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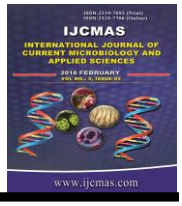

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Correlation and Path Analysis in Bitter Gourd (*Momordica charantia* L.)

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A B S T R A C T

An experiment was conducted to study the association between yield and yield related characters in bitter gourd during *rabi*, 2012-13 at Vegetable Research Station, Dr.YSR Horticultural University, Hyderabad, Andhra Pradesh. Among the different traits studied, number of fruits per vine registered high, significant and positive correlation with fruit yield followed by number of primary branches, days to last fruit harvest, vine length and fruit flesh thickness. Number of fruits per vine exhibited very high positive direct effect on fruit yield followed by average fruit weight. Due weightage should be given to the above attributes at the time of selection of bitter gourd genotypes for realizing better yields in the developed varieties.

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the most nutritive cucurbitaceous vegetables valued for its medicinal properties. It has been identified as one of the promising vegetable for export by Agricultural Processed Food Products and Export Development Authority (APEDA). In India, bitter gourd occupies 6.76 million hectare with the annual production of 101.43 million tonnes (Rai and Pandey, 2007). But, the demand is likely to rise to 193 million tonnes by the year 2030. Yield of any crop is under polygenic control and is more responsive varying environmental conditions. An efficiency of selection in any breeding programme depends on knowledge degree of association of component characters.

The phenotypic correlation indicates the extent of observed relationship between characters and genotypic correlation indicates an inherent association between genes controlling any two characters. The direct and indirect contributions of various characters to yield were calculated through path coefficient analysis. An attempt was therefore, made in the present investigation to study the degree and direction of association between yield and its components in bitter gourd.

Materials and Methods

The experimental material consisted of seventeen genotypes including 10 F_1 hybrids resulted from mating of five nearly homozygous and genetically diverse parents

utilizing half diallel mating design and two commercial checks were grown in Randomized Black Design with three replication during *rabi*, 2012-13 at Vegetable Research Station, Dr.YSR Horticultural University, Hyderabad, Andhra Pradesh. The biometrical observations were recorded on fourteen quantitative traits *viz.*, days to first pistillate flower appearance, node of first pistillate flower appearance, days to first fruit harvest, days to last fruit harvest, fruit length (cm), fruit diameter (cm), fruit flesh thickness (mm), average fruit weight (g), number of fruits per vine, vine length (m), Number of primary branches vine internodal length (cm), number of seeds per fruit and fruit yield per vine (kg). The genotypic and phenotypic correlations and path analysis were worked out as per the methods of Al-Jibouri (1958) and Deway and Lu (1959), respectively.

Results and Discussion

The phenotypic (P) and genotypic correlation (G) coefficients were worked out for fourteen characters in bitter gourd and the results are presented in Table 1. In general, it was observed that genotypic correlation coefficients were higher than that of phenotypic correlation coefficients. This could be interpreted on the basis that there was a strong inherent genotypic relationship between the characters studied, but their phenotypic expression was impeded by the influence of environmental factors. The results are in accordance with Shrivatstava and Shrivatstava (1976) and Bhave *et al.* (2003).

Fruit yield per vine showed positive and significant correlations with days to last fruit harvest (0.7561 P, 0.7878 G), fruit diameter (0.5468 P, 0.6006 G), fruit flesh thickness (0.6289 P, 0.6578 G) , number of fruits per vine (0.8679 P, 0.8689 G), number of primary branches per vine (0.7915 P, 0.8262 G) and vine length (0.6825 P, 0.7810 G). This suggested that vigorous plant with profuse growth and long flowering duration is contributing positively for better yield. A very strong positive and significant correlation was recorded between yield and number of fruits and weight of fruit. It indicates that fruit number in bitter gourd plays important role while selecting for higher yielding genotypes. This trait also recorded negative and significant correlation with days to first fruit harvest (-0.2846 P, -0.3039 G). The similar results were reported by Bhave *et al*. (2003), Dey *et al*. (2005), Ram *et al*. (2006), Islam *et al*. (2009) and Sundaram (2010).

Among the different traits studied, number of fruits per vine registered high, significant and positive correlation with fruit yield followed by number of primary branches, days to last fruit harvest, vine length and fruit flesh thickness. It suggests that these are the most important parameters of yield, so more weightage should be given to these characters in bitter gourd breeding programme.

