The Bioscan 11(4):2975-2980,2016(Supplement on Genetics and Plant Breeding) www.thebioscan.com
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

CHARACTER ASSOCIATION AND PATH CO-EFFICIENT ANALYSIS FOR YIELD AND YIELD RELATED TRAITS IN BITTER GOURD (*MOMORDICA CHARANTIA* L.)

V. JATAV*, D. K. SINGH AND A. PANCHBHAIYA
Department of Vegetable Science, College of Agriculture,
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S.. Nagar, Uttarakhand- 263 145
e-mail: vinod.jatav@icar.gov.in)

KEYWORDS
Genotypic correlation phenotypic correlation path coefficient analysis bitter gourd.

Received on :
08.07.2016

Accepted on :
21.10.2016

***Corresponding author**

ABSTRACT
Twenty-four genotypes of bitter gourd were grown in Randomized Block Design with three replications including two checks (Pant Karela-1 and Pant Karela-2) to assess correlation co-efficient and path co-efficient analysis at G.B. Pant University of Agriculture and Technology, Pantnagar, during summer 2014., Correlation co-efficient studies indicated that fruit yield per plant had highly significant and positive correlation with number of fruits per plant (0.577) followed by average fruit weight (0.551), fruit diameter (0.550), main vine length (0.470), while it was significantly and negatively associated with days to first female flower (-0.459), days to first harvest (-0.444) and number of node to first male flower (-0.425). Path co-efficient analysis revealed that number of fruits per plant (0.875) exerted high order of positive direct effect towards yield followed by average fruit weight (0.797), days to first harvest ((0.190)); however, days to first female flower (-0.201) followed by weight of seed per fruit(-0.150), number of node to first female flower(-0.116). number of branches per vine (-0.064), exerted negative direct effect towards yield. Based on overall findings of the present study, it was concluded that for selection of superior genotypes primary emphasis should be given on fruit yield per plant followed by number of fruits per plant, average fruit weight and fruit diameter.

INTRODUCTION

Bitter gourd (*Momordica charantia* L., 2n = 2x = 22) is one of the important cucurbitaceous vegetables grown in India. Its native home is tropical Asia particularly, East India and south China. Eastern India (includes the states of Orissa, West Bengal, Assam, Jharkhand and Bihar) may be considered as a probable primary center of diversity of bitter gourd, where a wild feral form M. charantia var. muricata (Chakravarty, 1990) currently exists. The crop is highly cross pollinated due to monoecy. The bitter principle in bitter gourd is cucurbitacin, a bitter glucoside which prevents the spoilage of cooked vegetable and keeps fit for consumption even for two to three days. White-fruited Indian varieties are, in fact, relatively high in polypeptide-p, phenolics, polyphenolic compounds and natural oxidants and antioxidants. The fruits and seeds of bitter gourd possess cooling, appetitising, stomachic, antipyretic, carminative, antihelminthic, aphrodisiac and vermifuge properties (Grover and Yadav, 2004), and bitter gourd extracts also possess antioxidant, antimicrobial, antiviral, antihepatotoxic and antiulcerogenic properties while also having the ability to lower blood sugar (Welthinda *et al*., 1985 and Raman and Lan, 1996). Hypoglycemic glycoalkaloids *viz*., vicine present in seed (Dutta *et al*., 1981 and Handa *et al*., 1990) and charantin found in fruit (Lotlikar and Rao, 1962). MAP-30, a basic protein that inhibits human immunodeficiency virus (HIV) is present in both seed and fruit (Lee *et al*., 1995). In India, bitter gourd is grown in an area of 78,890 ha and production of 807,470 tonnes with productivity of 10.23 t/ha. Telangana is the leading bitter gourd producing state followed by Chhattisgarh and Odisha (NHB, 2015).

For rational improvement of yield and its components, the understanding of nature and magnitude of variation in the available material and association of characters with yield and among themselves and the extent of environmental influence on the characters which is statistically determined by correlation coefficient is although useful in determining the relative influence of the various characters on yield they do not provide an exact picture of the relative importance of the direct and indirect influences of each of the characters towards the yield. Path coefficient analysis proved helpful in partitioning the correlation coefficient into direct and indirect effects. It gives an idea about the contribution of each independent character on dependent character *i.e.* yield. Genotypic and phenotypic correlation was worked out according to Searle's (1961) and path analysis as per Dewey and Lu (1959). The present study was conducted to determine the association of different characters with yield, direct and indirect influence of characters towards yield and yield contributing traits to identify better combinations as selection criteria for developing high yielding bitter gourd genotypes.

