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Studies on genetic variability among local landraces of bitter gourd (*Momordica charantia* L.) for yield attributing traits under northern dry zone of Karnataka

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Abstract
An appreciable level of variation within crop varieties is essential to initiate and sustain crop improvement using plant breeding methods. A study was conducted to evaluate the Local germplasm lines of bitter gourd for yield and yield attributing traits between June 2019 to September 2019. The twenty-five cultivars collected from different agro-climatic regions of India constituted the treatment, which was lied out in a Randomized Complete Block Design with two replicates. Eighteen yield and yield attributing characters were studies and analysis of variance revealed that there were significant differences among the genotypes studied for all the characters. Among the twenty-five germplasm Ludhiana Local was identified as the best genotypes as it recorded higher yield per plant followed by Preethi, Kerala Local, Vizag Local and Faizabad Local. Maximum phenotypic and genotypic coefficient of variation (PCV and GCV) was recorded for total yield per plant, number of fruits per plant, average fruit weight, fruit length. High heritability was observed for all the characters. High estimates of heritability linked with a high genetic advance as a percentage of the mean were recorded for sex ratio, internodal length, leaf area, average fruit weight, fruit length, number of fruits per plant, fruit diameter. These results are suggestive that the cultivars evaluated in this study are good candidates on which improvement activates can be initiated the incorporation of high grain yield traits would also have a long run advantage.

Keywords: Variability, heritability, genetic advance, bitter gourd

Introduction
Bitter gourd (*Momordica charantia* L.) is one of the most important cucurbitaceous crop belongs to the family cucurbitaceae with 2n= 2x=22. It is a large genus with many annual and perennial climber species. Because of their monoecious nature, bitter gourd is a highly cross pollinated. Used as roasted, curried, stuffed or sliced and fried, bitter gourd can also be pickled, canned and dehydrated and rich in medicinal properties such as purgative, carminative and anti-diabetic, etc. (Singh *et al.*, 2016) [14]. The fruit acts as an anthelmintic, stomachic, laxative and ant bilious. It is in addition, a tonic fruit used for rheumatism, gout and diabetes as well. In abortion, haemorrhoids and even in biliaesness a decoction of the root extract is helpful (Khulakpam *et al.*, 2015) [6]. The fruit yield is the main factor for determining improvement of a crop. Similarly yield in bitter gourd, is a quantitative trait that highly influenced by other yield related parameters. The selection of desirable types should be based on yield as well as on other yield attributing traits. The information on mutual association between yield and yield related attributing traits is very vital for efficient utilization of available genetic stock in crop improvement programme of bitter gourd.
Yield in bitter gourd is a complex trait which influenced by several traits like, number of primary branches per vine, number of nodes per vine, sex ratio, number of fruits per vine and average fruit weight is a main factor. Heritability indicates how much of phenotypic variability has a genetic origin and gives objective information for the genetic selection process. It is therefore important to obtain adequate information on the magnitude and type of genetic variability and its subsequent heritability for any proposed breeding programme aimed at improving the yield potential of crops. The role of genetic variability in a crop is of paramount importance in selecting the best genotypes for rapid yield and related character improvement and in selecting the most prospective parents to make the hybridization programme successful

(Naseeruddin *et al*., 2011 and Singh *et al.,* 2014) [8, 13]. This is because the selection of superior genotypes is proportional to the amount of present genetic variability and the degree to which the characteristics are inherited. If the characteristics are chosen on the basis of high heritability with high genetic advance over mean, the selection efficiency increases. The magnitudes of such estimates also suggest to extent to which improvement is possible through selection. This present study was undertaken to estimates the component of variance, heritability and genetic advance over mean.

Material and methods

The present investigation on five species of *Momordica* was conducted between June 2019 to September 2019 at Experimental Farm (Block VII) of the Department of Vegetable Science, Kittur Rani Chenamma College of Horticulture, Arabhavi, Belagavi District (Karnataka). Situated in Northern Dry Zone of Karnataka State at 16^0 15' North latitude, 74^0 45' East longitude and at an altitude of 612.05 m above the mean sea level. Arabhavi comes under Zone-3 and Region-2 among the agro climatic zones of Karnataka, has benefited from both South-West and North-East monsoons. The average rainfall of this area is about 315 mm distributed over a period of five months (August 2019 to December 2019) with peak during October. The command area receives water from Ghataprabha Left Bank Canal (GLBC) from mid-July to mid-March. In this experiment 25 genotypes of bitter gourd were raised for evaluation and variability studies. The details of the genotypes are furnished in table.1 These genotypes were raised in randomized block design replicated two times with ten plants in each replication following a spacing of 2 x0.75m. The Experimental area was ploughed repeatedly and brought to a fine tilth. The farm yard manure (20 t/ha) was incorporated in the soil before final harrowing. The land was levelled and the entire plot was divided into three blocks. The treatments were randomly assigned in each replication. The main and sub irrigation channels were laid out by considering gradient of the site. The cultural operation and plant protection measures were followed as per the package of practices recommended by UHS, Bagalkot for bitter gourd.

