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Original Research Article

Correlation and Path Coefficient Analysis for Yield and Yield Contributing Traits in Brinjal (*Solanum melongena* L.)

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A B S T R A C T

The associations of yield and its components offer important information in any breeding programme by furnishing information regarding the nature and magnitude of various traits and help in measurement of direct effect of one variable on other. In the present investigation, genotypic and phenotypic correlation coefficients and path coefficient analysis were carried out by evaluating twenty two genotypes of brinjal (*Solanum melongena* L.) for thirteen quantitative traits. Analysis of variance suggested significant difference among all the genotypes for all the traits under study. In general, magnitudes of genotypic correlation coefficient were higher than their corresponding phenotypic correlation coefficient, implying a significant inherent relationship in different pair of traits. Based on the correlation coefficient analysis, fruit yield per plant had significant and positive association with number of fruits per plant and fruit length both at genotypic and phenotypic levels. Path coefficient analysis showed that the traits *viz*., number of fruits per plant and fruit weight exhibited highest direct effects on fruit yield and also indirectly influenced the other yield contributing traits of brinjal. It was concluded from the study that these traits shall be used as key indices towards the direct selection of elite genotypes for the successful breeding programme for yield improvement of brinjal germplasm.

Introduction

Brinjal or eggplant (*Solanum melongena* L.) is one of the most popular vegetable crops belonging to the family Solanaceae. It is widely grown for its tender fruits in tropics and subtropics (Chowdhury and Tah, 2011), especially in Central, Southern and Southeast Asia and in some African countries except high altitudes. The immature and tender fruits are used in different Indian cuisine like *pakoras*, *bharta* and in curries (Singh *et al*., 2014) which makes it versatile and most common vegetable crop in India. It is also known as poor man's vegetable owing to its highest production potential and easy availability among the consumers. India is regarded as its centre of origin, where the large fruited cultivars have been domesticated (De Candolle, 1886). But, Vavilov (1928) was in the opinion that its source of origin was in the area of Indo-Burma, with Indian sub-continent and China being primary and secondary centers of diversity (Zeven and Zhukovsky 1975; Nath *et al*., 1987).

In India, brinjal cultivation is taken up in an area of 0.67 million hectares with an annual production of 12.40 million tonnes and productivity of 18.51 t/ha (Anonymous, 2018). It is hardy annual herbaceous plant with erect or semi-spreading growth habit. The heterostyly behavior makes it an often cross pollinated crop (Timmapur, 2008). Inflorescence is often solitary but sometimes it constitutes a cluster of 2-5 flowers. Flower is complete and hermaphrodite. There is a plenty of variability in brinjal for fruit colour and shape. There are three main botanical varieties under the species *Solanum melongena* L. The round or egg shaped cultivars are grouped under var. *esculentum*, the long, slender types are included under var. *serpentinum* and dwarf brinjal plants are categorized under var. *depressum*.

Brinjal has a healthy nutritional profile. The fruits are low in calories and contain a good amount of minerals like potassium, calcium, sodium, iron, zinc and copper as well as dietary fibre (USDA, 2014). Besides this, brinjal fruits are reported to be a rich source of ascorbic acid and phenolics (Somawathi *et al.*, 2014; Tripathi *et al.*, 2014). Brinjal is a fair source of fatty acids and has got de-cholesterolizing property, due to the presence of 65.1 per cent linoleic and lenolenic poly-3-unsaturated fatty acids (Shafeeq, 2005). White brinjal is said to be good for diabetic patients (Tripathi *et al.*, 2014).

The basic goal of any crop improvement programmes is to increase crop yield potential, for which it is important to understand the physiological behavior of the existing material in the plant genetic pool and to determine the major traits affecting the yield. Although yield is the main objective of a breeder, direct selection of genotypes based on yield alone would not be effective, because yield is a complex character and is collectively influenced by association of many component traits. Hence, the knowledge of the association between yield and its component traits obtained through the estimation of correlations will make the selection competence more operative for the breeders (Rekha and Celine, 2013).

