity of the bitter gourd. At present improving of yield and quality traits in bitter gourd is most important to meet globalization demand for fresh vegetable for export and nutrition value because of its anti-diabetic property. However, yield potential of bitter gourd in India is very low due to poor yielding varieties (Renbomo and Kanti 2015) and also there is a huge gap between demand and supply chain. Keeping all this prospects, the current investigation was carried out to assess the extent and nature of genetic variability and heritability among the bitter gourd genotypes.

Mounica *et al.* (2019) disclosed that, the maximum fruit weight (57.56g), number of fruits/plant, mean fruit weight, and fruit yield/plant was recorded in genotype Amanshri followed by Galaxy Selection-9.

Rashid *et al*. (2020) investigated that lot of genotypic and phenotypic coefficients of changes were remarked for diameter of fruit (35.65 and 34.62) followed by total chlorophyll (30.08 and 20.02) and fruit length (23.70 and 23.44) in bottle gourd germplasms.

Sahoo and Singh (2020) reported that, broad level of variability integrated with maximal value of PCV and GCV were noticed for node at which initial staminate flower, node number at which initial pistillate flower, sex ratio: (M/F), days to foremost staminate flower, fruit yield/ plant (kg), and fruit yield (q/ha) in cucumber germplasms.

Singh and Kandasamy (2020) reported that, MC 13 was identified as the superior bitter gourd genotypes as it recorded higher fruit yield per vine succeeded by MC 1, MC 20 and MC 14. Maximal PCV and GCV were documented for total fruit yield per vine succeeded by total number of fruits/plant and sex ratio.

Widest range of deviations was noted for diameter of fruit, fruit length, fruit girth, mean weight of fruit and fruit yield/plant in watermelon genotypes. Maximum GCV and PCV was observed for seed size, mean fruit weight and vine length succeeded by total soluble sugar and foremost pistillate flowering node (Jagtap and Bhuktar 2021).

MATERIALS AND METHODS

The current experiment was performed at KRC College of Horticulture, Arabhavi period of 2022. Arabhavi is located in northern parts of Karnataka which receives the rain from south-west and north-west monsoons. The experimental place is situated at an elevation of 640 m above mean sea level, at 16°12 N latitude and 74°54′ E longitude. The well drained sandy loamy soil is distributed in this locality with pH of 6-6.5. The station's mean minimum and maximum temperature were 30°C and 22°C respectively, during the period of experiment. The experiment was laid out in a randomized complete block design (RCBD) with two replications. The 20 days old seedlings were transplanted at a spacing of 120 × 90 cm under field condition. Recommended basal dose of fertilizer (Package of Practices, UHS, Bagalkot) was incorporated in soil (50% of nitrogen along with full dose of phosphorus and potash) just before transplanting. Five plants of each genotype from each replication were used for observations.

Statistical analysis. Analysis of variance was performed as per the procedure provided by Panse and Sukhatme (1957). Heritability, phenotypic (PCV) and genotypic coefficients of variation (GCV) were computed in accordance with Burton and Devane (1953). Genetic advance has been estimated as per formula proposed by Johnson *et al.* (1955). The range of genetic advance over per cent of mean was classified as low (0 - 10 %), moderate (11 – 20 %) and high (20 % and above) as proposed by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

Analysis of Variance. The analysis of variance for different quantitative and qualitative characters in fifty genotypes of bitter gourd genotypes was presented in Table 1. The analysis of variance indicated significantly higher amount of variability among the genotypes for all the characters studied *viz.*, number of primary branches per plant, days to first male and female flowering, vine length, node number at which first male flower appearance, days to 50 per cent flowering, fruit length (cm), sex ratio, number of fruits per vine, fruit yield per hectare (kg/ha), fruit diameter (cm), average fruit weight (g), node number at which first female flower appearance, fruit yield per vine (kg), L:D ratio, ascorbic acid (mg/100g), β-carotene content (mg/100g), tuberculates and fruit exocarp (mm) indicates the presence of sufficient amount of variability in all the characters under study. These findings are in line with earlier reports of Sahoo and Singh (2020); Bhaiya *et al*. (2020); Thakur *et al*. (2018).