MATERIALS AND METHODS

The experiment was conducted at Vegetable Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar during February-June, 2014. Vegetable Research

Centre, Pantnagar is situated in the foot hills of Shivalik range of Himalayas in the narrow belt called 'Tarai'. Geographically, it is situated at an altitude of 243.84 m above mean sea level, and between 29ºNorth latitude and 79.3º East longitude. The experimental materials used for present investigation are comprised 24 germplasm of bitter gourd. The experiment was laid out in randomized block design with three replications. Each genotype was following spacing at 2.0 x 0.6 m apart. All the recommended agronomic package and practices and protective measures were followed to raise a good crop. The data recorded on 19 quantitative characters, namely days to first male flower, days to first female flower, number of node to first male flower, number of node to first female flower, days to first harvest, number of fruits per plant, average fruit weight, fruit length, fruit diameter, number of seed cavity per fruit, length of seed cavity, main vine length, number of primary branches per vine, length of internodes, number of seeds per fruit, weight of seeds per fruit, seed index, fruit yield per plant and fruit yield per hectare. The observations were recorded on five randomly selected competitive plants per replication for each entry. Correlation and path coefficient analysis were calculated following Searle's (1961) and Dewey and Lu (1959), respectively.

RESULTS AND DISCUSSION

The expression of a complex character like yield is a sum total of the contribution of many simply inherited characters therefore, direct selection for yield may not be effective since it is dependent on many contributing traits. These traits are generally correlated to each other and also with yield, therefore, selection practiced for an individual character might subsequently bring about a simultaneous change in other, and thus an understanding of the association between the component characters and their relative contribution to yield is essential to bring a rational improvement in their desirable traits. Pleiotropy is the simple property of genes which affects two or more characters. So, it carries simultaneous variation in the characters. Pleiotropy does not necessarily cause a detectable correlation because correlation resulting from it is the overall effects of the gene that affects both the characters.

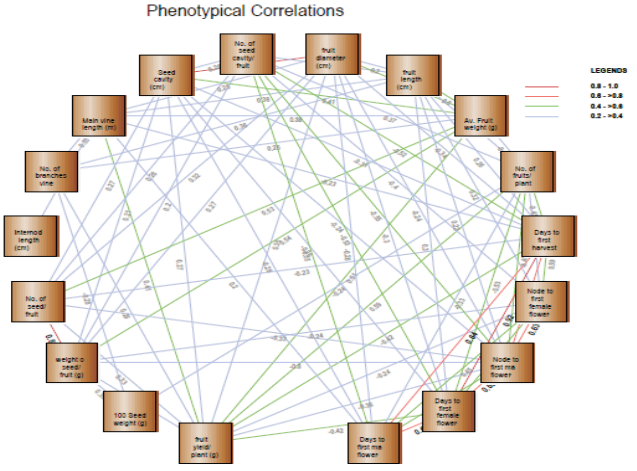

Figure 1: Phenotypic correlation coefficient between among characters

Some genes increase both characters (positive correlation), while others increase one and decrease the other (negative correlation).

Fruit yield per plant showed highly significant and positive genotypic and phenotypic correlation with number of fruits per plant (0.577, 0.590, respectively) followed by average fruit weight (0.551, 0.507), fruit diameter (0.550, 0.353), main vine length (0.470, 0.418), length of seed cavity (0.439, 0.274), number of seeds per fruit (0.404, 0.327), number of branches per vine (0.392, 0.290) and weight of seeds per fruit (0.329, 0.278). Whereas, it was significant and negatively associated with days to first female flower (-0.459, -0.421), days to first harvest (-0.444, -0.417), number of node to first male flower (-0.425, -0.385), number of node to first female flower (-0.315, -0.237) respectively, depicted in Table 1 and 2; Fig 1 and 2. Genetic correlations were generally higher than phenotypic correlations for most of the traits. It means that there is strong association between these traits genetically, but the phenotypic value is lessened by the significant interaction of environment. This suggests the possibility of indirect selection in these traits with direct selection in another trait would be effective for yield improvement. Similar to this investigation was reported by Dubey *et al* . (2013), Kumar *et al.* (2013), Choudhary *et al* . (2014), Pathak *et al*. (2014), Singh *et al*. (2014) and Gupta *et al*. (2015).

Path coefficient analysis gives ideas about the contribution of each independent character on dependent character *i.e.* yield. Since the mutual relationship of component characters might vary both in the magnitude and direction, it may tend to vitiate the association of total yield with attributes, it is necessary to partition the genetic correlation into direct and indirect effects of each other. Correlation is useful for making rational improvement in yield and its components but these does not provide an exact picture of the relative importance of direct and indirect influences of each of the component characters. Moreover, when more and more variables are included, the indirect contribution becomes complex (Dewey and Lu, 1959). In such situation it becomes necessary to study path coefficient analysis which takes into account the causal relationship in addition to degree of relationship.

