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Association between Yield and Attributing Traits in Brinjal

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Abstract

Though brinjal is the second major vegetable crop in India, productivity of this crop in India is much lesser than the global productivity. Hence, breeders aim at further improvement of the crop, which cannot be done by targeting yield itself, but also involves other characters that are associated with it. Thus correlation and path analysis studies were performed using twenty diverse brinjal genotypes grown in three seasons. Yield exhibited highly significant positive correlation with fruit number per plant at genotypic level, while significant and positive association at phenotypic level. Days to 50%flowering possessed significantly positive correlation with yield at both phenotypic and genotypic level. Days to first flowering had significant positive while plant height possessed significant negative association with yield at phenotypic level. Path analysis showed high direct positive effect of days to 50% flowering and number of fruits per plant on yield. Therefore, days to 50% flowering, number of fruits per plant, average weight of fruit, fruit girth and number of primary branches per plant were positively and significantly while plant height was negatively inter related among themselves indicating that simultaneous selection for these characters might bring an improvement in yield.

Keywords: Brinjal, agronomic traits, correlation, path analysis

Brinjal, also known as eggplant or aubergine (*Solanum melongena* L.) is one of the chief solanaceous fruit vegetable crops grown widely throughout the year in all parts of the world. It is extensively grown in both subtropical and tropical areas of the world and popular among people of all sections and hence, it is referred to as "vegetable of the masses" (Roychowdhury and Tah, 2011). The immature brinjal fruit is consumed as cooked vegetable in several ways. It is a rich source of nutrients, particularly, carbohydrates, proteins, dietary fibre and vitamins like Thiamin, Niacin, Pantothenic acid and folic acid as well as minerals like Calcium, Iron, Potash, Zinc, Copper and Manganese (Thamburaj and Singh, 2013).

Brinjal is the second major vegetable crop in India and it is grown in an area of about 668.7 mha having production and productivity of 12399.9 mT and 18.5 mT/ha respectively whereas it is most important vegetable of Bihar and it is grown in an area of about 58.20 mha having production and productivity of 1149.43 mT and 19.79 mT/ha respectively (Anonymous, 2017). Productivity of this crop in India is much lesser than the global productivity and this creates the need for further improvement of the crop. Improvement of yield cannot be done by targeting yield itself, but also involves other characters that are associated with it. The study of correlation between different characters provides an idea of this association, and may be efficiently utilized to formulate selection strategies for improving yield and other traits. This scheme of selection for more than one character at a time is also advantageous for the breeders (Kalloo, 1994). However, correlation coefficient analysis measures the linear relationship between various traits and determines the component characters, on which selection can be based for genetic improvement in yield. Thus, path analysis is performed to split the correlation coefficients into direct and indirect effects, which thereby predicts the non-linear components of selection. The correlation and path studies help in creation of the plant ideotype that may be used for selection for improvement of the crop.

Therefore, this investigation was framed to study the inter-relation between the yield and attributing traits in twenty brinjal genotypes.

MATERIALS AND METHODS

Twenty diverse genotypes of brinjal collected from different institutes and developed at Bihar agricultural University, Sabour and maintained at the Department of Horticulture (Vegetable and Floriculture), Bihar agricultural University, Sabour were used for the study. These genotypes were grown in autumn-winter season of 2013-14 (September 2013 transplanting), summer-rainy season of 2014-15 (April 2014 transplanting) and early autumn-winter season of 2015-16 (August 2015 transplanting), in randomised block design replicated thrice in each season, maintaining a spacing of 60 cm × 60 cm. Standardised agro-techniques were maintained to raise a good crop. Five plants were randomly selected in each plot excluding the border ones in each replication followed by tagging and numbering for data recording. Observations were recorded for plant height (cm), plant spread (cm), number of primary branches per plant, days to first flowering, days to 50 percent flowering, days to first harvest, fruit length (cm), fruit girth (cm), average fruit weight (g), number of fruits per plant, fruit yield per plant (g) and total yield (q ha^{-1}) were considered for this study. The pooled data were subject to analyses. Single correlation coefficients at both genotypic and phenotypic levels between pair of characters were calculated based on the formulae by Al-Jibouri *et al.* (1958).

