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Short Communication

Character association analysis in bottle gourd (*Lagenaria siceraria* Molina Standl.)

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Bottle gourd is an important rainy and summer season vegetable crop has a tremendous potential for export. Yield is a complex trait and usually has low genetic gain. So, direct selection may not give accurate outcomes in any crop improvement. Hence, correlation studies between yield and its attributing traits which are otherwise simple and highly heritable have been of immense help in selecting suitable genotype and also to ascertain the magnitude of correlation and path analysis in bottle gourd genotypes. The experimental material consisted of 23 bottle gourd genotypes *viz.*, IC 249663, PSR 13300, PSR 13156, PSR 13290, RJR 27, PSR 13176, RJR 201, IC 446596, IC 249654, IC 249672, IC 249671, IC 249668, IC 446594, RJR 533, IC 249665, IC 249658, IC 249653, IC 446592, IC 249650, RJR 420, IC 249656, IC 256053 and NSJ 298 obtained from NBPGR, Hyderabad along with one check variety i.e. Pusa Naveen sown in randomized block design with three replications in spring summer of 2012 at Horticultural College and Research Institute, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh. Row to row and plant to plant spacings were maintained at 2m and 1m respectively, in a plot size of 6m × 4m. Six plants were maintained in each plot for recording the observations. Recommended cultural practices were adopted for proper growth and stand of the crop. Observations on tendril length (cm), no. of primary branches per vine, total vine length (m), no. of nodes per vine, internodal length (cm), days to 1st male flower appearance, days to 1st female flower appearance, node at which 1st male flower appeared, node at which 1st female flower appeared, days to first fruit harvest, no. of fruits per vine, fruit weight (g), fruit length (cm), fruit diameter (cm), fruit yield per vine (kg), total yield (t/ha), no. of seeds per fruit and 100 seed weight (g) for each genotype were recorded from five randomly selected plants per plot per replication. Phenotypic and genotypic correlations were worked out by using formula suggested by Falconer (1964). The direct and indirect contributions of various characters to yield were calculated through path coefficient analysis as suggested by Dewey and Lu (1959).

Phenotypic and genotypic correlation coefficients among different pairs of characters of bottle gourd are presented. Correlation studies showed that genotypic correlation appeared to be higher than the corresponding phenotypic correlation. These observations indicate that in majority of the cases, the environment had not appreciable influenced the expressions of character associations. In the present finding, the fruit yield per vine (kg) had significant positive correlation with traits like tendril length (cm), number of nodes per vine, number of primary branches per vine, total vine length (m), internodal length (cm), number of fruits per vine, fruit weight (g), fruit diameter (cm), number of seeds per fruit and 100 seed weight (g) at both phenotypic as well as genotypic levels.

This indicated that fruit yield can be improved by making selections on the bases of these yield attributing characters. These findings are in line with those of Husna *et al.* (2011) and Kamal *et al.* (2012) in bottle gourd and Blessings *et al.* (2012) in pumpkin. Fruit weight recorded significant positive correlations, both at phenotypic and genotypic levels, with fruit length and fruit diameter, meaning that an increase in fruit length and fruit diameter would have a positive impact on fruit weight. However, no. of fruits per vine had non-significant negative correlation with fruit weight but it had significant positive correlation with fruit yield per vine. Nevertheless, emphasis should be given during selection to the fruit length and fruit diameter for a higher weight and larger fruit size. In the context of consumer preference (1-2

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kg fruit weight) and market demand (both for domestic and export trade), fruit size and number of fruits per vine need to be compromised. Similar results have been reported by Pandit *et al.* (2009). Yield per vine showed significantly negative association with days to 1st female flower appearance, node at which 1st male and female flowers appeared. This suggests that early appearance of female flowers is an indication of high yield. Days to appearance of 1st female flower appearance has shown significant negative association with number of fruits per vine and yield per vine indicating that delayed female flower appearance will have negative effect on fruit number and yield per vine. Such associations with yield has also reported by Narayan *et al*., (1996) and Kumar *et al*. (2007).