In present investigation, path coefficient analysis revealed that

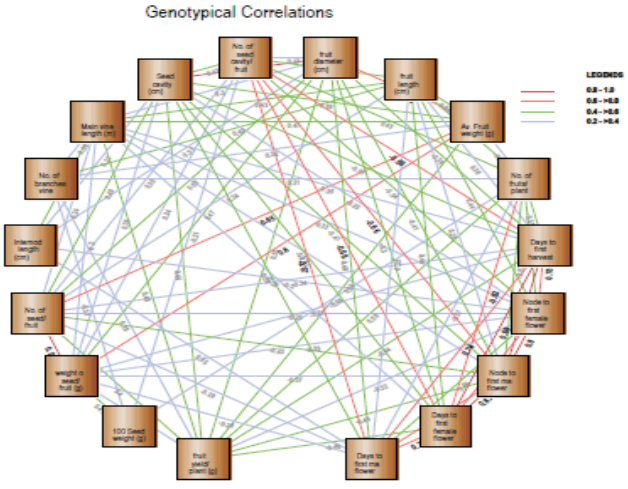

Figure 2 : Genotypic correlation coefficient between among characters

Table1: Phenotypic correlation coefficient for various characters

Character	Days to first male flower	Days to first female flower	Node to firstmale flower	Node to first female flower	Days to first harvest	No. of fruits /plant	Av. Frui t weight (g)	fruit length (cm)	fruit diameter (cm)	Seed cavity (cm)	Main vine length (m)	No. of branches /vine	Internodal length (cm)	No. of seed/fruit	weight of seed/fruit (g)	100 Seed weight (g)	fruit yield /plant (g)	fruit yield /ha (q)
Days to first male flower																		
Days to first female flower	0.689**																	
Node to first male flower	0.599**	0.679**																
Node to first female flower	0.447**	0.565**	0.694**															
Days to first harvest	0.639**	0.923**	0.692**	0.591**														
No. of fruits/plant-0.329**	-0.532**	-0.470**	-0.340**	-0.448**														
Av. Fruit weight (g)	0.044NS	0.024NS	-0.051NS	0.105NS	-0.079NS	-0.323**												
fruit length (cm) 0.149NS	0.297*	0.202NS	0.324**	0.255*	-0.326**	0.500**												
fruit diameter (cm)	-0.280*	-0.301*	-0.281*	-0.157NS	-0.342**	-0.033NS	0.510**	0.203NS										
Seed cavity (cm) -0.265*	-0.262*	-0.264*	-0.093NS	-0.309**	-0.001NS	0.409**	0.096NS	0.904**										
Main vine length (m)	0.176NS	-0.168NS	-0.218NS	-0.182NS	-0.275*	0.040NS	0.399**	0.363**	0.218NS	0.070NS								
No. of branches/vine	-0.006NS	-0.013NS	-0.071NS	0.035NS	-0.026NS	0.148NS	0.251*	0.362**	0.073NS	0.024NS	0.302**							
Internodal length (cm)	0.154NS	0.033NS	0.061NS	-0.045NS	-0.052NS	0.076NS	-0.027NS	-0.056NS	0.114NS	0.102NS	0.292*	-0.054NS						
No. of seed/fruit -0.188NS	-0.133NS	-0.326**	-0.191NS	-0.229NS	-0.097NS	0.528**	0.143NS	0.324**	0.269*	0.200NS	0.077NS	0.042NS						
weight of seed/fruit (g)	-0.155NS	-0.073NS	-0.291*	-0.236*	-0.182NS	-0.156NS	0.539**	0.075NS	0.269*	0.205NS	0.164NS	-0.043NS	0.030NS	0.880**				
100 Seed weight (g)	0.083NS	0.176NS	0.118NS	-0.098NS	0.093NS	-0.245*	0.145NS	-0.110NS	-0.035NS	-0.084NS	0.029NS	-0.281*	0.069NS	-0.028NS	0.348**			
fruit yield/plant (g)	-0.174NS	-0.421**	-0.385**	-0.237*	-0.417**	0.590**	0.507**	0.134NS	0.353**	0.274*	0.418**	0.290*	0.105NS	0.327**	0.278*	-0.072NS		
fruit yield/ha (q)	-0.174NS	-0.421**	-0.385**	-0.237*	-0.417**	0.590**	0.507**	0.134NS	0.353**	0.274*	0.418**	0.290*	0.105NS	0.327**	0.278*	-0.072NS	1.000**	

(Significance Levels- 0.05 0.01 0.005 0.001 %If correlation r = > 0.231 0.301 0.327 0.379, respectively)

