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CHARACTER ASSOCIATION AND PATH ANALYSIS STUDIES IN BITTER GOURD

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ABSTRACT

Character association and path analysis in twenty four genetically diverse genotypes of bitter gourd was studied for 22 important characters. The phenotypic and genotypic association of fruit yield was significantly positive with all the characters except - Internodal length at 90 DAT (cm), Number of nodes per vine at 90 DAT, Number of branches per vine at 90 DAT X6 - Fruit diameter (mm), Rind thickness (mm), Node at which first female flower appeared, Number of female flowers per vine, Number of male flowers per vine, Sex ratio (%), Days to first harvest (DAT). The genotypic path coefficient analysis revealed that – Fruit length (cm), Node at which first male flower appeared, Average fruit weight (g), Total number of fruits per vine, Crop duration (days), Number of seeds per fruit, had high direct positive effect on total fruit yield.

Key words : Correlation, Path analysis, Yield, Bitter gourd.

Introduction

Bitter gourd (*Momordica charantia* L.; 2n = 22) is an economically important Cucurbitaceous vegetable, which has 90 genera and 750 species (Ram, 2006) and is widely cultivated in India, China, Malaysia, Africa and South America (Raj *et al*., 1993). It is also known as bitter melon, bitter gourd, bitter cucumber, bitter squash, balsam pear, karela, cassilla and maiden apple (Morton, 1967). Indian bitter gourd has wide phenotypic variation with respect to growth habit, maturity, fruit shape, size, colour, surface texture and sex expression (Behera *et al*., 2006). For successful planning of breeding programme, the analysis of variability for important traits among genotypes and association with characters in relation to yield and yield attributing traits would be of great importance. Though, there is a wide range of genetic variability available in India, not much attention has been given to the genetic improvement of this crop. Hence, there is need for development of new varieties and hybrids with high productivity. However, under complex situation, correlations alone become insufficient to explain relationships among characters and thus path analysis of economic yield components with yield is important. However, in wild melon the information on correlation and path analysis is meager. Therefore, field investigation was carried out with a view to study the character association and direct and indirect effect of independent characters on dependent bitter gourd yield by assessing the bitter gourd eighteen germplasm stocks maintained at M.A.R.S., Raichur (Karnataka), India.

Materials and Methods

The present study was carried out at M.A.R.S., Raichur (Karnataka), India during 2019-20 eighteen germplasm. The genotypes were assessed in a field experiment under a randomized block design with two replications. 10 plants maintained in each treatment with spacing of 2 m × 1 m between rows and plants, respectively. Cultural practices including need based plant protection measures were followed as per the recommendations. The data were recorded on five randomly selected plants from each treatment for 19 characters. Observations recorded on various growth

yields and quality attributes (Table 1). Genotypic correlation coefficient and direct and indirect effects were computed by using procedure given by Deway and Lu (1957).

Results and Discussion

The correlation studies revealed that, in general, the estimate of genotypic correlation coefficient was higher than the corresponding phenotypic correlation coefficient thereby indicating a strong inherent association between various traits under study and masking effect of environment in the total expression of genotypes Fruit yield per vine (Table 1) exhibited highly significant positive association with Vine length at 90 DAT (cm), Fruit length (cm), Days to first male flower appeared (DAT), Node at which first male flower appeared, Average fruit weight (g), Total number of fruits per vine, Days to last harvest (DAT)

Fruiting period (days), Crop duration (days), Number of seeds per fruit, Seed weight per fruit (g/fruit). This vividly suggests the, possibility of simultaneous improvement of these traits in improving fruit yield per vine. Similar results were reported by Changyuan *et al*. (2002). Sarkar *et al*. (1999) in pointed gourd, Podder *et al*. (2010) snake gourd, Chakraborty *et al*. (2013) and Sowmya *et al*. (2019) in bitter gourd found similar results. Hanchinamani and Patil (2009) and Kumar *et al*. (2011b) in cucumber, Reddy (2004) in snap melon, Iqbal *et al*. (2016) in bitter gourd, Singh *et al*. (2014) in bitter gourd, in cucumber.