Further path coefficient analysis can be used to determine the traits having the greatest influence on yield and allow the partitioning of correlation coefficients into direct and indirect effects, giving the relative importance of each of the causal factors. The concept of path coefficient is a decision making tool helping the breeders to evaluate the contribution of each variable and to determine the direct and indirect effects of an independent variable on dependence variable (Akinnola, 2012). Thus, the investigation was undertaken to study the association of traits on yield and the direct and indirect effects of yield attributes on yield of brinjal in order to determine and select best genotypes for further brinjal improvement programme.

Materials and Methods

The present study was carried out at the Experimental Farm, Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP), India during *Kharif* 2019. The experimental material comprising of twenty two genotypes of brinjal was evaluated for thirteen horticultural traits. The details of the genotypes along with their source of availability are given in table 1. The experiment was laid out in RBD with three replications and the healthy seedlings from each genotype were planted at a recommended spacing of 60 × 45 cm. All the standard cultural practices and plant protection measures were followed uniformly from time to time to raise a healthy crop. After eliminating the border and unhealthy plants five plants were randomly selected in each genotype per replication for observations. Observations were recorded for thirteen different horticultural traits viz., days to 50 per cent flowering, days to first picking, number of fruits per plant, fruit length (cm), fruit breadth (cm), fruit volume (cc), fruit weight (g), number of leaves per plant, plant height (cm), plant spread (cm), number of primary branches per plant, stem girth (cm) and fruit yield per plant (g). In order to determine the relationships between examined traits and fruit yield, phenotypic and genotypic correlation coefficient were firstly calculated from the mean values of traits using the formulae of Johnson *et al.,* (1955). Further, path coefficient analysis was performed according to Dewey and Lu (1959) to compute the direct and indirect effects of the traits on fruit yield per plant.

Results and Discussions

Analysis of variance was conducted to exclude the variance from overall variation due to factors other than genotypes. The mean sum of squares showed significant variation among the evaluated genotypes for all the traits studied, indicating the presence of high degree of genetic variability among the genotypes which is useful for brinjal improvement.

Inheritance of quantitative trait like yield is often influenced by variation in other linked or pleiotropically affected trait (Hallard, 1939). Thus, character association study was conducted in order to know how various traits are correlated with yield and inter-correlated among each other, on which selection can be used for genetic improvement in the fruit yield. The genotypic and phenotypic correlation coefficient for fruit yield and its component traits in brinjal are presented in table 2. The present study indicated a strong inherent relationship between the traits, because the magnitude of genotypic correlation coefficient was generally higher than their corresponding phenotypic correlation coefficient. This may be due to the effect of environment in modifying the total expression of the genotypes, thus altering the phenotypic expression.

The trend of correlation coefficients revealed highest significant and positive association of fruit yield per plant with number of fruits per plant (0.686, 0.669) and fruit length (0.313, 0.263) both at genotypic and phenotypic level, respectively. Similar trends of positive and significant correlation were reported by Mangi *et al.,* (2016), Rathod *et al.,* (2016), Chauhan *et al.,* (2017), Gupta *et al.,* (2017) and Saha *et al.,* (2019). This suggested that fruit yield per plant can be enhanced by the selecting genotypes with more number of fruits per plant and fruits with greater length. However, the traits which exerted negative and significant correlation with fruit yield per plant were days to 50% flowering (-0.512, -0.492) and days to first picking (-0.509, -0.497) both at genotypic and phenotypic level and with stem girth (-0.258) only at genotypic level. Hence, this may be concluded that the traits viz., days to 50% flowering, days to first picking and stem girth can be taken into account for early fruit bearing of crop and the fruit yield per plant can be improved by simultaneous improvement in number of fruits per plant and fruit length.