Genotypic correlation between traits X and Y:

$$R_{xy}(g) = \frac{\sigma_g^2(xy)}{\sqrt{\sigma_g^2(x)\sigma_g^2(y)}}$$

Where, $\sigma_g^2(xy)$ = Genotypic Covariance between X and Y

$\sigma_g^2(x)$ = Genotypic Variance for X

$\sigma_g^2(y)$ = Genotypic Variance for Y

Phenotypic correlation between traits X and Y:

$$R_{xy}(p) = \frac{\sigma_p^2(xy)}{\sqrt{\sigma_p^2(x)\sigma_p^2(y)}}$$

Where, $\sigma_p^2(xy)$ = Phenotypic covariance between X and Y

$\sigma_p^2(x)$ = Phenotypic Variance for X

$\sigma_p^2(y)$ = Phenotypic Variance for Y

Path analysis was carried out by using the estimates of correlation coefficient in all possible combinations among the dependent variables according to Dewey and Lu (1959).

Path coefficient was calculated by solving the equation which is as follows:-

$$(A)_{0\times 1} = (B)_{0\times 1}\,(C)_{0\times 1}$$

Where, A = Column of correlation r_{ij}

B = Correlation matrix of r_{ij} and

C = Column vector of directs, p_{jy}

Residual factor was calculated by the formula below:

$$p_{xy} = (1 - R^2)^{1/2}$$

Where,

$R^2 = \Sigma r_{ij} p_{iy}$

r_{ij} = Correlation between i^{th} and y trait

p_{iy} = Direct effect of i^{th} trait on y.

RESULTS AND DISCUSSION

The statistical data relating to phenotypic and genotypic correlation coefficient has been presented in Tables 1 and 2, respectively. It was observed that yield has highly significant positive correlation with fruit number per plant at genotypic level, while significant and positive association at phenotypic level. Days to 50% flowering possessed significantly positive correlation with yield at both phenotypic and genotypic level. Days to first flowering had significant positive while plant height possessed significant negative association with yield at phenotypic level. Similar significant positive association with fruit yield was quoted by Singh and Khanna (1978) for number of fruits per plant.

Highly significant positive correlation of plant spread, days to first flowering, days to 50% flowering, days to first harvest and fruit girth, and highly significant negative association of number of fruits per plant with average fruit weight has been observed at both phenotypic and genotypic level. On the other hand highly significant negative correlation of average fruit weight with number of fruits per plant at genotypic level and significant at phenotypic level has been recorded. Besides, plant height exhibited significant positive association with average fruit weight at genotypic level.

Fruit girth showed highly significant positive association with plant spread, days to first flowering, days to 50% flowering and highly

Table 1: Phenotypic correlation coefficients for different characters under study

Characters	PH	PS	NPB	DFF	D50%F	DFH	FL	FG	NFPP	AW	FYP
PH	1.00	0.414**	-0.125	0.119	-0.086	0.402**	-0.218	0.243	-0.298*	0.243	-0.276*
PS		1.00	-0.133	0.180	0.242	0.424**	-0.145	0.437**	0.460**	0.549**	-0.160
NPB			1.00	0.129	-0.148	-0.026	-0.194	-0.094	0.319*	-0.281*	-0.050
DFF				1.00	0.622**	0.171	-0.433*	0.508**	-0.216	0.509**	0.298*
D50%F					1.00	0.152	-0.149	0.599**	-0.492**	0.684**	0.313*
DFH						1.00	-0.080	0.196	-0.166	0.365**	-0.015
FL							1.00	-0.408**	-0.033	-0.056	-0.005
FG								1.00	-0.716**	0.814**	-0.001
NFPP									1.00	-0.801**	0.378*
AFW										1.00	0.104
FYP											1.00

*** and * depict significance at 5% and 1% levels of probability respectively.*

Characters: *Plant height* **(***PH), Plant spread (PS), Number of primary branches / plant (NPB), Days to first flowering (DFF), Days to 50% flowering (D50F), Days to first harvest (DFH), Fruit length (FL), Fruit girth (FG), Average fruit weight (AFW), Number of fruit / plant (NFPP), Fruit yield/plant (FYP).*