Observation were recorded on days of first male flower opening, days of first female flower opening, days to 50 per cent flowering, days to first harvest, sex ratio (M/F), number of primary branches, internodal length (cm), leaf area (cm^2), flower size (mm), average fruit weight (g), average fruit length (cm), fruit diameter (cm), seed length (mm), number of seeds per fruit, 100 seed weight (g), pulp thickness (cm), number of fruits per plant and total yield per plant (kg). The data recorded on each character of different genotypes was statistically analyzed using Windostat Version 9.2 from Indostat services.

Table 1: Details of *Momordica* species genotypes used in the experiment

1	P A White	IARI, New Delhi.
2	Chaman Local	Pune, Maharashtra.
3	Summer special	Pune, Maharashtra.
4	Jonpuri Local	Pune, Maharashtra.
5	Jalahari Local	Pune, Maharashtra.
6	Ludhiana Local	Ludhiana, Punjab.
7	ABG 59/2	NBPGR, New Delhi
8	Phule green gold	Rahuri, Maharashtra.
9	Kalambella Local	Tumkur, Karnataka.
10	Malappanahalli Local	Tumkur, Karnataka.
11	Vizag Local	Visakhapatnam, Andhra Pradesh.
12	Preethi	KAU, Kerala.
13	Chandigarh Local	Chandigarh (U.T).
14	Shindikurbet Local	Belagavi, Karnataka.
15	Kerala Local	Trivendrum, Kerala.
16	Ghaziyabad Local	Gaziyabad, Uttar Pradesh.
17	Sira Local	Tumkur, Karnataka.
18	Badavanahalli Local	Tumkur, Karnataka.
19	Magod Local	Tumkur, Karnataka.
20	Chinnappanahalli Local	Tumkur, Karnataka.
21	Balenahalli Local	Tumkur, Karnataka.
22	CO-1	TNAU, Tamil Nadu.
23	Faizabad Local	Ayodhya, Uttar Pradesh.
24	Vellakulam Local	Vellakulam, Tamil Nadu.
25	Selection-2	IARI, New Delhi.

Result and discussion

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Therefore, the primary goal of conservation of germplasm is to collect and sustain genetic diversity in indigenous crop species selection in order to make it available to present and future generations. The analysis of variance indicated the existence of high significant differences among genotypes for all eighteen yield and yield contributing characters of bitter gourd is presented in Table 2. The analysis of variance showed significant ($p<0.01$) differences among the genotypes for all the characters studied. This considerable variations among the genotypes for all of the traits indicated the existence of plenty scope of selection for the improvement of this crop. However, widest range of variability was recorded for leaf area (66.70 to 115.23 cm^2) followed by total yield per plant (0.54 to 2.67 kg), fruit length (8.67 to 24.79 cm). The range of variations obtained for internodal length (5.66 to 9.10 cm), number of primary branches (8.10 to 10.13) and seed length (1.89 to 2.97 cm) was least compared to other characters.

For crop improvement, knowledge on the nature and extent of

genetic variability present in a population for desirable characters is important. Awareness of the genotypic and phenotypic coefficients of variance is useful in the design of variable population selection criteria. There were significant differences among all the 25 genotypes studied (Table 2). Leaf area and average fruit weight exhibited high genotypic and phenotypic variances followed by number of fruits per plant and fruit diameter. These results are in conformity with those obtained for average fruit weight by Durga (2015) [4, 5] and Vivek *et al*. (2017) [17]. GCV helps to determine the range of character genetic variations and provides measures to compare the genetic variability found in different quantitative characters. The high PCV estimates suggest that there is sufficient genetic variation among the genotypes and that these attributes are suitable for further improvement through selection. In the present study higher phenotypic and genotypic coefficient variation were recorded for total yield per plant, number of fruits per plant, average fruit weight, fruit length. indicating wide range of variability. It indicates the existence of high variability which will be amenable for further improvement through selection. The moderate phenotypic and genotypic coefficient variation were recorded for sex ratio, flower size, internodal length, leaf area, pulp thickness, fruit diameter, seed length, number of seeds per fruit. The low phenotypic and genotypic coefficient variation were recorded for days to first male flower opening, days to first female flower opening, days to first harvest, days to 50 per cent flowering, number of primary branches, 100 seed weight. These results are in conformity with those obtained for average fruit weight, total yield per plant, number of fruits per plant by Nithinkumar. (2018) [9]; Anupam *et al*. (2018) for fruit length and total yield per plant; Maneesh *et al*. (2014) [7], Rani *et al*. (2015) [11], Vivek *et al*. (2017) [17], Devender *et al*. (2018) and Tanvi (2019) [16] for total yield per plant, average fruit weight, fruit length.

