The Bioscan 9(2): 707-711, 2014 (Supplement on Genetics and Plant Breeding)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

GENETIC ARCHITECTURE AND ASSOCIATION ANALYSIS IN BITTER GOURD (*MOMORDICA CHARANTIA* L.) LANDRACES

MANEESH KUMAR SINGH[1], D. R. BHARDWAJ AND D. K. UPADHYAY*
Indian Institute of Vegetable Research, Varanasi-221305 (U.P.), INDIA
[1]Department of Horticulture, Udai Pratap College an Autonomous Institute, Varanasi - 221 005 (U.P.)
e-mail: dhananjay.gpb2011@gmail.com

KEYWORDS
Momordica charantia L.
Diversity
Indian genotypes
Genetic parameters
Correlation coefficients
Path analysis

Received on :
21.03.2012

Accepted on :
07.03.2012

***Corresponding author**

ABSTRACT
The nature and magnitude of genetic diversity were estimated in 25 bitter gourd genotypes on 10 quantitative traits during the summer season under indo-gangetic plains of eastern Uttar Pradesh, so as to identify promising traits on which selection can be made. The experiment carried out following randomizing block design with three replications results indicted that high phenotypic and genotypic coefficients of variation were found for fresh fruit yield per plant followed by fruit length, fruit width and number of fruits per plant, indicating high genetic variability in these traits. High heritability coupled with high genetic advance as percent of mean was observed for fruit length, yield per plant, fruit diameter, fruit weight, branch per plant and seeds per fruit, indicating the possible role of additive gene action. The path coefficient analysis based on fruit diameter as a dependent variable implicated that plant height had the highest positive direct effect on fruit yield. The emphasis should be given to improve fruit yield per plant in bitter gourd, focus should be given on fruit weight, fruit length, fruit diameter and plant height as it has positive correlation with fruit yield per plant.

INTRODUCTION

The genus *Momordica* (family Cucurbitaceae) includes about 60 species that are native to Indo-Myanmar and India is suggested as possible centre of domestication (Sands, 1928). Among all the species, *Momordica charantia* L. (bitter gourd) is cultivated largely due to its nutritional and medicinal properties (Satkar *et al.,* 2013). There is a large diversity in bitter gourd for fruit shape (tapering/spindle shaped, elliptical, oblong, long cylindrical, top shaped, and globular), colour (white, milky white, Dark green, light green,) and fruit surface (protuberant and non-protuberant). Genetic variability forms the basis for crop improvement. Genotypic and phenotypic coefficients of variation are useful in detecting the amount of variability present in the available genotypes. The main purpose of estimating heritability and the genetic parameters that compose the heritability and the genetic parameters that compose the heritability estimate is to compare the expected gains from selection based on alternative selection strategies (Holland *et al.* 2003). Correlation analysis is a biometrical technique to find out the nature and degree of associations among various traits. Therefore, information on variability and heritability of plant characters and association among yield and quality characters are of vital importance in plant breeding programme. The present study was under taken to ascertain the magnitude and extend of genetic variability, heritability, genetic advance and the association of 10 characters in bitter gourd genotypes.

MATERIALS AND METHODS

The experiment was conducted at Indian Institute of Vegetable Research, Varanasi (U.P.) India during the summer season of 2009-10. The experimental materials of comprised 25 diverse genotypes viz. GY-323, GY-333, DRAR-1, VRBT-1, MC-84, DVBTG-7, DVBTG-5, PDM, DRBS-1, DRBS-2, DRBS-36, DRBS-41, DRBS-87, DRBS-88, DRBS-89, DRBS-100, IC-85641, IC-113878, IC-505208, PGB-6, Arka Harit, VRBT-37, VRBT-41, VRBT-04 and VRBT-63)' of bitter gourd, which were collected from different parts of India. The experiment was laid down in a Randomized Block Design (RBD) with three replications. The crop was managed as per recommended package of practices to raise the crop during summer season. In each replication, seeds of each genotype were sown in 3m long rows at 45cm distance between lines and 30 cm between plants. Ten plants of each genotype were randomly selected from each replication for recording horticultural traits viz., days to first female flower anthesis (DFA), days to edible maturity (DEM), branch per plant (BP), plant height (PH), fruit diameter (FD), fruit length (FL), fruit per plant (FP), fruit weight (FW), seeds per fruit (SF) and yield per plant (YP). The analysis of variance for different quantitative characters in bitter gourd was estimated as procedure for suggested by Panse and Sukhatme (1985). Genotypic and phenotypic coefficients of variation were estimated using the procedure suggested by Burton and De Vane (1953) and heritability in broad sense and genetic advance expressed in percent of mean were calculated (Burton, 1952). The correlations were worked out

