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RESEARCH ARTICLE

Correlation and path analysis for yield, yield attributes and shoot and fruit borer tolerance in brinjal (*Solanum melongena* L.)

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SUMMARY

The present investigation was carried out in the Department of Horticulture, Faculty of Agriculture, Annamalai University, during the period 2014 - 2015 to asses the correlation and path co-efficient analysis of 60 genotypes of brinjal for yield and shoot and fruit borer tolerance. The experiment was laid out in Randomized Block Design with three replications. Among the sixteen morphological characters studied, number of long styled flowers per plant (8.803), number of short styled flowers per plant (5.403), number of fruits per plant (3.099), fruit weight (0.757), days to first harvesting (0.133) and shoot and fruit borer incidence (0.082) showed positive direct effect in path co-efficient analysis. Positive correlation was recorded for fruit weight (0.885), fruit girth (0.644) and number of fruits per plant (0.622). Therefore, these characters are important which may be included in selection criteria for improvement in fruit yield per plant as well as tolerance to shoot and fruit borer incidence.

Key Words : Brinjal, Correlation, Direct and indirect effects, Path analysis, Shoot and fruit borer tolerance

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Brinjal (*Solanum melongena* L.) belonging the family Solanaceae is an important and popular vegetable crop originated from India has accumulated with wide range of variability in this crop. Many local cultivars are popular in different locations for their qualitative traits though they are poor yielders and susceptible to various pest and diseases. Now, it is high time to introduce new genotypes in order to increase potentiality of vegetable production. Strategies are also developed to boost vegetable production by some national level institutions like NBPGR. Further, the crop exhibits

rich genetic diversity and scope for improvement for various horticultural traits.

In this regard, efforts have been made to study some of the germplasm lines of brinjal collected from NBPGR, New Delhi and from different places of India for various qualitative and quantitative traits. Diversity in their colour, size, shape of fruits and yield potentiality is appreciable which has been confirmed through evaluation of these germplasm lines and their F_1 hybrids obtained through diallele cross.

Association of characters would help in minimizing the pressure of time on breeders, by providing correct information on the characters, which have to be considered for formulating a selection index. Path co-efficient analysis provides an effective means of partitioning direct or indirect causes of association. Correlation measures only the mutual association between two variables, whereas path co-efficient analysis specifically measures the relative importance of different yield components. In any crop improvement programme, knowledge on the association of characters is of significant importance since it contributes indirectly to the success of selection. Yield is a complex entity associated with number of component characters, It is the prime concern of the plant breeder and final factor on which selection programmes are to be envisaged. According to Graffius (1964) all changes in yield must be accompanied by changes in one or more characters. All changes in the components need not, however, be expressed by changes in yield. This is due to varying degrees of positive and negative correlations between yield and its components and among components themselves. Correlation and path analysis will establish the extent of association between yield and its component and also bring out the relative importance of their direct and indirect effects and thus, give a clear understanding of their association with yield. A study of association of these characters helps in selection of genotypes and also suggests the advantage of a selection scheme for more than one character at a time, which could be explained that improvement of one character results in the simultaneous improvement of all positively related characters (Kalloo, 1988). The aim of the present study was to find out the association of characters between yield and yield components and shoot and fruit borer tolerance in sixty genotypes of brinjal.

MATERIAL AND METHODS

The present experiment was carried out in the Department of Horticulture, Faculty of Agricuture, Annamalai University, Annamalainagar, Chidambaram, Tamil Nadu during 2014 - 2015. The experiment was laid out in Randomized Block Design with three replications. Sixty brinjal genotypes were collected from various places from India. Among these 30 accessions were collected from NBPGR, New Delhi, 6 genotypes from Cuddalore district, 5 genotypes each from Kannayakumari and Salem districts, 4 genotypes from Tamil Nadu Agricultural University, Coimbatore. 3 genotypes each from Madurai and Kerala, 2 genotypes from Bihar, 1 genotype from Horticultural Research Station, Pechiparai and 1 genotype from Vellore district, . All the recommended package of practices was followed to raise a good crop. The row to row and plant to plant spacing were maintained at 60 cm x 45 cm, respectively. Five competitive plants were marked in each plot per replication and observations were recorded on these plants for 16 quantitative characters *viz.*, plant height, number of primary branches/plant, number of secondary branches/plant, number of long styled flowers/ plant, number of medium styled flowers/plant, number of short styled flowers/plant, number of flowers/plant, days to first flowering, fruit set percentage, number of fruits/plant, shoot and fruit borer incidence, fruit length, fruit girth, fruit weight and fruit yield/ plant. For shoot and fruit borer incidence, the number of fruits affected by fruit borer in each plant was recorded at each harvest, without pesticide and fungicidal application. The percentage was worked out on the basis of total number of fruits harvested/plant and expressed in percentage. The correlations of co-efficients among yield and quality attributes were calculated as suggested by Panse and Sukhatme (1967). Path co-efficient analysis was carried out according to Dewey and Lu (1959) by partitioning the genotypic correlation co-efficients into direct and indirect effects.