Association of characters as determined by simple correlation coefficient may not provide an exact picture of the relationship between yield components and yield. The correlation coefficients between various characters were partitioned into direct and indirect relationship by the path analysis technique. Path coefficient analysis (Table 1 and 2) revealed that total vine length (m) exerted a high positive direct effect on fruit yield per vine (kg) followed by number of fruits per vine, fruit weight (g) and fruit diameter. Husna *et al*., (2011) found that fruit weight and number of fruits per vine had maximum direct effect on fruit yield. On other hand Rahaman *et al*., (2002) reported positive direct effect of total vine length on fruit yield per vine. Number of nodes per vine, inter nodal length, node at which 1st male and female flowers appeared fruit length, no. of seeds per fruit and 100 seed weight represented negative direct effects on fruit yield. The contributions of yield components like fruit diameter, total vine length, fruit weight and number of fruits per vine were high in the present study. Further, number of nodes per vine, internodal length, number of seeds per fruit and 100 seed weight, though exhibited significant correlation with yield per vine, showed negative direct effect on fruit yield per vine via indirect effects of tendril length, no. of primary branches, days to 1st male and female flower appearance and fruit diameter. Tendril length, no. of primary branches and days to 1st fruit harvest had a very low positive direct on fruit yield per vine. This is due to high negative indirect effects exhibited by internodal length, days to 1st male and female flower appearance, node at which 1st male and female flower appeared no. of fruits per vine, fruit diameter and no. of seeds per fruit. The contributions of negative and positive indirect effects via different parameters were responsible for exhibiting the positive total genotypic correlation with yield. The estimated residual effects were 0.0927 and 0.1787 at genotypic and phenotypic levels, respectively, indicating that 90% of the variability in the bottle gourd was contributed by the traits studied in the path analysis.

Positively significant associations of yield per vine with

Table 1. Phenotypic path coefficient analysis among different characters in bottle gourd genotypes

	TL	NNV	NPBV	TVL	IL	DFM	DFF	NFM	NFF	DFH	NFV	FW	FL	FD	NSF	100 SW	YV
TL	**0.0661**	0.0267	0.0341	0.0252	0.0100	-0.0046	-0.0082	-0.0111	-0.0147	-0.0045	0.0125	0.0295	-0.0116	0.0359	0.0328	0.0315	**0.5894**
NNV	-0.1345	**-0.3324**	-0.1317	-0.2227	-0.0198	-0.0171	-0.0258	-0.0124	-0.0244	-0.0705	-0.0071	-0.1667	-0.0043	-0.1209	-0.1635	-0.1568	**0.5499**
NPBV	0.0338	0.0259	**0.0654**	0.0360	0.0248	0.0038	-0.0107	-0.0039	-0.0048	0.0067	0.0148	0.0225	-0.0119	0.0323	0.0358	0.0354	**0.5604**
TVL	0.2700	0.4746	0.3900	**0.7082**	0.5495	0.0365	-0.0328	-0.0204	-0.0378	0.0738	0.0919	0.3027	0.0164	0.2584	0.3500	0.4307	**0.5365**
IL	-0.0816	-0.0320	-0.2041	-0.4178	**-0.5384**	-0.0150	0.0633	0.0303	0.0756	0.0201	-0.0706	-0.0832	-0.0270	-0.0833	-0.1102	-0.2113	**0.2332**
DFM	0.0028	-0.0021	-0.0024	-0.0021	-0.0011	**-0.0405**	-0.0193	-0.0302	-0.0095	-0.0240	0.0152	0.0005	-0.0023	0.0014	0.0027	0.0052	**-0.1732**
DFF	-0.0020	0.0012	-0.0026	-0.0007	-0.0019	0.0076	**0.0160**	0.0100	0.0097	0.0119	-0.0071	0.0000	0.0018	-0.0022	-0.0037	-0.0028	**-0.2157**
NFM	-0.0115	0.0026	-0.0041	-0.0020	-0.0038	0.0511	0.0427	**0.0684**	0.0388	0.0375	-0.0212	-0.0075	-0.0092	0.0012	-0.0157	-0.0127	**-0.2142**
NFF	0.0144	-0.0048	0.0048	0.0035	0.0091	-0.0153	-0.0391	-0.0368	**-0.0650**	-0.0315	0.0214	0.0108	0.0056	0.0081	0.0124	0.0131	**-0.2993**
DFH	-0.0068	0.0212	0.0102	0.0104	-0.0037	0.0594	0.0744	0.0549	0.0485	**0.1002**	-0.0518	0.0173	0.0174	-0.0063	-0.0067	0.0015	**-0.0761**
NFV	0.1112	0.0124	0.1331	0.0761	0.0769	-0.2196	-0.2597	-0.1821	-0.1934	-0.3034	**0.5864**	-0.0935	-0.3421	0.2561	0.2338	0.1143	**0.5100**
FW	0.2774	0.3118	0.2137	0.2658	0.0961	-0.0081	-0.0003	-0.0678	-0.1038	0.1075	-0.0991	**0.6219**	0.2010	0.2956	0.3379	0.4042	**0.7162**
FL	0.0004	0.0000	0.0004	0.0000	-0.0001	-0.0001	-0.0002	0.0003	0.0002	-0.0004	0.0012	-0.0007	**-0.0021**	0.0011	0.0004	0.0001	**-0.1822**
FD	0.0133	0.0089	0.0121	0.0089	0.0038	-0.0008	-0.0034	0.0004	-0.0031	-0.0015	0.0107	0.0116	-0.0131	**0.0245**	0.0163	0.0150	**0.7482**
NSF	-0.0050	-0.0050	-0.0055	-0.0050	-0.0021	0.0007	0.0023	0.0023	0.0019	0.0007	-0.0040	-0.0055	0.0018	-0.0067	**-0.0101**	-0.0061	**0.7645**
100 SW	0.0413	0.0408	0.0469	0.0526	0.0340	-0.0112	-0.0150	-0.0161	-0.0175	0.0013	0.0169	0.0562	-0.0025	0.0529	0.0523	**0.0865**	**0.7479**

