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Physical characteristics, genetic diversity and heritability of Bitter gourd (*Momordica charatia* L.)

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Abstract
Twenty genotypes of bitter gourd (*Momordica charantia* L.) were examined for genetic variability and heritability in order to assess population variability and identify genotypically diverse and economically attractive genotypes for use in crop development. The experiment was conducted after High phenotypic and genotypic coefficients of variation were noted for yield per vine (71.68), fruit weight (39.17), seed weight per fruit (37.25), fruit length (34.16), number of seeds per fruit (32.70), and internodal distance per vine (27.15), according to results from a randomizing block design with three replications. The amount of accessible genetic variability for these parameters was indicated by the modest phenotypic and genotypic coefficients of variation found for the number of fruits per vine (19.81), the number of female flowers per vine (15.53), and the days to marketable yield (5.05). The yield per vine (99.70), weight of fruit (99.10), number of male flowers per plant (97.40), length of vine (96.00), number of seeds per fruit (91.80), and length of fruit (91.40) all show high heritability and high genetic advancement, indicating additive gene action in control of these traits. Phenotypic selection based on these traits in the segregating population is likely to produce the desired individuals.

Keywords: Bitter gourd, heritability, genotypic and phenotypic coefficient of variation and genetic advancement

Introduction
Locally referred to as Karela, bitter gourd (*Momordica charantia* L.) is a crucial vegetable for home gardens. It is a warm seasonal climbing annual endemic to South Asia that grows quickly. The bitter gourd belongs to the Cucurbitaceae family of tropical and subtropical vines. It is commonly planted for its edible fruit, which is one of the most bitter vegetables. In terms of iron and ascorbic acid concentration, bitter gourd has a comparatively high nutritional value when compared to other cucurbits (H.N. Singh et.al1997) [13]. Bitter gourd has the highest concentration of vitamins and minerals of any cucurbit vegetable (Kundu, B.C. *et al*., 2012) [7]. Crop improvement is based on genetic variability. The degree of diversity in the available genotypes can be found using both genotypic and phenotypic coefficients of variation. Comparing the projected gains from selection based on alternative selection procedures is the primary goal of measuring heritability and the genetic characteristics that make up the heritability estimate (Yadav Murlee et.al 2013) [15]. Therefore, data on plant character diversity, heritability, genetic advancement, and the relationship between yield and quality traits are crucial to plant breeding programs. Therefore, the goal of the current study is to evaluate the variability in bitter gourd (*Momordica charantia* L.) for future breeding programs by measuring phenotypic and GCV as well as heritability and genetic advancement.

Materials and Methods
During the 2012–13 kharif season, the experiment was carried out at the College of Agriculture, Indore, RVSKVV, Gwalior (M.P.), India. Twenty different bitter gourd genotypes (Table 1) that were gathered from various regions of India made up the experimental materials. Three replications of the Randomized Block Design (RBD) experiment were used. In order to raise the crop during the kharif season, it was handled in accordance with the suggested package of methods. Each genotype's seeds were planted in 3-meter-long rows with a 1-meter gap between

lines and plants in each replication. To record horticultural traits, five plants of each genotype were chosen at random from each replication. The mean data was analyzed using the statistical analysis of variance coefficient of variation, heritability, and genetic progress in percentage of mean.

Results and Discussion

For every attribute examined, the analysis of variance showed extremely significant differences between the 20 genotypes of bitter gourd. Given that the PCV was discovered to be higher than the comparable GCV, the environment has a significant impact in the expression of different characteristics. The yield per vine (144.18 to 1294.10 kg) had the highest range, followed by the number of male flowers per plant (172.40 to 372.96) and the length of the vine (129.27 to 321.70 cm). These traits showed more variability, suggesting a greater potential for selection among the current genotype, while the fruit diameter (2.20 to 3.93 cm) had the lowest range (Table 2). For yield per vine, fruit weight and length, seed weight per fruit, number of seeds per fruit, and internodal distance per vine, high PCV and GCV values were noted. The larger degree of variability in Table 1 was further demonstrated by the high magnitude of GCV.

Genetic variability: Table 2 provides estimates for genotypic coefficient of variation, phenotypic coefficient of variation, heritability, and genetic progress as a percentage of mean for the traits being studied. For the majority of the qualities examined, the PCV was found to be higher than the GCV. The yield assigning GCV for different yields ranged from 2.78 to 71.68. Yield per vine had the highest GCV (71.79%), followed by fruit weight (39.17), seed weight per fruit (37.25), and fruit length (34.16). However, the GCVs for the number of fruits per vine (19.81), length of vine (22.30), and intermodal distance per vine (27.15) were moderate. Days to marketable yield (5.05), days to 50% female flower initiation (04.85), crop longevity (03.43), and days to 50% male flower initiation (02.78) all had low GCVs. Yield per vine (71.79%) had a high PCV, while seed weight per fruit (40.74%), fruit weight (39.35%), fruit length (35.73%), number of seeds per fruit (34.15%), and internodal distance per vine (29.38%) had moderate PCVs. Days to 50% female flower initiation (8.36%), days to marketable yield (8.17%), days to 50% male flower initiation (7.73%), and crop longevity (5.28%) all had low PCVs.