Phenotypic and genotypic coefficient of variation. In the current investigation maximum (>20 %) rate of GCV and PCV were noticed for vine length and number of primary branches per plant indicating that, wider variability exhibited in these characters. Parallel outcomes were gained by Singh and Kandasamy (2020) for vine length as well as total primary branches per vine in bitter gourd, Khan *et al*. (2015) for vine length and total primary branches in bitter gourd, Patil *et al*. (2022) for vine length in spine gourd, Keshari *et al*. (2020) for total primary branches in cucumber. It indicated the presence of high variability in the genotypes for selection. High assessment of GCV and PCV (>20%) were noted for reproductive parameters like node number at which first female flower appearance and sex ratio. Similar results also found by

Singh and Kandasamy (2020) for sex ratio in bitter gourd, Sahoo and Singh (2020) for sex ratio and node number where the first female flower appearance in cucumber. Maximal degree of PCV and GCV (>20%) were reported for yield attributing characters *viz*., fruit length, fruit yield per vine, L:D ratio, average fruit weight, fruit yield per hectare. Parallel outcome was noticed by Keshari *et al*. (2020) for fruit length, mean fruit weight and fruit yield in cucumber lines, Tiwari *et al.* (2021) for fruit yield per hectare in bitter gourd. It represented the existence of maximal variability in the germplasms for selection. The disparity between GCV and PCV values were less for maximum of the parameters studied which was indicating that, parameters under investigation were less impacted by environment. Thus, simple selection is the solution for more advancement. Assessment of high GCV and PCV (>20%) were reported for beta carotene as well as ascorbic acid (mg/100g) content and the correspondence outcomes were also documented Singh and Kandasamy (2020) for ascorbic acid in bitter gourd, Akter *et al*. (2013) for beta carotene in pumpkin.

Moderate GCV and PCV (11-20%) were registered for days taken to earliest staminate flower opening and node number where the earliest male flowering. Correspondence result was noticed by Singh and Kandasamy (2020) for total days taken to earliest staminate flowering together with node where the earliest staminate flowering in bitter gourd, Tyagi *et al*. (2018) for node number where the earliest staminate flower opening in bitter gourd, Chaudhary *et al*. (2018) for node number at which earliest staminate flowering in bitter gourd. It indicated that, the apparent deviation is not only due to genotypes but also due to little impact of environment on expression of the trait. Moderate GCV as well as high PCV were noted for diameter of the fruit in addition to total fruits in each vine indicating medium variability for these parameters in the genetic stock. The correspondence findings were founded by Singh *et al*. (2019) for fruit diameter in sponge gourd, Bhaiya *et al*. (2020) for total fruits in each vine in cucumber.

