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CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS IN BOTTLE GOURD (*LAGENARIA SICERARIA* MOL.) GENOTYPES

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Abstract

The present study was conducted with 24 bottle gourd genotypes including one check variety *i.e.* Pusa Naveen, sown in Randomized Block Design (RBD) with three replications in spring summer- 2012 to assess the nature and magnitude of association among yield and its contributing traits in bottle gourd. Correlation studies revealed that yield per vine had significant positive association with 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) both at phenotypic and genotypic levels indicating the importance of these traits in selection for yield and are identified as yield attributing characters. The character association revealed the overriding importance of fruit length and diameter in determining the average fruit weight. Path co-efficient analysis revealed that maximum direct contribution towards yield per vine with total vine length (m), number of fruits per vine and fruit weight (g). Hence, direct selection for total vine length (cm), number of fruits per vine and fruit weight (g) may be reliable for yield improvement in bottle gourd.

Key words: Bottle gourd, character association, path coefficient analysis and selection.

Introduction

Bottle gourd or white flower gourd is one of the most popular cucurbits in India with diploid chromosome number 2n=22. It is mainly grown as rainy and summer season vegetable. But it can't tolerate cold. It is a rich source of potassium, vitamin C, protein, sulphur, fat and phosphorous. It is good for people suffering from biliousness and indigestion (Thumburaj and Singh, 2003). It is a highly cross pollinated crop due to its monoecious and andromonecious nature (Swiander *et al.*, 1994) and has wide genetic diversity. It is originated in Africa (Singh, 1990) and from there by floating on the seas, it travelled to India. Bottle gourd in India has a tremendous potential for export and has created a huge demand in Gulf markets already. 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 immnse help in selecting suitable genotype.

However, where the number of independent variables influencing a particular dependant variable increased, certain amount of independence arises among independent variables. Under such complex condition, the correlations are alone not sufficient to explain the true association for an effective manipulation of the traits. Knowledge of correlations, if accompanied by the understanding of the magnitude of contribution (direct and indirect) of each of the component characters to the final make up of fruit yield, the selection criteria formulated would be effective in selecting the genotypes and using them effectively in crop improvement programme. Path analysis facilitates the partitioning of correlation coefficient in the direct and indirect effects on yield and yield attributing traits. Therefore, an attempt was made to ascertain the magnitude of correlation and path analysis in bottle gourd genotypes.

Materials and Methods

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

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Table 1: Phenotypic correlation matrix 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	1.0000	0.4045**	0.5165**	0.3813**	0.1515	-0.0698	-0.1237	-0.1676	-0.2220	-0.0678	0.1896	0.4461**	-0.1758	0.5427**	0.4971**	0.4774**	0.5894**
NNV		1.0000	0.3963**	0.6701**	0.0595	0.0513	0.0776	0.0373	0.0735	0.2120	0.0212	0.5014**	0.0130	0.3636**	0.4917**	0.4717**	0.5499**
NPBV			1.0000	0.5507**	0.3791**	0.0586	-0.1638	-0.0597	-0.0740	0.1019	0.2270	0.3437**	-0.1820	0.4946**	0.5469**	0.5420**	0.5604**
TVL				1.0000	0.7759**	0.0516	-0.0463	-0.0288	-0.0534	0.1041	0.1298	0.4275**	0.0231	0.3648**	0.4943**	0.6082**	0.5365**
IL					1.0000	0.0279	-0.1176	-0.0562	-0.1405	-0.0374	0.1312	0.1545	0.0501	0.1547	0.2047	0.3925**	0.2332*
DFM						1.0000	0.4763**	0.7468**	0.2365*	0.5925**	-0.3745**	-0.0130	0.0569	-0.0343	-0.0671	-0.1289	-0.1732
DFF							1.0000	0.6239**	0.6019**	0.7430**	-0.4429**	-0.0004	0.1106	-0.1389	-0.2301	-0.1733	-0.2157
NFM								1.0000	0.5669**	0.5485**	-0.3745**	-0.0130	0.0569	-0.0343	-0.0671	-0.1289	-0.2142
NFF									1.0000	0.4841**	-0.3298**	-0.1669	-0.0861	-0.1248	-0.1910	-0.2019	-0.2993*
DFH										1.0000	-0.5174**	0.1729	0.1739	-0.0628	0.0673	0.0149	-0.0761
NFV											1.0000	-0.1594	-0.5835**	0.4368**	0.3987**	0.1949	0.5100**
FW												1.0000	0.3232**	0.4754**	0.5433**	0.6500**	0.7162**
FL													1.0000	-0.5337**	-0.1828	-0.0293	-0.1822
FD														1.0000	0.6636**	0.6115**	0.7482**
NSF															1.0000	0.6043**	0.7645**
100 SW																1.0000	0.7479**

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

TL= Tendril length; NNV= Number of Nodes per Vine; NPBV=Number of Primary branches per Vine; TVL=Total Vine Length
IL=Internodal length; DFM=Days to 1st male flower; DFF=Days to 1st female flower; NFM=Node at 1st male flower
NFF=Node at 1st female flower; DFH= Days to 1st fruit harvest; NFV=number of fruits per vine; FW=Fruit weight
FL= Fruit length; FD= Fruit Diameter; NSF=Number of seeds per fruit; 100SW= 100 seed weight

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 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 appearance, node at which 1st female flower appearance, 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).