Table 1: Estimates of mean, range, variability, heritability (bs) and genetic gain for yield and yield related traits in bitter gourd

Parameters	Days to first female flower anthesis	Days to edible maturity	Branch per plant	Plant height (cm)	Fruit diameter (cm)	Fruit length (cm)	Fruit per plant	Fruit weight (g)	Seed per fruit	Yield per plant (Kg)
Mean (%)	39.01	52.80	8.64	101.51	2.39	10.35	15.07	35.33	11.79	1.12
SE± (%)	0.97	1.45	0.52	1.46	0.19	0.51	0.81	1.44	0.53	0.15
Range (%)	31.25-48.52	41.75-58.52	5.31-15.34	59.66-153.53	1.10-4.10	4.35-18.49	8.51-21.30	14.59-59.69	6.61-18.19	0.48-1.99
PCV (%)	12.30	8.72	30.55	26.40	34.16	45.98	25.34	31.36	26.15	41.55
GCV (%)	12.31	8.49	30.35	26.39	33.40	45.92	25.27	31.61	26.13	40.52
Heritability (bs)	99.80	94.70	98.70	100.00	95.60	99.70	99.50	99.90	99.90	95.20
Genetic advance	9.88	8.96	5.36	54.54	1.61	9.68	7.20	22.99	6.34	0.91
GA as per cent of mean	25.33	16.97	62.04	53.73	67.36	93.53	47.78	65.07	53.77	81.25

as per methods suggested by Johnson *et al.* (1955) and Al-Jibouri *et al.* (1958) and path analysis was calculated according to Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance for 10 quantitative characters revealed that mean squares were highly significant for all the characters indicating enough variability in genotypes. However, the absolute variability in different characters does not permit identification of characters showing the higher degree of variability. The higher degree of variation was observed in phenotypic and genotypic variance among the characters studied. A close proximity in the phenotypic and genotypic coefficients of variability was observed indicating a little influence of environment in the expression of various horticultural traits studied. Maximum variation was shown by fruit yield per plant followed by fruit length. Low variance was observed for branch per plant, plant height, fruit diameter, fruits per plant, fruit weight and seed per fruit. In the present investigation all the characters except weight of fruit showed narrow differences between the values of GCV and PCV (Table-1) indicating variability due to genetic constitution. This indicates better scope of selection through these traits for improvement in bitter gourd on the basis of phenotypic characters alone with equal probability of success. The heritability was very high for all the traits studied indicated less influence of environment in the expression of these traits. The heritability alone in predicting the resultant effect of selecting best individual genotype as it suggests the presence of additive gene effects. The higher estimates of heritability coupled with higher genetic advance only for plant height, whereas high heritability with moderate genetic advance only for fruit height indicated that heritability of these traits is mainly owing to additive effects and consequently a high genetic advance is expected from selection under such situations. High heritability accompanied by low genetic advance for days to first flower anthesis, edible maturity, branch per plant, fruit diameter, fruit length, fruits per plant, seeds per fruit and yield per plant is indicative of non-additive gene action; therefore selection in early generation for these traits may not be effective due to linkage. These finding were also supported by Islam *et al.* (2009) and Kundu, *et al.,* (2012)

The genotypic correlation were higher than their corresponding phenotypes for all the traits studied suggesting strong inherent association between these traits at genotypic level (Table 3), which was in agreement with the results obtained by Srivastva and Srivastva (1976), Singh *et al.* (1977), Indresh (1982), Lawande and Patil (1989), Panthi *et al.* (1995), Singh *et al.* (2013) and Reddy *et al.* (2014) for yield per plant. Yield per plant showed significant positive association with plant height, fruit diameter, fruit length and seeds per fruit. Seeds per fruit have positive significant correlation with days to first flower anthesis, plant height, fruit diameter, fruit length, fruits per plant and fruit weight. Fruit weight had a positive significant correlation with fruit diameter, fruit length and fruits per plant. Fruit length showed significant positive association with plant height and fruit diameter, whereas fruit diameter showed significant positive correlation with days to first flower anthesis and plant height. Plant height had a significant positive

Table 2: Correlation coefficient at genotypic (above diagonal) and phenotypic (below diagonal) level in bitter gourd genotypes.

