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Short communication

Genetic variability, correlation coefficient and path analysis in bitter gourd

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ABSTRACT

Thirteen diverse genotypes of bitter gourd were evaluated for genetic variability during 2007 and 2008 for 13 traits under Allahabad conditions. The genotypes were planted at 1 m x 1 m distance for two summer seasons. The analysis of variance showed significant difference among all the genotypes for yield and its attributing traits. The highest range of variation was recorded for yield/ha, followed by fruit weight, number of nodes per vine, days to first appearance of female flower, days to first appearance of male flower, fruit length and minimum variation was observed for the trait yield per vine. Vine length had significant and positive correlation with number of nodes per vine, internodal length, fruit width and number of fruit per vine. Number of primary branches per vine had significant and negative correlation with internodal length and significant positive correlation with fruit length.

Key words: Bitter gourd, genetic variability, correlation coefficient.

Bitter gourd is one of the important and popular cucurbitaceous vegetable crop grown in India, China and South East Asia. In spite of large number of varieties available in India, only few are promising, this fact draws the attention of vine breeder for its improvement. Genetic variability plays an important role in crop breeding for selecting the elite genotypes for making rapid improvement in yield and other desirable characters as well as to select the potential parent for hybridization programme. Correlation and path coefficient analysis furnishes information regarding the nature and magnitude of various association and help in measurement of direct and indirect influence of one variable on the other. The correlation coefficient indicates the degree of relationship between two or more characters, clean picture of association between yield and its contributing traits. It is most important to know the direct and indirect influence of yield component for selecting suitable genotypes for improving the yield. Keeping in view the need of crop improvement with regard to yield and its contributing characters, the present investigation in bitter gourd was carried out.

The present experiment was conducted during 2007 and 2008 at Vegetable Research Farm, Department of Horticulture, AAI, Allahabad. Thirteen diverse genotypes of bitter gourd were sown in summer season of both the years at a spacing of 1 m × 1 m distance. The experiment was laid out in a Randomized Block Design with three replications. The recommended package and practices were followed for better growth and development of the crop. The observations were recorded for thirteen traits, *viz*. vine length (m), number of primary branches per vine, number of nodes, internodal length (cm), first effective node, days to first appearance of male flower, days to first appearance of female flower, number of fruits per vine, fruit length (cm), fruit width (cm), fruit weight (g), yield per vine (kg), yield /ha (q). Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (%) and genetic advance as per cent of mean were worked out as per the method of Johanson *et al.* (7). The correlation coefficient was calculated as suggested by Al-Jibouri *et al.* (1) and path coefficient of various characters was calculated as per the procedure of Dewey and Lu (3).

The analysis of variance showed significant difference among all the genotypes for yield and its attributing traits (Table 1). This indicated that there is scope of effective selection and can be used in the further crop improvement programme. The highest range of variation was recorded for yield/ha, followed by fruit weight, number of nodes per vine, days to first appearance of female flower, days to first appearance of male flower, fruit length and minimum variation was observed for the trait yield per vine (Table 1). Larger the range of variation among the genetic materials better will be the chance of selection and hybridization for developing better varieties/hybrids. Similar results were also reported by Yadav *et al.* (11) for most of the traits in bitter gourd.

The phenotypic coefficient of variability was higher than the genotypic coefficient of variability for all the

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Table 1. PCV, GCV, heritability and genetic advance as per cent of mean for different traits in bitter gourd.

Trait	Range		GCV (%)	PCV (%)	Heritability % (Broad sense)	Genetic advance as percent of mean
	Max.	Min.				
Vine length (m)	4.21	1.93	21.37	33.28	41	28.27
Primary branches/vine	14.66	6.00	16.91	29.86	32	19.72
No. of nodes/ vine	57.66	32.33	16.10	22.47	51	23.76
Internodal length (cm)	7.33	3.16	16.52	25.70	41	21.87
Days to 1st appearance of male flower	55.00	39.33	9.08	11.63	61	14.61
Days to 1st appearance of female flower	53.00	35.00	11.18	11.68	92	22.05
First effective node	14.00	4.00	22.72	56.44	16	18.83
Fruit length (cm)	15.03	4.33	32.76	33.09	98	66.80
Fruit width (cm)	15.90	7.38	19.99	20.72	93	39.76
Fruit weight (g)	69.20	27.63	18.44	48.59	14	14.41
No. of fruits/ vine	16.00	6.33	26.32	29.03	82	49.16
Yield/ vine (kg)	1.12	0.20	42.69	67.49	40	55.63
Yield (q/ha)	76.97	32.01	43.51	68.08	41	57.30

thirteen traits (Table 1). Minimum variability between phenotypic coefficient of variability and genotypic coefficient of variability was recorded for the character like fruit length, days to first appearance of female flower, fruit width, days to first appearance of male flower, number of fruits/vine while higher variability between PCV and GCV was observed for first effective node, fruit weight, yield per vine, yield/ha, number of primary branches per vine and vine length (Table 1). Lower variation between PCV and GCV revealed greater stability of the character against environmental fluctuation. Higher values of genotypic coefficient of variation are an indication of greater range of variability among the population and the scope of improvement of these characters through simple selection. These results are also in agreement with the results of Yadav *et al.* (11) in bitter gourd.

