

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.807.343>

## Character Association and Path Coefficient Analysis in F<sub>3</sub> Population of Bottle Gourd

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### ABSTRACT

Yield is a complex character controlled by a large number of contributing characters and their interactions. For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters with yield. The path coefficient technique helps in estimating direct and indirect contribution of various components in building up the total correlation towards yield. The present study was conducted with 10 lines and bottle gourd genotypes including one check variety *i.e.* Kanak, sown in Randomized Block Design (RBD) with three replications in rainy season-2015 to assess the nature and magnitude of association among yield and its contributing traits in bottle gourd at Vegetable Research Farm of the Department of Horticulture, Institute of Agricultural Sciences, BHU, Varanasi. A highly significant and positive genotypic correlation was observed for number of fruits per plant with fruit yield per plant (kg) and fruit weight (kg) while this character had highly significant negative association with fruit girth (cm). Path coefficient analysis revealed that average fruit weight had the highest positive direct effect on fruit yield followed by number of fruits per plant, fruit girth (cm), days to 50% male flowering, fruit length (cm), days to 50% female flowering and number of primary branches per vine.

#### Keywords

Yield, Correlation,  
Path coefficient  
analysis

#### Article Info

##### Accepted:

20 June 2019

##### Available Online:

10 July 2019

### Introduction

Bottle gourd (*Lagenaria siceraria*), one of the oldest crop of tropics and one of the least calorie vegetable, providing just 14 calories per 100 g is attaining fast popularity among the health conscious urban elite. In vegetable breeding programmes the co-relation coefficient analysis have been used frequently in order to know the mutual relationship between variables, affecting the target variables and the finding and guide for

component variable on which selection should be based for future improvement. Simple correlation gives information about inheritance of two characters and identifies the characters needed for improvement of the target parameters. It reveals both the strength as well as nature of relationship between two characters. Significance of correlation value means the association between two characters is high. Negative co-relation means the increase in one variable will lead to decrease in other variable. When value of genotypic

co-relation is higher than phenotypic co-relation the association between two characters is strong genetically. The correlation coefficient needs to be split into direct and indirect effects using path coefficient analysis for critical evaluation as many characters affect a given trait. Thus, the correlation and path analysis in combination can give a better insight into cause and effect relationship between different pairs of characters.

If the correlation coefficient between a causal factor and the effect is almost equal to its direct effects, then correlation explains the true relationship through this trait will be effective. If the correlation coefficient is positive, but the direct effect is negative or negligible, the indirect effects seem to be cause of positive correlation. In such situations, the indirect causal factors are to be considered simultaneously for selection. Correlation coefficient may be negative but the direct effect is positive and high. Under these circumstances, a restricted simultaneous selection model is to be followed *i.e.* restrictions to be imposed to nullify the undesirable indirect effects in order to make use of the direct effect. The residual effect determines how best the causal factors account for the variability of the dependent factor. If residual effect is high, some other factors, which have not been considered here, need to be included in this analysis to account fully for the variation in yield.

Using path coefficient analysis for critical evaluation as many characters affect a given trait. Thus, the correlation and path analysis in combination can give a better insight into cause and effect relationship between different pairs of characters. Positive and significant correlation coefficient was recorded for fruit yield per plant along with days to anthesis of first female flower, vine length, number of primary branches, lengths

of fruit, weight of fruit and number of fruits per plant. Positive and direct effects of length of fruit, weight of fruit and number of fruits per plant on yield signify the importance of traits in bottle gourd improvement (Husna *et al.*, 2011; Yadav and Kumar, 2011).

## **Materials and Methods**

The experimental materials for the study comprised of 10 lines and 25 F<sub>3</sub> genotypes of bottle gourd (*Lagenaria siceraria* (Molina) Standley) provided by the Department of Horticulture, Institute of Agricultural Sciences, BHU, Varanasi. The experiment was planted at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during rainy season in the year 2015 following Randomised Block Design with three replications with 12 blocks and 105 plots having 10 plants per plot. The distance between plant to plant 2 m, and row to row 0.6 m was maintained. Fertiliser was applied at the rate of 100:75:60 NPK respectively was applied to the soil and light irrigation was applied during the cropping period.