Table2: Genotypic correlation coefficient for various characters

Character	Days to first male flower	Days to first female flower	Node to first male flower	Node to first female flower	Days to first harvest	No. of fruits/plant	Av. Fruit weight (g)	fruit length (cm)	fruit diameter (cm)	Seed cavity (cm)	Main vine length (m)	No. of branches /vine	Internodal length (cm)	No. of seed/fruit	weight of seed /fruit (g)	100 Seed weight (g)	fruit yield /plant (g)	fruit yield/ha (q)
Days to first male flower																		
Days to first female flower	0.737**																	
Node to first male flower	0.624**	0.790**																
Node to first female flower	0.485**	0.740**	0.755**															
Days to first harvest	0.740**	0.976**	0.846**	0.782**														
No. of fruits/plant	-0.366**	-0.625**	-0.518**	-0.487**	-0.509**													
Av. Fruit weight (g)	0.029NS	0.034NS	-0.073NS	0.172NS	-0.085NS	-0.309**												
fruit length (cm)	0.253*	0.438**	0.293*	0.438**	0.355**	-0.412**	0.580**											
fruit diameter (cm)	-0.484**	-0.496**	-0.380**	-0.196NS	-0.575**	-0.040NS	0.729**	0.172NS										
Seed cavity (cm)	-0.536**	-0.518**	-0.394**	-0.225NS	-0.572**	0.002NS	0.593**	0.038NS	1.002**									
Main vine length (m)	0.213NS	-0.221NS	-0.288*	-0.298*	-0.318**	0.017NS	0.458**	0.436**	0.327**	0.120NS								
No. of branches/vine	-0.091NS	-0.092NS	-0.146NS	0.057NS	-0.122NS	0.208NS	0.317**	0.495**	0.003NS	-0.116NS	0.383**							
Internodal length (cm)	0.254*	-0.010NS	0.089NS	-0.201NS	-0.176NS	0.136NS	-0.006NS	-0.036NS	0.305**	0.207NS	0.437**	-0.068NS						
No. of seed/fruit	-0.289*	-0.191NS	-0.433**	-0.276*	-0.337**	-0.122NS	0.646**	0.240*	0.545**	0.490**	0.226NS	0.164NS	0.007NS					
weight of seed/fruit (g)	-0.258*	-0.117NS	-0.374**	-0.332**	-0.274*	-0.171NS	0.602**	0.140NS	0.474**	0.385**	0.192NS	-0.047NS	0.071NS	0.932**				
100 Seed weight (g)	0.107NS	0.192NS	0.145NS	-0.143NS	0.100NS	-0.263*	0.142NS	-0.119NS	-0.063NS	-0.163NS	0.030NS	-0.374**	0.149NS	0.044NS	0.414**			
fruit yield/plant (g)	-0.182NS	-0.459**	-0.425**	-0.315**	-0.444**	0.577**	0.551**	0.136NS	0.550**	0.439**	0.470**	0.392**	0.172NS	0.404**	0.329**	-0.085NS		
fruit yield/ha (q)	-0.182NS	-0.459**	-0.425**	-0.315**	-0.444**	0.577**	0.551**	0.136NS	0.550**	0.439**	0.470**	0.392**	0.172NS	0.404**	0.329**	-0.085NS	1.000**	

Table3 : Phenotypic path coefficient for various characters

Sr.No	Character	Days to first male flower	Days to first female flower	Number of node to first male flower	Number of node to first female flower	Days to first harvest	Number of fruits per plant	Average fruit weight (g)	fruit length (cm)
1	Days to first male flower	0.0281	0.0194	0.0154	0.0126	0.018	-0.0093	0.0012	0.0042
2	Days to first female flower	-0.1389	-0.2015	-0.1263	-0.1138	-0.1859	0.1073	-0.0048	-0.0597
3	Number of node to first male flower	0.0656	0.0751	0.1198	0.0756	0.0765	-0.0541	-0.0055	0.0263
4	Number of node to first female flower	-0.0519	-0.0656	-0.0733	-0.1161	-0.0686	0.0394	-0.0121	-0.0376
5	Days to first harvest	0.1216	0.1756	0.1215	0.1125	0.1903	-0.0852	-0.015	0.0486
6	Number of fruits per plant	-0.2883	-0.466	-0.3954	-0.2973	-0.3918	0.8754	-0.2824	-0.2854
7	Average fruit weight (g)	0.0353	0.0191	-0.0366	0.0835	-0.0627	-0.2574	0.7979	0.3988
8	fruit length (cm)	0.0014	0.0028	0.0021	0.0031	0.0024	-0.0031	0.0048	0.0095
9	fruit diameter (cm)	0.0039	0.0042	0.0034	0.0022	0.0048	0.0005	-0.0071	-0.0028
10	Number of seed cavity per fruit	0.0251	0.0241	0.0251	0.0181	0.0236	-0.0171	0.0044	0.0156
11	Length of Seed cavity (cm)	0.0053	0.0053	0.0049	0.0019	0.0062	0	-0.0082	-0.0019
12	Main vine length (m)	0.0189	-0.0109	-0.018	-0.0135	-0.021	0.0038	0.035	0.0353
13	Number of branches per vine	0.0004	0.0008	0.0043	-0.0022	0.0016	-0.0095	-0.0161	-0.0233
14	Internodal length (cm)	0.0051	0.0011	0.0012	-0.0015	-0.0017	0.0025	-0.0009	-0.0019
15	Number of seeds per fruit	-0.0324	-0.0229	-0.0571	-0.0329	-0.0393	-0.0167	0.0909	0.0246
16	Weight of seed/fruit (g)	0.0233	0.011	0.0444	0.0354	0.0274	0.0234	-0.0809	-0.0113
17	Seed index (g)	0.0034	0.0071	0.0049	-0.004	0.0038	-0.0099	0.0059	-0.0045
18	Fruit yield per plant (g)	-0.174	-0.4212	-0.3598	-0.2366	-0.4166	0.5901	0.507	0.1345
19	Partial R^2	-0.0049	0.0849	-0.0431	0.0275	-0.0793	0.5165	0.4046	0.0013