The results obtained in the present investigation indicated high heritability for the characters like fruit length, fruit width, days to first appearance of female flower and number of fruits per vine (Table 1). High heritability indicates that large proportion of phenotypic variance is attributed to genotypic variance and therefore, reliable selection could be made for these traits on the basis of phenotypic expression. This view was also reported by Yadav *et al.* (11) for number of fruits per vine in bitter gourd. Days to first appearance of male flower and number of nodes per vine showed moderate heritability, whereas lower heritability was recorded in fruit weight and first effective node. Although, estimates of high heritability are useful to vine breeder as they provide basis of transmissible genes from parent to progeny. More reliable conclusion can be drawn when heritability is considered along with the genetic advance. Johnson *et al.* (5) had also suggested that high heritability coupled with high advance could be helped in establishing close relationship between genotypic and phenotypic characters. The highest genetic advance as per cent of mean was obtained for fruit length followed by yield/ha and yield per vine. High heritability estimates coupled with high expected genetic advance as per cent of mean were observed for fruit length, number of fruits per vine, and fruit width (Table 1). This indicated substantial contribution of additive genetic variance for these characters. On the other hand, high values of heritability associated with low genetic advance as per cent of mean were observed for fruit width, days to first appearance of female flower (Table 1). This indicates the predominance of non-additive variance (Panse, 8) in the expression of these characters.

Estimates of genetic correlation along with phenotypic correlation, not only provides information about the extent of inherent correlation but also indicates the extent to which the phenotypically expressed correlations are influenced by the environment. Such estimation provides the information regarding the components on which the selection pressure can be exercised most effectively for effective crop improvement The correlation parameters indicates that the genotypic correlation are more than the phenotypic correlation for all the characters studied in the present investigation (Table 2), thereby establishing an inherent relationship among the characters. Vine length had significant

Table 2. Correlation coefficient of different traits in bitter gourd.

Trait		Vine length (m)	Primary branches/ vine	Nodes/ vine	Internodal length (cm)	Days to 1st appearance of male flower	Days to 1st appearance of female flower	First effective node	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Fruits/ vine	Yield/ vine (kg)	Yield/ha (q)
Vine length (m)	r_p	1.0000	0.1062	0.4704*	0.2942*	-0.1387	0.2456	0.0967	-0.0092	0.2849*	-0.0252	0.2884*	0.0768	0.0125
	r_g		-0.3385	0.7645	0.3664	-0.4371	0.3783	0.3913	-0.0495	0.5258	-0.2833	0.3473	-0.0122	0.0130
Primary branches/vine	r_p		1.0000	0.1682	-0.4150*	0.0036	0.0621	-0.1018	0.2544*	0.0889	-0.1451	0.0091	-0.0959	-0.1733
	r_g			0.0566	-0.7272	-0.4166	0.1295	-0.4574	0.4409	0.2401	-0.4313	0.1148	-0.1664	-0.1900
Nodes/vine	r_p			1.0000	0.0870	-0.3027*	0.0477	0.1839	0.0443	0.0723	-0.0672	0.1372	-0.0336	-0.1233
	r_g				0.3778	-0.4396	0.0375	0.050	0.027	0.0887	-0.4371	0.2287	-0.1034	-0.1335
Internodal length (cm)	r_p				1.0000	0.1181	-0.2661*	0.2234	-0.2580*	-0.2011	-0.0785	-0.0219	-0.0620	-0.3955*
	r_g					0.6223	-0.4942	0.5801	-0.4390	-0.3093	-0.5967	-0.2683	-0.4066	-0.4166
Days to 1st appearance of male flower	r_p					1.0000	-0.1950	0.0943	-0.1747	-0.0627	0.0708	-0.3972*	-0.1146	-0.0355
	r_g						-0.1952	0.2099	-0.2363	-0.0956	0.5694	-0.4748	-0.0366	-0.0433
Days to 1st appearance of female flower	r_p						1.0000	-0.0257	0.0721	0.2355	0.0428	0.2523	-0.0828	-0.1993
	r_g							-0.0167	0.0772	0.2849	0.2057	0.3037	-0.1914	-0.2001
First effective node	r_p							1.0000	0.2802*	-0.0421	-0.0874	-0.2217	-0.1727	-0.4510*
	r_g								0.6541	-0.0671	-0.1406	-0.5363	-0.4866	-0.4900
Fruit length (cm)	r_p								1.0000	-0.0013	0.1487	0.0233	0.0967	0.1121
	r_g									-0.0059	0.3471	0.0192	0.1407	0.1517
Fruit width (cm)	r_p									1.0000	0.0070	-0.1124	-0.1349	-0.2112
	r_g										0.1253	-0.1530	-0.2889	-0.2995
Fruit weight (g)	r_p										1.0000	0.1450	0.8454*	0.7223*
	r_g											0.2945	0.9235	0.7553
Fruits/vine	r_p											1.0000	0.5989*	0.7533*
	r_g												0.8455	0.8543
Yield/ vine (kg)	r_p												1.0000	0.9553*
	r_g													0.9575
Yield/ha (q)	r_p													1.0000
	r_g													