RESULTS AND DISCUSSION

The correlation co-efficient between yield and yield components are shown in Table 1.

In general, the genotypic correlation were higher in magnitude over respective phenotypic correlations (Table 1), suggesting a strong inherent relationship in different genotypes. This is not unusual in brinjal and has been reported by Singh and Singh (1981).

The potential productivity of any crop is basically valued in terms of yield per unit area as well as its

Table 1 : Phenotypic (P) and genotypic (G) correlation co-efficient between yield and its component characters

Characters		Plant height	Number of primary branches/ plant	Number of secondary branches/ plant	Number of long styled flowers/ plant	Number of medium styled flowers/ plant	Number of short styled flowers/ plant	Number of flowers / plant	Number of days to 1st flowering	Number of days to 1st harvesting	Fruit set percentage	Number of fruits/ plant	Shoot and fruit borer incidence	Fruit length	Fruit girth	Fruit weight	Fruit yield / plant
Plant height	G	1.000	0.397**	0.438**	0.399**	0.436**	-0.392**	0.358*	-0.348*	-0.183	0.246	0.361**	-0.186	0.124	0.230	0.206	0.302*
	P	1.000	0.378**	0.424**	0.378**	0.423**	-0.375**	0.335*	-0.331*	-0.152	0.244	0.356*	-0.180	0.118	0.215	0.205	0.296*
Number of primary branches per plant	G		1.000	0.560**	0.438**	0.381**	-0.521**	0.298*	-0.276	-0.369**	0.395**	0.439**	-0.031	0.173	0.003	0.217	0.379**
	P		1.000	0.528**	0.410**	0.368**	-0.470**	0.284*	-0.270	-0.311*	0.363**	0.417**	-0.027	0.165	0.009	0.213	0.363**
Number of secondary branches per plant	G			1.000	0.743**	0.679**	-0.655**	0.633**	-0.687**	-0.590**	0.500**	0.671**	-0.245	-0.042	0.184	0.018	0.311*
	P			1.000	0.711**	0.644**	-0.606**	0.600**	-0.641**	-0.484**	0.474**	0.647**	-0.236	-0.041	0.181	0.017	0.299*
Number of long styled flowers per plant	G				1.000	0.629**	-0.643**	0.829**	-0.646**	-0.739**	0.407**	0.694**	-0.306*	-0.140	0.240	0.133	0.402**
	P				1.000	0.605**	-0.601**	0.805**	-0.620**	-0.635**	0.371**	0.676**	-0.301*	-0.138	0.228	0.130	0.393**
Number of medium styled flowers per plant	G					1.000	-0.428**	0.828**	-0.633**	-0.556**	0.440**	0.701**	-0.192	-0.105	0.201	0.036	0.349*
	P					1.000	-0.406**	0.805**	-0.607**	-0.484**	0.408**	0.681**	-0.181	-0.102	0.194	0.039	0.338*
Number of short styled flowers per plant	G						1.000	-0.243	0.455**	0.332*	-0.401**	-0.438**	0.351*	0.081	-0.240	-0.078	-0.317*
	P						1.000	-0.184	0.418**	0.294*	-0.400**	-0.418**	0.335*	0.077	-0.221	-0.073	-0.300*
Number of flowers per plant	G							1.000	-0.630**	-0.740**	0.368**	0.725**	-0.174	-0.132	0.183	0.092	0.358*
	P							1.000	-0.604**	-0.624**	0.314*	0.696**	-0.167	-0.128	0.175	0.092	0.347*
Days to 1st flowering	G								1.000	0.463**	-0.366**	-0.574**	0.297*	0.053	-0.095	-0.064	-0.310*
	P								1.000	0.412**	-0.343*	-0.555**	0.285*	0.050	-0.093	-0.060	-0.304*
Days to 1st harvesting	G									1.000	-0.571**	-0.772**	0.068	0.080	-0.160	-0.135	-0.396**
	P									1.000	-0.490**	-0.668**	0.069	0.070	-0.128	-0.107	-0.337*
Fruit set percentage	G										1.000	0.904**	-0.158	-0.034	0.297*	0.300*	0.622**
	P										1.000	0.896**	-0.156	-0.033	0.276	0.283*	0.599**
Number of fruits per plant	G											1.000	-0.212	-0.080	0.304*	0.260	0.622**
	P											1.000	-0.211	-0.080	0.290*	0.256	0.611**
Shoot and fruit borer incidence	G												1.000	0.159	0.067	0.057	-0.006
	P												1.000	0.152	0.064	0.061	-0.004
Fruit length	G													1.000	-0.030	0.252	0.165
	P													1.000	-0.001	0.249	0.156
Fruit girth	G														1.000	0.600**	0.644**
	P														1.000	0.584**	0.616**
Fruit weight	G															1.000	0.885**
	P															1.000	0.870**
Fruit yield per plant	G																1.000
	P																1.000

