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Correlation and path coefficient analysis of fruit yield and yield attributes in twenty seven genotypes of bitter gourd (*Momordica Charantia* L.)

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Abstract
The experiments were conducted at Vegetable Research Farm, College of Horticulture, Mojerla, SKLTSHU, Hyderabad (Telangana) during *Rabi* season of 2017-18. Twenty seven bitter gourd genotypes were studied for evaluation of correlation and path co-efficient analysis of fruits yield and Yield attributes in bitter gourd (*Momordica charantia* L.). Fruit yield per vine exhibited high positive and significant correlation with vine length, average fruit weight, fruit length, number of fruits per vine, fruit weight, fruit diameter and number of seeds per fruit. It was observed that with increase in vine length, there is corresponding increase in average fruit weight, number of fruits per vine, fruit diameter, fruit length and number of seeds per fruit. Path coefficient analysis of different yield and yield contributing traits on fruit yield per plant revealed with number of primary branches per vine, days to first male and female flower appearance, nodes at which first male and female flower appearance, days to first and last fruit harvest, average fruit weight, fruit fly infestation per cent and 100 seed weight exhibited positive direct effects on fruit yield these characters play a major role in recombination breeding and suggested that direct selection based on these traits will be rewarded for crop improvement of bitter gourd.

Keywords: Bitter gourd, momordica charantia, correlation, path co-efficient analysis

Introduction
Bitter gourd (*Momordica charantia* L.) is one of the most important cucurbitaceous vegetable crops grown widely all over the world. It is a very versatile vegetable for culinary purposes. The fruits are valuable owing to its high nutritive and medicinal properties. It is used in the treatment of general fever, malaria and diabetes (Kedar and Chakraborti, 1982) [9] and has highest content of iron and vitamin-C (Choudhary *et al*., 2003) [3]. It has been reported that protein of bitter gourd inhibited the growth of immune deficiency virus (HIV-1) in human beings. It has good nutritional value with 2.1 g of protein, 4.2 g of carbohydrate, 1.8 g of iron 20 mg of calcium, 55 mg of phosphorous, 210 IU of vitamin A and 88 mg of vitamin C per 100 gram of edible portion. The antidiabetic properties of crop have been studied extensively and a hypoglycaemic principle called "cheratin" has been isolated.
Bitter gourd belongs to the family cucurbitaceae and is native of India with a secondary centre of diversity in China and South East Asia (Gruthew, 1977) [8]. Bitter gourd is a typical day neutral plant and is mainly cross-pollinated. It is a warm season crop reasonably resistant to salinity and grows under wide range of soil and climatic conditions.
Considering the potentiality of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific end use. Yield is a complex character controlled by large number of contributing characters and their interactions. A study of correlation and path analysis between different quantitative and qualitative characters provides an idea of association that could be effectively exploited to formulate selection strategies for improving yield components. For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters with yield.

Materials and Methods
Field experiment was conducted Vegetable Research Farm, College of Horticulture, Mojerla, SKLTSHU, Hyderabad (Telangana) during *Rabi* season of 2017-18. In present experiment twenty seven bitter gourd genotypes were evaluated for Correlation and Path co efficient

Analysis of fruit yield and it's attributing traits in bitter gourd (*Momordica charantia* L.). The experiment was laid out in a Randomized Block Design (RBD) with three replications. Appropriate agronomic practices were followed to raise a good crop. Five randomly taken plants were used to record observations on yield and yield attributed traits, as total vine length, number of primary branches per vine, number of nodes per vine, internodal length, number of days to first male flower appearance, number of days to first female flower appearance, nodes at which first male flower appears, nodes at which first female flower appears, fruit days to first fruit harvest, days to last fruit harvest, number of fruits per vine, average fruit weight, fruit length, fruit diameter, fruit fly infestation, number of seeds per fruit, 100 seed weight, total fruit yield per vine which included correlation co-efficient calculated for all quantitative and qualitative character combinations at phenotypic and genotypic levels correlation analysis by the formula given by Al-Jibouri *et al.* (1958) [1] and path co-efficient analysis developed by Wright (1921) [19] and elaborated by Dewey and Lu (1959) [5].

a) Correlation analysis

To determine the degree of association of characters with yield and also among the yield components, the correlation coefficients were calculated.

$$r_g(xy) = \frac{Cov_g(xy)}{\sqrt{\sigma_g^2(x)\,.\,\sigma_g^2(y)}}$$

$$r_p(xy) = \frac{Cov_p(xy)}{\sqrt{\sigma_p^2(x)\,.\,\sigma_p^2(y)}}$$

Where,

r_g (xy), r_p (xy) are the genotypic and phenotypic correlation coefficients respectively.