The results of path co-efficient analysis at both genotypic and phenotypic level showing direct (diagonal values) and indirect effects of different contributing traits on fruit yield per vine of bitter gourd was mentioned in Tables 3 and 4. The traits *viz.*, days to first harvest (DAT), days to last harvest (DAT) and fruiting period showed high heritability with yield during path coefficient analysis, so these are discarded from this analysis. Most of the characters contributing towards fruit yield per vine has been included in the study, which is depicted by the very negligible (0.230) residual effect

The perusal of data represented in the Table 3 revealed that among all the characters studied, average fruit weight had highest positive direct effect (1.048) on fruit yield per vine followed by number of seeds per fruit (0.923), total number of fruits per vine (0.754), crop duration (0.635), number of male flowers per vine (0.518), number of nodes per vine at 90 DAT (0.505), node at which first male flower appeared (0.363), sex ratio (0.305), number of branches per vine at 90 DAT (0.097), rind thickness (0.036).

These finding are in agreement with the results obtained by Dhaliwal *et al*. (1996) in muskmelon, Singh *et al*. (2002) and Rao *et al*. (2004) in cucumber, Sowmya *et al*. (2019) in bitter gourd. The results obtained by Karthick *et al*. (2019a) in the experiment with cucumber germplasm shown that number of fruits per vine had highest positive direct effect, contrastingly sex ratio had highest negative direct effect on fruit yield per vine than other traits.

Whereas, highest negative direct effect on fruit yield per vine was exhibited by seed weight per fruit (-0.999), number of female flowers per vine (-0.703), fruit diameter (-0.489), days to first male flower appeared (-0.260), internodal length at 90 DAT (-0.211), vine length at 90 DAT (-0.164), node at which first female flower appeared (-0.163), fruit length (-0.016), days to first female flower appeared (-0.008). These results were in agreement with the findings of Pal *et al*. (2017) in cucumber for days to first harvest and fruit diameter. Solanki and Shah (1989) also found the similar findings.

The data presented in the Table 3 revealed that maximum positive indirect effects on fruit yield per vine was exhibited by number of seeds per fruit through seed weight per fruit (0.694) followed by total number of fruits per vine *via* number of female flowers per vine (0.650), average fruit weight *via* fruit diameter (0.580) and number of seeds per fruit (0.593), number of seeds per fruit *via* average fruit weight (0.522), seed weight per fruit through number of female flowers per vine (0.518), number of female flowers per vine *via* fruit diameter (0.515), crop duration *via* days to first male flower appeared (0.482) and node at which first male flower appeared (0.457), average fruit weight *via* seed weight per fruit (0.431) and rind thickness (0.426). High positive indirect effects of fruit diameter *via* average fruit weight and hundred seed weight *via* fruit diameter were also recorded on yield per plant by Pal *et al*. (2017) in cucumber. Similar results were also found by Rajput *et al*. (1991) and Ying *et al*. (2004) in cucumber.

Maximum negative indirect impact on fruit yield per vine was shown by seed weight per fruit through number of seeds per fruit (-0.752) followed by total number of fruits per vine through fruit diameter (-0.649), average fruit weight through total number of fruits per vine (-0.613) and number of female flowers per vine (-0.590), number of female flowers per vine through number of male flowers per vine (-0.491), number of female flowers per vine *via* days to first female flower appeared (-0.443), total number of fruits per vine *via* average fruit weight (-0.441), number of male flowers per vine *via* sex ratio (-