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Path co-efficient analysis depicting the direct (Bold) and indirect effects of various characters on yield per plant

Characters	Plant height	Number of primary branches/ plant	Number of secondary branches/ plant	Number of long styled flowers/ plant	Number of medium styled flowers/ plant	Number of short styled flowers/ plant	Number of flowers/ plant	Days to 1st flowering	Days to 1st harvesting	Fruit set percentage	Number of fruits/ plant	Shoot and fruit borer incidence	Fruit length	Fruit girth	Fruit weight
Plant height	**-0.088**	0.023	-0.086	3.514	2.487	-2.120	-4.199	-0.024	-0.024	-0.447	1.118	-0.015	-0.002	0.010	0.156
Number of primary branches/ plant	-0.035	**0.060**	-0.110	3.857	2.175	-2.812	-3.488	-0.019	-0.049	-0.719	1.361	-0.002	-0.003	0.000	0.164
Number of secondary branches/ plant	-0.038	0.033	**-0.197**	6.544	3.877	-3.538	-7.414	-0.048	-0.078	-0.910	2.079	-0.020	0.000	0.008	0.013
Number of long styled flowers/ plant	-0.035	0.026	-0.146	**8.803**	3.588	-3.475	-9.716	-0.045	-0.098	-0.740	2.152	-0.025	0.002	0.011	0.100
Number of medium styled flowers/ plant	-0.038	0.022	-0.134	5.535	**5.707**	-2.313	-9.708	-0.044	-0.074	-0.800	2.173	-0.015	0.002	0.009	0.027
Number of short styled flowers/ plant	0.034	-0.031	0.129	-5.662	-2.443	**5.403**	2.846	0.031	0.044	0.730	-1.358	0.028	-0.001	-0.011	-0.059
Number of flowers per plant	-0.031	0.017	-0.125	7.299	4.728	-1.312	**-11.719**	-0.044	-0.098	-0.670	2.246	-0.014	0.002	0.008	0.069
No. of days to 1st flowering	0.030	-0.016	0.135	-5.684	-3.612	2.459	7.387	**0.070**	0.061	0.665	-1.777	0.024	-0.001	-0.004	-0.048
No. of days to 1st harvesting	0.016	-0.022	0.116	-6.507	-3.175	1.796	8.671	0.032	**0.133**	1.039	-2.391	0.005	-0.001	-0.007	-0.102
Fruit set percentage	-0.021	0.023	-0.098	3.583	2.510	-2.169	-4.313	-0.025	-0.076	**-1.820**	2.801	-0.012	0.000	0.014	0.227
Number of fruits/ plant	-0.031	0.026	-0.132	6.114	4.003	-2.369	-8.494	-0.040	-0.102	-1.645	**3.099**	-0.017	0.001	0.014	0.197
Shoot and fruit borer incidence	0.016	-0.001	0.048	-2.697	-1.098	1.898	2.044	0.020	0.009	0.286	-0.658	**0.082**	-0.003	0.003	0.043
Fruit length	-0.011	0.010	0.008	-1.233	-0.600	0.436	1.546	0.003	0.010	0.061	-0.248	0.013	**-0.021**	-0.001	0.190
Fruit girth	-0.020	0.000	-0.036	2.112	1.144	-1.296	-2.143	-0.006	-0.021	-0.540	0.943	0.005	0.000	**0.047**	0.454
Fruit weight	-0.018	0.013	-0.003	1.169	0.204	-0.420	-1.081	-0.004	-0.018	-0.547	0.807	0.004	-0.005	0.028	**0.757**