The degree of variability for many features in bitter gourd was revealed by a study of genotypic and phenotypic coefficient of variation, and the results are consistent with those of Dey S.S. *et al*. (2009) [4], Islam *et al*. (2009) [5], and Rajput *et al*. (1996) [11]. Higher phenotypic and genotypic coefficients of variation for yield per vine, fruit weight and length, seed weight per fruit, number of seeds per fruit, and internodal distance per vine show that these genotypes differ greatly from one another in terms of these traits, providing more room for selection. In line with the results of Miah *et al*. (2000) [9], PCV and GCV recorded for the number of female flowers/plant, number of fruits/vine, days 50% female flower initiation, days to marketable production, and crop duration were low. B.C. Kundu *et al*. (2012) [7].

Heritability and genetic advance: Because they highlight the relevance of non-additive genetic influences, high heritability combined with low genetic advancement, low heritability combined with high genetic advancement, or low heritability combined with low genetic advancement provide less room for selection. A higher percentage of additive genetic diversity and thus a large genetic gain anticipated from selection are indicated by high heritability and high genetic advancement. H.N. Singh and associates(1997) [13]. According to Singh, H.N. *et al*. (1997) [13], selection may not be successful for traits with heritability that have minimal genetic advancements as a percentage of mean since these traits seem to be governed by non-additive gene activity.

Table 1: mean performance of 16 genotypes as influenced by Morphology and Phenological characters o f bitter gourd

S. No.	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
Jhalri	226.40	9.00	10.83	275.40	14.98	46.33	74.67	09.33	09.25	03.53	37.25	11.83	3.06	341.82	75.67	151.57
Mc-84	133.60	9.20	07.33	203.20	12.14	52.67	73.46	09.20	08.60	03.03	30.92	18.00	3.20	284.59	83.33	147.80
Long jhalri	256.20	12.73	05.70	372.96	22.22	48.33	68.33	17.67	13.38	03.93	73.23	18.50	4.61	1294.10	79.33	162.48
Mc-23	176.47	9.20	07.67	250.14	15.16	49.67	59.67	11.73	08.41	03.08	30.90	12.67	1.75	362.02	69.67	157.94
swasti	129.27	8.53	06.83	172.40	28.84	50.33	63.67	16.47	05.73	03.77	22.30	07.00	1.26	144.18	73.67	133.72
GY-323	188.80	09.20	05.60	238.00	15.03	48.30	63.70	11.70	09.30	02.75	26.35	06.50	1.73	342.45	73.90	147.90
Jhaldhar spl	321.70	14.26	03.00	232.20	14.16	49.67	70.67	19.47	24.77	02.68	56.10	08.47	1.45	109.63	80.67	158.25
PDM	189.10	09.25	05.85	239.00	15.10	48.50	63.90	12.20	09.40	02.80	27.00	07.10	1.63	342.68	74.50	148.00
Ns-1024	166.93	06.53	05.47	253.20	14.74	47.67	68.67	11.07	10.00	03.63	25.00	09.83	1.71	276.55	81.67	147.18
VRBT-1	189.40	09.52	06.00	240.40	15.40	48.50	64.50	12.40	09.65	02.83	27.15	07.40	1.85	285.15	74.80	148.15
White long	276.00	11.80	04.43	280.40	16.19	50.33	64.67	14.13	11.52	02.55	26.18	15.55	3.03	370.19	74.67	152.00
DVBTG-5	190.50	09.80	06.50	245.00	15.15	48.60	64.80	12.00	09.80	02.88	27.35	08.60	1.90	287.40	75.20	148.40
Green long	268.27	12.20	05.57	291.30	16.62	55.67	60.87	13.47	11.27	02.67	26.08	10.33	2.50	341.42	71.67	151.90
DRBS-36	192.15	10.30	06.90	245.00	15.70	49.50	65.00	11.90	11.90	02.90	28.40	09.30	2.00	288.70	76.10	148.55
PBIG-1	190.60	10.53	05.80	183.20	12.19	53.67	62.67	09.87	10.30	03.05	23.07	06.00	1.08	227.55	72.67	139.14
IC-505208	200.25	11.10	07.00	255.00	15.90	49.80	66.40	11.80	10.05	03.00	28.75	10.70	2.65	290.30	77.30	149.20
Muland local	226.67	09.27	09.43	260.90	14.18	44.33	60.00	12.87	09.53	02.20	22.08	10.33	1.60	284.17	70.00	148.63
VRBT-04	215.60	11.40	07.15	258.00	16.00	49.90	67.60	11.30	10.15	03.01	39.60	11.40	2.73	344.20	78.40	150.33
Chhuh type	188.67	11.67	10.57	236.40	16.30	47.67	69.67	10.73	08.63	02.73	26.73	12.97	3.42	286.49	85.33	145.62
VRBT-37	220.00	11.60	07.20	259.00	16.20	50.20	68.70	11.50	10.25	03.04	30.10	12.80	2.95	343.15	79.10	151.50
Mean	207.32	10.35	6.74	249.53	15.12	49.48	66.04	12.54	10.59	3.00	31.22	10.76	2.30	391.73	76.93	133.72
S.Em+_	7.69	0.75	0.61	5.47	1.13	2.91	3.67	1.27	0.90	0.29	0.95	0.85	0.31	12.31	4.03	4.89
C.D(P=0.05)	22.75	2.21	1.80	16.18	3.34	8.61	10.86	3.75	2.66	0.85	2.81	2.51	0.91	36.43	11.92	14.47

