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Association and Genetic Assessment in Brinjal

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Abstract
Brinjal is an important vegetable that directly consumed as cooked form. Fifteen brinjal genotypes were sown under randomized complete block design with three replications to determine the genetic variability existed for six yield contributed traits. Environmental error seemed to be low as minor differences observed genotypic and phenotypic variance. Most of the traits showed significant correlation with the fruit yield. Cluster analysis grouped genotypes in three clusters; selection from the genotypes belong to cluster 1 showed high genetic diversity for leaf length, leaf width and fruit diameter. PC3 showed maximum diversity for fruit yield. In future, breeding for high fruit yield, genotype VRIB-1-2013 could be of better choice.

Keywords: Brinjal, Association, Cluster, Principle component analysis

1. Introduction
Brinjal (*Solanum melongena* L.) is an important vegetable of central, southern and southeast Asia (Kalloo, 1988). Brinjal is poor's man food and consumed as vegetable in every class of peoples because of its nutritive value (rich in Vitamin A and B) and low price (Lakshmi *et al*. 2013). In Pakistan number of brinjal cultivars are available that showed diversity in shape, color, taste and plant texture. To meet the market and consumer requirements, the strategy of the breeder is to produce not only varieties with high yield and pest resistance (especially EFSB), but also with good fruit quality that has both commercial and nutritive value. Association study between plant traits towards fruit yield are very important because, these parameters determined the future success of breeding programme (Nalini *et al*. 2009). To bring about a genetic improvement in any segregating population the knowledge of association between yield and yield related traits will trigger the selection efficiency (Asish *et al*. 2008). Principal component analysis (PCA) provided with the information about the importance of the largest contributor to total variation at each axis of differentiation (Sharma, 1998). Clustering genotypes according to their morphological and behavioral response helps breeder to drafta standing genetic variability (Hair *et al*. 1995). The aim of the present study to estimated genotypic and phenotypic association of plants traits towards fruit yield, their inter dependence, their direct and indirect effects. Further estimation of genetic diversity to group the genotypes of similar behavior in a single cluster.

2. Materials and Method
2.1 Plant Material
Experiments were carried out on a sandy loam soil at the Vegetable Research Institute, Faisalabad, Pakistan, situated at 31.26 N and 73.06 E, with an elevation of 184 m above sea level. Fifteen local/exotic genotypes of brinjal including two check i.e. Dilnasheen (Round) and Nirala (Long), were planted under randomized complete block design (RCBD) during 2012-13 keeping distance 50 cm × 100 cm. The plot size was 5m × 2m. All the agronomic and plant protection measures were kept uniform. At maturity, ten plant were selected randomly and plant height measured with the help of meter rod from collar to the plant tip. Twenty selected fruits from each replication subjected to varnier caliper to calculate fruit diameter. Leaf length and leaf width measured with help of meter rod. During each picking tender fruits were harvested from each replications and after ten picking plant yield per each genotype measured in tons per hectare.

The plot means for each characters were subjected to analysis of variance using the method of Steel *et al*. (1997). Phenotypic correlations were worked out according to the method given by Kwon and Torrie (1964). The direct and indirect effects of each trait were assessed by path analysis using the method of Dewey and Lu (1959). Further, data were subjected to principle component and cluster analysis based upon ward linkage and Euclidean distance by using statistical software Mini Tab (ver. 15.0).

3. Results and discussions

From the experiment under study, data collected were subjected to analysis of variance, which showed highly significant differences among all the traits studied. For Fruit yield there were highly significant differences among all the genotypes. It was revealed that VRIB-1-2013 had the maximum fruit weight (139.24 g) followed by VRIB-12-6 (135.60 g) while WEL had the minimum value (30.62 g) per plant.The experiment was performed for genetic evaluation of the Characters studied. Various estimates showed valuable results which are discussed below.