Table 1 : Genotypic correlation co-efficient for different parameters in bitter gourd genotypes.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X1	1.000	0.386**	-0.400**	0.147	-0.123	-0.446**	0.025	0.281*	0.386**	0.112	0.006	0.350**	-0.028	0.237	-0.135	0.408**	0.049	0.149	0.147	0.189	0.226	0.156	**0.200**
X2		1.000	0.156	-0.060	-0.193	-0.143	-0.225	0.069	-0.007	0.012	0.088	0.023	-0.277	0.292**	-0.355**	0.160	0.279**	-0.190	-0.280**	-0.286*	-0.184	0.121	**-0.268****
X3			1.000	-0.457**	-0.082	0.094	-0.049	-0.393**	-0.312**	-0.493**	-0.417**	-0.072	0.021	-0.327**	-0.483**	-0.030	-0.191	-0.596**	-0.588**	-0.582**	-0.378**	-0.376**	**-0.588****
X4				1.000	-0.276*	-0.244	-0.078	0.464**	0.039	0.504**	0.615**	-0.029	0.068	-0.018	0.148	0.001	0.162	0.510**	0.504**	0.486**	0.149	0.256	**0.267****
X5					1.000	-0.036	-0.070	0.134	-0.054	0.128	0.035	0.073	0.066	-0.056	0.349**	-0.083	0.175	-0.001	-0.048	0.021	0.044	-0.214	**0.460****
X6						1.000	0.476**	-0.571**	-0.513**	-0.531**	-0.234	-0.733**	-0.421**	0.281**	0.554**	-0.861**	-0.455**	-0.464**	-0.374**	-0.534**	0.229	0.140	**-0.200**
X7							1.000	-0.119	0.150	-0.266	-0.022	-0.164	0.064	-0.156	0.406**	-0.354**	-0.411**	-0.074	0.033	-0.067	0.379 **	0.130	**0.195**
X8								1.000	0.836**	0.885**	0.728**	0.560**	0.408**	-0.337**	-0.232	0.324**	0.855**	0.724**	0.545**	0.758**	0.124	0.013	**0.286****
X9									1.000	0.871**	0.589**	0.631**	0.558**	-0.580**	-0.339**	0.339**	0.862**	0.465	0.264	0612**	0.238	-0.030	**0.188**
X10										1.000	0.899**	0.537**	0.539**	-0.333**	-0.114	0.320**	0.905**	0.671**	0.474**	0.719**	0.119	0.106	**0.408****
X11											1.000	0.343**	0.504**	-0.326**	-0.059	0.060	0.710**	0.578**	0.427**	0.595**	0.028	0.160	**0.183**
X12												1.000	0.699**	-0.461**	-0.563**	0.863**	0.650**	0.338*	0.186	0.377**	-0.413**	-0.518**	**0.128**
X13													1.000	-0.824**	-0.202	0.384**	0.489**	0.223	0.106	0.297*	-0.143	-283**	**0.241**
X14														1.000	0.302**	-0.119	-0.439**	-0.173	-0.066	-0.216	0.056	0.244	**0.055**
X15															1.000	-0.585**	-0.395**	-0.049	0.055	-0.036	0.566**	0.411**	**0.655****
X16																1.000	0.259	0.301**	0.253	0.332**	-0.395**	-0.299*	**0.365****
X17																	1.000	0.389**	0.146	0.397**	0.055	-0.040	**0.027**
X18																		1.000	0.968**	0.961**	0.109	0.246	**0.303****
X19																			1.000	0.924**	0.102	0.275**	**0.318****
X20																				1.000	0.141	0.256	**0.381****
X21																					1.000	0.752**	**0.444****
X22																						1.000	**0.281****

****** Significance at 1% probability ***** Significance at 5% probability

X1 - Internodal length at 90 DAT (cm) X2 - Number of nodes per vine at 90 DAT X3 - Number of branches per vine at 90 DAT X4 - Vine length at 90 DAT (cm)

X5 – Fruit length (cm) X6 - Fruit diameter (mm) X7 - Rind thickness (mm) X8 - Days to first male flower appeared (DAT)

X9 - Days to first female flower appeared (DAT) X10 - Node at which first male flower appeared X11 - Node at which first female flower appeared X12 - Number of female flowers per vine

X13 - Number of male flowers per vine X14 - Sex ratio (%) X15 - Average fruit weight (g) X16 - Total number of fruits per vine

X17 - Days to first harvest (DAT) X18 - Days to last harvest (DAT) X19 - Fruiting period (days) X20 - Crop duration (days)

X21 - Number of seeds per fruit X22 - Seed weight per fruit (g/fruit) X23 - Fruit yield per vine (g/vine)

