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Genetic variability, characters association and path analysis for fruit yield components in eggplant (*Solanum melongena* L.)

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Abstract
During 2016-17 the field experiment was conducted in the new orchard of Main Agricultural Research Station, Raichur to study the Genetic variability in brinjal (*Solanum melongena* L.). Sixteen genotypes of brinjal were evaluated in Randomized Complete Block Design with two replications. Analysis of variance revealed that considerable variability among the genotypes for all the characters and the Genetic variability studies revealed that the higher PCV, GCV and heritability were noticed for fruit yield and its attributes. The number of leaves per plant exhibited highest positive significant association with fruit yield per plant at both genotypic and phenotypic level, followed by number of branches per plant and average fruit weight and the Path coefficient analysis results shows that the number of fruits per plant, number of leaves per plant, fruit girth, average fruit weight and leaf area exerted maximum direct effect on fruit yield per plant at both phenotypic and genotypic level and these are good contributors to fruit yield. Hence, the study indicated that the above traits could be utilized in future for the brinjal crop improvement programme.

Keywords: correlation, fruit yield, genetic variability, heritability, path coefficient

Introduction
Eggplant or brinjal (*Solanum melongena* L.) is the most popular and widely cultivated vegetable crop in the tropic and subtropics regions of the globe mainly for its immature fruits as vegetables (Manoko and Van der Weerden, 2004) [8]. It belongs to the family Solanaceae (Daunay *et al.*, 2001) [3]. Eggplants have indigenous medicinal uses, which range from weight reduction to treatment of several ailments including asthma, skin infections and constipation. It is important to improve the productivity of the crop per unit area so as to satisfy the demands of dietary needs through vigorous breeding programs. The success of increasing the productivity of any crop through breeding largely depends on the presence of variability among the breeding materials. Furthermore, the choice of breeding programs depends on knowledge of the nature and magnitude of variations in the available material, magnitude of association of characters with yield, extent to which these characters are heritable as well as extent of environmental influence on them (Aruah *et al.*, 2012) [1]. Effectiveness of selection directly depends on the amount of heritability and genetic advance in relation to the average performance of the character (Kumar *et al.*, 2013) [7]. Assessment of genetic diversity is very important in eggplant for further yield improvement owing to its increasing high demand in many parts of the world. Therefore, the aim of the research was to evaluate genetic variability among sixteen eggplant cultivars collected from different parts of the country.

Material and Method
The present investigation was carried out in the New Orchard, Dept. of Horticulture, Main Agricultural Research Station, University of Agricultural Sciences, Raichur, Karnataka, India to estimate genetic variability, heritability, genetic advance and phenotypic and genotypic correlation in sixteen brinjal genotypes during the *kharif* of 2016-17. These cultivars are representing a broad genetic base and all of them have been collected from different corners of the country. The genotypes name, source, fruit color and shape are presented in Table (1). brinjal seeds of sixteen genotypes were sown in the pro trays and seedlings were transplanted to the main experimental plot with spacing of 75 x 60 cm in ridges and furrows. The statistical design was RCBD with two replications. All cultural practices concerning brinjal

production were followed as recommended package of practices.

Observations were recorded in five randomly selected plants in each replication. Analysis of variance estimated by adopting randomized complete block design with two replications. Genotypic and phenotypic coefficient of variation was calculated using the formulae suggested by Burton (1952) [2]. Broad sense heritability was calculated as per Hanson and cope (1956) and genetic advance was estimated by the method suggested by Johnson *et al*. (1955) [6]. Genotypic and phenotypic correlations were computed by using the formula given by Weber and Moorthy (1952) [10]. Path analysis was carried out by using both phenotypic and genotypic correlation coefficients to know the direct and indirect effects of the components on yield as suggested by Wright (1921) [11] and illustrated by Dewey and Lu (1959) [4].