Table 2: Genotypic correlation coefficients for different characters under study

Characters	PH	PS	NPB	DFF	D50F	DFH	FL	FG	NFPP	AFW	FYP
PH	1.00	0.442**	-0.280*	0.112	-0.140	0.526**	-0.242	0.310*	-0.352**	0.275*	-0.367**
PS		1.00	-0.254*	0.157	0.317*	0.429**	-0.158	0.531**	-0.501**	0.607**	-0.150
NPB			1.00	0.062	-0.214	-0.059	-0.256*	-0.110	0.391**	-0.359**	-0.061
DFF				1.00	0.740**	0.193	-0.482**	0.554**	-0.209	0.543**	0.393
D50F					1.00	0.125	-0.194	0.725**	-0.589**	0.772**	0.316*
DFH						1.00	-0.123	0.249	-0.173	0.398**	0.015
FL							1.00	-0.420**	-0.029	-0.053	0.013
FG								1.00	-0.768**	0.866**	-0.010
NFPP									1.00	-0.818**	0.371**
AFW										1.00	0.083
FYP											1.00

*** and * depict significance at 5% and 1% levels of probability respectively.*

Characters: *Plant height* **(***PH), Plant spread (PS), Number of primary branches / plant (NPB), Days to first flowering (DFF), Days to 50% flowering (D50F), Days to first harvest (DFH), Fruit length (FL), Fruit girth (FG), Average fruit weight (AFW), Number of fruit / plant (NFPP), Fruit yield/plant (FYP).*

Table 3: Phenotypic path matrix with respect t to yield per plant

Character	PH	PS	NPB	DFF	D50F	DFH	FL	FG	NFPP	AFW
PH	**0.038**	0.016	-0.005	0.004	-0.004	0.016	-0.008	0.009	-0.011	0.009
PS	-0.065	**-0.159**	0.021	-0.029	-0.039	-0.068	0.023	-0.069	0.073	-0.087
NPBB	0.016	0.017	**-0.126**	-0.016	0.019	0.004	0.025	0.018	-0.040	0.035
DFF	-0.011	-0.017	-0.012	**-0.093**	-0.058	-0.016	0.040	-0.047	0.020	-0.047
D50F	-0.028	-0.078	-0.048	0.200	**0.322**	0.049	-0.048	0.192	-0.158	0.220
DFH	-0.072	-0.076	0.005	-0.030	-0.027	**-0.179**	0.014	-0.035	0.029	-0.065
FL	-0.021	-0.014	-0.019	-0.042	-0.014	-0.008	**0.095**	-0.039	-0.003	-0.005
FG	0.022	0.039	-0.009	0.046	0.054	0.018	-0.036	**0.090**	-0.064	-0.073
NFPP	-0.423	-0.653	0.453	-0.308	-0.698	-0.235	-0.047	-1.016	**1.419**	-1.136
AFW	0.269	0.608	-0.311	0.565	0.758	0.404	-0.062	0.902	-0.880	**1.108**
r_p FYP	0.276*	-0.160	0.050	0.298**	0.313*	-0.015	-0.005	-0.001	0.378*	0.104

Residual effect = 0.2527

r_p FYP = Phenotypic correlation coefficient with respect to fruit yield per plant

Characters: *Plant height* **(***PH), Plant spread (PS), Number of primary branches / plant (NPB), Days to first flowering (DFF), Days to 50% flowering (D50F), Days to first harvest (DFH), Fruit length (FL), Fruit girth (FG), Average fruit weight (AFW), Number of fruit / plant (NFPP), Fruit yield/plant (FYP).*

Table 4: Genotypic path matrix with respect to yield per plant

Character	PH	PS	NPBB	DFF	D50F	DFH	FL	FG	NFPP	AFW
PH	**0.130**	0.043	0.111	0.017	0.048	0.052	0.121	0.325	0.527	0.003
PS	0.058	**0.098**	0.101	0.024	0.109	0.049	0.079	0.557	0.748	0.007
NPBB	0.036	0.025	**0.397**	0.010	0.073	0.006	0.128	0.116	0.584	0.004
DFF	0.015	0.015	0.025	**0.155**	0.254	0.019	0.242	0.581	0.313	0.006
D50F	0.018	0.031	0.085	0.115	**0.343**	0.012	0.097	0.760	0.881	0.009
DFH	0.068	0.048	0.023	0.030	0.043	**0.100**	0.062	0.261	0.261	0.005
FL	0.032	0.015	0.102	0.075	0.066	0.012	**0.502**	0.441	0.044	0.001
FG	0.040	0.052	0.044	0.086	0.248	0.025	0.211	**1.049**	1.148	0.010
NFPP	0.046	0.049	0.155	0.032	0.202	0.017	0.015	0.806	**1.494**	0.010
AFW	0.036	0.060	0.143	0.084	0.265	0.040	0.027	0.908	1.223	**0.012**
r_g FYP	0.367**	-0.150	-0.061	0.393	0.316*	0.015	0.013	-0.010	0.371**	0.083