Results and Discussion

Phenotypic and genotypic correlation co-efficient among different pairs of characters of bottle gourd are presented in table 1 & 2. Correlation studies showed that genotypic correlation appeared to be higher than the corresponding phenotypic correlation. These observations indicated that in majority of the cases, the environment had not appreciable influenced the expressions of characters 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

Table 2: Genotypic correlation matrix 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	1.0000	0.6051**	0.8165**	0.6383**	0.4997**	-0.0325	-0.0517	-0.2043	-0.2854*	0.0923	0.2306	0.4988**	-0.2507*	0.6550**	0.6667**	0.5877**	0.6832**
NNV		1.0000	0.7113**	0.8692**	0.4648**	0.0582	0.0138	-0.0297	0.0492	0.5279**	-0.0433	0.8394**	0.0070	0.5513**	0.7580**	0.7793**	0.8347**
NPBV			1.0000	0.7953**	0.6687**	0.0212	-0.1861	-0.0365	-0.0596	0.1295	0.2470*	0.4552**	-0.2558*	0.6494**	0.7068**	0.6842**	0.6945**
TVL				1.0000	0.8475**	0.1113	-0.1022	-0.0510	-0.1194	0.2462*	0.2026	0.6952**	-0.0464	0.5782**	0.7853**	0.9490**	0.8642**
IL					1.0000	0.1503	-0.1833	-0.0529	-0.2673*	-0.1267	0.4037**	0.3675**	-0.0518	0.4303**	0.5717**	0.9187**	0.6673**
DFM						1.0000	0.6647**	0.8324**	0.3622**	0.8088**	-0.4209**	0.0112	0.0476	-0.0278	-0.0731	-0.1398	-0.1803
DFF							1.0000	0.8242**	0.6938**	0.8756**	-0.7126**	0.0605	0.2225	-0.1808	-0.3521**	-0.2498*	-0.3473**
NFM								1.0000	0.7509**	0.7888**	-0.3951**	-0.1096	-0.1854	0.0413	-0.2166	-0.2442*	-0.2678*
NFF									1.0000	0.6141**	-0.4201**	-0.1841	-0.1060	-0.1333	-0.2157	-0.2776*	-0.3752**
DFH										1.0000	-0.8406**	0.3142**	0.3441**	-0.0417	-0.1143	-0.0011	-0.1415
NFV											1.000	-0.1888	-0.6661**	0.4745**	0.4367**	0.2200	0.4660**
FW												1.0000	0.3330**	0.5031**	0.5927**	0.7111**	0.7418**
FL													1.0000	-0.5643**	-0.1827	-0.0319	-0.2208
FD														1.0000	0.6977**	0.6300**	0.8015**
NSF															1.0000	0.6496**	0.8428**
100 SW																1.0000	0.8182**

***Significant at 5 per cent level; ** Significant at 1 per cent level**

TL= Tendril length; NNV= Number of Nodes per Vine; NPBV=Number of Primary branches per Vine; TVL=Total Vine Length
IL=Internodal length; DFM=Days to 1st male flower; DFF=Days to 1st female flower; NFM=Node at 1st male flower
NFF=Node at 1st female flower; DFH= Days to 1st fruit harvest; NFV=number of fruits per vine; FW=Fruit weight
FL= Fruit length; FD= Fruit Diameter; NSF=Number of seeds per fruit; 100SW= 100 seed weight

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 level. 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 Husan *et al.* (2011) and Kamal *et al.* (2012) in bottle gourd; Kumar *et al.* (2008), Arun kumar *et al.* (2011) and Hossian *et al.* (2010) in cucumber 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 fruit weight non significant negative correlation with 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 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 appearance. 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 above associations with yield was 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

Table 3: 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

TL= Tendril length; NNV= Number of Nodes per Vine; NPBV=Number of Primary branches per Vine; TVL=Total Vine Length
IL=Internodal length; DFM=Days to 1st male flower; DFF=Days to 1st female flower; NFM=Node at 1st male flower
NFF=Node at 1st female flower; DFH= Days to 1st fruit harvest; NFV=number of fruits per vine; FW=Fruit weight
FL= Fruit length; FD= Fruit Diameter; NSF=Number of seeds per fruit; 100SW= 100 seed weight

picture of the relationship between yield components and yield. The correlation coefficients between various characters were portioned into direct and indirect relationship by the path analysis technique. Path coefficient analysis (table 3 & 4.) 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. Husan *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 appearance, 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 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 appearance, 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.

Table 4: 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**
100SW	-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

TL = Tendril length; NNV = Number of Nodes per Vine; NPBV = Number of Primary branches per Vine; TVL = Total Vine Length
IL = Internodal length; DFM = Days to 1st male flower; DFF = Days to 1st female flower; NFM = Node at 1st male flower
NFF = Node at 1st female flower; DFH = Days to 1st fruit harvest; NFV = number of fruits per vine; FW = Fruit weight
FL = Fruit length; FD = Fruit Diameter; NSF = Number of seeds per fruit; 100SW = 100 seed weight

Concusion

Correlation and path analysis studies were conducted with twenty three genotypes and one check variety of bottle gourd. Positively significant associations of yield per vine with 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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