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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN BITTER GOURD (*MOMORDICA CHARANTIA* L.)

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ABSTRACT

Bitter gourd (*Momordica charantia* L.) is a vital vegetable crop in tropical regions and has gained increasing attention for its anti-diabetic properties, particularly in its immature fruits. A study was conducted during the *Zaid* season of 2024 at the Main Experiment Station, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya (U.P), to evaluate genetic diversity among 30 bitter gourd genotypes using 16 quantitative and 4 qualitative traits. Results showed that the phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were both highest for fruit yield per plant, followed by ascorbic acid content, number of fruits per plant and number of seeds per fruit, while the lowest values were observed for moisture content. High heritability combined with high genetic advance as a percentage of mean was recorded for ascorbic acid content, number of seeds per fruit, fruit yield per plant, number of fruits per plant, average fruit weight and 100-seed weight. These traits appear to be predominantly controlled by genetic factors with minimal environmental influence, indicating strong potential for improvement through direct selection.

Keywords**:** Variability, heritability, GCV, PCV, genetic advance.

Introduction

Vegetables play an important role in the balanced diet by providing not only energy but also by supplying vital protective nutrients like minerals, antioxidants, and vitamins. Consumption in sufficient quantity provides all required essential nutrients and a fair amount of fibres. Vegetables also play an important role in neutralizing the acids produced during digestion of proteins and fatty foods and thus promote digestion and also prevents constipation. Apart from providing nutrition, vegetable provide protection against many diseases. eg. Bitter gourd used for treating diabetes. Bioflavonoids which are compounds closely associated with vitamins are found in several vegetables they increase the efficiency of vitamin c and protect body from free radicals.

Bitter gourd (*Momordica charantia* L.) is one of the important cucurbitaceous vegetables grown in our country. Among the cucurbits, it is considered a prized vegetable because of its high nutritive value especially ascorbic acid and iron (Behera, 2004).Bitter gourd fruits are highly nutritious (Gopalan *et al*. 1982).The tender and immature fruit is a rich source of Calcium (20 mg/100 g), Phosphorus (55 mg/100 g), Iron (1.8 mg/100 g), Vitamin- A (219 IU/100 g) and vitamin C (88 mg/100 g). The roots, vines, leaves, flowers and seeds of bitter gourd are also used in medicinal preparations (Morton, 1967).Plants contains an active phytochemicals compound which important for human, such as triterpenes, proteins and steroids. Scholars point out that *M. charantia* rich in term of minerals such as Cu, Fe, Mg, Zn and Ca. There is also fatty acid were identified in *M. charantia* includes lauric, myriaatic, palmitic, stearic and linolaic. Charantin is a typical cucurbitane-type triterpenoid in *M. charantia*. Structurally, Charantin is the mixture of two compounds, namely, sitosterylglucoside and stigmasterylglucoside. Scholars point out that Charantin is a potential substance with anti-diabetic properties characteristics and could be used to treat diabetes. It is adapted to a wide range of environments and can be grown tropical and sub-tropical climate (Lim, 1998).

It is highly cross-pollinated and monoecious in nature, with separate yellow male and female flowers and exhibits large variations for fruit and vegetative characters (Resmi and Sreelathakumary 2012). Exogenous management of growth regulators has changed the sex expression towards femaleness by enhancing the production of female flowers and reducing that of male flowers, resulting in an increase in seed yield and quality in bitter gourd (Yin *et al.* 2014).

Depending on genetic variability present in base population *viz.,* character association, cause and effect relationship, heritability and genetic advance breeders can make an effective selection in a breeding programme. Genetic variability increases the genetic potentiality and wider scope for improvement in the genotypes. To explore the purpose of improvement by selection it is essential to study first the extent of genetic variability and heritability along with genetic advance. Yield is a complex character influenced by several genetic factors interacting with environment and requires giving a better insight of the ancillary characters for better selection.