Cov_g, Cov_p are the genotypic and phenotypic covariance of xy, respectively.

σ^2_g and σ^2_p are the genotypic and phenotypic variance of x and y, respectively.

The calculated value of 'r' was compared with table 'r' value with n-2 degrees of freedom at 5% and 1% level of significance, where, n refers to number of pairs of observation.

b) Path coefficient analysis

Standard path coefficients which are the standardized partial regression coefficients were obtained using statistical software packages called GENRES. These values were obtained by solving the following set of 'p' simultaneous equation using above package.

$P_{01} + P_{02}\, r_{12} + \text{---------} + P_{0P}\, r_{1P} = r_{01}$

$P_{01} + P_{12}\, r_{02} + \text{---------} + P_{0P}\, r_{2P} = r_{02}$

↓

$P_{01} + r_{1P} + P_{02}\, r_{2P} + \text{---------} + P_{0P} = r_{0P}$

Where, P_{01}, P_{02}, ------------- P_{0P} are the direct effects of variables 1,2,--------p on the dependent variable 0 and r_{12}, r_{13}, ------------ r_{1P}--------- $r_{P(P-1)}$ are the possible correlation coefficients between various independent variables and r_{01}, r_{02}, r_{03} ---- r_{0P} are the correlation between dependent and independent variables.

The indirect effects of the i^th^ variable *via* j^th^ variable is attained as ($P_{oj\ x}$ rij). The contribution of remaining unknown factor is measured as the residual factor, which is calculated and given below.

$P^2ox = 1-[P^2_{01}+2P_{01}P_{02}r_{12}+2P_{01}P_{03}r_{13}+\text{------------}+P^2_{02}+ 2P_{02}P_{03}r_{13}+ \text{--------}+P^2_{0P}]$

Residual factor = $\sqrt{(P^2_{ox})}$

Negligible - 0.00 to 0.09; Low - 0.10 to 0.19; Moderate 0.20 to 0.29; High - 0.30 to 1.0;Very high - >1.00

Results and Discussion

Interrelationship study in growth and yield parameters

Correlation co-efficient was analyzed for all possible combinations of yield and yield contributing characters are presented in (Table1). Gupta (2013) [7] also reported higher estimates of genotypic correlation than the corresponding phenotypic correlation coefficients between yield and yield components.

The results of phenotypic correlation and genotypic correlation are presented character wise Vine length exhibited positive significant correlation with number of primary branches per vine, number of nodes per vine, intermodal length, average fruit weight, fruit length, fruit diameter, number of seeds per fruit and 100 seed weight. Negative significant correlation was noticed with days to first male flower, days to first female flower, node at which first female flower, days to first harvest, and days to last harvest. The Number of primary branches per vine recorded positive, significant correlation with number of fruits per vine, average fruit weight, fruit length, fruit diameter, number of seeds per fruit, 100 seed weight. Negative significant correlation was noticed with nodes at first male flower, nodes at first female flower, days to last harvest. Number of nodes per vine recorded both phenotypic and genotypic correlation exhibited significant positive correlation with nodes at which first male flower, average fruit weight, fruit length, number of seeds per fruit. Negative significant correlation was noticed with intermodal length, days to first male flower, days to first female flower, days to first fruit harvest, days to last harvest and number of fruits per vine. Internodal length recorded both phenotypic and genotypic correlation exhibited significant positive correlation with number of fruits per vine, average fruit weight, fruit length, number of seeds per fruit, 100 seed weight. Negative significant correlation was noticed with days to first male flower, days to first female flower, nodes at which first male flower, nodes at which first female flower and days to last harvest and fruit fly infestation. Days to first male flower appearance showed both phenotypic and genotypic correlation exhibited significant positive correlation with days to first female flower, days to first fruit harvest, days to last fruit harvest. Negative significant correlation was noticed with nodes at which first male flower appears, nodes at which first female flower appears, number of fruits per vine, average fruit weight, fruit length and fruit fly infestation and number of seeds per fruit.