Importance about the contribution made by each component character to fruit yield was of prime importance in evolving high yielding varieties. Therefore, genotypic and phenotypic correlations were further analyzed by path coefficient technique because correlation coefficients are the indication of simple association between variables. Correlation studies in combination with path coefficient analysis provide a better picture of the cause and effect relationship of different attributes by partitioning genotypic and phenotypic correlation coefficients into direct and indirect effects of various traits. A perusal of data (Table 3) revealed that number of fruit per plant exhibited highest significantly positive direct effect (1.112, 0.979) on fruit yield per plant both at genotypic and phenotypic, respectively. Further, fruit yield per plant was also directly influenced by significantly positive effects of fruit weight (0.808, 0.658) followed by fruit volume (0.147, 0.093) and plant height (0.105, 0.106) both at genotypic and phenotypic level, respectively. The results are in confirmation with the findings of Angadi *et al.,* (2017), Yadav *et al.*, (2018) and Saha *et al.,* (2019). The direct negative significant effect on fruit yield per plant was observed by traits viz., days to first picking (-0.263, -0.106) both at genotypic and phenotypic level. Whereas, fruit length (-0.086) and fruit breadth (-0.122) had significant negative direct effect on fruit yield per plant only at genotypic level and days to 50% flowering (-0.023) and number of leaves per plant (-0.015) had same effect at phenotypic level. The high indirect effect showed that most of the traits influenced the fruit yield per plant *via* fruit weight and number of fruits per plant suggesting that these traits should be considered in selection programme.

Table.1 List of brinjal (*Solanum melongena* L.) genotypes used in the present study

S.No.	Genotypes	Source(s)
1.	Jawahar Brinjal	ICAR-IIVR, Varanasi (UP)
2.	Kavya	ICAR-IIVR, Varanasi (UP)
3.	Swarna Shree	ICAR-IIVR, Varanasi (UP)
4.	BB-58	ICAR-IIVR, Varanasi (UP)
5.	CO-11	ICAR-IIVR, Varanasi (UP)
6.	DBR-8	ICAR-IIVR, Varanasi (UP)
7.	DRNKV-02-104	ICAR-IIVR, Varanasi (UP)
8.	DRNKV-104-43	ICAR-IIVR, Varanasi (UP)
9.	IVBL-116-131	ICAR-IIVR, Varanasi (UP)
10.	JB-2	ICAR-IIVR, Varanasi (UP)
11.	JB-18	ICAR-IIVR, Varanasi (UP)
12.	JB-67	ICAR-IIVR, Varanasi (UP)
13.	KKM-1	ICAR-IIVR, Varanasi (UP)
14.	NBJ-19	ICAR-IIVR, Varanasi (UP)
15.	PLR-1	ICAR-IIVR, Varanasi (UP)
16.	Pusa Purple Long	ICAR-IARI, New Delhi
17.	Pusa Purple Cluster	ICAR-IARI, New Delhi
18.	Bhagyamati	ICAR-IIVR, Varanasi (UP)
19.	PBH-4	PAU, Ludhiana (Punjab)
20.	PBH-3	PAU, Ludhiana (Punjab)
21.	PBHR-41	PAU, Ludhiana (Punjab)
22.	PBHR-42	PAU, Ludhiana (Punjab)

Table.2 Estimates of genotypic and phenotypic correlation co-efficient between yield and yield contributing traits of brinjal