*Significance at 5% level of probability

Table 3. Phenotypic direct (bold) and indirect effect of yield components on yield in bitter gourd.

Trait	Vine length (m)	Primary branches/ vine	Nodes/ vine	Internodal length (cm)	Days to 1st appearance of male flower	Days to 1st appearance of female flower	First effective node	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Fruits/ vine	Yield/ vine (kg)
Vine length (m)	**0.0093**	0.0010	0.0044	0.0027	-0.0013	0.0023	0.0009	-0.0001	0.0027	-0.0002	0.0027	0.0007
Primary branches/vine	-0.0002	**-0.0021**	-0.0004	0.0009	0.0000	-0.0001	0.0002	-0.0005	-0.0002	0.0003	0.0000	0.0002
Nodes/ vine	0.0017	0.0006	**0.0036**	0.0003	-0.0011	0.0002	0.0007	0.0002	0.0003	-0.0002	0.0005	-0.0001
Internodal length (cm)	-0.0013	0.0018	-0.0004	**-0.0044**	-0.0005	0.0012	-0.0010	0.0011	0.0009	0.0003	0.0001	0.0003
Days to 1st appearance of male flower	-0.0001	0.0000	-0.0002	0.0001	**0.0007**	-0.0001	0.0001	-0.0001	0.0000	0.0000	-0.0003	-0.0001
Days to 1st appearance of female flower	-0.0005	-0.0001	-0.0001	0.0006	0.0004	**-0.0022**	0.0001	-0.0002	-0.0005	-0.0001	-0.0006	-0.0002
First effective node	-0.0001	0.0001	-0.0002	-0.0003	-0.0001	0.0000	**-0.0013**	-0.0004	0.0001	0.0001	0.0003	0.0002
Fruit length (cm)	-0.0001	0.0027	0.0005	-0.0027	-0.0018	0.0008	0.0030	**0.0106**	0.0000	0.0016	0.0002	0.0010
Fruit width (cm)	-0.0026	-0.0008	-0.0007	0.0018	0.0006	-0.0021	0.0004	0.0000	**-0.0091**	-0.0001	0.0010	0.0012
Fruit weight (g)	-0.0002	-0.0013	-0.0006	-0.0007	0.0006	0.0004	-0.0008	0.0014	0.0001	**0.0091**	0.0013	0.0077
Fruits/ vine	0.0022	0.0001	0.0011	-0.0002	-0.0031	0.0020	-0.0017	0.0002	-0.0009	0.0011	**0.0078**	0.0047
Yield/ vine (kg)	0.0755	-0.0943	-0.0330	-0.0609	-0.1127	0.0813	-0.1697	0.0950	-0.1326	0.8309	0.5887	**0.9829**
Yield (q/ha)	**0.0835**	**-0.0924**	**-0.0260**	**-0.0628**	**-0.1183**	**0.0835**	**-0.1692**	**0.1072**	**-0.1395**	**0.8430**	**0.6018**	**0.9986**
Partial R^2	0.0008	0.0002	-0.0001	0.0003	-0.0001	-0.0002	0.0002	0.0011	0.0013	0.0077	0.0047	0.9816

Table 4. Genotypic direct (bold) and indirect effect of yield components on yield in bitter gourd.