Table3 : Continue..

Sr.No	Character	fruit diameter (cm)	Number of seed cavity per fruit	Length of seed cavity (cm)	Main vine length (m)	Number of branches per vine	Internodal length (cm)	Number of seeds per fruit	Weight of seed per fruit (g)	Seed index (g)
1	Days to first male flower	-0.0079	-0.0154	-0.0074	0.0057	-0.0002	0.0043	-0.0053	-0.0044	.0023
2	Days to first female flower	0.0607	0.1064	0.0528	0.0237	0.0026	-0.0066	0.0268	0.0148	-0.0355
3	Number of node to first male flower	-0.0289	-0.0657	-0.0288	-0.0232	-0.008	0.0043	-0.0398	-0.0355	0.0144
4	Number of node to first female flower	0.0183	0.0461	0.0108	0.0169	-0.004	0.0052	0.0222	0.0274	0.0114
5	Days to first harvest	-0.065	-0.0981	-0.0588	-0.0431	-0.0049	-0.0099	-0.0435	-0.0347	0.0177
6	Number of fruits per plant	-0.0292	0.3276	-0.0011	0.0361	0.1292	0.0668	-0.0852	-0.1367	-0.2144
7	Average fruit weight (g)	0.4073	-0.0771	0.326	0.3005	0.2001	-0.0215	0.4217	0.4303	0.1158
8	fruit length (cm)	0.0019	-0.0032	0.0009	0.0036	0.0034	-0.0005	0.0014	0.0007	-0.001
9	fruit diameter (cm)	-0.014	-0.0023	-0.0127	-0.0035	-0.001	-0.0016	-0.0045	-0.0038	0.0005
10	Number of seed cavity per fruit	-0.0076	-0.0457	-0.0121	0.0066	0.0005	-0.0026	-0.0126	-0.0092	0.0083
11	Length of Seed cavity (cm)	-0.0183	-0.0053	-0.0202	-0.0022	-0.0005	-0.0021	-0.0054	-0.0041	0.0017
12	Main vine length (m)	0.0231	-0.0134	0.0103	0.093	0.0306	0.0263	0.0164	0.0139	0.0027
13	Number of branches per vine	-0.0047	0.0007	-0.0016	-0.0212	-0.0643	0.0034	-0.0049	0.0028	0.0181
14	Internodal length (cm)	0.0038	0.0019	0.0034	0.0094	-0.0018	0.0333	0.0014	0.001	0.0023
15	Number of seeds per fruit	0.0557	0.0474	0.0462	0.0303	0.0132	0.0072	0.172	0.1514	-0.0048
16	Weight of seed/fruit (g)	-0.0404	-0.0302	-0.0308	-0.0225	0.0065	-0.0045	-0.1321	-0.1501	-0.0523
17	Seed index (g)	-0.0014	-0.0073	-0.0034	0.0012	-0.0114	0.0028	-0.0011	0.0141	0.0405
18	Fruit yield per plant (g)	0.3535	0.1661	0.2737	0.4113	0.29	0.1046	0.3275	0.2779	-0.0724
19	Partial R^2	-0.005	-0.0076	-0.0055	0.0382	-0.0187	0.0035	0.0563	-0.0417	-0.0029

(R SQUARE = 0.9241, RESIDUAL EFFECT = 0.2755)