Characters	Days to first female flower anthesis	Edible maturity	Branch per plant	Plant height	Fruit diameter	Fruit length	Fruit per plant	Fruit weight	Seed per fruit	Yield per plant
Days to first flower female anthesis	0.0	0.462*	-0.099	0.541*	0.616**	0.278	0.214	0.327	0.596*	0.296
Edible maturity	0.449*	0.0	-0.165	0.179	0.064	-0.061	0.093	0.285	-0.081	-0.297
Branch per plant	-0.099	-0.155	0.0	0.179	0.022	0.280	-0.004	-0.229	0.255	0.270
Plant height	0.540*	0.174	0.178	0.0	0.602*	0.687**	0.239	0.360	0.544*	0.596*
Fruit diameter	0.603**	0.041	0.019	0.645**	0.0	0.548*	0.294	0.538*	0.745**	0.743**
Fruit length	0.277	-0.061	0.279	0.686**	0.534*	0.0	0.624**	0.493*	0.619**	0.533*
Fruit per plant	0.273	0.091	-0.006	0.238	0.285	0.622**	0.0	0.637**	0.477*	0.186
Fruit weight	0.327	0.278	-0.227	0.359	0.525*	0.492*	0.635**	0.0	0.403*	0.178
Seed per fruit	0.595*	-0.081	0.253	0.544*	0.731**	0.618**	0.476*	0.403*	0.0	0.603**
Yield per plant	0.289	-0.269	0.260	0.582*	0.709**	0.521*	0.178	0.179	0.588**	0.0

**, * Significant at 1 % and 5 % level, respectively.

correlation with only for days to first flower anthesis whereas edible maturity had positive significant correlation with days to first flower anthesis.

The genotypic correlations were partitioned into direct and indirect effects to know the relative importance of the components. It was determined that direct and indirect effects obtained at genotypic level were different from those at the phenotypic level (Table 3), which might be due to varying degree of influence of environment. This was supported by results of component variance analysis and correlation at the environmental level. Fruit length was observed to be negative at phenotypic and genotypic level respectively, the corresponding value at the genotypic/phenotypic level was positive. This type of change in direction and magnitude of direct and indirect effect from genotypic to phenotypic level and vice-versa might be due to environmental factors influencing various traits. The path analysis at phenotypic level may not provide a true picture of direct and indirect causes, and it is advisable to understand the contribution of different traits towards the fruit yield per plant at the genotypic level. The residual effect in path coefficient analysis usually indicates that there are traits other than those included in pathways that contribute to the dependent variable. Path coefficient analyses did not account for all variation in fruit yield as indicated by the magnitude of residual effect (Table-3) indicating that there are other traits also that contributed to fruit yield. The low residual effect (0.02352) at genotypic level indicates that all the important characters correlated with fruit yield in bitter gourd. Dey *et al.* (2006), Husna *et al.* (2011) and Yadav *et al.* (2013) also supported the results.

Knowledge of correlation alone, however, is often misleading as the correlation observed may not be always true. Two characters may show correlation just because they are correlated with third common trait. In such cases, it is necessary to take into account the causal relationship between the variables in addition to the degree of relationship. For this path analysis, which reveals the direct and indirect association is the most reliable method. There was a significant and positive association between fruit yield per plant and fruit diameter (r=0.743), path analysis had also revealed that fruit diameter had positive direct contribution (r=0.862) towards fruit yield per plant. Similarly, fruit yield and fruit diameter had significant and positive correlation with fruit yield per plant (r=0.709 and r=0.712). Plant height also had high and positive direct contribution (0.265), whereas fruit weight had high and negative direct contribution (-0.290). The branch per plant (0.127) also had high and positive significant contribution towards the fruit yield per plant. The characters such as seeds per fruit, fruit diameter, plant height and number of fruits per plant contributed indirectly towards fruit yield per plant through their effect on fruit weight. Singh *et al.* (1977), Lawande and Patil (1989) and Sharma and Sengupta (2013) also reported similar results.

There was adequate genetic variability within the genotypes evaluated for improvement of fruit yield and growth related traits. The genetic variation suggested that a positive response to direct selection is possible for all the traits studied. Correlation and path coefficient analyses indicated that selection for more fruits and average fruit weight could be

Table 3: Path analysis showing direct (above diagonal) and indirect (below diagonal) effects of various characters on fruit yield at phenotypic and genotypic level in bitter gourd.