Trait	Vine length (m)	Primary branches/ vine	Nodes/ vine	Internodal length (cm)	Days to 1st appearance of male flower	Days to 1st appearance of female flower	First effective node	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Fruits/ vine	Yield/vine (kg)
Vine length (m)	**0.0161**	-0.0054	0.0123	0.0059	-0.0070	0.0061	0.0063	-0.0008	0.0084	-0.0045	0.0056	-0.0002
Primary branches/vine	0.0085	**-0.0251**	-0.0014	0.0183	0.0105	-0.0033	0.0115	-0.0111	-0.0060	0.0108	-0.0029	0.0042
Nodes/vine	0.0288	0.0021	**0.0377**	0.0142	-0.0166	0.0014	0.0019	0.0010	0.0033	-0.0165	0.0086	-0.0039
Internodal length (cm)	-0.0246	0.0489	-0.0254	**-0.0672**	-0.0418	0.0332	-0.0390	0.0295	0.0208	0.0401	0.0180	0.0273
Days to 1st appearance of male flower	-0.0050	-0.0047	-0.0050	0.0071	**0.0113**	-0.0022	0.0024	-0.0027	-0.0011	0.0065	-0.0054	-0.0004
Days to 1st appearance of female flower	-0.0184	-0.0063	-0.0018	0.0241	0.0095	**-0.0487**	0.0008	-0.0038	-0.0139	-0.0100	-0.0147	-0.0093
First effective node	-0.0056	0.0066	-0.0007	-0.0083	-0.0030	0.0002	**-0.0144**	-0.0094	0.0010	0.0020	0.0077	0.0070
Fruit length (cm)	0.0004	-0.0036	-0.0002	0.0035	0.0019	-0.0006	-0.0053	**-0.0081**	0.0000	-0.0028	-0.0002	-0.0011
Fruit width (cm)	-0.0358	-0.0164	-0.0060	0.0211	0.0065	-0.0194	0.0046	0.0004	**-0.0681**	0.0085	0.0104	0.0197
Fruit weight (g)	-0.0554	-0.0844	-0.0855	-0.1167	0.1114	0.0402	-0.0275	0.0679	-0.0245	**0.1956**	0.0576	0.1415
Fruits/vine	0.0821	0.0271	0.0540	-0.0634	-0.1122	0.0715	-0.1268	0.0045	-0.0362	0.0696	**0.2363**	0.1998
Yield/ vine (kg)	-0.0075	-0.1025	-0.0637	-0.2503	-0.0225	0.1179	-0.2996	0.0866	-0.1779	0.4455	0.5206	**0.6157**
Yield (q/ha)	**-0.0165**	**-0.1637**	**-0.0858**	**-0.4119**	**-0.0520**	**0.1964**	**-0.4851**	**0.1542**	**-0.2941**	**0.7448**	**0.8417**	**1.0003**
Partial R^2	-0.0003	0.0041	-0.0032	0.0277	-0.0006	-0.0096	0.0070	-0.0012	0.0200	0.1457	0.1989	0.6159

and positive correlation with number of nodes per vine, internodal length, fruit width and number of fruit per vine. Number of primary branches per vine had significant and negative correlation with internodal length and significant positive correlation with fruit length. Number of nodes per vine had negative and significant correlation with days to first appearance of male flower. Significant and negative correlation for internodal length was found with days to first appearance of female flower and fruit length. Days to first appearance of male flower showed significant and negative correlation with number of fruits per vine. Significant and positive correlation for first effective node was recorded with fruit length. Fruit weight had highly significant and positive correlation with yield per vine. Significant and positive correlation for number of fruits per vine was recorded with yield per vine. Similar result was also reported by Lawande and Patil (7). Paranjape and Rajput (9) reported that yield was mainly contributed by number of fruits/ vine, average fruit weight, fruit length and number of female flowers, whereas physiological attributes were mutually associated and had effects on yield. These results were also in agreement with the results of Sharma and Bhutani (10), Bhave *et al.* (2), Dey *et al.* (4), and Kutty and Dahrmati (6).

Genotypic path coefficient analysis showed highest positive direct effect for yield per vine, followed by number of fruits per vine, fruit weight, days to first appearance of male flower, number of nodes per vine, vine length with the dependent variable yield per hectare (Table 4). On the other hand negative and direct effect was observed for the character fruit width, fruit length, first effective node, days to first appearance of female flower, internodal length and number of primary branches per vine with the dependent variable yield per hectare (Table 4). Bhave *et al.* (2) reported that vine length, branch number per vine, fruit length, average fruit weight, seed number per vine had the highest positive direct effects followed by flowering duration, harvesting span, fruit length and fruit number per vine. Similar results were also reported by Dey *et al.* (4), and Kutty and Dahrmati (6).

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