TRAITS		DTFF	DTFP	NFPP	FL	FB	FV	FW	NLPP	PH	PS	NPBPP	SG	R with FYPP
DTFF	**G**	1.00	0.928**	-0.208	-0.234	0.046	-0.464**	-0.236	-0.152	0.193	0.044	0.036	0.165	**-0.512****
	P	1	0.874**	-0.206	-0.226	0.039	-0.423**	-0.217	-0.151	0.187	0.028	0.036	0.138	**-0.492****
DTFP	**G**			-0.304*	-0.293*	0.038	-0.381**	-0.101	-0.095	0.209	0.162	0.143	0.212	**-0.509****
	P			-0.291*	-0.240	0.039	-0.360**	-0.104	-0.087	0.194	0.141	0.135	0.199	**-0.497****
NFPP	**G**				0.216	-0.358**	-0.128	-0.569**	-0.379**	0.202	-0.079	-0.323**	-0.291*	**0.686****
	P				0.138	-0.360**	-0.114	-0.539**	-0.364**	0.191	-0.074	-0.284*	-0.276*	**0.669****
FL	**G**					-0.518**	-0.256*	0.073	0.451**	0.213	0.097	0.249*	-0.184	**0.313***
	P					-0.381**	-0.147	0.040	0.387**	0.129	0.057	0.196	-0.115	**0.263***
FB	**G**						0.549**	0.238	-0.021	-0.150	-0.061	0.001	0.461**	**-0.205**
	P						0.525**	0.215	-0.027	-0.158	-0.051	-0.010	0.446**	**-0.203**
FV	**G**							0.223	0.172	-0.215	0.129	0.010	0.053	**0.139**
	P							0.213	0.159	-0.196	0.107	0.021	0.054	**0.146**
FW	**G**								0.396**	-0.096	0.200	0.286*	0.063	**0.175**
	P								0.375**	-0.085	0.180	0.264*	0.047	**0.172**
NLPP	**G**									0.028	0.053	0.607**	0.356**	**-0.048**
	P									0.031	0.052	0.566**	0.339**	**-0.047**
PH	**G**										0.147	0.323**	0.054	**0.229**
	P										0.084	0.306*	0.037	**0.213**
PS	**G**											0.427**	0.147	**0.125**
	P											0.362**	0.136	**0.111**
NPBPP	**G**												0.386**	**-0.048**
	P												0.368**	**-0.034**
SG	**G**													**-0.258***
	P													**-0.242**
FYPP	**G**													**1.00**
	P													**1.00**

*significant at 5% level; **significant at 1% level, DTFF-Days to 50 per cent flowering, DTFP-Days to first picking, NFPP-Number of fruits per plant, FL-Fruit length (cm), FB-Fruit breadth (cm), FV-Fruit volume (cc), FW-Fruit weight (g), NLPP-Number of leaves per plant, PH-Plant height (cm), PS-Plant spread (cm), NPBPP-Number of primary branches per plant, SG-Stem girth (cm), FYPP- Fruit yield per plant (g), G-Genotypic level, P-Phenotypic Level

Table.3 Direct and indirect effects of different quantitative traits on the yield of brinjal genotypes at the genotypic and phenotypic level