Days to first female flower appearance showed positive significant correlation with Number of days to first female flower appearance is having significant positive correlation with days to first fruit harvest, days to last fruit harvest. Negative significant correlation was noticed with fruit fly infestation. Nodes at which first male flower appearance showed positive and significant correlation with nodes at which first female flower appears, fruit fly infestation. Negative significant correlation was noticed with number of fruits per vine. Nodes at which first female flower appearance recorded positive and significant correlation with This character recorded positive and significant correlation with fruit fly infestation and negative significant correlation was noticed with number of fruits per vine.

Days to first fruit harvest recorded positive and significant correlation with days to last fruit harvest, number of fruits per vine, 100 seed weight, fruit diameter and negative significant correlation was noticed with fruit fly infestation. Days to last fruit harvest showed positive and significant correlation with number of fruits per vine, fruit diameter, and it had significant negative correlation with fruit length, average fruit weight, fruit fly infestation, number of seeds per fruit, 100 seed weight. Number of fruits per vine showed positive significant correlation average fruit weight, number of seeds per fruit, 100 seed weight and it had significant negative correlation with fruit fly infestation. Average fruit weight showed positive and significant correlation with fruit length, fruit diameter, number of seeds per fruit, 100 seed weight and there is no any negative significant correlation with fruit yield per vine. Fruit length showed positive significant correlation with fruit diameter, number of seeds per fruit, 100 seed weight and there is no any negative significant correlation with fruit yield per vine. Fruit diameter showed positive and significant correlation with number of seeds per fruit, 100 seed weight and there is no any negative significant correlation with fruit yield per vine. Fruit fly infestation per cent showed positive and non-significant correlation with number of seeds per fruit, 100 seed weight, vine length, number of primary branches per vine, days to first male flower, days to female flower, nodes at which male flower appears, days to last harvest, number of seeds per fruit and there is no any significant negative correlation with dependent fruit yield per vine. Number of seeds per fruit showed positive and significant correlation with 100 seed weight, vine length, number of primary branches per vine, days to first male flower, days to first and last harvest, average fruit weight, fruit fly infestation, number of seeds per fruit. 100 seed weight the correlation between 100 seed weight and fruit yield per vine was significant as well as with all the other characters. The trend of association observed in this study is mostly based upon the genetic contribution. Therefore, the value of 'r' for genotypic correlation between yield, yield contributing characters and quality characters should be considered for selecting the suitable characters for improvement. These results are in consonance with the finding of Parhi *et al*. (1995) [12], Rajput *et al*. (1996) [14], Kumar *et al*. (2008) [10], Dey *et al*. (2005) [6], Sundaram *et al*. (2010) [18], Gupta *et al*. (2013) [7], Pathak *et al*. (2014) [11].

Total fruit yield per vine recorded positive and significant correlation with characters vine length, number of primary branches per vine, days to first male flower appearance, nodes at which first male flower appears, nodes at which first female flower appears, days to first fruit harvest, days to last fruit harvest, average fruit weight, number of seeds per fruit. It also registered significant negative correlation with number of nodes per vine, internodal length, days to first female flower appearance, number of fruits per vine, fruit length, fruit diameter and 100 seed weight. These results are in consonance with the finding of Sharma and Bhutani *et al.*, (2001) [15], Dalamu and Behera (2013) [4], Singh *et al.*, (2012) [17], Radha Rani *et al.*, (2014) [13].

Path co-efficient analyses

It was analyzed for yield and yield contributing traits are presented in (Table 2). It was observed that genotypic direct and indirect effects were higher than their corresponding phenotypic values.

Direct effects

Path coefficient analysis showed that the characters total vine length, number of primary branches per vine, days to first male and female flower appearance, nodes at which first male and female flower appears, days to first and last fruit harvest, average fruit weight, fruit fly infestation and 100 seed weight exhibited positive direct effects on fruit yield and these traits also recorded positive correlation with yield. This suggested that direct selection based on these traits will be rewarding for crop yield improvement. These results were conformity with Chakraborty *et al*. (2013) [2] and Yadav *et.al.* (2013) [20].

Indirect effects on growth and yield parameters

Number of primary branches per vine showed negligible positive indirect effect on fruit yield through fruit length and days to first male flower appearance also exhibited negligible positive indirect effect on fruit yield through days to first female flower appearance and days to first fruit harvest. Nodes to first female flower appears showed negligible positive indirect effect on fruit yield through nodes at which first male flower appears. Days to first harvest showed negligible positive indirect effect on days to first female flower appearance. Average fruit weight also exhibited negligible positive indirect effect through on fruit yield through 100 seed weight. This suggested that indirect selection based on number of primary branches per vine, days to first male and female flowering, days to first fruit harvest and average fruit weight will be effective in yield improvement. Similar result was observed by Singh *et al.* (2008) [16] reported that yield can be improved directly by improving fruit length and vine length. Yadav *et al.*, (2013) [20] reported that yield can be improved directly by improving fruit length, fruit weight, number of primary branches per vine.