Data were recorded for nineteen quantitative morphological, phenological and yield parameters from five plants in each replication. The genotypic and phenotypic correlation coefficient based on variance and covariance components was computed by the formula suggested by Al-jibouri *et al.*, (1958). The variance analysis for each character and covariance analysis for each pair characters were calculated. All the possible simple correlation coefficients among independent and dependent variables were calculated. Working out path analysis was done in three steps: direct effects, indirect effects and residual effects as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

## Results and Discussion

Progress of selection depends not only on the proportion of genetic variance that a breeder uses in determining the magnitude of heritability but the practical objective also includes assessment of nature and magnitude of interrelationship existing among characters of economic worth, and the once that contribute to their performance directly or indirectly. The genotypic and phenotypic correlation coefficient between fruit yield and its component characters in F<sub>3</sub> population of bottle gourd were exhibited in Table 1 and Table 2. In the present study it was revealed that the genotypic correlation coefficient was found to be highly significant and positive for days to first germination, average fruit weight, number of fruits per plant and fruit girth with fruit yield per plant. Similar results were noticed in number of fruits per plant by Mlavedonic *et al.*, (2012) and Janaranjani *et al.*, (2015) and in fruit weight (kg) by Ahmed *et al.*, (2005) and Husna *et al.*, (2011).

Significant and negative correlation was noticed with days to 50% female flowering. Days to 50% germination exhibited highly significant positive association with number of primary branches per vine and significant negative association with vine length and fruit length. Vine length showed highly significant positive association with average fruit weight, fruit yield per plant, and number of fruits per plant and fruit length. Genotypic correlation coefficient for number of primary branches per vine showed significant negative association with two traits namely days to 50% male flowering and days to 50% female flowering, while significant positive correlation was observed for three characters *i.e.* number of fruits per plant, fruit yield per plant and average fruit weight. Highly significant positive correlations for days to 50% male flowering were observed with days to 50% female flowering. This trait showed

significant negative correlation with number of fruits per plant and fruit yield per plant. Days to 50% female flowering showed negative association with traits like fruit yield per plant, number of fruits per plant, average fruit weight and fruit girth. A highly significant and positive genotypic correlation was observed for number of fruits per plant with fruit yield per plant and average fruit weight while this character had highly significant negative association with fruit girth. Fruit length had highly significant and positive genotypic correlation with average fruit weight and also with fruit yield per plant. Fruit girth had significant and positive genotypic correlation with average fruit weight. Average fruit weight showed highest significant and positive correlation with fruit yield per plant.

Number of days for first germination registered positive significant phenotypic correlation with fruits per plant and average fruit weight where as it showed non-significant positive phenotypic correlation with days to 50% germination, vine length, number of primary branches per vine, fruit length, fruit girth. It exhibited negative non-significant phenotypic correlation with days to 50% female flowering. Days to 50% germination registered significant positive phenotypic correlation with number of primary branches per vine. It has positive non-significant correlation with days to first germination, days to 50% male flowers, number of fruits per plant and fruit girth. It exhibited negative significant correlation with vine length and negative non-significant phenotypic correlation with days to 50% female flowering, fruit length and average fruit weight. Vine length has significant positive phenotypic correlation with number of primary branches per vine, number of fruits per plant, fruit length and average fruit weight. Vine length has positive non-significant correlation with fruit girth and

negative non-significant correlation with days to 50% male flowering, and days to 50% female flowering. Number of primary branches per vine recorded positive significant correlation with number of fruits per plant and fruit girth. It showed positive non-significant correlation with fruit length and average fruit weight. The trait had negative significant correlation with days to 50% female flowering and negative non-significant correlation with days to 50% male flowering. Number of fruits per plant recorded positive significant correlation with days to first germination, vine length non-significant correlation with fruit length and average fruit weight and negative significant correlation with fruit girth. Mladenovic *et al.*, (2012) had revealed positive significant association of fruit length and negative significant association of fruit weight with vine length in bottle gourd.