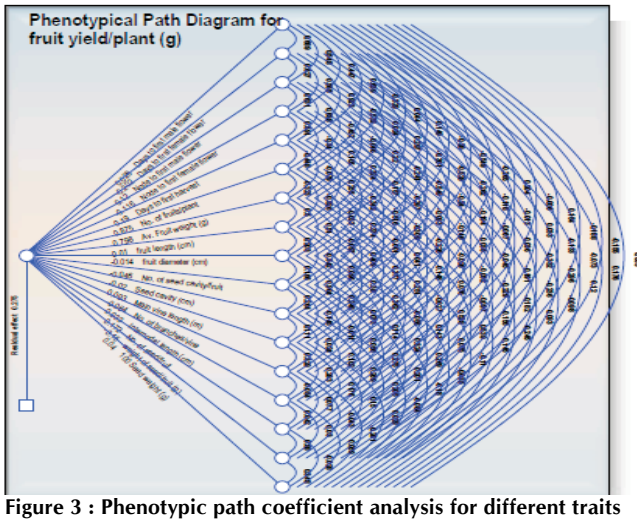

Figure 3 : Phenotypic path coefficient analysis for different traits

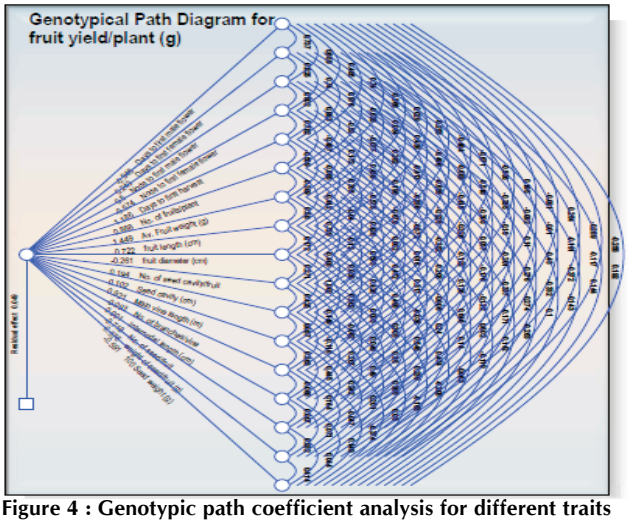

Figure 4 : Genotypic path coefficient analysis for different traits

number of fruits per plant (0.875) exerted high order of positive direct effect towards yield followed by average fruit weight

Table4: Genotypic path coefficient for various characters

Sr. No	Character	Days to first male flower	Days to first female flower	Number of node to first male flower	Number of node to first female flower	Days to first harvest	Number of fruits per plant	Average fruit weight (g)	fruit length (cm)
1	Days to first male flower	-0.9479	-0.6987	-0.6243	-0.4599	-0.7011	0.3473	-0.0271	-0.2398
2	Days to first female flower	0.1789	0.2427	0.2003	0.1797	0.2368	-0.1516	0.0082	0.1063
3	Number of node to first male flower	0.3293	0.4127	0.5	0.401	0.4417	-0.2648	-0.0384	0.141
4	Number of node to first female flower	-0.2786	-0.425	-0.4604	-0.5741	-0.4489	0.2794	-0.0988	-0.2515
5	Days to first harvest	0.8773	1.1572	1.0478	0.9274	1.1861	-0.6035	-0.1003	0.4216
6	Number of fruits per plant	-0.3252	-0.5544	-0.47	-0.4319	-0.4516	0.8875	-0.2742	-0.3659
7	Average fruit weight (g)	0.0414	0.0489	-0.1112	0.2495	-0.1226	-0.4477	1.4492	0.8411
8	fruit length (cm)	-0.1826	-0.3161	-0.2035	-0.3161	-0.2565	0.2976	-0.4189	-0.7218
9	fruit diameter (cm)	0.1266	0.1296	0.108	0.0512	0.1504	0.0104	-0.1905	-0.0449
10	Number of seed cavity per fruit	-0.1303	-0.1327	-0.1273	-0.1042	-0.1319	0.0832	-0.0232	-0.0789
11	Length of Seed cavity (cm)	-0.0546	-0.0528	-0.0423	-0.0229	-0.0583	0.0002	0.0605	0.0039
12	Main vine length (m)	0.1796	-0.2353	-0.2813	-0.3006	-0.3242	0.015	0.4352	0.3925
13	Number of branches per vine	0.0085	0.0086	0.0139	-0.0053	0.0113	-0.0193	-0.0295	-0.046
14	Internodal length (cm)	0.0002	0	0.0001	-0.0001	-0.0001	0.0001	0	0
15	Number of seeds per fruit	0.2076	0.1374	0.3087	0.1982	0.2418	0.0873	-0.4639	-0.172
16	Weight of seed/fruit (g)	-0.1488	-0.0675	-0.2139	-0.1911	-0.1575	-0.0986	0.3464	0.0803
17	Seed index (g)	-0.0634	-0.1132	-0.0853	0.0844	-0.0594	0.1552	-0.0837	0.0705
18	Fruit yield per plant (g)	-0.1822	-0.4586	-0.4407	-0.3151	-0.4441	0.5775	0.5511	0.1364
19	Partial R^2	0.1727	-0.1113	-0.2204	0.1809	-0.5267	0.5125	0.7986	-0.0984

Table4: Continue..