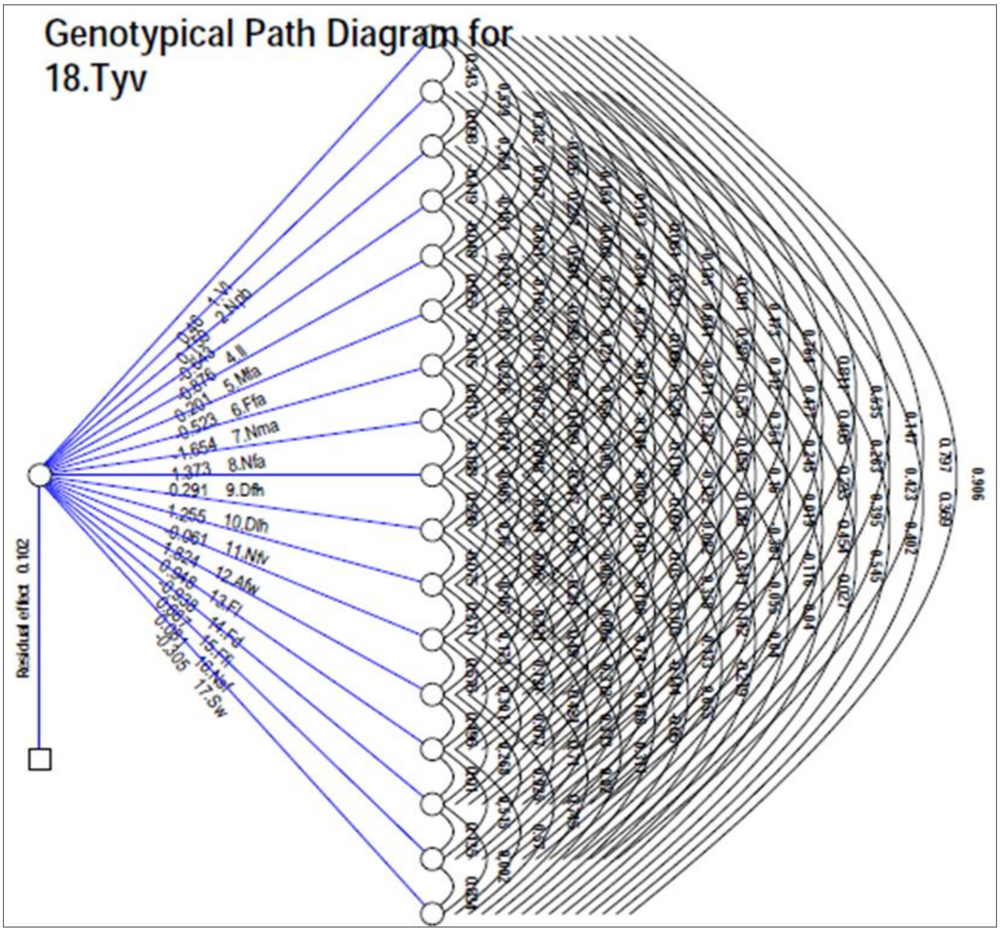

Fig 1: Genotypic path diagram representing direct and indirect effects for fruit yield in bitter gourd