Accordingly days to first male flowering, days to first female flowering, node number at which first female flower appears,, number of primary branches per vine,, number of fruits per plant, fruit length, fruit girth, average fruit weight, were taken as independent variables and their contribution towards total fruit yield per plant (dependant trait) was determined. The data revealed that fruit weight showed the highest positive direct effect on fruit yield followed by number of fruits per plant, fruit girth, days to 50% male flowering, fruit length, days to 50% female flower and number of primary branches per vine whereas, days to 50% germination and days to first germination showed negative direct effects on fruit yield per plant (kg).

Days to first germination showed positive indirect effect on fruit yield through average fruit weight, number of fruits per plant, fruit length, number of primary branches per vine, and fruit girth. Similarly, days to 50% germination exhibited positive indirect effect

on fruit yield per plant *via.* fruit yield per plant, fruit girth, number of primary branches per vine and days to 50% male flowering. Vine length exhibited positive indirect effect on fruit yield per plant through fruit weight, fruit yield per plant, days to 50% germination, number of primary branches per vine and fruit girth. Number of primary branches per vine had positive indirect effect on fruit yield through number of fruits per plant, fruit weight and fruit girth. Days to 50% male flowering showed positive indirect effect on fruit yield per plant through days to 50% female flowering and fruit girth. Days to 50% female flower showed positive indirect effect on fruit yield per plant through days to 50% male flowering, days to first germination. Number of fruits per plant had positive indirect effect through vine length, fruit length and average fruit weight. Fruit length showed positive indirect effect on fruit yield per plant through average fruit weight, days to 50% germination and number of fruits per plant. Fruit girth showed positive indirect effect on fruit yield per plant through fruit weight. Fruit weight showed positive indirect effect on fruit yield per plant through number of fruits per plant, fruit length and fruit girth. The effect of residual factor (0.406) on fruit yield per plant indicated that some other major components like number of male flowers, number of female flowers, sex ratio would have been included in the study affecting fruit yield per plant.

The correlation coefficients, in the present investigation both at the phenotypic and genotypic levels, indicated that character association in general were more favourable for breeding high yielding cultivars in bottle gourd. The estimates of genotypic correlation coefficients were mostly found to be higher in magnitude, though similar in direction than their corresponding estimates of phenotypic correlation coefficients.