Residual effect = 0.1935.

r_g FYP = Genotypic correlation coefficient with respect to fruit yield per plant

Characters: *Plant height* **(***PH), Plant spread (PS), Number of primary branches / plant (NPB), Days to first flowering (DFF), Days to 50% flowering (D50F), Days to first harvest (DFH), Fruit length (FL), Fruit girth (FG), Average fruit weight (AFW), Number of fruit / plant (NFPP), Fruit yield/plant (FYP).*

significant negative correlation with fruit length at both phenotypic and genotypic level, while it showed significant positive association with plant height at genotypic level. Fruit length exhibited highly significant negative association with days to first flowering at genotypic level while significant negative correlation at phenotypic level. Besides, there was significant negative association of fruit length with number of primary branches at genotypic level. Number of fruits per plant showed highly significant negative association with days to 50% flowering and fruit girth, at both phenotypic and genotypic level, while highly significant positive association with number of primary branches per plant at genotypic and significant association at phenotypic level. Besides, it also showed highly significant negative correlation with plant height at genotypic and significant negative association at phenotypic level. These results were also confirmed by the findings of Devi and Sankar (1990), Thangamani and Jansirani (2012).

Days to first harvest exhibited highly significant positive correlation with plant height and plant spread at both phenotypic and genotypic level. Days to 50% flowering and days to first flowering were highly significantly positively correlated at both phenotypic and genotypic level, while days to 50% flowering also has significant positive correlation with plant spread at genotypic level. Number of primary branches per plant exhibited highly significant and negative association with plant height and plant spread at genotypic level only, while plant height and plant spread were highly significantly positively correlated at both phenotypic and genotypic level. These results get support with the findings of Singh and Singh (1974) in chilli, and Patel and Sarnaik (2004) and Shinde *et al*. (2012) in brinjal.

Since correlation coefficient only gives a picture of the linear relationship between a pair of traits, the other components can be interpreted through the path coefficient analysis which also depicts the direct and indirect effects of different traits on a dependent variable, which here is yield.

Genotypic path coefficient analysis showed that there has been very high direct effect of number of fruits per plant and high direct effect of days to 50% flowering on yield. Days to 50% flowering has also exerted moderate positive indirect effect on yield via days to first flowering, number of fruits per plant, fruit girth and average fruit weight. Besides, number of fruits per plant has exerted high positive indirect effect via plant height, plant spread, number of primary branches per plant and days to 50% flowering, while very high positive indirect effect via average fruit weight and fruit girth. Fruit girth has exerted moderate positive indirect effect via days to first harvest on yield. The residual has been recorded to be 0.1935, which envisages that the unexplained variances were 19.35%.

Phenotypic path analysis depicted that there was high direct effect of days to 50% flowering and very high direct effect of number of fruits per plant on yield. Besides, days to 50% flowering exerted high positive indirect effect via average fruit weight and high indirect negative effect via number of fruits per plant and on yield. Number of fruits per plant also exerted high indirect negative effect via average fruit weight. Days to first flowering exerted moderate indirect positive effect via days to 50% flowering, high indirect positive effect via average fruit weight and high indirect negative effect via number of fruits per plant. Plant height exerted high indirect negative effect via fruit number plant and high indirect positive effect via average fruit weight. The residual has been recorded to be 0.2527, which depicted that the unexplained variances were 25.27%.

These results find accordance with Praneetha (2006), Bansal and Mehta (2008), Lokhare *et al.* (2008) and Shinde *et al*. (2012) and Karak *et al*. (2012).

Among the yield components the days to 50% flowering, number of fruits per plant, average weight of fruit, fruit girth and number of primary branches per plant were positively and significantly while plant height was negatively inter related among themselves indicating that simultaneous selection for these characters might bring an improvement in yield per plant. This was also reported by Shinde *et al*. (2012). Thus, for improvement of productivity of brinjal, these traits should be used as selection criteria.

CONCLUSION

It may be concluded from the study that the brinjal plant ideotype for high yield should be of moderate height with late flowering and first harvest, having high number of fruits per plant of moderate size.

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