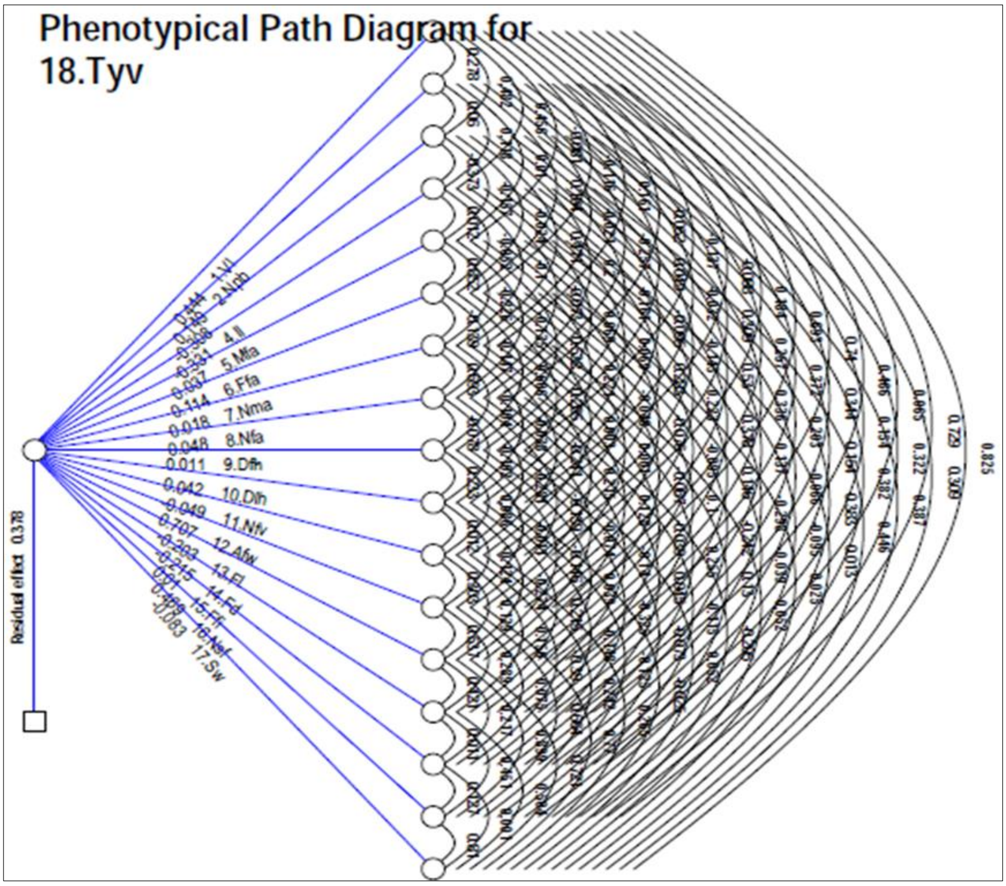

Fig 2: Phenotypic path diagram representing direct and indirect effects for fruit yield in bitter gourd

Table 1 (a): Phenotypic (P) and genotypic (G) correlation coefficients among yield and yield attributes in 27 genotypes of bitter gourd