Phenotypic Residual effect = 0.1787; Diagonal (under lined) values indicate direct effects, P: Phenotypic

TL – Tendril length NNV – No. of nodes per vine NPBV – No. of primary branches per vine TVL – Total vine length IL – Internodal length DFM – Days to first male flower appearance

DFF – Days to first female flower appearance NFM – Node at which first male flower appears NFF – Node at which first female flower appears DFH – Days to first harves

NFV – No. of fruits per vine FW – Fruit weight FL – Fruit length

FD – Fruit diameter YV – Yield per vine

NSF – No. of seeds per fruit 100 SW – 100 seed weight

Table 2. Genotypic path coefficient analysis among different characters in bottle gourd genotypes

	TL	NNV	NPBV	TVL	IL	DFM	DFF	NFM	NFF	DFH	NFV	FW	FL	FD	NSF	100 SW	YV
TL	**0.0061**	0.0037	0.0050	0.0039	0.0030	-0.0002	-0.0003	-0.0012	-0.0017	0.0006	0.0014	0.0030	-0.0015	0.0040	0.0041	0.0036	**0.6832**
NNV	-1.0357	**-1.7114**	-1.2174	-1.4876	-0.7955	-0.0997	-0.0236	0.0508	-0.0843	-0.9036	0.0742	-1.4366	-0.0120	-0.9436	-1.2973	-1.3338	**0.8347**
NPBV	0.0375	0.0327	**0.0460**	0.0366	0.0307	0.0010	-0.0086	-0.0017	-0.0027	0.0060	0.0114	0.0209	-0.0118	0.0299	0.0325	0.0315	**0.6945**
TVL	2.1232	2.8912	2.6542	**3.3262**	2.8188	0.3703	-0.3398	-0.1698	-0.3971	0.8188	0.6739	2.3123	-0.1543	1.9233	2.6122	3.1565	**0.8642**
IL	-0.6804	-0.6329	-0.9105	-1.1539	**-1.3616**	-0.2047	0.2496	0.0720	0.3639	0.1725	-0.5497	-0.5004	0.0706	-0.5859	-0.7785	-1.2509	**0.6673**
DFM	-0.0027	0.0048	0.0018	0.0093	0.0125	**0.0831**	0.0553	0.0692	0.0301	0.0673	-0.0350	0.0009	0.0040	-0.0023	-0.0061	-0.0116	**-0.1803**
DFF	0.0019	-0.0005	0.0068	0.0037	0.0067	-0.0243	**-0.0365**	-0.0301	-0.0253	-0.0320	0.0260	-0.0022	-0.0081	0.0066	0.0129	0.0091	**-0.3473**
NFM	0.0768	0.0112	0.0137	0.0192	0.0199	-0.3130	-0.3099	**-0.3760**	-0.2823	-0.2965	0.1486	0.0412	0.0697	-0.0155	0.0814	0.0918	**-0.2678**
NFF	-0.0471	0.0081	-0.0098	-0.0197	-0.0441	0.0597	0.1144	0.1238	**0.1649**	0.1013	-0.0693	-0.0304	-0.0175	-0.0220	-0.0356	-0.0458	**-0.3752**
DFH	0.0113	0.0645	0.0158	0.0301	-0.0155	0.0988	0.1070	0.0964	0.0750	**0.1222**	-0.1027	0.0384	0.0420	-0.0051	-0.0140	-0.0001	**-0.1415**