Heritability. High heritability (>60%) integrated with GAM (>20%) were reported for growth parameters such as number of primary branches per plant and vine length. As large heritability integrated with more GAM determines the frequency of additive gene interaction. Hence, selection would be effectual. Correspondence results were noted in earlier studies by Singh and Kandasamy (2020) for total branches production for a vine in bitter gourd, Kumari *et al*. (2020) for total primary branches in cucumber, Abhishek *et al*. (2020) for vine length as well as primary branches per vine in bottle gourd. The high values of heritability together with more GAM values were reported for reproductive traits *viz*., node number at which first male flower appearance, days to first male flowering, node number at which first female flower appearance and sex ratio. These outcomes are in correspondence with the conclusions for sex ratio by Patil *et al*. (2022) for node at which production of initial pistillate flower appearing in spine gourd, Tyagi *et al*. (2018) for node at which production of initial staminate flower, node at which production of initial staminate flower in bitter gourd, Sahoo and Singh (2020) for days taken to earliest staminate flowering, sex ratio, node at which earliest staminate flower opening and node at which initiation of pistillate flower in cucumber genotypes. Singh and Kandasamy (2020) for sex ratio, days to initial staminate flowering, node at which initiation of staminate flower, node at which initial pistillate flower appearance in bitter gourd. This represented that, intensity of additive element for these attributes. Thus, higher rate of genetic advancement for these parameters can be attained via selection using existing germplasm. Large heritability (>60%) integrated with more GAM (>20%) were noted for majority of the yield contributing traits *viz*., average fruit weight, fruit length, fruit yield per vine, fruit yield per hectare and number of fruits per vine. Correspondence findings were determined by Chaudhary *et al*. (2018) for total fruits produced from each vine, fruits production from each plant, fruit yield production per hectare, fruit length and mean weight of the fruit in bitter gourd. Maximal heritability (>60%) integrated with high GAM (>20%) were reported for the quality traits *viz*., ascorbic acid, beta carotene and exocarp/fruit thickness. Parallel result were noticed by Chaudhary *et al*. (2018) for ascorbic acid and fruit exocarp thickness in bitter gourd, Singh and Kandasamy (2020) for ascorbic acid (mg/100g) in bitter gourd and Akter *et al*. (2013) for beta carotene in pumpkin.

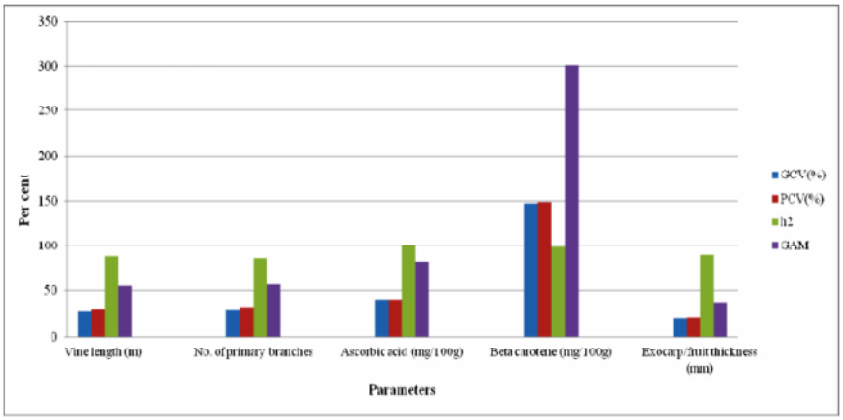

Fig. 1. GCV, PCV, h^2 and genetic advance over per cent of mean for growth and quality parameters in bitter gourd.

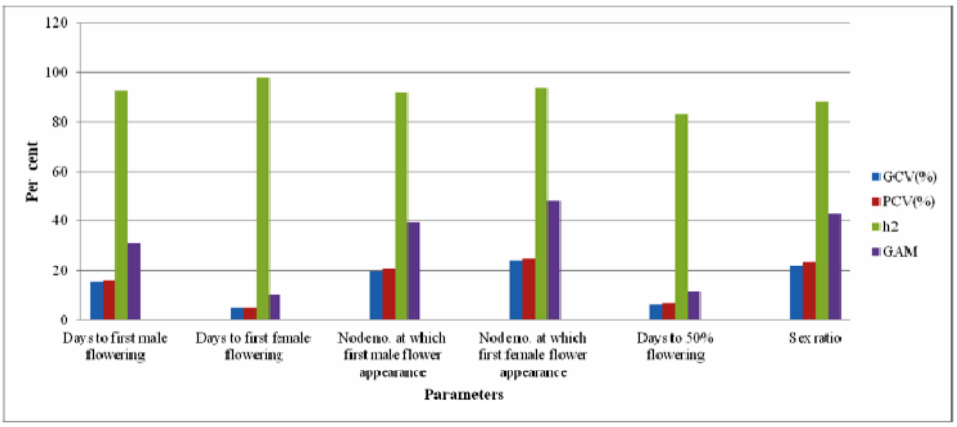

Fig. 2. GCV, PCV, h^2 and genetic advance over per cent of mean for reproductive parameters in bitter gourd.