**Table.1 Genotypic correlation coefficient between fruit yield and its component characters in bottle gourd**

Order	Character	Days to first germination	Days to 50% germination	Vine length (cm)	Number of primary branches per vine	Internodal length (cm)	Number of internodes per vine	Node number at which first male flower appears	Node number at which first female flower appears	Days to 1st male flowering	Days to 50% male flowering	Days to 1st female flowering	Days to 50% female flowering	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (kg)	Yield per plant (kg)
1	Days to first germination	1.000	-0.053	0.034	0.116	<b>0.409*</b>	-0.129	-0.091	<b>-0.335*</b>	-0.197	-0.302	<b>-0.334**</b>	<b>-0.433**</b>	<b>0.319*</b>	0.170	0.285	<b>0.461**</b>	<b>0.478**</b>
2	Days to 50% Germination		1.000	-0.275	<b>0.354*</b>	0.012	<b>-0.597**</b>	<b>-0.412*</b>	-0.157	-0.131	0.064	-0.142	-0.090	0.135	-0.293	0.226	-0.138	-0.039
3	Vine length (cm)			1.000	0.219	<b>0.339*</b>	<b>0.497**</b>	-0.302	-0.061	-0.058	-0.163	-0.123	-0.161	<b>0.331*</b>	0.260	0.040	<b>0.520**</b>	<b>0.527**</b>
4	Number of primary branches per Vine				1.000	-0.002	-0.282	-0.287	-0.224	<b>-0.325*</b>	-0.294	<b>-0.431**</b>	-0.400	<b>0.497**</b>	0.007	0.204	0.197	0.314
5	Internodal length (cm)					1.000	0.124	-0.206	<b>-0.460**</b>	0.001	-0.163	-0.264	<b>-0.356*</b>	<b>0.447**</b>	-0.081	0.091	<b>0.412**</b>	0.4552
6	Number of internodes per vine						1.000	0.075	-0.0106	0.059	-0.059	0.232	0.134	0.024	0.222	-0.464**	0.109	0.038
7	Node number at which first male flower appears							1.000	<b>-0.513**</b>	-0.208	-0.293	-0.289	-0.234	-0.178	0.173	-0.1649	-0.039	0.160
8	Node number at which first female flower appears								1.000	0.219	0.349*	<b>0.637**</b>	<b>0.647**</b>	-0.284	-0.051	0.0437	<b>-0.364*</b>	<b>0.344*</b>
9	Days to first male flowering									1.000	<b>0.890**</b>	<b>0.520**</b>	<b>0.501**</b>	<b>-0.607**</b>	-0.129	0.129	-0.130	<b>-0.394*</b>
10	Days to 50% male flowering										1.000	<b>0.593**</b>	<b>0.591**</b>	<b>-0.516**</b>	-0.160	0.054	-0.139	<b>-0.343*</b>
11	Days to first female flowering											1.000	<b>0.957**</b>	<b>-0.460**</b>	-0.143	-0.240	-0.290	<b>-0.440**</b>
12	Days to 50% female flowering												1.000	<b>-0.506**</b>	-0.026	-0.258	<b>-0.355*</b>	<b>-0.520**</b>
13	Number of fruits per plant													1.000	0.000	<b>-0.377*</b>	<b>0.342*</b>	<b>0.656**</b>
14	Fruit length (cm)														1.000	-0.062	<b>0.394*</b>	0.277
15	Fruit girth(cm)															1.000	0.2756	0.054
16	Average fruit weight (kg)																1.0000	<b>0.979**</b>

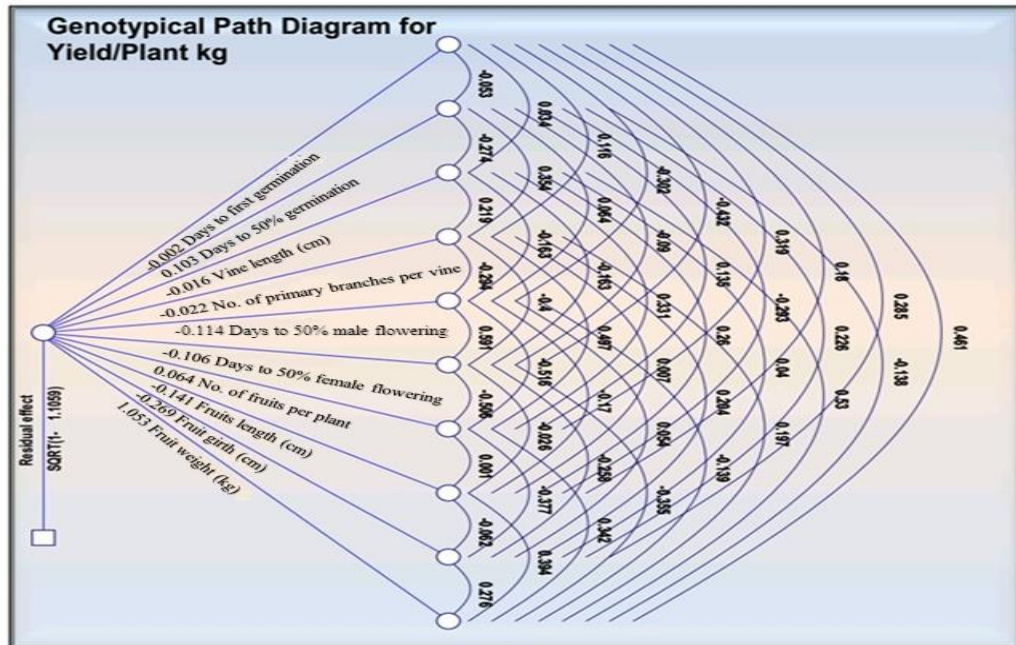
Table.2 Phenotypic correlation coefficient between yield and its component character in bottle gourd