Table 1. Genotypes used for the experiment with their source of collection and salient features

Sl. No.	Genotypes	Source of collection	Salient features	Season	Fruit colour
1	Arka Anand	IIHR, Bangalore	Long shaped, spiny fruit with yield potential of 33-35 t/ha.	*Kharif*	Green
2	Arka Kusumakar	IIHR, Bangalore	Long shaped fruit with yield potential of 35-40 t/ha	*Kharif*	Green
3	Arka Neelkant	IIHR, Bangalore	Long shaped fruit with yield potential of 44-50 t/ha	*Kharif*	Purple
4	Arka Nidhi	IIHR, Bangalore	Long shaped fruit with yield potential of 35-40 t/ha	*Kharif*	Purple
5	EPH-718	Syngenta	Round shaped attractive fruit with high shelf life	*Kharif*	Purple with white stripes
6	Simran	VRR Seeds	Round shaped fruit with average keeping quality	*Kharif*	Purple with green stripes
7	Matti Gulla	ZRS,Chianky, Palamu, Jharkhand	Round shaped fruit with yield potential of 35-40 t/ha	*Kharif*	Green with purple stripes
8	Pant Samrat	ZRS,Chianky, Palamu, Jharkhand	Round shaped fruit with yield potential of 44-45 t/ha	*Kharif*	Purple
9	Swarn Shyamli	ZRS,Chianky, Palamu, Jharkhand	Round shaped fruit with early flowering	*Kharif*	Purple
10	R-2580	V.R.S. Kalyanpur, Uttar Pradesh	Round shape fruit with average keeping quality	*Kharif*	Green with white patch's at blossom
11	Arka Shirish	IIHR, Bangalore	Very long fruits	*Kharif*	Green
12	L-3268	V.R.S. Kalyanpur, Uttar Pradesh	Round shaped fruit with less shoot and fruit borer incidence	*Kharif*	Purple with green stripes
13	R-2581	V.R.S. Kalyanpur, Uttar Pradesh	Round shaped fruit with high fruit yield of 45-50 t/ha	*Kharif*	Greenish white
14	Swarn Shree	ZRS,Chianky, Palamu, Jharkhand	Small oval shaped, spiny fruit with more shelf life	*Kharif*	White
15	L-2232	V.R.S. Kalyanpur, Uttar Pradesh	Long shaped, spiny fruit with yield potential of 45-48 t/ha	*Kharif*	Green with white stripes
16	Swarn Mani	ZRS,Chianky, Palamu, Jharkhand	Small oval shaped, spiny fruit with more shelf life	*Kharif*	Purple

Results and Discussion

The analysis of variance for seven characters is presented in Table 2. The results revealed that the genotypes showed significant differences for all the characters indicating the existence of enormous amount of genetic variability for growth and yield attributes. Variability is the most important characteristic feature of any population. Estimation of variability is an important prerequisite for realizing response to selection as the progress in the breeding depends upon its amount, nature and magnitude. The genetic proportion of this variability measured in terms of genotypic coefficient of variation (GCV) alone represents the heritable component of total variability. The higher the GCV, the more will be chance for exploitation of that particular character in a selection programme. The genetic variability in terms of GCV alone is not sufficient for determination of amount of heritable variability. In addition, estimation of heritability and genetic advance as percent of mean is also needed to assess the extent of genetic gain expected from effective selection. As heritability in broad sense includes both additive and epistatic gene effects, it will be reliable only when it is accompanied with high genetic advance (Burton, 1952; Johnson *et al*., 1955) [2, 6]. In the present investigation, the variability available for the thirteen characters under study in a population of sixteen genotypes were analyzed using the above three parameters.