In expressing the reliability of phenotypic importance, heritability estimates serve as a predictive instrument. Therefore, for a specific character, high heritability helps in successful selection. All the characters exhibited high heritability in the current analysis, ranging from 65.93 to 95.85 percent (Table 2). These results are in conformity with those obtained for average fruit weight, number of seeds per fruit and 100 seed weight by Dalmu (2011) [2]; Durga (2015) [4, 5] for days to first harvest, days to 50 per cent flowering, number of primary branches, internodal length, total yield per plant, average fruit weight and fruit length; Nithinkumar. (2018) [9] for days to first female flower opening, pulp thickness, fruit length, fruit diameter, average fruit weight and number of seeds per fruit; Tanvi (2019) [16] for days to first female flower opening, 100 seed weight, number of primary branches, total yield per plant, fruit length, fruit length and days to first male flower opening. The heritability in broad sense is not the real indicator of characters. Since only additive components of variance are transferred efficiently from parents to their progeny. Hence heritability in a broad sense may deceive in judging the effectiveness of selection for traits more accurately. Attributes observing high heritability with genetic advance indicate additive gene action hence, selection would be valid for such trait.

The genetic advance is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. The genetic advance expressed as a percentage of mean ranged from 8.00 to 85.26 and the important characters like sex ratio, internodal length, leaf area, average fruit weight, fruit length, number of fruits per plant, fruit diameter, seed length, number of seeds per fruit, total yield per plant recorded higher estimates. These results are in conformity with those obtained for number of fruits per plant, number of seeds per fruit, leaf area, average fruit weight, fruit length and total yield per plant by Subhasmita (2015) [15] and Anupam *et al*. (2018) for fruit diameter, average fruit weight and number of fruits per plant. This suggested that these characteristics are under the influence of the action of additive genes and that phenotypic selection would be successful for their enhancement. Genetic variation coefficients along with heritability offer a simple picture of the amount of improvement to be expected from a decision. The high heritability character suggested the existence of additive gene action and this character could be fixed by recourse to selection.

Table 2: Analysis of variance in *Momordica charantia* genotypes (mean sum of squares) for growth, earliness, yield

Sl. No.	Source of variation/Characters	Replications	Treatments (Genotypes)	Error	S.Em±	CD (5%)	CD (1%)
	Degrees of freedom	**2**	**25**	**25**			
A. Growth parameters							
1.	Internodal length	15.80	32.10**	1.760	0.817	0.559	0.757
2.	Number of primary branches	0.117	16.02**	3.588	0.267	0.798	1.081
3.	Leaf area	613.20	10960.86**	52.27	1.022	3.046	4.128
4.	Flower size	50.74	324.40**	73.03	1.208	3.600	4.879
B. Earliness parameters							
1.	Days to first male flower opening	156.99	257.12**	52.79	1.027	3.061	4.148
2.	Days to first female flower opening	140.04	619.19**	13.13	0.512	1.526	2.068
3.	Days to first harvest	176.72	592.41**	11.99	0.489	1.459	1.977
4.	Days to 50% flowering	211.68	1060.20**	9.975	0.446	1.330	1.803
C. Yield parameters							
1.	Average fruit weight	635.17	7534.87**	157.02	1.772	5.279	7.154
2.	Fruit length	38.45	521.75**	24.90	0.705	2.102	2.849
3.	Number of fruits per plant	367.74	2479.21**	39.08	0.884	2.634	3.569
4.	Pulp thickness	130.73	441.96**	60.85	1.103	3.286	4.453
8.	Fruit diameter	158.34	1804.78**	49.06	0.990	2.951	3.999
9.	Sex ratio	366.82	582.09**	19.29	0.621	1.850	2.507
10.	Total yield per plant	1.4901	20.803**	0.266	0.0731	0.217	0.294
D. Seed parameters							
1.	100 seed weight (Seed Index)	89.83	110.00**	18.91	0.615	0.183	2.482
2.	Number of seeds per fruit	69.90	429.13**	21.39	0.654	1.948	2.641
3.	Seed length	0.693	4.296**	0.214	0.065	0.195	0.264

**Significant at 1% *Significant at 5%

Table 3: Estimates of mean, range, components of variance, heritability and genetic advance for growth, yield and quality parameters in genotypes of *Momordica charantia* L.