Characters		Vine length (cm)	Number of branches per vine	Number of nodes per vine	Intermodal length (cm)	Days to first male flower appearance	Days to first female flower appearance	Nodes at which first male flower appears	Nodes at which first female flower appears	Days to first fruit harvest	Days to last fruit harvest	Number of fruits per vine	Average fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit fly infestation (%)	Number of seeds per fruit	100 Seed weight (g)	Total fruit yield per vine (kg)
Vine length (cm)	P	1.0000	0.2778*	0.4816**	0.4564**	-0.0811	-0.1160	0.1607	-0.0518	-0.1367	-00876	0.1841	0.6928**	0.7405**	0.4662**	0.0645	0.7287**	0.8247**	0.4435
	G	1.0000	0.3427	0.5394	0.3821	-0.1257	-0.1538	0.1929	-0.0608	-0.1354	-0.1911	0.1730	0.7641	0.8109	0.5345	0.1471	0.7970	0.9058	0.4604
Number of branches per vine	P		1.0000	0.0598	0.1179	0.0100	0.1637	-0.0209	-0.2571*	0.0492	-0.0320	0.3094**	0.2572*	0.3718**	0.3443**	0.1537	0.3223**	0.3089**	0.1494
	G		1.0000	0.0980	0.1586	0.0571	0.2372	-0.0380	-0.3436	0.3213	0.0411	0.3871	0.3124	0.4771	0.4053	0.2632	0.4234	0.3687	0.1587
Number of nodes per vine	P			1.0000	-0.3728**	-0.1573	-0.0245	0.4709***	0.2003	-0.1607	-0.0952	-0.1429	0.5297***	0.3357**	0.2030	0.1543	0.3820***	0.3868	-0.3081
	G			1.0000	-0.4194	-0.1807	-0.0213	0.5012	0.2305	-0.3214	-0.0859	-0.2115	0.5729	0.3538	0.2453	0.2332	0.3948	0.4020	-0.6427
Intermodal length (cm)	P				1.0000	0.0121	-0.0520	-0.0997	-0.0734	0.0692	0.0694	0.2833*	0.228*	0.3777**	0.1365	-0.0659	0.3835**	0.4464**	-0.3311
	G				1.0000	-0.0484	-0.1210	-0.1049	-0.1277	0.1212	-0.0142	0.3242	0.2265	0.4529	0.1596	0.0186	0.4542	0.5445	-0.8762
Days to first male flower appearance	P					1.0000	0.8524**	-0.2260*	-0.1345	0.5319**	0.2207*	-0.0476	-0.0765	-0.0946	0.1460	-0.2983**	-0.0954	0.0132	0.0366
	G					1.0000	0.9545	-0.2125	-0.1538	0.8921	0.4560	-0.1408	-0.1189	-0.1219	0.1282	-0.3813	-0.1160	0.0269	0.2006
Days to first female flower appearance	P						1.0000	-0.1388	-0.1465	0.6057**	0.2650*	0.0031	0.0008	-0.0667	0.1000	-0.2423*	-0.0386	0.0249	0.1141
	G						1.0000	-0.1455	-0.2263	0.9524	0.4594	-0.0500	-0.0072	-0.0968	0.0821	-0.3114	-0.0550	0.0402	-0.5231
Nodes at which first male flower appear	P							1.0000	0.6932**	-0.1043	-0.0381	-0.2411*	0.2151	0.1278	-0.0389	0.2548*	0.1298	0.0519	0.0178
	G							1.0000	0.8127	-0.1737	0.0480	-0.3467	0.2271	0.1410	-0.0296	0.3584	0.1420	0.0399	-1.6540
Nodes at which first female flower appears	P								1.0000	-0.0783	-0.1024	-0.2807*	-0.1392	-0.0741	-0.1395	0.0453	-0.1151	-0.2050	0.0484
	G								1.0000	-0.1877	-0.0645	-0.3442	-0.1501	-0.0865	-0.1861	0.1028	-0.1334	-0.2186	1.3734
Days to first fruit harvest	P									1.0000	0.2329*	0.0860	-0.0110	-0.1463	0.0392	-0.3246**	-0.0731	0.0515	0.0108
	G									1.0000	0.5978	0.1496	-0.0605	-0.2100	-0.0653	-0.7405	-0.1437	0.0547	0.2908
Days to last fruit harvest	P										1.0000	0.0122	-0.1241	-0.2742*	0.2149	-0.1478	-0.1249	-0.0248	0.0418
	G										1.0000	-0.0751	-0.1668	-0.3213	0.4499	-0.3122	0.1682	-0.0499	1.2552
Number of fruits per vine	P											1.0000	0.3028**	0.1293	0.1558	-0.3902**	0.2420*	0.2650*	-0.0494
	G											1.0000	0.3708	0.1728	0.1211	-0.4211	0.3133	0.3108	-0.0611
Average fruit weight (g)	P												1.0000	0.5370**	0.289**	0.0747	0.6641**	0.7695**	0.7072
	G												1.0000	0.5760	0.3008	0.6766	0.7102	0.8199	1.8242
Fruit length (cm)	P													1.0000	0.420**	0.2174	0.8995**	0.7207**	-02030
	G													1.0000	0.4955	0.2683	0.9253	0.7450	0.9478
Fruit diameter (cm)	P														1.0000	0.0109	0.4514**	0.5035**	-0.2147
	G														1.0000	0.0098	0.5150	0.5701	-0.9384
Fruit fly infestation (%)	P															1.0000	0.1268	0.0007	0.0099
	G															1.0000	0.1347	0.0023	0.6869
Number of seeds per fruit	P																1.0000	0.8096**	0.4688
	G																1.0000	0.8335	0.0810
100 seed weight (g)	P																	1.0000	-0.0835
	G																	1.0000	-0.3054
Total fruit yield per vine (kg)	P																		1.0000
	G																		1.0000

*Significant at 5% level; **Significant at 1 percent level

Table 2 (a): Phenotypic (P) and genotypic (G) path coefficient analysis indicating direct and indirect effects of components characters on fruit yield in 27 genotypes of bitter gourd.