Table 2. Analysis of variance for yield and yield attributing characters of various genotypes

Sl. no.	Source of variation	Means sum of squares			S.Em±	CD (5%)
		Repli.	Genotypes	Error		
	Degrees of freedom	1	15	15		
1.	Leaf area (cm)	0.00	32.77 *	0.00	39.67	119.02
2.	Number of leaves / plant	0.109	28.47*	6.19	1.75	5.30
3.	Number of branches/ plant	0.15	8.54*	0.85	0.63	1.96
4.	Number of fruits /plant	3.45	18.57*	4.05	1.42	4.29
5.	Average weight of fruit (g)	0.50	41.26*	5.08	1.6	4.80
6.	Average length of fruit (cm)	0.06	23.37*	1.21	0.78	2.35
7.	Average girth of fruit (mm)	0.13	4.45*	72.08	6.02	18.06

* Significant at 5 per cent probability

Genotypic (GCV) and phenotypic (PCV) coefficient of variation

A relatively high estimate of genotypic and phenotypic coefficient of variation were observed for fruit length, leaf area, average fruit weight, number of branches per plant, number of leaves per plant and number of fruits per plant (Table 3). The results revealed that there is considerable scope for improving these characters in desirable direction through a selection programme. Thus it could be inferred that, the selection for the improvement of these characters would be effective. This is in corroboration with the findings of Prabakaran (2010) in Brinjal. In this study, the coefficient of phenotypic and genotypic variation in respect of all the characters do not differ much in their magnitude suggesting that the characters are not much amenable to environmental factors, thus the selection may be based very well on the phenotypic values.

Heritability and genetic advance as percent of mean

The results of the present investigation showed that, heritability (broad sense) were high in leaf area, average fruit weight, number of leaves per plant, fruit length, number of fruits per plant and number of branches per plant (Table 3), thereby suggesting that straight selection for these traits may bring worthwhile improvement in identifying superior genotypes in brinjal. Besides, high heritability estimates coupled with high genetic advance were observed for fruit length, leaf area, average fruit weight, number of fruits per plant, fruit length, which indicated that these characters were under additive gene effects and these characters were more reliable for effective selection. These results were in conformity with of Prabakaran (2010).

Table 3: Estimates of variability, heritability and genetic advance for different characters in brinjal genotypes

Sl. no.	Characters	Range		Mean	GCV (%)	PCV (%)	h^2_{BS} (%)	GA	GAM (%)
		Min	Max						
1.	Number of leaves / plant	33.50	62.00	49.75	18.53	19.20	0.93	18.34	36.87
2.	Number of branches per plant	11.50	19.10	15.72	11.42	12.57	0.82	3.35	21.38
3.	Leaf area (cm)	659.50	1377	959.14	23.64	23.98	0.97	459.5	47.99
4.	Number of fruits per plant	27.00	50.00	40.12	14.88	15.70	0.89	11.65	29.04
5.	Weight of fruit (g)	25.50	60.50	42.94	23.54	24.12	0.95	20.33	47.34
6.	Length of fruit (cm)	6.50	18.50	11.19	33.00	34.44	0.91	7.29	65.13
7.	Girth of fruit (mm)	152.50	184.7	168.4	6.62	8.32	0.63	18.30	10.86

GV- Genotypic variance, GCV- Genotypic co-efficient of variance,
h^2_{BS} -Broad sense heritability, GA-genetic advance, PV- Phenotypic variance,
PCV- Phenotypic co-efficient of variance and GAM- Genetic advance as per cent of mean

Correlation studies

The phenotypic and genotypic correlation coefficients among different characters showed that marketable yield per plant had positive and significant association with number of leaves per plant, number of branches per plant, average fruit weight and leaf area (Table 4).

Significant positive correlation of leaf area with, fruit girth, average fruit weight was recorded. Significant positive correlation of number of leaves with number of branches, average fruit weight, leaf area and fruit girth was recorded. Significant positive correlation of average fruit weight with fruit girth was recorded. Significant positive correlation of number of branches per plant with average fruit weight and leaf area was recorded. Significant positive correlation of number of fruits per plant with fruit length was also recorded.