TRAITS		DTFF	DTFP	NFPP	FL	FB	FV	FW	NLPP	PH	PS	NPBPP	SG	FYPP
DTFF	G	**0.180**	-0.244	-0.232	0.020	-0.006	-0.068	-0.191	-0.001	0.020	0.001	0.003	0.006	**-0.512****
	P	**-0.023**	-0.093	-0.202	-0.016	0.000	-0.039	-0.143	0.002	0.020	0.001	0.001	0.001	**-0.492****
DTFP	G	0.167	**-0.263**	-0.338	0.025	-0.005	-0.056	-0.081	-0.001	0.022	0.003	0.011	0.007	**-0.509****
	P	-0.020	**-0.106**	-0.285	-0.017	0.000	-0.034	-0.069	0.001	0.021	0.007	0.003	0.001	**-0.497****
NFPP	G	-0.037	0.080	**1.112**	-0.019	0.044	-0.019	-0.459	-0.003	0.021	-0.001	-0.024	-0.010	**0.686****
	P	0.005	0.031	**0.979**	0.010	-0.003	-0.011	-0.355	0.006	0.020	-0.004	-0.007	-0.002	**0.669****
FL	G	-0.042	0.077	0.241	**-0.086**	0.063	-0.038	0.059	0.003	0.022	0.001	0.018	-0.006	**0.313***
	P	0.005	0.026	0.135	**0.072**	-0.003	-0.014	0.026	-0.006	0.014	0.003	0.005	-0.001	**0.263***
FB	G	0.008	-0.010	-0.398	0.044	**-0.122**	0.081	0.192	0.000	-0.016	-0.001	0.000	0.016	**-0.205**
	P	-0.001	-0.004	-0.352	-0.027	**0.008**	0.049	0.141	0.000	-0.017	-0.002	0.000	0.003	**-0.203**
FV	G	-0.083	0.100	-0.142	0.022	-0.067	**0.147**	0.180	0.001	-0.022	0.002	0.001	0.002	**0.139**
	P	0.001	0.038	-0.112	-0.011	0.004	**0.093**	0.140	-0.002	-0.021	0.005	0.001	0.000	**0.146**
FW	G	-0.042	0.026	-0.633	-0.006	-0.029	0.033	**0.808**	0.003	-0.010	0.003	0.021	0.002	**0.175**
	P	0.005	0.011	-0.528	0.003	0.002	0.020	**0.658**	-0.006	-0.009	0.009	0.007	0.000	**0.172**
NLPP	G	-0.027	0.025	-0.422	-0.039	0.003	0.025	0.320	**0.007**	0.003	0.001	0.045	0.012	**-0.048**
	P	0.004	0.009	-0.356	0.028	0.000	0.015	0.247	**-0.015**	0.003	0.003	0.015	0.002	**-0.047**
PH	G	0.035	-0.055	0.225	-0.018	0.018	-0.031	-0.077	0.000	**0.105**	0.002	0.024	0.002	**0.229**
	P	-0.004	-0.021	0.187	0.009	-0.001	-0.018	-0.056	0.000	**0.106**	0.004	0.008	0.000	**0.213**
PS	G	0.008	-0.043	-0.088	-0.008	0.007	0.019	0.162	0.000	0.015	**0.015**	0.031	0.005	**0.125**
	P	-0.001	-0.015	-0.073	0.004	0.000	0.010	0.118	-0.001	0.009	**0.049**	0.009	0.001	**0.111**
NPBPP	G	0.006	-0.038	-0.359	-0.021	0.000	0.002	0.231	0.004	0.034	0.007	**0.074**	0.013	**-0.048**
	P	-0.001	-0.014	-0.278	0.014	0.000	0.002	0.174	-0.009	0.032	0.018	**0.026**	0.003	**-0.034**
SG	G	0.030	0.056	0.323	0.016	-0.056	0.008	0.051	0.002	0.006	0.002	0.028	**0.034**	**-0.258***
	P	-0.003	-0.021	-0.270	-0.008	0.003	0.005	0.031	-0.005	0.004	0.007	0.009	**0.007**	**-0.242**

Residual effect: 0.0218 and 0.1104 at genotypic and phenotypic level

Diagonal values= direct effect; half diagonal values = indirect effect

*significant at 5% level; **significant at 1% level, DTFF-Days to 50 per cent flowering, DTFP-Days to first picking, NFPP-Number of fruits per plant, FL-Fruit length (cm), FB-Fruit breadth (cm), FV-Fruit volume (cc), FW-Fruit weight (g), NLPP-Number of leaves per plant, PH-Plant height (cm), PS-Plant spread (cm), NPBPP-Number of primary branches per plant, SG-Stem girth (cm), FYPP- Fruit yield per plant (g), G-Genotypic level, P-Phenotypic Level.

The estimates of residual effect reflects the adequacy and appropriateness of the traits chosen for the study as it determines the extent of causal factors which accounts for the variability of the dependent factor. In this study, low unexplained variation (residual effect) of 0.0218 and 0.1104 was observed at genotypic and phenotypic levels, respectively. Hence, it is clear that the thirteen traits taken under investigation were appropriate for the genetic analysis of brinjal. From the above results, it can be concluded that the traits like number of fruits per plant and fruit length are important determinants for improving fruit yield per plant as they showed significant positive correlation with fruit yield. Path coefficient analysis showed that the traits *viz*., number of fruits per plant and fruit weight exerted highest direct effects on fruit yield and also indirectly influenced the other yield contributing traits of brinjal. This suggests that plant breeders should give greater emphasis on the above mentioned traits which showed high significant correlation as well as direct and indirect effects on fruit yield per plant, while selecting elite genotype for further improvement.

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