Sr. No	Character	fruit diameter (cm)	Number of seed cavity per fruit	Length of seed cavity (cm)	Main vine length (m)	Number of branches per vine	Internodal length (cm)	Number of seeds per fruit	Weight of seed per fruit (g)	Seed index (g)
1	Days to first male flower	0.4591	0.6359	0.5078	-0.1848	0.0866	-0.241	0.2741	0.245	-0.1018
2	Days to first female flower	-0.1203	-0.1658	-0.1256	-0.062	-0.0224	-0.0024	-0.0465	-0.0285	0.0465
3	Number of node to first male flower	-0.2065	-0.3275	-0.2073	-0.1527	-0.0749	0.0548	-0.215	-0.1858	0.0722
4	Number of node to first female flower	0.1124	0.308	0.1292	0.1874	-0.0325	0.1152	0.1585	0.1906	0.0821
5	Days to first harvest	-0.6823	-0.8052	-0.6782	-0.4174	-0.1448	-0.2087	-0.3996	-0.3244	0.1192
6	Number of fruits per plant	-0.0353	0.3801	0.0016	0.0144	0.1846	0.1211	-0.1079	-0.152	-0.2331
7	Average fruit weight (g)	1.0562	-0.1732	0.8594	0.6846	0.4594	-0.0084	0.9366	0.872	0.2053
8	fruit length (cm)	-0.124	0.2929	-0.0275	-0.3075	-0.3571	0.0259	-0.1729	-0.1007	0.0862
9	fruit diameter (cm)	-0.2614	-0.0708	-0.2618	-0.0789	-0.0008	-0.0798	-0.1424	-0.1239	0.0165
10	Number of seed cavity per fruit	0.0526	0.1943	0.0825	-0.0289	-0.0121	0.0096	0.0681	0.0465	-0.0404
11	Length of Seed cavity (cm)	0.1021	0.0433	0.1019	0.0088	-0.0118	0.0211	0.0499	0.0392	-0.0166
12	Main vine length (m)	0.2783	-0.1372	0.0797	0.9213	0.3346	0.41	0.2227	0.1853	0.0276
13	Number of branches per vine	-0.0003	0.0058	0.0108	-0.0337	-0.0929	0.0063	-0.0152	0.0044	0.0348
14	Internodal length (cm)	0.0002	0	0.0001	0.0003	0	0.0006	0	0	0.0001
15	Number of seeds per fruit	-0.3912	-0.2516	-0.3517	-0.1735	-0.1176	-0.005	-0.7178	-0.6692	-0.0314
16	Weight of seed/fruit (g)	0.2728	0.1376	0.2214	0.1158	-0.027	0.0407	0.5367	0.5757	0.2385
17	Seed index (g)	0.0374	0.1228	0.0965	-0.0177	0.221	-0.0878	-0.0258	-0.2447	-0.5908
18	Fruit yield per plant (g)	0.5497	0.1896	0.4389	0.4753	0.3922	0.1721	0.4035	0.3294	-0.0851
19	Partial R^2	-0.1437	0.0368	0.0447	0.4379	-0.0364	0.0001	-0.2897	0.1896	0.0503

(R SQUARE = 0.9976, RESIDUAL EFFECT = 0.0486)

(0.797), days to first harvest (0.190), number of seeds per fruit (0.172). However, days to first female flower (-0.201) followed by weight of seed per fruit (-0.150), number of node to first female flower (-0.116), number of branches per vine (-0.064), exerted negative direct effect towards yield, depicted in Table 3 and 4; Fig. 3 and 4. The information obtained from path analysis revealed that number of fruits per plant, followed by average fruit weight, fruit length days to first female flower, days to first harvest, internodal length and main vine length had high positive direct effect on yield at both genotypic and phenotypic levels. Thus, these traits may be used as effective selection parameters for obtaining high yield in breeding programme for yield enhancement in bitter gourd. Similar to this study observed by Pandey *et al*. (2012), Dalamu and Behera (2013), Kumar *et al*.(2013), Jadhav *et al*. (2014), Pathak *et al*.(2014), Singh and Singh (2014) and Saryam *et al*. (2015).

Hence, Correlation coefficient studies indicated that fruit yield per plant had highly significant and positive correlation with number of fruits per plant followed by average fruit weight and fruit diameter. Whereas, path coefficient analysis revealed that number of fruits per plant exerted high order of positive direct effect towards yield followed by average fruit weight, days to first harvest. Based on overall findings of the present study, it is concluded that for selection of superior genotypes, primary emphasis should be given on fruit yield per plant followed by number of fruits per plant, average fruit weight and fruit diameter. Therefore, these parameters can be utilized

for future bitter gourd yield improvement programmes.

REFERENCES

Chakravarty, H. L. 1990. Cucurbits of India and their role in the development of vegetable crops.Biology and utilization of *Cucurbitaceae,* Cornell Univ. Press, Ithaca, NY.pp.325-334.