X1- length of vine (cm); X2- Number of branches per vine; X3- Internodal distance per vine (cm); X4- Number of male flowers per plant; X5- Number of female flowers per plant; X6- Days to 50% male flower initiation; X7- Days to 50% female flower initiation; X8- Number of fruits per vine; X9- Length of fruit (cm); X10- Diameter of fruit (cm); X11- Weight of fruit (gm); X12- Number of seeds per fruit; X13-Seed weight per fruit(gm); X14- Yield per vine (kg); X15- Days to marketable yield; X16- Crop duration

Table 2: Estimates of genotypic and phenotypic coefficients of variation, heritability and genetic advance of various characters

S. N.	Character	Range		Grand mean	Genotypic coefficient of variance	Phenotypic coefficient of variance	Heritability percent	Genetic advance (K=2.06)	Genetic Advance percent
		Max	Min						
1	Length of vine	321.70	129.27	207.32	22.30	22.76	96.00	93.32	45.01
2	No. of branches/vine	14.26	6.53	10.35	16.16	18.45	76.70	03.02	29.17
3	Internodal distance/vine	10.83	3.00	06.74	27.15	29.38	85.40	03.48	51.63
4	No. of male flower/plant	372.96	172.40	249.53	16.45	16.66	97.40	83.43	33.43
5	No. of female flower/plant	28.84	12.14	15.12	15.53	18.05	74.00	04.16	27.51
6	Days to 50% male flower initiation	55.67	44.33	49.48	2.78	07.73	13.00	01.02	02.06
7	Days to 50% female flower initiation	74.67	59.67	66.04	4.85	08.36	33.70	03.83	05.79
8	No. of fruits / vine	19.47	9.33	12.54	19.81	23.39	71.80	04.34	34.60
9	Length of fruit (cm)	24.77	5.73	10.59	34.16	35.73	91.40	07.13	67.32
10	Diameter of fruit (cm)	3.93	2.20	03.00	12.35	17.18	51.70	00.55	18.33
11	Weight of fruit (gm)	73.23	22.08	31.22	39.17	39.35	99.10	25.08	80.33
12	No. of seeds / fruit	18.50	6.00	10.76	32.70	34.13	91.80	06.95	64.59
13	Seed weight /fruit	4.61	1.08	02.30	37.25	40.74	83.60	01.62	70.43
14	Yield / vine	1294.10	144.18	391.73	71.68	71.79	99.70	577.63	147.45
15	Days to marketable yield	85.33	69.67	76.93	5.05	08.17	38.30	04.95	6.43
16	Crop duration	162.48	133.72	149.41	3.43	05.28	42.10	06.85	4.58

For every character under investigation, the genotypes showed high heritability values: yield per vine (99.70), fruit weight (99.10), number of male flowers per vine (97.40), vine length (96.00), number of seeds per fruit (91.80), and fruit length (91.40). The percentage of mean genetic advancement varied from 02.06% for days to 50% for male flower initiation to 147.45% for yield per vine. Additionally, fruit weight (80.33%), seed weight per fruit (70.43), and fruit length (cm) (67.32) all showed high genetic advancement. Internodal distance per vine (51.63), vine length (45.01), number of fruits per vine (34.60), and number of male flowers per plant (33.43) all showed moderate genetic advancement. High genetic advancement suggested that these attributes are governed by additive genes, and selection will reward improvements in these traits. The conclusions of Yadav Murlee *et al*. (2013) [15] are supported by the aforementioned finding. Days to marketable yield (06.43), days to 50% female flower initiation (05.79), crop longevity (04.58), and days to 50% male flower initiation (02.06) all showed minimal genetic advancement.

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