Sl. No	Characters	Grand Mean	Range		GV	PV	Coefficient of Variations		h^2	GA	GAM
			Min.	Max			PCV	GCV			
1.	Days to first male flower opening	43.10	37.82	47.49	4.25	6.45	5.89	4.78	65.93	3.45	8.00
2.	Days to first female flower opening	55.77	48.04	63.89	12.62	13.17	6.50	6.37	95.85	7.16	12.84
3.	Days to first harvest	68.73	56.92	75.50	12.01	12.65	5.17	5.04	94.94	7.01	10.21
4.	Days to 50% flowering	74.22	60.47	81.49	20.87	22.29	6.36	6.15	93.62	9.54	12.86
5.	Sex ratio	25.47	19.65	31.47	11.72	12.52	13.89	13.44	93.58	6.82	25.47
6.	Flower size	26.16	22.31	30.50	5.23	8.28	10.99	8.74	63.25	3.74	14.32
7.	Internodal length	6.57	5.66	9.10	0.632	0.705	12.77	12.09	89.60	1.55	23.58
8.	Leaf area	91.30	66.70	115.23	200.55	216.38	15.70	15.56	92.68	29.19	31.76
9.	No primary branches	8.87	8.105	10.13	0.259	0.409	7.20	5.73	63.41	0.835	9.40
10.	Average fruit weight	54.70	34.17	74.49	153.70	163.24	23.35	22.66	94.15	25.01	45.72
11.	Fruit length	14.56	8.67	24.79	10.35	11.38	23.17	22.09	90.89	6.31	43.39
12.	No fruits per plant	27.40	18.90	29.69	49.83	54.46	26.93	25.76	91.49	14.45	52.75
13.	Pulp thickness	27.87	23.30	34.51	7.94	10.47	11.61	10.10	75.79	5.05	18.13
14.	Fruit diameter	34.72	23.37	44.97	36.57	38.62	17.89	17.41	94.71	12.12	34.91
15.	100 seed weight	18.28	15.58	22.28	1.89	2.68	8.96	7.53	70.07	2.38	13.04
16.	Seed length	2.45	1.89	2.97	0.085	0.094	12.50	11.89	90.48	0.57	23.30
17.	No seeds per fruit	24.49	18.90	29.69	8.49	9.38	12.50	11.89	90.50	5.71	23.31
18.	Total yield per plant	1.560	0.546	2.672	0.418	0.465	43.71	41.44	89.81	1.33	85.26

GV- Genotypic variance
PV- Phenotypic variance
GCV- Genotypic co-efficient of variation
PCV- Phenotypic co-efficient of variation
h^2- Broad sense heritability
GA- Genetic advance
GAM- Genetic advance as per cent of mean

Conclusion

Based on variability and heritability estimates, it could be concluded that characteristics such as number of fruits per plant, average fruit weight and fruit length can be improved by direct selection in crop improvement of bitter gourd. In general, additive gene action (Panse and Sukatme, 1957) [10] regulates the character that displays elevated heritability with elevated genetic advancement and can be enhanced by simple or progeny selection techniques. The selection of high heritability characteristics combined with high genetic advancement is expected to accumulate more additive genes, contributing to more performance enhancement. In the present investigation, high heritability along with high genetic advance was noticed for sex ratio, internodal length, leaf area, average fruit weight, fruit length, number of fruits per plant, fruit diameter, seed length, number of seeds per fruit, total yield per plant. High estimates of heritability linked with a moderate genetic advance as a percentage of the mean were recorded for days to first female flower opening, days to 50 per cent flowering, flower size, pulp thickness, 100 seed weight. Characters with high heritability and moderate to low genetic advance may be strengthened by incorporating superior segregating population genotypes produced from combination breeding (Samadia, 2005) [12]. In the present study, five superior genotypes, *viz.*, Ludhiana Local, Preethi, Kerala Local, Vizag Local and Faizabad Local were found to be potential enough to be used as parents in heterosis breeding. These genotypes recorded highest values for one or the other yield contributing characters and hence their utilization in combination breeding may help in generating high yielding varieties/ hybrids by pyramiding all the favourable genes.

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