Table 2 : Phenotypic correlation co-efficient for different parameters in bitter gourd genotypes.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X1	1.000	0.384**	-0.397**	0.146	-0.094	-0.439**	0.024	0.266*	0.219	0.097	0.010	0.280*	-0.032	0.223	-0.132	0.384**	0.040	0.147	0.137	0.177	0.220	0.154	**0.189**
X2		1.000	0.151	-0.061	-0.150	-0.142	-0.221	0.059	-0.011	0.018	0.066	0.018	-0.260	0.267*	-0.350**	0.152	0.189	-0.186	-0.264*	-0.268*	-0.180	0.122	**-0.254**
X3			1.000	-0.448**	-0.093	0.104	-0.050	-0.358**	-0.171	-0.421**	-0.370**	-0.062	0.020	-0.302*	-0.469**	-0.026	-0.141	-0.591**	-0.557**	-0.539**	-0.361**	-0.364**	**-0.538****
X4				1.000	-0.203	-0.235	-0.078	0.436**	0.059	0.439**	0.544**	-0.018	0.066	-0.018	0.146	-0.001	0.098	0.497**	0.476**	0.460**	0.148	0.251	**0.251**
X5					1.000	-0.053	-0.017	0.101	0.013	0.106	-0.017	0.116	0.036	0.010	0.254	-0.045	0.244	-0.001	-0.094	0.035	0.041	-0.153	**0.333****
X6						1.000	0.465**	-0.531**	-0.230	-0.457**	-0.210	-0.577**	-0.390**	0.257	0.541**	-0.802**	-0.341**	-0.460**	-0.345**	-0.497**	0.226	0.138	**-0.175**
X7							1.000	-0.106	0.097	-0.219	-0.017	-0.145	0.047	-0.139	0.400**	-0.338*	-0.267*	-0.070	0.030	-0.059	0.373**	0.134	**0.187**
X8								1.000	0.475**	0.835**	0.653**	0.380**	0.348**	-0.327*	-0.208	0.273*	0.582**	0.687**	0.487**	0.676**	0.116	0.017	**0.246**
X9									1.000	0.458**	0.301*	0.326*	0.276*	-0.273*	-0.185	0.170	0.336*	0.235	0.115	0.352**	0.196	0.031	**0.123**
X10										1.000	0.716**	0.340*	0.445**	-0.309*	-0.097	0.257	0.552**	0.604***	0.413**	0.609**	0.105	0.109	**0.338****
X11											1.000	0.191	0.402**	-0.317*	-0.055	-0.013	0.455**	0.507**	0.350**	0.475**	0.027	0.134	**0.108**
X12												1.000	0.599**	-0.233	-0.441**	0.768**	0.270*	0.242	0.147	0.291*	-0.318*	-0.403**	**0.150**
X13													1.000	-0.779**	-0.196	0.348**	0.237	0.194	0.109	0.256	-0.142	-0.285*	**0.206**
X14														1.000	0.286*	-0.045	-0.242	-0.155	-0.067	-0.190	0.054	0.240	**0.104**
X15															1.000	-0.552**	-0.262*	-0.051	0.047	-0.036	0.553**	0.407**	**0.638****
X16																1.000	0.149	0.288*	0.241	0.306*	-0.363**	-0.276*	**0.354****
X17																	1.000	0.268*	-0.104	0.209	-0.004	-0.026	**0.026**
X18																		1.000	0.930**	0.909**	0.105	0.241	**0.281****
X19																			1.000	0.859**	0.110	0.259	**0.280****
X20																				1.000	0.160	0.257	**0.355****
X21																					1.000	0.748**	**0.422****
X22																						1.000	**0.274****