Characters		Days to first female flower anthesis	Edible maturity	Branch per plant	Plant height	Fruit diameter	Fruit length	Fruit per plant	Fruit weight	Seed per fruit	rg on Yield/ plant
Days to first female flower anthesis	G	-0.094	-0.125	-0.013	0.136	0.531	-0.008	0.039	-0.095	-0.075	0.297
	P	-0.113	-0.100	-0.010	0.143	0.429	0.001	0.023	-0.076	-0.008	0.289
Edible maturity	G	-0.043	-0.270	-0.021	0.045	0.056	0.002	0.017	-0.083	0.010	-0.287
	P	-0.051	-0.223	-0.016	0.046	0.029	0.000	0.010	-0.065	0.001	-0.269
Branch per plant	G	0.009	0.044	0.127	0.045	0.019	-0.008	-0.001	0.067	-0.082	0.270
	P	0.011	0.035	0.104	0.047	0.014	0.001	-0.001	0.053	-0.003	0.260
Plant height	G	-0.051	-0.048	0.023	0.251	0.571	-0.020	0.043	-0.104	-0.069	0.596**
	P	-0.061	-0.039	0.018	0.265	0.461	0.002	0.026	0.083	-0.007	0.582**
Fruit diameter	G	-0.058	-0.017	0.003	0.166	0.862	-0.016	0.053	-0.156	-0.094	0.743**
	P	-0.068	-0.009	0.002	0.171	0.712	0.002	0.031	-0.122	-0.010	0.709**
Fruit length	G	-0.026	0.016	0.035	0.173	0.472	-0.030	0.113	-0.143	-0.078	0.533**
	P	-0.031	0.014	0.029	0.182	0.380	0.003	0.067	-0.144	-0.008	0.521**
Fruit per plant	G	-0.020	-0.025	-0.001	0.060	0.253	-0.018	0.182	-0.185	-0.060	0.186
	P	-0.024	-0.020	-0.001	0.063	0.203	0.002	0.108	-0.147	-0.006	0.178
Fruit weight	G	-0.031	-0.077	-0.029	0.090	0.464	-0.015	0.116	-0.290	-0.051	0.178
	P	-0.037	-0.062	-0.024	0.095	0.374	0.002	0.169	-0.232	-0.005	0.179
Seed per fruit	G	-0.056	0.022	0.032	0.137	0.643	-0.018	0.087	-0.117	-0.126	0.603**
	P	-0.067	0.018	0.026	0.144	0.520	0.002	0.052	-0.094	-0.013	0.588**

**, * Significant at 1% and 5% level, respectively; Residual effect: G, 0.02352; P, 0.3155; Bold values denote direct effect and non-bold indicate indirect effect; rg = Genotypic correlation on fruit yield.

criteria for simultaneously increasing fruit yield in bitter gourd. Therefore, due attention should be paid to improve these traits while selection of high yielding genotypes or for choosing desirable parents for heterosis breeding.

REFERENCES

Al-Jibouri, H. R., Miller, P. A. and Robinson, H. F. 1958. Genotypic and environmental variance and covariance in upland cotton cross of inter specific origin. *Agronomy J.* **50**: 633-337.

Burton, G. W. 1952. Quantitative inheritance in grasses. *Proc 6th International Grassland Congress.* **1**: 277- 283.

Burton, G. W. and De Vane E. W. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy J.* **45**: 478-481.

Dewey, D. R. and Lu K. H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy J.* **51**: 515-518.

Dey, S. S., Behera, T. K., Pal, Anand and Munshi, A. D. 2005. Correlation and path coefficient analysis in bitter gourd (Momordica charantia L.) *Veg. Sci.* **32(2):** 173-176 .

Hanson, C. H., Robinson, H. P. and Comstock, R. E. 1956. Biometrical studies of yield in segregating population of Korean Lespedeca. *Agronomy J.* **48**: 268-272.

Holland, J. B. Nyquist W. E. and Cervantes-Martinez, C. T. 2003. Estimating and interpreting he-ritability for plant breeding; A update, pl. *breed. Rev.* **22:**109-112.

Husna, A., Mahmud, Islam, F. M. R., Mahmud M. A. A. and Ratna, M. 2011. Genetic variability, correlation and path co-efficient analysis in bottle gourd (*Lagenaria siceraria* L.) *Advances in Biological Research,* **5(6):** 323-327.

Indresh, B. T. 1982. Studies on genotypic and phenotypic variability in bitter gourd. Thesis abstract. *Uni Agril. Sci. Banglore.* **8(1):** 52.

Islam, M. R., Hossain, M. S., Bhuiyan, M. S. R., Husna, A. and Syed, M.A. 2009. Genetic Variability and Path-Coefficient Analysis of Bitter Gourd (*Momordica charantia* L.) *Internat. J. Sustainable Agric.,* **1(3):** 53-57.

Johnson, H. W., Robinson, H. P. and Comstock, R. E. 1955. Estimates of genetic and environmental variability in soybean. *Agronomy J.* **47**: 314-318.