Character	Days to first germination	Days to 50% germination	Vine length (cm)	Number of primary branches per vine	Internodal length (cm)	Number of internodes per vine	Node number at which first male flower appears	Node number at which first female flower	Days to 1st male flowering	Days to 50% male flowering	Days to 1st female flowering	Days to 50% female flowering	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (kg)	Yield/Plant (kg)
Days to First Germination	<b>1.000</b>	0.190	0.039	0.136	0.313	-0.098	0.0142	-0.152	0.013	-0.076	-0.145	-0.176	0.210	0.141	0.190	0.293	0.298
Days to 50% Germination		<b>1.000</b>	-0.200	0.272	0.051	<b>-0.482**</b>	-0.1760	-0.030	0.015	0.101	-0.031	-0.005	0.105	-0.262	0.119	-0.077	-0.080
Vine Length cm			<b>1.000</b>	0.224	<b>0.327*</b>	<b>0.497**</b>	-0.1774	-0.011	0.001	-0.089	-0.065	-0.101	0.253	0.250	0.039	<b>0.443**</b>	<b>0.494**</b>
Primary Branches/ Vine				<b>1.000</b>	0.090	-0.249	-0.0840	-0.122	-0.129	-0.111	-0.252	-0.209	<b>0.416**</b>	0.044	0.201	0.132	<b>0.326*</b>
Internodal Length cm					<b>1.000</b>	0.142	0.0182	-0.233	0.122	0.027	-0.067	-0.149	0.247	-0.030	0.052	<b>0.328*</b>	<b>0.398*</b>
Number of internodes/ Vine						<b>1.000</b>	0.0847	0.026	0.092	-0.013	0.228	0.140	-0.007	0.217	<b>-0.446**</b>	0.103	0.045
Node number at which first male flower appears							<b>1.0000</b>	-0.104	0.032	0.019	0.033	0.003	-0.114	0.140	-0.122	0.010	0.033
Node number at which first female flower appears								<b>1.000</b>	0.301	<b>0.416**</b>	<b>0.631**</b>	<b>0.587**</b>	-0.208	-0.041	-0.001	-0.230	0.247
Days to 1st male flowering									<b>1.000</b>	<b>0.816**</b>	<b>0.510**</b>	<b>0.533**</b>	<b>-0.357*</b>	-0.061	0.090	-0.087	0.188
Days to 50% Male Flowering										<b>1.000</b>	<b>0.622**</b>	<b>0.586**</b>	-0.299	-0.082	0.043	-0.100	0.156
Days to 1st female flowering											<b>1.000</b>	<b>0.878**</b>	-0.279	-0.088	-0.198	-0.231	-0.277
Days to 50% Female Flowering												<b>1.000</b>	-0.280	0.034	-0.182	-0.287	-0.297
Number of fruits per plant													<b>1.000</b>	0.033	-0.195	0.025	<b>0.499**</b>
Fruit Length (cm)														<b>1.000</b>	-0.021	0.309	0.311
Fruit girth(cm)															<b>1.000</b>	0.173	0.125
Average fruit Weight (kg)																<b>1.000</b>	<b>0.757**</b>

**Table.3 Direct and indirect effect of genotypic (G) path coefficient for 16 characters in 35 genotypes of bottle gourd**