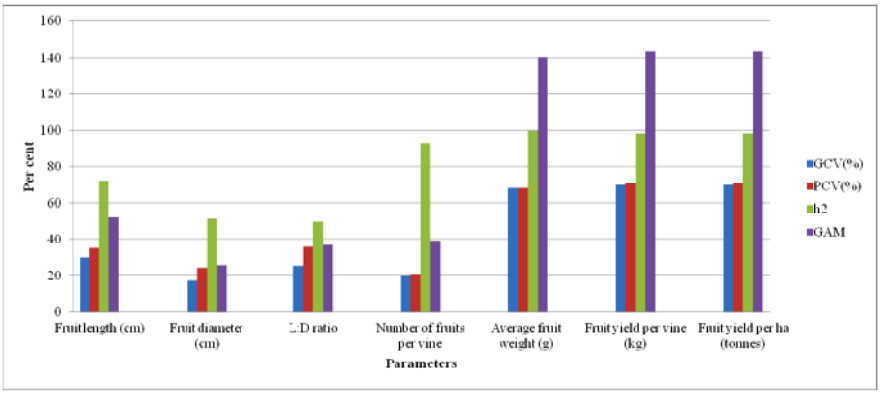

Fig. 3. GCV, PCV, h^2 and genetic advance over per cent of mean for yield parameters in bitter gourd.

Table 1: Analysis of variance in bitter gourd genotypes (mean sum of squares) for growth, reproductive, yield and quality parameters

Sr. No.	Source of variation	Replication	Treatments (Genotypes)	Error	S.Em±	CD (5%)	CD (1%)
	Degrees of freedom	1	49	49			
A. Vegetative parameters							
1.	Vine length (m)	0.17	1.99**	0.13	0.26	0.73	0.97
2.	No. of primary branches	16.83	16.3**	1.3	0.81	2.29	3.05
B. Reproductive parameter							
1.	Days to first male flowering	49.00	45.12**	1.22	0.94	2.67	3.57
2.	Days to first female flowering	10.19	7.14**	0.08	0.20	0.56	0.75
3.	Node number at which first male flower appearance	3.77	2.59**	0.11	0.24	0.67	0.61
4.	Node number at which first female flower appearance	12.23	30.73**	1.01	0.71	2.02	2.69
5.	Days to 50 per cent flowering	4.84	14.44**	1.35	0.82	2.34	3.11
6.	Sex ratio (Male: Female)	19.25	26.65**	1.67	0.91	2.59	3.46
C. Yield parameter							
1.	Fruit length (cm)	22.10	40.27**	6.53	1.81	5.13	6.85
2.	Fruit diameter (cm)	1.92	1.29**	0.41	0.45	1.29	1.72
3.	L: D ratio (Length: diameter)	0.04	2.68**	0.90	0.67	1.91	2.54
4.	Number of fruits per vine	49.15	26.18**	0.92	0.68	1.93	2.58
5.	Average fruit weight (g)	26.88	1682.99**	1.13	0.75	2.13	2.85
6.	Fruit yield per vine (kg)	0.03	0.60**	0.005	0.05	0.13	0.18
7.	Fruit yield per hectare (tonnes)	2.47	51.05**	0.38	0.43	1.23	1.64
D. Quality parameter							
1.	Ascorbic acid (mg/100g)	0.30	881.72**	0.18	0.30	0.85	1.14
2.	β-carotene(mg/100g)	0.00002	0.004 **	0.01	0.00	0.01	0.02
3.	Exocarp /Skin thickness(mm)	3.71	1.72**	0.09	0.22	0.62	0.82

**Significant at 1% *Significant at 5%

Table 2: Estimates of mean, range, components of variance, heritability and genetic advance for quality parameters in bitter gourd genotypes.