Characters		Vine Length (cm)	Number of branches per vine	Number of nodes per vine	Intermodal length (cm)	Days to first male flower appearance	Days to first female flower appearance	Nodes at which first male flower appears	Nodes at which first female flower appears	Days to first fruit harvest	Days to last fruit harvest	Number of fruits per vine	Average fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit fly infestation (%)	Number of seeds per fruit	100 Seed weight (g)	Correlation coefficient
Vine length (cm)	P	0.443	0.1232	0.2136	0.2024	-0.036	-0.0515	0.0713	-0.023	-0.060	-0.0389	0.0817	0.3073	0.3284	0.2068	0.0286	0.3232	0.3658	0.668
	G	0.460	0.1578	0.2483	0.1759	-0.057	-0.0708	0.0888	-0.028	-0.062	-0.0880	0.0797	0.3518	0.3733	0.2461	0.0677	0.3669	0.4170	0.745
Number of branches per vine	P	0.041	0.1494	0.0089	0.0176	0.0015	0.0244	-0.003	-0.038	0.0074	-0.0048	0.0462	0.0384	0.0555	0.0514	0.0230	0.0481	0.0461	0.364
	G	0.054	0.1587	0.0156	0.0252	0.0091	0.0376	-0.006	-0.054	0.0510	0.0065	0.0614	0.0496	0.0757	0.0643	0.0418	0.0672	0.0585	0.458
Number of nodes per vine	P	-0.148	-0.0184	-0.308	0.1148	0.0485	0.0075	-0.145	-0.061	0.0495	0.0293	0.0440	-0.1632	-0.103	-0.0625	-0.047	-0.1177	-0.1192	0.460
	G	-0.346	-0.0630	-0.642	0.2696	0.1162	0.0137	-0.322	-0.148	0.2066	0.0552	0.1359	-0.3682	-0.227	-0.1576	-0.149	-0.2537	-0.2584	0.482
Intermodal length (cm)	P	-0.151	-0.0390	0.1234	-0.3311	-0.004	0.0172	0.0330	0.0243	-0.022	-0.0230	-0.093	-0.0738	-0.125	-0.0452	0.0218	-0.1270	-0.1478	0.176
	G	-0.338	-0.1389	0.3675	-0.8762	0.0424	0.1061	0.0919	0.1119	-0.106	0.0125	-0.284	-0.1985	-0.396	-0.1398	-0.016	-0.3980	-0.4771	0.219
Days to first male flower appearance	P	-0.003	0.0004	-0.005	0.0004	0.0366	0.0312	-0.008	-0.004	0.0195	0.0081	-0.001	-0.0028	-0.003	0.0053	-0.010	-0.0035	0.0005	0.035
	G	-0.022	0.0115	-0.036	-0.0097	0.2006	0.1915	-0.042	-0.030	0.1790	0.0915	-0.028	-0.0238	-0.024	0.0257	-0.076	-0.0233	0.0054	0.059
Days to first female flower appearance	P	-0.013	0.0187	-0.002	-0.0059	0.0972	0.1141	-0.015	-0.016	0.0691	0.0302	0.0004	0.0001	-0.007	0.0114	-0.027	-0.0044	0.0028	0.121
	G	0.080	-0.1241	0.0111	0.0633	-0.499	-0.5231	0.0761	0.1184	-0.498	-0.2403	0.0261	0.0038	0.0506	-0.0430	0.1629	0.0288	-0.0211	0.129
Nodes at which first male flower appear	P	0.002	-0.004	0.0084	-0.001	-0.004	-0.002	0.0178	0.0123	-0.001	-0.0007	-0.004	0.0038	0.0023	-0.0007	0.0045	0.0023	0.0009	0.186
	G	-0.311	0.0628	-0.829	0.1735	0.3516	0.2406	-1.654	-1.344	0.2874	-0.0794	0.5734	-0.3757	-0.233	0.0489	-0.592	-0.2348	-0.0659	0.200
Nodes at which first female flower appears	P	-0.002	-0.014	0.0097	-0.003	-0.006	-0.007	0.0336	0.0484	-0.003	-0.0050	-0.013	-0.0067	-0.003	-0.0068	0.0022	-0.0056	-0.0099	-0.140
	G	-0.085	-0.4720	0.3166	-0.1754	-0.211	-0.3108	1.1162	1.3734	-0.257	-0.0886	-0.472	-0.2061	-0.118	-0.2556	0.1412	-0.1832	-0.3003	-0.171