Yield being a complex trait, it is difficult to exploit various yield contributing characters through the knowledge of correlation, therefore it is important to carry out other analysis including path coefficient that provides a clear indication for selection criterion (Mc Giffens *et al.*, 1994*)*. The estimates of direct effects of the fourteen yield related characters on yield are presented in Table 2. At genotypic level, node of first pistillate flower appearance and number of seeds per fruit had positive negligible direct effects on fruit yield per vine, while days to first fruit harvest had negative negligible direct effect on fruit yield per vine.

Table.1 Estimates of genotypic (G) and phenotypic correlation coefficients among fourteen yield components in bitter gourd

Characters		Days to first pistillate flower appearance	Node of first pistillate flower appearance	Days to first fruit harvest	Days to last fruit harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit flesh thickness (mm)	Average Fruit weight (g)	No. of fruits per vine	Number of primary branches per vine	Vine length (m)	Internodal length (cm)	Number of seeds per fruit	Fruit yield per vine (kg)
Days to first pistillate flower appearance	**P**	**1.0000**	0.6434**	0.8779**	0.2712	-0.0875	0.1311	0.0687	0.1350	-0.1612	-0.1361	-0.1636	0.4501**	0.2379	-0.1509
	G	**1.0000**	0.7093**	0.9097**	0.3046*	-0.1037	0.1377	0.0606	0.1593	-0.1775	-0.1109	-0.1637	0.4845**	0.2493	-0.1624
Node of first pistillate flower appearance	**P**		**1.0000**	0.4994**	0.3363*	-0.2507	0.1178	0.1262	0.1323	-0.1524	-0.1449	0.0568	0.4806**	0.1634	-0.1014
	G		**1.0000**	0.5578**	0.3989**	-0.2780*	0.1501	0.1207	0.1416	-0.1719	-0.1750	0.1092	0.5592**	0.1785	-0.1181
Days to first fruit harvest	**P**			**1.0000**	0.1293	0.0011	0.0582	0.0036	0.1391	-0.2599	-0.2217	-0.2295	0.4044**	0.1797	-0.2846*
	G			**1.0000**	0.1292	-0.0068	0.0648	-0.0220	0.1665	-0.2856*	-0.2354	-0.2642	0.4535**	0.1993	-0.3039*
Days to last fruit harvest	**P**				**1.0000**	-0.2619	0.6178**	0.5583**	-0.1231	0.6539**	0.5299**	0.5556**	0.4603**	0.1011	0.7561**
	G				**1.0000**	-0.2789*	0.6424**	0.5833**	-0.1302	0.6836**	0.5489**	0.6157**	0.4884**	0.1177	0.7878**
Fruit length (cm)	**P**					**1.0000**	-0.0781	-0.1049	0.7315**	-0.4352**	0.1556	0.0063	0.1127	0.7120**	-0.1476
	G					**1.0000**	-0.0815	-0.1221	0.7590**	-0.4462**	0.1703	0.0117	0.1055	0.7451**	-0.1459
Fruit diameter (cm)	**P**						**1.0000**	0.8572**	0.1189	0.3918**	0.4279**	0.3134*	0.5175**	0.2458	0.5468**
	G						**1.0000**	0.9010	0.1228	0.4119**	0.4608**	0.3860**	0.5651**	0.2785*	0.6006**
Fruit flesh thickness (mm)	**P**							**1.0000**	0.1335	0.4316**	0.5202**	0.4812**	0.3888**	0.1133	0.6289**
	G							**1.0000**	0.1391	0.4548**	0.5452**	0.5602**	0.4243**	0.1108	0.6578**
Average Fruit weight (g)	**P**								**1.0000**	-0.5987**	0.1188	0.1021	0.3793**	0.7730**	-0.1487
	G								**1.0000**	-0.5964**	0.1345	0.1150	0.3849**	0.8051**	-0.1443
Number of fruits per vine	**P**									**1.0000**	0.6035**	0.5012**	-0.1268	-0.3770**	0.8679**
	G									**1.0000**	0.6235**	0.5702**	-0.1321	-0.3858**	0.8689**
Number of primary branches vine	**P**										**1.0000**	0.6695**	0.0792	0.1066	0.7915**
	G										**1.0000**	0.7875**	0.1119	0.1173	0.8262**
Vine length (m)	**P**											**1.0000**	0.2967*	0.0354	0.6825**
	G											**1.0000**	0.3487*	0.0605	0.7810**
Internodal length (cm)	**P**												**1.0000**	0.4053**	-0.0816
	G												**1.0000**	0.4219**	-0.0803
Number of seeds per fruit	**P**													**1.0000**	0.0320
	G													**1.0000**	0.0293
Fruit yield per vine (kg)	**P**														**1.000**
	G														**1.000**