SL. No.	Character	Days to First germination	Days to 50% germination	Vine length (cm)	Number of primary branches per vine	Internodal length (cm)	Number of internodes per vine	Node number at which first male Flower appears	Node number at which first female Flower appears	Days to first male flowering	Days to 50% male Flowering	Days to first female flowering	Days to 50% female flowering	Number of fruits/plant	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Fruit yield per plant(kg)
1	Days to first Germination	- <b>0.447**</b>	0.024	-0.015	-0.052	-0.183	0.058	0.04	0.1498	0.088	0.135	0.149	0.194	-0.143	-0.080	-0.127	-0.206	<b>0.478</b>
2	Days to 50% germination	0.075	- <b>1.405**</b>	0.3857*	-0.497**	-0.017	0.838**	0.5784*	0.2205	0.185	-0.080	0.190	0.127	-0.189	0.411**	-0.317*	0.194	<b>-0.039</b>
3	Vine length (cm)	0.006	-0.0469	<b>0.171</b>	0.037	0.058	0.085	-0.0517	-0.010	-0.010	-0.028	-0.021	-0.028	0.057	0.045**	0.007	0.091	<b>0.527</b>
4	Number of primary branches per vine	0.010	0.060	0.037	<b>0.171</b>	-0.000	-0.048	-0.0491	-0.038	-0.056	-0.050	-0.074	-0.068	0.085	0.001	0.035	0.034	<b>0.314</b>
5	Internodal length (cm)	0.156	0.005	0.129	-0.001	<b>0.382**</b>	0.047	-0.0787	-0.176	0.000	-0.062	-0.101	-0.136	0.171	-0.031	0.035	0.157	<b>0.455</b>
6	Number of internodes per vine	0.197	0.912**	-0.759**	0.431**	-0.180	- <b>1.529**</b>	-0.1153	0.016	-0.091	0.091	-0.355*	-0.205	-0.037	-0.339	0.709**	-0.167	<b>0.038</b>
7	Node number at which first male flower appears	0.168	0.756**	0.555**	0.528**	0.379**	-0.139	- <b>1.8367*</b>	0.942**	0.381*	0.538**	0.531**	0.420	0.326*	-0.318	0.303	0.072	<b>-0.160</b>
8	Node number at which first female flower appears	0.321	0.151	0.059	0.215	0.442**	0.010	0.492**	<b>-0.950**</b>	-0.211	-0.335*	-0.611**	-0.621**	0.272	0.049	-0.042	0.349*	<b>-0.344</b>
9	Days to first male flowering	0.432	0.288	0.128	0.713**	-0.002	-0.130	0.456**	-0.481**	- <b>2.195**</b>	-1.971**	-	-	1.333**	0.283	-0.284	0.306	<b>-0.394</b>
10	Days to 50% male flowering	-0.314	0.066	-0.169	-0.305*	-0.169	-0.062	-0.304	0.362*	0.932**	<b>1.038**</b>	0.616**	0.614**	-0.536**	-0.176	0.056	-0.144	<b>-0.343</b>
11	Days to first female flowering	-0.581**	-0.248	-0.213	-0.751**	-0.461**	0.404*	-0.504**	1.109**	0.922**	1.033**	<b>1.742**</b>	1.666**	-0.802**	-0.249	-0.418**	-0.506**	<b>-0.440</b>
12	Days to 50% female flowering	1.087**	0.227	0.409*	1.006**	0.894**	-0.338**	0.588**	-1.626**	-1.260**	-1.4865**	-2.405**	- <b>2.514**</b>	1.271**	0.066	0.648**	0.891**	<b>-0.520</b>
13	Number of fruits per plant	-0.676**	-0.285	-0.702**	-1.054**	-0.947**	-0.051	0.377**	0.602**	1.288**	1.094**	0.977**	1.072**	- <b>2.120**</b>	-0.001	0.799**	-0.725**	<b>0.656</b>
14	Fruit length (cm)	0.010	-0.032	0.028	0.001	-0.009	0.024	0.019	-0.006	-0.014	-0.0187	-0.0157	-0.003	0.0001	<b>0.100</b>	-0.007	0.043	<b>0.277</b>
15	Fruit girth (cm)	-0.464**	-0.368*	-0.066	-0.331	-0.148	0.755**	0.268	-0.071	-0.211	-0.0875	0.391*	0.410*	0.613**	0.100	- <b>1.628**</b>	-0.4487	<b>0.054</b>
16	Average fruit weight (kg)	0.478**	-0.144	0.549**	0.204	0.427**	0.113	-0.041	-0.378*	-0.145	-0.1443	-0.301*	0.368**	0.355**	0.408*	0.286	<b>1.037**</b>	<b>0.979**</b>