Sr. No.	Characters	Mean	Range	GV	PV	GCV(%)	PCV(%)	h^2	GA	GAM
A. Growth parameters										
1.	Vine length (m)	3.41	2.12-7.18	0.93	1.06	28.27	30.20	87.64	1.86	54.52
2.	No. of primary branches	9.28	5.39-15.33	7.50	8.80	29.52	31.97	85.24	5.21	56.15
B. Reproductive parameters										
1.	Days to first male flowering	29.98	27.94-37.11	21.67	23.44	15.53	16.15	92.45	9.22	30.76
2.	Days to first female flowering	37.43	33.72-41.11	3.53	3.61	5.02	5.08	97.82	3.83	10.23
3.	Node number at which first male flower appearance	5.58	3.98-7.78	1.24	1.35	19.97	20.84	91.83	2.20	39.42
4.	Node number at which first female flower appearance	15.86	6.26-26.21	14.86	15.87	24.30	25.11	93.63	7.68	48.44
5.	Days to 50 per cent flowering	40.56	36.50-47.00	6.55	7.90	6.31	6.93	82.90	4.80	11.83
6.	Sex ratio (Male: Female)	15.92	10.8-21.28	12.49	14.16	22.20	23.63	88.23	6.84	42.95
C. Yield parameters										
1.	Fruit length (cm)	13.68	5.64-24.38	16.87	23.40	30.02	35.35	72.11	7.19	52.51
2.	Fruit diameter (cm)	3.80	2.44-5.75	0.44	0.85	17.40	24.24	51.51	0.98	25.73
3.	L: D ratio (Length: diameter)	3.70	1.89-6.88	0.89	1.79	25.50	36.14	49.77	1.37	37.05
4.	Number of fruits per vine	18.07	9.17-28.80	12.63	13.55	19.66	20.37	93.18	7.07	39.10
5.	Average fruit weight (g)	42.47	9.19-126.51	840.93	842.06	68.29	68.33	99.87	59.70	140.58
6.	Fruit yield per vine (kg)	0.77	0.14-2.25	0.30	0.31	70.20	70.72	98.54	1.11	143.56
7.	Fruit yield per hectare (tonnes)	7.17	1.32-20.83	25.34	25.71	70.20	70.72	98.54	10.29	143.56
D. Quality parameters										
1.	Ascorbic acid (mg/100g)	52.80	23.6-114.80	440.77	440.95	39.76	39.77	99.96	43.24	81.89
2.	β-carotene(mg/100g)	0.03	0.0026-0.34	0.00	0.00	147.66	149.06	98.13	0.10	301.32
3.	Exocarp /Skin thickness(mm)	4.75	3.00-7.37	0.81	0.91	18.97	20.03	89.63	1.76	36.99

GV- Genotypic variance ; PV-Phenotypic variance; GCV- Genotypic coefficient of variation; PCV- Phenotypic coefficient of variation; h^2–Broad sense heritability; GA- Genetic advance; GAM-Genetic advance over per cent of mean

CONCLUSION

Analysis of variance exhibited that, enough amount of significant differences present among the fifty bitter gourd germplasms with respect to the different types of traits *viz*., number of primary branches per plant, vine length (m), days to first male and female flowering, sex ratio, node number at which first male flower appearance, days to 50 per cent flowering, fruit diameter (cm), average fruit weight (g), node number at which first female flower appearance, L:D ratio, number of fruits per vine, fruit yield per vine (kg), fruit length (cm), fruit yield per hectare (kg/ha), ascorbic acid (mg/100g), β-carotene content (mg/100g), tuberculates and fruit exocarp (mm). This represented that, ample amount of variation present among the bitter gourd genotypes.

FUTURE SCOPE

- Genotypic evaluation of bitter gourd lines are the most important for selection of desirable parent for development of superior variety or hybrid.
- At present improving of yield and quality traits in bitter gourd is most important to meet globalization demand for fresh vegetable for export and nutrition value because of its anti-diabetic property.
- The genotypes included in this investigation are highly significant for different traits so these germplasms are more amenable for further breeding programme.

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Conflict of Interest. None.

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