* Significant at 5% level of significance ** Significant at 1% level of significance

Table.2 Phenotypic (P) and genotypic (G) path coefficient analysis (direct and indirect effects) of the yield contributing characters in bitter gourd

Characters		Days to first pistillate flower appearance	Node of first pistillate flower appearance	Days to first fruit harvest	Days to last fruit harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit flesh thickness (mm)	Average Fruit weight (g)	No. of fruits per vine	Number of primary branches per vine	Vine length (m)	Internodal length (cm)	Number of seeds per fruit
Days to first pistillate flower appearance	**P**	**0.0223**	0.0144	0.0196	0.0061	-0.0020	0.0029	0.0015	0.0030	-0.0036	-0.0030	-0.0037	0.0101	0.0053
	G	**-0.2310**	-0.1639	-0.2102	-0.0704	0.0240	-0.0318	-0.0140	-0.0368	0.0410	0.0256	0.0378	-0.1119	-0.0576
Node of first pistillate flower appearance	**P**	-0.0189	**-0.0294**	-0.0147	-0.0099	0.0074	-0.0035	-0.0037	-0.0039	0.0045	0.0043	-0.0017	-0.0141	-0.0048
	G	0.0189	**0.0267**	0.0149	0.0106	-0.0074	0.0040	0.0032	0.0038	-0.0046	-0.0047	0.0029	0.0149	0.0048
Days to first fruit harvest	**P**	-0.0919	-0.0523	**-0.1047**	-0.0135	-0.0001	-0.0061	-0.0004	-0.0146	0.0272	0.0232	0.0240	-0.0423	-0.0188
	G	-0.0078	-0.0048	**-0.0086**	-0.0011	0.0001	-0.0006	0.0002	-0.0014	0.0025	0.0020	0.0023	-0.0039	-0.0017
Days to last fruit harvest	**P**	0.0434	0.0539	0.0207	**0.1602**	-0.0419	0.0989	0.0894	-0.0197	0.1047	0.0849	0.0890	0.0737	0.0162
	G	0.0440	0.0577	0.0187	**0.1446**	-0.0403	0.0929	0.0843	-0.0188	0.0988	0.0794	0.0890	0.0706	0.0170
Fruit length (cm)	**P**	0.0032	0.0091	0.0000	0.0096	**-0.0365**	0.0029	0.0038	-0.0267	0.0159	-0.0057	-0.0002	-0.0041	-0.0260
	G	0.0175	0.0468	0.0011	0.0470	**-0.1683**	0.0137	0.0205	-0.1278	0.0751	-0.0287	-0.0020	-0.0178	-0.1254
Fruit diameter (cm)	**P**	0.0051	0.0046	0.0023	0.0242	-0.0031	**0.0392**	0.0336	0.0047	0.0154	0.0168	0.0123	0.0203	0.0096
	G	-0.0423	-0.0461	-0.0199	-0.1973	0.0250	**-0.3072**	-0.2768	-0.0377	-0.1265	-0.1416	-0.1186	-0.1736	-0.0855
Fruit flesh thickness (mm)	**P**	0.0002	0.0004	0.0000	0.0018	-0.0003	0.0028	**0.0033**	0.0004	0.0014	0.0017	0.0016	0.0013	0.0004
	G	0.0108	0.0216	-0.0039	0.1043	-0.0218	0.1610	**0.1787**	0.0249	0.0813	0.0975	0.1001	0.0758	0.0198
Average Fruit weight (g)	**P**	0.0804	0.0789	0.0829	-0.0734	0.4360	0.0709	0.0796	**0.5960**	-0.3569	0.0708	0.0609	0.2261	0.4608
	G	0.1180	0.1049	0.1234	-0.0965	0.5623	0.0910	0.1031	**0.7408**	-0.4419	0.0996	0.0852	0.2852	0.5964
Number of fruits per vine	**P**	-0.1672	-0.1580	-0.2696	0.6783	-0.4514	0.4064	0.4476	-0.6210	**1.0373**	0.6260	0.5199	-0.1315	-0.3910
	G	-0.2267	-0.2194	-0.3646	0.8727	-0.5697	0.5259	0.5806	-0.7614	**1.2767**	0.7960	0.7279	-0.1686	-0.4926
Number of primary branches per vine	**P**	0.0019	0.0020	0.0031	-0.0074	-0.0022	-0.0060	-0.0073	-0.0017	-0.0084	**-0.0140**	-0.0094	-0.0011	-0.0015
	G	-0.0131	-0.0206	-0.0277	0.0647	0.0201	0.0543	0.0642	0.0158	0.0735	**0.1178**	0.0928	0.0132	0.0138
Vine length (m)	**P**	-0.0001	0.0000	-0.0001	0.0003	0.0000	0.0002	0.0003	0.0001	0.0003	0.0003	**0.0005**	0.0002	0.0000
	G	0.0501	-0.0334	0.0808	-0.1883	-0.0036	-0.1181	-0.1713	-0.0352	-0.1744	-0.2409	**-0.3059**	-0.1067	-0.0185
Internodal length (cm)	**P**	-0.0126	-0.0134	-0.0113	-0.0129	-0.0032	-0.0145	-0.0109	-0.0106	0.0035	-0.0022	-0.0083	**-0.0280**	-0.0113
	G	0.0947	0.1093	0.0887	0.0955	0.0206	0.1105	0.0830	0.0753	-0.0258	0.0219	0.0682	**0.1955**	0.0825
Number of seeds per fruit	**P**	-0.0168	-0.0116	-0.0127	-0.0072	-0.0504	-0.0174	-0.0080	-0.0547	0.0267	-0.0075	-0.0025	-0.0287	**-0.0708**
	G	0.0044	0.0032	0.0035	0.0021	0.0132	0.0049	0.0020	0.0143	-0.0068	0.0021	0.0011	0.0075	**0.0177**