Table 4: Genotypic and phenotypic correlation co-efficients between different characters in brinjal genotypes

		X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1	G	0.9182**	0.6771**	-0.2154	0.8657**	0.0681	0.6081**	0.9419**
	P	0.798**	0.6431**	-0.2022	0.8151**	0.0562	0.4685**	0.7448**
X_2	G	1	0.5812**	-0.0136	0.6631**	0.2414	0.5697**	0.9390**
	P	1	0.5445**	0.0617	0.5931**	0.1985	0.3701*	0.6766**
X_3	G		1	-0.5314**	0.8343**	-0.5375**	1.0247**	0.6037**
	P		1	-0.4852**	0.8100**	-0.5057**	0.8182**	0.4905**
X_4	G			1	-0.5589**	0.5983**	-0.5691**	0.1811
	P			1	-0.4968**	0.5572**	-0.4937**	0.1527
X_5	G				**1**	-0.2675	0.8837**	0.8091**
	P				**1**	-0.2538	0.6737**	0.6920**
X_6	G					1	-0.7639**	0.1915
	P					1	-0.6306**	0.1320
X_7	G						1	0.5449**
	P						1	0.4293*

G-Genotypic P-Phenotypic ** Significant at 1 per cent level of Significance
X_1 -No. of leaves per plant X_2 -No. of branches per plant X_3 - Leaf area (cm^2) x_4- No. fruits per plant
X_5-Avg. weight of fruit (g) X_6 - Fruit length (cm) X_7 -Fruit girth (mm) x_8- fruit yield per plant

Table 5: Direct and indirect effects on bulb yield per plot at genotypic and phenotypic level in brinjal

		X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	G	0.5915	0.5431	0.4005	-0.1274	0.5120	0.0403	0.3597
	P	0.1557	0.1243	0.1002	-0.0315	0.1270	0.0087	0.0730
X_2	G	-0.1623	-0.1768	-0.1028	0.0024	-0.1172	-0.0427	-0.1007
	P	0.0394	0.0494	0.0269	0.0030	0.0293	0.0098	0.0183
X_3	G	0.2798	0.2402	0.4133	-0.2196	0.3448	-0.2221	0.4235

	P	0.2543	0.2153	0.3953	-0.1918	0.3202	-0.1999	0.3235
X_4	G	-0.1396	-0.0088	-0.3445	0.6483	-0.3623	0.3879	-0.369
	P	-0.0882	0.0269	-0.2116	0.4362	-0.2167	0.2430	-0.2153
X_5	G	0.5041	0.3861	0.4858	-0.3255	0.5823	-0.1557	0.5146
	P	0.3570	0.2598	0.3548	-0.2176	0.4380	-0.1112	0.2951
X_6	G	0.0093	0.0331	-0.0737	0.0820	-0.0367	0.1371	-0.1047
	P	0.0085	0.0300	-0.0764	0.0841	-0.0383	0.1510	-0.0952
X_7	G	0.3579	0.3352	0.6030	-0.3349	0.5200	-0.4495	0.5885
	P	0.2498	0.1973	0.4363	-0.2632	0.3592	-0.3363	0.5332
Correlation with yield	G	0.9419	0.939	0.6037	0.1811	0.8091	0.1915	0.5449
	P	0.7448	0.6766	0.4905	0.1527	0.692	0.1320	0.4293

Residual effect at genotypic level: 0.6540 Residual effect at phenotypic level: 0.3152

*Significant at 5% level of significance **Significant at 1% level of significance

X_1 - No. of leaves per plant X_2 -No. of branches per plant X_3 - Leaf area (cm^2) x_4- No. fruits per plant

X_5- Avg. weight of fruit (g) X_6 - Fruit length (cm) X_7 - Fruit girth (mm) x_8- fruit yield per plant

Path coefficient analysis

Direct and indirect effects of various characters on bulb yield per plot was studied and the results are presented in Table 5. In the present study the residual effect for direct and indirect effects were 0.654 and 0.315 at genotypic and phenotypic levels respectively. Path coefficient analysis revealed that number of fruits per plant, number of leaves per plant, fruit girth, average fruit weight, leaf area and fruit length exerted maximum direct effect on fruit yield per plant at both phenotypic and genotypic level.

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