Fig.1 Genotypic path diagram for yield per plant (kg)



Interrelationship among various quantitative traits and yield contributing traits was observed to be significant and positive both at genotypic and phenotypic level. The results clearly revealed a scope of simultaneous improvement of these traits selection.

**Path coefficient analysis**

Degree of relationship through the estimate of correlation simply measures the nature of symmetrical association between various traits. In order to determine an efficient criterion for selection of various quantitative traits to improve the yield performance, it is essential to know the direct and indirect contribution of the traits towards this improvement through the study of cause and effect relationship.

Direct and indirect effect of genotypic path coefficient for 16 characters in 35 genotypes of bottle gourd is presented in Table 3. Genotypic path diagram for yield per plant

(kg) is exhibited by Figure 1. In present investigation, fruit weight followed by number of fruits per plant showed high positive and direct effect had significant positive correlation with fruit yield per plant (kg). Therefore, the fruits with higher weight and plants having more number of fruits should be considered in selection criteria for increasing fruit yield per plant. The present study suggested that more emphasis should be given to selecting genotypes with high fruit weight. Directly or indirectly all characters showed positive effect on fruit yield per plant, which is in confirmation to the finding of Umamaheswarappa *et al.*, (2004) who also reported that number of fruits per vine had maximum direct effect on fruit yield followed by fruit weight. Ahmed *et al.*, (2005) also reported that fruit weight; number of fruits per plant, fruit length had positive direct effects on fruit yield per plant of bottle gourd.

Direct effect have also been reported for average fruit weight (kg), fruit length (cm)



and various traits by Badade *et al.*, 2001; Kumar *et al.*, 2007; Yadav *et al.*, 2007 and Pandit *et al.*, 2009 in bottle gourd; Singh *et al.*, 2002 and Rao *et al.*, 2004 in cucumber, Dora *et al.*, 2002 in pointed gourd, Choudhary *et al.*, 2003 in muskmelon, and Rolonia *et al.*, 2003 in watermelon, and Narankutty *et al.*, 2006 in snake gourd.

In conclusion, for most of the characters genotypic correlation coefficients were higher than phenotypic correlation coefficients indicating lesser phenotypic expression under the influence of environment. Days to first germination, vine length, number of primary branches per vine, days to 50% female flowering, fruit weight and fruit length registered a positive significant correlation at both phenotypic and genotypic levels with fruit yield per plant indicating the importance of these traits in selection for yield and are identified as yield attributing characters on which selection can be relied upon for the genetic improvement of yield of bottle gourd. Overall the path analysis confined that direct effect of fruit weight, number of fruits per plant, fruit girth, days to 50% male flowering, fruit length, days to 50% female flowering and number of primary branches per vine whereas, indirect effect of days to days to 50% germination, vine length, fruit girth should be considered simultaneously for amenability in fruit yield per plant of bottle gourd. The high direct effect of these traits appeared to be the main factors for their strong association with fruit yield per plant (kg). Hence, direct selection for these traits should be effective indicating the effectiveness of direct selection. The estimates of residual variability demonstrate that some other traits like sex ratio, 100 seed weight would have been considered in the evaluation of selective potential of present material. On the basis of these studies the quantum importance of individual character is marked to facilitate the selection programme for better gains.

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**How to cite this article:**

Das, S.P. and Singh, A.K. 2019. Character Association and Path Coefficient Analysis in F<sub>3</sub> Population of Bottle Gourd. *Int.J.Curr.Microbiol.App.Sci*. 8(07): 2748-2757.  
doi: <https://doi.org/10.20546/ijcmas.2019.807.343>