Kundu, B. C., Hossain, M. M., Mian, M. A. Khaleque and Mian, I. H. 2012. Genetic divergence in bitter gourd (*Momordica charntia* L.) *J. Asiat. Soc. Bangladesh, Sci.* **38(2):** 125-134.

Lawande, K. E. and Patil, A. V. 1989. Correlation studies in bitter gourd (*Momordica charantia* L.). *J. Maharastra Agricultural University,* **14(1):** 77-79.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi, p. 347.

Panthi, G. H., Mishra, N. and Mishra, R. S. 1995. Correlation and path coefficient studies in bitter gourd. *Indian J. Horticulture.* **52(2):** 132-136.

Reddy, P. Karthik, Reddy, R. V. S. K and Vijya Padma, S. S. 2013. Performance of parents and hybrids for yield and yield attributing characters in ridge gourd (Luffa acutangula (Roxb.) L.). *The Bioscan,* **8(4):** 1373-1377.

Sand, W. N. 1928. The bitter-cucumber or peria. *Malaya Agric.,* **16(2):** 32.

Satkar, K. P., Kulthe, A. A. and Chalke, P. R. 2013. Preparation of bitter gourd ready-to-serve beverage and effect of storage temperature on its keeping quality. *The Bioscan*. **8(1):** 115-117.

Sharma, A. and Sengupta, S. K. 2013. Genetic diversity, heritability and morphological characterization in bottle gourd (*Lagenaria siceraria* (Mol.) Stand). **8(4):** 1361-1365

Singh, A. K., Pan, R. S. and Bhavana, P. 2013. Heterosis and combining ability analysis in bittergourd (*Momordica charantia* L.). *The Bioscan,* **8(4):** 1533-1536.

Singh, H. N., Srivastav, J. P. and Prasad, R 1977. Genetic variability and correlation studies in bitter gourd. *Indian J. Agricultural Science*. **47**: 406-407.

Srivastava, V. K. and Srivastava, L. C. 1976. Genetic parameter correlation coefficient and path coefficient analysis in bitter gourd (*Momordica charantia* L.). *Indian Journal Horticulture*. **33**: 66-70.

Yadav, Murlee, Pandey, T. K., Singh, D. B. and Singh, G. K. 2013. Genetic variability, correlation coefficient and path analysis in bitter gourd. *Indian J. Hort*. **70(1):** 144-149.

..........From P. 696

be distinguished in the text and in the references by letter arranged alphabetically followed by the citation of the years eg.2004a, 2004b.

Standard abbreviations and units should be used, SI units are recommended. Abbreviations should be defined at first appearance and their use in the title and abstract should be avoided. Generic names of chemical should be used. Genus and species names should be typed in italics.

PROOFS AND REPRINTS

Page proofs will be sent by e-mail to the corresponding author. The corrected proofs should be returned to the Executive Editor within 7 days of receipt. The delay in sending the proofs may shift the paper to the next issue. Correspondence through e-mail will be preferred to avoid delay.

No gratis reprints are supplied. Authors have to purchase 25 or a multiple of it (as ordered) by paying the cost decided on the basis of number of printed pages. The paper will not be printed without proper payment of reprint cost in due time.

MEMBERSHIP OF THE JOURNAL

The individual membership is open only for students and authors. Others can become members of the journal by paying the institutional rates. The membership form should be neatly filled preferably in BLOCK letters. All the authors should become subscribers.

CORRESPONDENCE

Any correspondence regarding the manuscript should be made with Executive Editor to whom the paper has been submitted.

All correspondence regarding subscription, non-receipt of the issues etc. should be made with the managing editors.

REMITTANCES

All payments must be made by DD in the name of "The Bioscan" payable at Ranchi. Outstation cheques will not be accepted.

Address for correspondence
Dr. M. P. Sinha
Executive Editor
D-13, Harmu Housing Colony
Ranchi - 834002, Jharkhand (India)
e-mail: m_psinha@yahoo.com

THE BIOSCAN : SUBSCRIPTION RATES

		India (Rs.)	SAARC Countries	Other Countries
Individuals	One Year	1,000	2,000(I:C)	US $200
	Life Member*	10,000		
Institutions	One Year	3,000	6,000(I:C)	US $400
	Life Member*	30,000		

*Life Member will receive the journal for 15 years while other benefits will continue whole life

THE BIOSCAN : MEMBERSHIP FORM

Please enter my subscription for the above journal for the year .... / life member.

Name: ....

Address: ....

E-mail: ....

Payment Rs. : .... by DD / MD in favour of

THE BIOSCAN payable at Ranchi, No. .... Dated .... is enclosed.

NOTE: FOR MEMBERSHIP THE ABOVE INFORMATION CAN BE SENT ON SEPARATE SHEET