** Significance at 1% probability * Significance at 5% probability

X1 - Internodal length at 90 DAT (cm) X2 - Number of nodes per vine at 90 DAT X3 - Number of branches per vine at 90 DAT X4 - Vine length at 90 DAT (cm)
X5 – Fruit length (cm) X6 - Fruit diameter (mm) X7 - Rind thickness (mm) X8 - Days to first male flower appeared (DAT)
X9 - Days to first female flower appeared (DAT) X10 - Node at which first male flower appeared X11 - Node at which first female flower appeared X12 - Number of female flowers per vine
X13 - Number of male flowers per vine X14 - Sex ratio (%) X15 - Average fruit weight (g) X16 - Total number of fruits per vine
X17 - Days to first harvest (DAT) X18 - Days to last harvest (DAT) X19 - Fruiting period (days) X20 - Crop duration (days)
X21 - Number of seeds per fruit X22 - Seed weight per fruit (g/fruit) X23 - Fruit yield per vine (g/vine)

Table 3 : Genotypic path co-efficient showing direct and indirect effects of different parameters on fruit yield per vine in bitter gourd genotypes.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
X1	**-0.211**	-0.082	0.085	-0.031	0.026	0.094	-0.005	-0.060	-0.082	-0.024	-0.001	-0.074	0.006	-0.050	0.029	-0.086	-0.040	-0.048	-0.033	**0.200**
X2	0.195	**0.505**	0.079	-0.030	-0.097	-0.072	-0.114	0.035	-0.003	0.006	0.044	0.011	-0.140	0.147	-0.179	0.081	-0.144	-0.093	0.061	**-0.268****
X3	-0.039	0.015	**0.097**	-0.044	-0.008	0.009	-0.005	-0.038	-0.030	-0.048	-0.040	-0.007	0.002	-0.032	-0.047	-0.003	-0.056	-0.037	-0.036	**-0.588****
X4	-0.024	0.010	0.075	**-0.164**	0.045	0.040	0.013	-0.076	-0.006	-0.083	-0.101	0.005	-0.011	0.003	-0.024	0.000	-0.080	-0.025	-0.042	**0.267****
X5	0.002	0.003	0.001	0.004	**-0.016**	0.001	0.001	-0.002	0.001	-0.002	-0.001	-0.001	-0.001	0.001	-0.005	0.001	0.000	-0.001	0.003	**0.460****
X6	0.218	0.070	-0.046	0.119	0.018	**-0.489**	-0.233	0.279	0.251	0.260	0.115	0.359	0.206	-0.138	-0.271	0.421	0.261	-0.112	-0.069	**-0.200**
X7	0.001	-0.008	-0.002	-0.003	-0.003	0.017	**0.036**	-0.004	0.005	-0.010	-0.001	-0.006	0.002	-0.006	0.015	-0.013	-0.002	0.014	0.005	**0.195**
X8	-0.073	-0.018	0.102	-0.120	-0.035	0.148	0.031	**-0.260**	-0.217	-0.230	-0.189	-0.145	-0.106	0.087	0.060	-0.084	-0.197	-0.032	-0.003	**0.286****
X9	-0.003	0.000	0.003	0.000	0.000	0.004	-0.001	-0.007	**-0.008**	-0.007	-0.005	-0.005	-0.004	0.005	0.003	-0.003	-0.005	-0.002	0.000	**0.188**
X10	-0.018	-0.002	0.081	-0.082	-0.021	0.087	0.043	-0.145	-0.142	**-0.163**	-0.147	-0.088	-0.088	0.054	0.019	-0.052	-0.117	-0.019	-0.017	**0.408****
X11	0.002	0.032	-0.151	0.223	0.013	-0.085	-0.008	0.264	0.214	0.326	**0.363**	0.125	0.183	-0.118	-0.022	0.022	0.216	0.010	0.058	**0.183**
X12	-0.246	-0.016	0.050	0.020	-0.051	0.515	0.115	-0.393	-0.443	-0.377	-0.241	**-0.7025**	-0.491	0.324	0.395	-0.606	-0.265	0.290	0.364	**0.128**
X13	-0.015	-0.144	0.011	0.035	0.034	-0.218	0.033	0.211	0.289	0.279	0.261	0.362	**0.518**	-0.426	-0.104	0.199	0.154	-0.074	-0.147	**0.241**
X14	0.072	0.089	-0.100	-0.006	-0.017	0.086	-0.048	-0.103	-0.177	-0.102	-0.100	-0.141	-0.251	**0.305**	0.092	-0.036	-0.066	0.017	0.074	**0.055**
X15	-0.141	-0.372	-0.507	0.155	0.366	0.580	0.426	-0.243	-0.356	-0.119	-0.062	-0.590	-0.211	0.316	**1.048**	-0.613	-0.037	0.593	0.431	**0.655****
X16	0.308	0.120	-0.022	0.000	-0.063	-0.649	-0.267	0.244	0.255	0.241	0.045	0.650	0.289	-0.090	-0.441	**0.754**	0.250	-0.298	-0.226	**0.365****
X17	0.120	-0.182	-0.370	0.308	0.013	-0.339	-0.042	0.482	0.389	0.457	0.378	0.239	0.189	-0.137	-0.023	0.211	**0.635**	0.089	0.162	**0.381****
X18	0.208	-0.169	-0.348	0.138	0.041	0.211	0.349	0.114	0.220	0.110	0.026	-0.381	-0.132	0.052	0.522	-0.365	0.130	**0.923**	0.694	**0.444****
X19	-0.156	-0.121	0.376	-0.256	0.214	-0.140	-0.130	-0.013	0.030	-0.106	-0.160	0.518	0.283	-0.243	-0.411	0.299	-0.255	-0.752	**-0.999**	**0.281****