Material and Methods

The present investigation was conducted during the *Zaid* season of 2024 at the Main Experiment Station, Department of Vegetable Science, AcharyaNarendra Deva University of Agriculture and Technology (Narendra Nagar), Kumarganj, Ayodhya (U.P.)- 224229. Thirty accessions were evaluated in a Randomized Block Design (RBD) with three replications, using a spacing of 3.0 m × 0.5 m. From each plot, five plants were randomly selected to record observations on twenty quantitative and qualitative characters. Data were collected on the following parameters: days to first staminate flower anthesis, days to first pistillate flower anthesis, node number to first staminate flower appearance, node number to first pistillate flower appearance, days to first fruit harvest, number of primary branches per plant, internodal length (cm), fruit length (cm), fruit diameter (cm), average fruit weight (g), vine length (m), seed-to-flesh ratio, number of fruits per plant, number of seeds per fruit, 100-seed weight (g), fruit yield per plant (kg), total soluble solids (%), dry matter content (%), moisture content (%) and ascorbic acid content (mg/100g). The data were statistically analyzed as per the procedure outlined by Panse and Sukhatme (2000). Heritability in the broad sense (h^2bs) was estimated using the formula proposed by Burton and De Vane (1953), which incorporates both genotypic and environmental variances to determine phenotypic variance. Genetic advance (GA) was calculated following the method suggested by Johnson *et al.* (1955).

Results and Discussion

In general, the phenotypic coefficient of variation was greater than the genotypic coefficient of variation for all of the traits investigated, showing that the environment had a significant impact on the expression of these characters. Similar findings were also reported by (Bannatti *et al.* 2023, Prasanth *et al.* 2020, Sidhu *et al.*(2017).The phenotypic coefficient of variation was observed lowest for dry moisture (1.02) while it was highest for fruit yield per plant (38.59) followed by ascorbic acid content (28.79), number of fruits per plant (26.14) and number of seed per fruit (25.26). Moderate estimate of PCV was observed for fruit length (18.85) followed by average fruit weight (18.12) and node number to first pistillate flower appearance (12.66). Genotypic coefficient of variation (GCV) was recorded minimum for moisture (0.93) whereas it was maximum for fruit yield per plant (38.02) followed by ascorbic acid content (28.68), number of fruits per plant (25.63) and number of seed per fruit (23.54). Moderate estimate of GCV was recorded for seed flesh ratio (17.91) followed by average fruit weight (17.50) and fruit length (16.88).

Estimates of heritability (broad sense) and genetic advance for different characters in bitter gourd has been presented in table-2. The heritability in broad sense ranged from 44.00 percent for days to first pistillate flower anthesis to 99.00 percent in case of ascorbic acid. High estimates of heritability (>80%) was recorded for characters i.e. ascorbic acid (99.00) followed by number of seed per fruit (99.00), fruit yield per plant (97.00), number of fruits per plant (96.00), average fruit weight (93.00), node number to first staminate flower appearance (92.00), 100 seed weight (92.00), vine length (86.00), seed flesh ratio (86.00), T.S.S (85.00), node number to first pistillate flower appearance (84.00), dry weight (83.00), moisture (83.00), internodal length (81.00) and fruit length (80.00). Apart from this moderate heritability (>60% to <80%) were recorded for fruit diameter (78.00) and primary branches per plant (66.00). Low heritability (<60%) was recorded for days to first staminate flower anthesis (56.00) followed by days to first fruit harvest (46.00) and days to first pistillate flower anthesis (44.00). Talukder (2018) also found similar kind of result and observed that lowest heritability was founded in fruit diameter (26.61) and high heritability was founded in vine length (87.35) followed by branch per vine (86.58), fruit length (75.22) and fruits per plant (62.51).

Highest value of genetic advance in per cent of mean was shown by fruit yield per plant (77.15) followed by ascorbic acid (58.88) and number of fruits per plant (51.86), whereas least value was observed for moisture (1.75). The character which observed very high estimates of genetic advance was ascorbic acid (53.49) followed by average fruit weight (25.38) and number of fruits per plant (10.31) and lowest genetic advance was reported for T.S.S (0.32).

High heritability coupled with high genetic advance in per cent of mean were recorded for ascorbic acid content (99.00 and 58.88) followed by number of seed per fruit (98.00 and 48.35), fruit yield per plant (97.00 and 77.15), number of fruits per plant (96.00 and 51.86), average fruit weight (93.00 and 34.28) and 100 seed weight (92.00 and 21.47) indicating that these traits were little influenced by environment. Thus, require low selection intensity for improvement.

Conclusion

The present study on bitter gourd revealed considerable exploitable variability across twenty yield-related traits. In general, the phenotypic coefficient of variation (PCV) exceeded the genotypic coefficient of variation (GCV) for all traits examined, indicating a substantial influence of environmental factors on their expression. Among the traits, the lowest PCV was observed for moisture content (1.02), while the highest was recorded for fruit yield per plant (38.59). Similarly, the GCV ranged from a minimum of 0.93 for moisture content to a maximum of 38.02 for fruit yield per plant.