Days to first fruit harvest	P	-0.001	0.0005	-0.001	0.0007	0.0058	0.0066	-0.001	-0.0008	0.0108	0.0025	0.0009	-0.0001	-0.001	0.0004	-0.003	-0.0008	0.0006	0.044
	G	-0.034	0.0934	-0.093	0.0352	0.2594	0.2770	-0.050	-0.054	0.2908	0.1739	0.0435	-0.0176	-0.061	-0.0190	-0.215	-0.0418	0.0159	0.046
Days to last fruit harvest	P	-0.003	-0.001	-0.004	0.0029	0.0092	0.0111	-0.001	-0.004	0.009	0.0418	0.005	-0.005	-0.011	0.009	-0.006	-0.005	-0.001	-0.097
	G	-0.239	0.0515	-0.107	-0.0179	0.5724	0.5767	0.0603	-0.08	0.7504	1.2552	-0.094	-0.209	-0.403	0.564	-0.391	-0.211	-0.062	-0.140
Number of fruits per vine	P	-0.009	-0.015	0.007	-0.014	0.0024	-0.002	0.0119	0.013	-0.004	-0.0006	-0.049	-0.015	-0.006	-0.007	0.019	-0.012	-0.013	0.252
	G	-0.010	-0.023	0.0129	-0.0198	0.0086	0.0031	0.0212	0.021	-0.009	0.0046	-0.061	-0.022	-0.010	-0.007	0.0257	-0.019	-0.019	0.347
Average fruit weight (g)	P	0.490	0.1819	0.3746	0.1576	-0.054	0.0006	0.1522	-0.098	-0.007	-0.0878	0.214	0.707	0.3798	0.204	0.0528	0.469	0.5442	0.866
	G	1.393	0.5700	1.0451	0.4132	-0.216	-0.013	0.4143	-0.277	-0.110	-0.3043	0.676	1.824	1.0507	0.548	0.1398	1.295	1.4957	0.930
Fruit length (cm)	P	-0.150	-0.075	-0.068	-0.0767	0.0192	0.0135	-0.025	0.015	0.0297	0.0557	-0.026	-0.109	-0.203	-0.085	-0.044	-0.182	-0.146	0.573
	G	0.768	0.4523	0.3353	0.4293	-0.115	-0.091	0.1336	-0.082	-0.199	-0.3045	0.163	0.545	0.9478	0.469	0.2543	0.877	0.7062	0.589
Fruit diameter (cm)	P	-0.100	-0.073	-0.043	-0.0293	-0.031	-0.021	0.0084	0.030	-0.008	-0.0461	-0.033	-0.062	-0.090	-0.214	-0.002	-0.096	-0.108	0.235
	G	-0.501	-0.380	-0.230	-0.1497	-0.120	-0.077	0.0278	0.174	0.0613	-0.4222	-0.113	-0.282	-0.465	-0.938	-0.009	-0.483	-0.535	0.281
Fruit fly infestation (%)	P	0.000	0.0015	0.0015	-0.007	-0.003	-0.002	0.0025	0.004	-0.003	-0.0015	-0.003	0.007	0.0022	0.001	0.009	0.001	0.0000	0.079
	G	0.101	0.1808	0.1602	0.0128	-0.261	-0.213	0.2462	0.070	-0.508	-0.2145	-0.289	0.052	0.1843	0.006	0.686	0.092	0.0016	0.078
Number of seeds per fruit	P	0.341	0.1511	0.1791	0.1798	-0.044	-0.018	0.0609	-0.054	-0.034	-0.0586	0.113	0.311	0.4217	0.211	0.059	0.468	0.3796	0.690
	G	0.064	0.0343	0.0320	0.0368	-0.009	-0.004	0.0115	-0.010	-0.011	-0.0136	0.025	0.057	0.0749	0.041	0.0109	0.081	0.0675	0.706
100 seed weight (g)	P	-0.068	-0.025	-0.032	-0.0372	-0.001	-0.002	-0.004	0.017	-0.004	0.0021	-0.022	-0.064	-0.060	-0.042	-0.001	-0.067	-0.083	0.711
	G	-0.276	-0.112	-0.122	-0.1663	-0.008	-0.012	-0.012	0.066	-0.016	0.0152	-0.094	-0.250	-0.227	-0.174	-0.000	-0.254	-0.305	0.723

Phenotypic residual effect = 0.3777; genotypic residual effect = 0.1019; diagonal (under lined) values indicate direct effect

Conclusion
Fruit yield had a positive and highly significant association with number of fruit per vine, average fruit weight, strong association of these traits revealed that the selection based on these traits would ultimately improve the fruit yield were positive and significant correlated with fruit yield plant per vine.

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