Phenotypic Residual effect = 0.1363; Genotypic Residual effect=0.1243; Diagonal (bold) values indicate direct effects, G: Genotypic P: Phenotypic

Days to last fruit harvest, fruit flesh thickness, number of primary branches per vine and internodal length had positive low direct effects, while fruit length had negative low direct effect on fruit yield per vine at genotypic level.

At genotypic level, days to first pistillate flower appearance had negative moderate direct effect on fruit yield per vine, whereas average fruit weight had positive and high direct effect. Fruit diameter and vine length had negative and high directs effects on fruit yield per vine at genotypic level. Number of fruits per vine exhibited very high positive direct effect on fruit yield followed by average fruit weight. The results obtained are in conformity with the results of several reports of earlier workers. Dey *et al*. (2005) and Sundaram (2010).

At phenotypic level, days to first pistillate flower, fruit diameter, fruit flesh thickness and vine length had positive and negligible direct effects on yield per vine, while node of first pistillate flower appearance, fruit length, number of primary branches, internodal length and number of seeds per fruit had negative and negligible direct effects on yield per vine. Days to last fruit harvest had positive and low direct effect, while days to first fruit harvest had negative and low direct effect on yield per vine at phenotypic level. Fruit weight and number of fruits per vine had high and very high positive direct effects respectively.

Based on the characters which had positive and negative effects on fruit yield could be exploited for selection to improve bitter gourd as they are directly responding for selection.

The residual factor determines how best the casual factors account for the variability of the dependent factor, the yield per vine in this case. The residual effects were 0.1243 and 0.1363, which were of low magnitude at genotypic and phenotypic levels indicating a very few characters which are to included for further effectiveness of the present study. On the basis of correlation and path analysis for fruit yield, it could be stated that simultaneous selection on the basis of number of fruits per vine, average fruit weight, fruit diameter, fruit flesh thickness, number of primary branches, days to last fruit harvest and vine length could help in genetic improvement of bitter gourd population.

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