NFV	0.1373	-0.0258	0.1470	0.1206	0.2403	-0.2505	-0.4242	-0.2352	-0.2501	-0.5004	**0.5953**	-0.1124	-0.3956	0.2824	0.2600	0.1310	**0.4660**
FW	0.4495	0.7564	0.4102	0.6265	0.3312	0.0101	0.0546	-0.0988	-0.1659	0.2832	-0.1702	**0.9012**	0.3001	0.4534	0.5341	0.6408	**0.7418**
FL	0.0151	-0.0004	0.0155	0.0028	0.0031	-0.0029	-0.0134	0.0112	0.0064	-0.0208	0.0402	-0.0201	**-0.0604**	0.0341	0.0110	0.0019	**-0.2208**
FD	0.1625	0.1368	0.1611	0.1435	0.1068	-0.0069	-0.0449	0.0102	-0.0331	-0.0103	0.1177	0.1248	-0.1400	**0.2481**	0.1731	0.1563	**0.8015**
NSF	-0.2908	-0.3306	-0.3083	-0.3425	-0.2494	0.0319	0.1536	0.0945	0.0941	0.0499	-0.1905	-0.2585	0.0797	-0.3043	**-0.4361**	-0.2833	**0.8428**
100 SW	-0.2814	-0.3732	-0.3276	-0.4544	-0.4399	0.0669	0.1196	0.1169	0.1329	0.0005	-0.1054	-0.3405	0.0153	-0.3016	-0.3110	**-0.4788**	**0.8182**

Genotypic Residual effect=0.0927; Diagonal (under lined) values indicate direct effects; G: Genotypic
TL – Tendril length NNV – No. of nodes per vine NPBV – No. of primary branches per vine TVL – Total vine length
IL – Internodal length DFM – Days to first male flower appearance
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NFV – No. of fruits per vine FW – Fruit weight FL – Fruit length
FD – Fruit diameter YV – Yield per vine
NSF – No. of seeds per fruit 100 SW – 100 seed weight

tendril length, number of nodes per vine, number of primary branches per vine, total vine length, internodal length, number of fruits per vine, fruit weight, fruit diameter, number of seeds per fruit and 100 seed weight indicated that simultaneous improvement can be made if selection is made for any one of the correlated traits. Path analysis revealed that total vine length, number of fruits per vine, fruit weight and fruit diameter exerted a high positive direct effect on fruit yield per vine. The characters like tendril length, no. of primary branches per vine, no. of nodes per vine, no. of seeds per fruit and 100 seed weight , though have significant positive correlation with yield, exhibited low direct effects. Besides direct selection for yield, indirect selection through fruit diameter, no. of seeds per fruit and 100 seed weight would prove worth for further improvement in the yield of bottle gourd.

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