Choudhary, B. R., Kumar, S. and Sharma, S. K. 2014. Evaluation and correlation for growth, yield and quality traits of ridge gourd (*Luffa acutangula*) under arid conditions. *Indian J. Agric. Sci.* **84(4):** 498-502.

Dalamu and Behera, T. K. 2013. Character association and path coefficient analysis of indigenous and exotic bitter gourd (*Momordica charantia* L.) germplasm. *Indian J. Agric. Sci.* **83(5):** 525-528.

Dewey, D. R. and Lu, K. H. 1959. A correlation and path analysis of components of crested wheat grass seed production. *Agron. J.* **15:** 515-518.

Dubey, R. K., Singh, V. and Upadhyay, G. 2013. Genetic variability and inter-relationship among some ridgegourd*(Luffa acutangula* L.*)* accessions under foot hills of Arunachal Pradesh. *Prog. Hort.* **45(1):** 191-197.

Dutta, E. K., Chakravarty, A. K., Chowdhury, U. S. and Pakrash, S. C. 1981. Vicine, a favism-inducing toxin from *Momordica charantia* L. seeds. *Indian J. Chem.* **208**: 669-671.

Gupta, N., Bhardwaj, M. L., Singh, S. P. and Sood, S. 2015. Correlation and path analysis of yield and yield components in some genetic stocks of bitter gourd (*Momordica charantia* L.).*SABRAO J. Breed. Genet.* **47(4):** 475-481.

Grover, J. K., and Yadav, S. P. 2004. Pharmacological actions and potential uses of *Momordica charantia*:A review. *J. Ethnnpharmacol.* **93:** 123-132.

Handa, C., Singh, J., Sharma, M. L., Kaul, A., Neerja, M. and Zafar, R. 1990. Hypoglycemic principle of *Momordica charantia* seeds. *Nat. Prod.* **6:** 16-19.

Jadhav, P. S., Rathod, A. H., Lipane, R. R., Beradand, P. B. and Suresh, B. G. 2014. Selection of promising lines from F_4 generation of chick pea genotypes through correlation and path coefficient analysis.*The Bioscan*.**9(4):** 1769-1771.

Kumar, R.,Ametal, K. D.,Dubey, R. B. and Pareek, S. 2013. Genetic variability, correlation and path analysis in sponge gourd (*Luffacylindrica*Roem.). *African J. Biotechnology.**12(6)*:** 539-543.

Lee, H. S., Huang, P. L., Bourinbalar, A. S., Chen, H. C. and Kung, H. F. 1995. Inhibition of the integrase of human immuno-deficiency virus (HIV) type I by anti-HIV plant proteins MAP30 and CAP31. Proc. *Ned. Acad. Sci.* **92:** 8818-8822.

Lotliksr, M. M. and Rao, M. R. R. 1962. Note on a hypoglycemic principle isolated from the fruits of *Mornordica charontia. J. Univ. Bombay.* **29:** 223-224.

NHB.2015. Indian Horticulture Database.National Horticulture Board, Ministry of Agriculture, Government of India,p. 279.

Pandey, P., V. B. Singh and Achila S. 2012. Correlation and path analysis of yield and yield contributing traits for higher yield and better marketable traits in sponge gourd (*Luffa cylindrica L* Roem.). *Prog. Horti.***44(1):** 126-129.

Pathak, M.,Manpreet and Pahwa, K. 2014. Genetic variability, correlation and path coefficient analysis in bitter gourd (*Momordicacharantia* L.). *Int. J. Ad. Res.* **8(2):** 179-184.

Raman, A.and Lau C. 1996. Anti-diabetic properties and phytochemistry of *Momordicacharantia* L.*Phytomedicine*.**2:** 349-362.

Saryam, D. K., Mittra, S. K., Mehta, A. K., Prajapati, S. and Kadwey, S. 2015. Correlation and path co-efficient analysis of quantitative traits in okra [*Abelmoschus esculentus* (L.)Moench].*The Bioscan*. **10(2):** 735-739.

Searle, S. R. 1961. Phenotypic, genotypic and environmental correlations.*Biometric.* **17:** 474-480.

Singh, B. and Singh, S. K. 2014. Evaluation trial of bottle gourd.*The Asian J. Hoti.* **9(1):** 116-119.

Singh, M. K., Bhardwaj, D. R. and Upadhyay, D. K. 2014. Genetic architecture and association analysis in bitter gourd (*Momordica charantia* L.) Landraces.*The Bioscan*. **9(2):** 707-711.

Welihinda, J., Karunanayake, E. M., Sheriff, M. H. and Jayasinghe, K. S. 1985. Effect of *Momordica charantia L* on the glucose tolerance in maturity onset diabetes. *J. Ethnopharmacol.***17:** 277-282.