Residual effect = 0.230

** Significance at 1% probability

***** Significance at 5% probability

X1 - Internodal length at 90 DAT (cm)
X2 - Number of nodes per vine at 90 DAT
X3 - Number of branches per vine at 90 DAT
X4 - Vine length at 90 DAT (cm)
X5 – Fruit length (cm)
X6 - Fruit diameter (mm)
X7 - Rind thickness (mm)
X8 - Days to first male flower appeared (DAT)
X9 - Days to first female flower appeared (DAT)
X10 - Node at which first male flower appeared
X11 - Node at which first female flower appeared
X12 - Number of female flowers per vine
X13 - Number of male flowers per vine
X14 - Sex ratio (%)
X15 - Average fruit weight (g)
X16 - Total number of fruits per vine
X17 - Crop duration (days)
X18 - Number of seeds per fruit
X19 - Seed weight per fruit (g/fruit)
X20 - Fruit yield per vine (g/vine)

Table 4 : Phenotypic path co-efficient showing direct and indirect effects of different parameters on fruit yield per vine in bitter gourd genotypes.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
X1	**-0.061**	-0.023	0.024	-0.009	0.006	0.027	-0.002	-0.016	-0.013	-0.006	-0.001	-0.017	0.002	-0.014	0.008	-0.023	-0.011	-0.013	-0.009	**0.189**
X2	0.040	**0.103**	0.016	-0.006	-0.016	-0.015	-0.023	0.006	-0.001	0.002	0.007	0.002	-0.027	0.028	-0.036	0.016	-0.028	-0.019	0.013	**-0.254**
X3	-0.099	0.038	**0.250**	-0.112	-0.023	0.026	-0.013	-0.090	-0.043	-0.106	-0.093	-0.016	0.005	-0.076	-0.118	-0.006	-0.135	-0.090	-0.091	**-0.538****
X4	0.000	0.000	-0.001	**0.002**	0.000	-0.001	0.000	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	**0.251**
X5	-0.004	-0.006	-0.004	-0.008	**0.038**	-0.002	-0.001	0.004	0.001	0.004	-0.001	0.004	0.001	0.000	0.010	-0.002	0.001	0.002	-0.006	**0.333****
X6	0.167	0.054	-0.040	0.089	0.020	**-0.379**	-0.177	0.201	0.087	0.173	0.080	0.219	0.148	-0.097	-0.205	0.304	0.189	-0.086	-0.053	**-0.175**
X7	0.003	-0.025	-0.006	-0.009	-0.002	0.052	**0.111**	-0.012	0.011	-0.024	-0.002	-0.016	0.005	-0.015	0.045	-0.038	-0.007	0.041	0.015	**0.187**
X8	0.018	0.004	-0.025	0.030	0.007	-0.037	-0.007	**0.069**	0.033	0.058	0.045	0.026	0.024	-0.023	-0.014	0.019	0.047	0.008	0.001	**0.246**
X9	0.022	-0.001	-0.017	0.006	0.001	-0.023	0.010	0.048	**0.101**	0.046	0.030	0.033	0.028	-0.028	-0.019	0.017	0.035	0.020	0.003	**0.123**
X10	0.012	0.002	-0.053	0.055	0.013	-0.057	-0.027	0.104	0.057	**0.125**	0.089	0.043	0.056	-0.039	-0.012	0.032	0.076	0.013	0.014	**0.338****