Table 1: Analysis of variance (mean squares) for twenty characters in bitter gourd.

S. No.	Traits	Source of Variation		
	d.f	Replication	Treatments	Error
		2	29	58
1.	Days to first staminate flower anthesis	1.878	47.289**	9.59
2.	Days to first pistillate flower anthesis	4.800	39.130**	11.61
3.	Node no. to first staminate flower appearance	0.0091	9.7368**	0.2385
4.	Node no. to first pistillate flower appearance	2.0237	8.2681**	0.4864
5.	Primary branches per plant	0.0634	0.5787**	0.0826
6.	Days to first fruit harvest	1.544	41.027**	11.40
7.	Fruit length (cm)	0.8098	6.0068**	0.4554
8.	Fruit diameter (cm)	0.0823	0.4606**	0.0391
9.	Average fruit weight (g)	37.76	500.37**	11.77
10.	Seed flesh ratio	5.9103	25.5162**	1.2864
11.	Internodal length (cm)	0.1627	0.8103**	0.05693
12	Vine length (m)	0.3763	0.9467**	0.0451
13.	No. of fruit per plant	4.323	79.064**	0.995
14.	Fruit yield per plan t(kg)	0.00541	0.9515	0.00956
15.	No. of seed per fruit	9.907	54.276**	0.188
16.	100 seed weight (g)	2.8476	8.8893**	0.2413
17.	T.S.S (%)	0.0529	0.0893**	0.0047
18.	Dry weight (%)	1.468	2.333**	0.144
19.	Moisture (%)	1.468	2.333**	0.144
20.	Ascorbic acid (mg\100g)	8.26	2043.32**	5.09

*Significant at 5% probability level, ** Significant at 1% probability level

Table 2: Estimates of range, grand mean, PCV, GCV, heritability in broad sense, genetic advance (GA) and GA in percent of mean for twenty characters in bitter gourd germplasm.

Sr. No.	Traits	Range		Grand Mean	GCV %	PCV %	h^2 (Broad Sense) %	Genetic Advance 5%	Genetic Advance as % of mean 5%
		Lowest	Highest						
1.	Days to first staminate flower anthesis	52	67	60.38	5.87	7.79	56.00	5.49	9.10
2.	Days to first pistillate flower anthesis	60	77.67	67.76	4.46	6.72	44.00	4.14	6.11
3.	Node no to first staminate flower appearance	6.44	12.53	9.44	18.83	19.53	92.00	3.53	37.41
4.	Node no to first pistillate flower appearance	16.93	10.70	13.85	11.62	12.66	84.00	3.04	21.97
5.	Primary branches per plant	4.20	5.87	5.05	8.05	9.85	66.00	0.68	13.54
6.	Days to first fruit harvest	68.33	82.33	76.47	4.10	6.03	46.00	4.40	5.76
7.	Internodal length(cm)	3.34	5.26	3.90	12.83	14.21	81.00	0.93	23.87
8.	Vine length (m)	1.74	3.63	2.54	21.57	23.14	86.00	1.05	41.44
9.	Fruit length(cm)	5.01	11.58	8.05	16.88	18.85	80.00	2.51	31.16
10.	Fruit diameter(cm)	2.64	4.29	3.40	11.00	12.43	78.00	0.68	20.04
11.	Average fruit weight(g)	53.96	99	72.89	17.50	18.12	93.00	25.38	34.28
12.	Seed flesh ratio	11.40	22.29	15.86	17.91	19.29	86.00	5.43	34.28
13.	No. of fruit per plant	12.32	28.69	19.88	25.63	26.14	96.00	10.31	51.86
14.	No. of seed per fruit	6.27	21.96	18.64	23.54	25.26	98.00	8.70	48.35
15.	100 seed weight	11.69	17.69	15.45	10.98	11.43	92.00	3.35	21.47
16.	TSS (%)	4.67	5.51	5.23	3.20	3.46	85.00	0.32	6.11
17.	Dry weight (%)	7.36	10.40	8.34	10.23	11.20	83.00	1.60	19.26
18.	Moisture (%)	89.60	92.94	91.65	0.93	1.02	83.00	1.60	1.75
19.	Ascorbic acid (mg\100g)	37.37	141.47	90.85	28.68	28.79	99.00	53.49	58.88
20.	Fruit yield per plant (kg)	0.78	2.84	1.47	38.02	38.59	97.00	1.13	77.15

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