Residual effect =0.151

tolerance to pest. Its improvement by direct selection is generally difficult because yield is governed by complex polygenic character largely influenced by its various component characters as well as by the environment. Hence, it becomes essential to estimate association of yield per plant with yield contributing characters and among themselves. The knowledge of magnitude and direction of correlation is used for judging how improvement in one character will cause simultaneous change in the other characters.

Data presented in Table 1 indicated that average fruit weight (0.885), fruit girth (0.644), fruit set percentage (0.622) and number of fruits per plant (0.622) had significant positive correlation with yield per plant at genotypic level. At phenotypic level, the positive correlation was recorded for fruit weight (0.870), fruit girth (0.616), fruit set percentage (0.599) and number of fruits per plant (0.611). Similar results were reported by Singh and Singh (1981); Dahatonde *et al.* (2010) and Rajya Lakshmi *et al*. (2014). Shoot and fruit borer incidence showed a negative and non-significant association with yield, both at genotypic (-0.006) and phenotypic (-0.004) levels.

A negative significant association of fruit yield per plant was observed with days to first harvesting, number of short styled flowers per plant and days to first flowering at genotypic and phenotypic levels indicating that the association between these two traits was negative and high. These results are in consonance with those reported by Singh and Kumar (2005) and Pathania *et al*. (2005). The genotypic correlation co-efficients were similar to phenotypic correlation co-efficients direction. Results indicated that these attributes were mainly influencing the yield of brinjal. This view was supported previously by Kalda *et al*. (1996).

Path co-efficients of component traits on yield:

The correlation co-efficient between yield and a particular yield component was the net result of direct effect of that attribute and indirect effect through other yield contributing traits. The total correlation between yield and a component trait may sometimes be misleading as it might be an over-estimate or under-estimate. Hence, direct selection based on character association may not be fruitful. Therefore, it is necessary to partition the total correlation co-efficients into direct and indirect effect of cause as devised by Wright (1921).

Path co-efficient analysis is an important tool for partitioning the correlation co-efficients into the direct and indirect effects of independent variables on a dependent variable with the inclusion of more variables in correlation study (Table 2). Their indirect association becomes more complex. Two characters may show correlation, just because they are correlated with a common third one. In such circumstances, path co-efficient analysis provides an effective means of a critical examination of specific forces action to produce a given correlation and measure the relative importance of each factor. In this analysis, fruit yield was taken as dependent variable and the rest of the characters were considered as independent variables.

Among the sixteen morphological characters studied, number of long styled flowers per plant (8.803), number of short styled flowers per plant (5.403), number of fruits per plant (3.099), fruit weight (0.757), days to first harvesting (0.133) and shoot and fruit borer incidence (0.082) showed positive direct effect. Number of flowers per plant recorded the maximum negative direct effect (-11.719) followed by fruit set percentage (-1.820) and plant height (-0.088), where as the trait, fruit length was found to have negligible direct effect (-0.021). Shoot and fruit borer incidence showed positive indirect effect on yield through number of flowers per plant (2.044), number of short styled flowers per plant (1.898), fruit set percentage (0.286), number of secondary branches per plant (0.048), fruit weight (0.043), days to first flowering (0.020) and plant height (0.016). The direct selection for these characters would be beneficial for crop improvement, since most of these characters also should have positive co-efficient of correlation in improving the fruit yield per plant and tolerance to shoot and fruit borer. Mohanty (1999); Mishra *et al*. (2007) and Lohakare *et al*. (2008) also have reported similar results in brinjal. The characters which recorded positive effect on yield had indirect positive effect via each other. Therefore, they do not affect each other adversely and hence, can be selected for improving the yield.

In the present study, the residual path effect made a positive contribution (0.151) which suggested that the characters which hold important role in determining the total fruit yield are included in the present study. For the improvement of yield and shoot and fruit borer tolerance, emphasis should be made on all yield contributing characters which are influencing it directly or indirectly.

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