X11	0.000	-0.002	0.012	-0.018	0.001	0.007	0.001	-0.021	-0.010	-0.023	**-0.032**	-0.006	-0.013	0.010	0.002	0.000	-0.015	-0.001	-0.004	**0.108**
X12	-0.041	-0.003	0.009	0.003	-0.017	0.085	0.021	-0.056	-0.048	-0.050	-0.028	**-0.147**	-0.088	0.034	0.065	-0.113	-0.043	0.046	0.059	**0.151**
X13	-0.011	-0.089	0.007	0.023	0.012	-0.133	0.016	0.119	0.094	0.152	0.137	0.204	**0.341**	-0.266	-0.067	0.119	0.087	-0.048	-0.097	**0.206**
X14	0.076	0.091	-0.103	-0.006	0.003	0.088	-0.047	-0.112	-0.093	-0.106	-0.108	-0.080	-0.266	**0.342**	0.098	-0.015	-0.065	0.018	0.082	**0.104**
X15	-0.145	-0.385	-0.515	0.160	0.279	0.595	0.440	-0.229	-0.204	-0.107	-0.060	-0.485	-0.215	0.314	**1.099**	-0.607	-0.039	0.607	0.447	**0.638****
X16	0.173	0.069	-0.012	-0.001	-0.020	-0.361	-0.152	0.123	0.077	0.116	-0.006	0.346	0.157	-0.020	-0.249	**0.450**	0.138	-0.163	-0.124	**0.354****
X17	0.023	-0.035	-0.070	0.060	0.005	-0.065	-0.008	0.088	0.046	0.080	0.062	0.038	0.033	-0.025	-0.005	0.040	**0.131**	0.021	0.034	**0.355****
X18	0.036	-0.030	-0.060	0.025	0.007	0.037	0.062	0.019	0.032	0.017	0.004	-0.052	-0.024	0.009	0.092	-0.060	0.027	**0.166**	0.124	**0.422****
X19	-0.021	-0.016	0.049	-0.034	0.020	-0.019	-0.018	-0.002	-0.004	-0.015	-0.018	0.054	0.038	-0.032	-0.054	0.037	-0.034	-0.100	**-0.134**	**0.274****

Residual effect = 0.251

** Significance at 1% probability

***** Significance at 5% probability

X1 - Internodal length at 90 DAT (cm)
X2 - Number of nodes per vine at 90 DAT
X3 - Number of branches per vine at 90 DAT
X4 - Vine length at 90 DAT (cm)
X5 – Fruit length (cm)
X6 - Fruit diameter (mm)
X7 - Rind thickness (mm)X1 - Internodal length at 90 DAT (cm)
X8 - Days to first male flower appeared (DAT)
X9 - Days to first female flower appeared (DAT)
X10 - Node at which first male flower appeared
X11 - Node at which first female flower appeared
X12 - Number of female flowers per vine
X13 - Number of male flowers per vine
X14 - Sex ratio (%)
X15 - Average fruit weight (g)
X16 - Total number of fruits per vine
X17 - Crop duration (days)
X18 - Number of seeds per fruit
X19 - Seed weight per fruit (g/fruit)
X20 - Fruit yield per vine (g/vine)

0.426), seed weight per fruit *via* average fruit weight (-0.411). Sharma and Bhutani (2001) also found similar results in bitter gourd.

Most of the characters contributing towards fruit yield per vine has been included in the study, which was depicted by the very negligible (0.251) residual effect (Table 4).

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