Genotypic and Phenotypic correlation analysis was performed between variables to determine the extent of relationship between them. Itwas found that Plant height, Leaf length, Leaf width and Fruit diameter had positive correlation with Fruit yield both at genotypic and phenotypic levels while Fruit length showed negative correlation with Fruit yield at both levels (Ishaq *et al*, 1998).The maximum correlation was found between Leaf length and Leaf width significant at both genotypic and phenotypic levels, also increasing leaf length wise has more strong correlation with Fruit yield than width wise. It was also found that Fruit length showed negative correlation with all of the other traits so decreased fruit length and increased Fruit diameter are desirable traits to increase overall yield.

As for as path coefficient analysis is concerned it is simply a standardized partial regression coefficient, which assesses the influence of causal variables on resultant variable directly and indirectly by partitioning the genotypic correlation coefficients. Such information may be useful in predicting correlated responses of different characters towards directional selection. Keeping Fruit weight as resultant variable and other traits as causal variables, the following results were obtained.

According to the results shown in Table 3, Fruit diameter exerts maximum direct effect on Fruit yield followed by Fruit length and Leaf width while Leaf length and Plant height showed negative direct effects on Fruit yield. Also we see that Fruit diameter exerts maximum indirect effect via Leaf width on Fruit yield and Leaf width has maximum indirect effects via Fruit diameter on Fruit yield. Fruit yield had maximum genotypic correlation with Fruit diameter followed by Leaf length while leaf length exerts maximum indirect effect on Fruit yield via Fruit diameter followed by Leaf width, So direct selection of plants based on these two traits i.e., Fruit diameter and Leaf width would be effective to increase Fruit yield or in other words overall yield.

As path coefficient analysis determines the effect of individual traits on overall Fruit yield, principal component and cluster analysis were also performed to determine the performance of individual advance lines and their effect on different variables.

Principal component analysis (PCA) reflects the importance of the largest contributor to the total variation at each axis of differentiation (Sharma, 1998). There are no tests to evaluate the significance of eigenvalues. Therefore, we follow the criterion established by Cheema *et al* 2011, which adapts very well to the purpose of this analysis. This criterion is based on the selection of principal components whose eigenvalues are >1. Principal component analysis reduced the original 06 quantitative characters in experiment to 3 principal components. The first three principal components with eigenvalues >1 explained 90.6% of variation among 15 accessions of Brinjal crop (Table 4). The proportions of the total variance attributable to the first three PC were 55.6, 19.7 and 15.3% respectively. There are no clear guidelines to determine the importance of a trait coefficient for each principal component. Johnson and Wichern (1988) regard a coefficient as significant that is greater than half divided by the square root of the standard deviation of the eigenvalue of the respective principal component.

The importance of traits to the different PC can be seen from the corresponding Eigen vectors which are presented in Table 6. The results showed that Leaf length, Leaf width and Fruit diameter had the highest loadings in PC1, so PC1 is a weighted average of these three characters indicating their significant importance for this component. On the other hand, other traits are less important to PC while the trait like Plant height had maximum loading in PC2 and Fruit length and Fruit yield showed maximum loadings in PC3.

The accessions that are close together are perceived as being si milar when rated on 06 variables on PCA biplot, while accessions which are further apart are more diverse from other accessions. Cluster analysis performed on all 15 accessions of Brinjal crop clearly differentiated them into three clusters (Figure 1) based on Ward linkage, Euclidean distance. Each cluster containing accessions that were highly similar. Cluster I consisted of 03 accessions, cluster II of 07 and cluster III of 05 accessions. Mean value for each cluster (Table6) revealed that accessions in cluster IShowed highest values for most of the traits (Plant height, Leaf length, Leaf width and Fruit diameter) but lower fruit yield while maximum Fruit yield was shown by Cluster 2 which showed average values for all of the traits studied. Cluster 3 clearly showed minimum value for Fruit yield and all other traits except Fruit length. When cluster analysis was performed on different variables it was found that Fruit length clearly showed maximum difference from all of the other traits studied and also it has a negative correlation both at genotypic and phenotypic levels with all of the other traits, so it is clearly depicted from the above results that by increasing the values of morphological traits like (Plant height, leaf length, Leaf width and Fruit diameter), overall yield do not increases by that proportion while taking the values of these traits to an average the plant becomes able to shift more of its energy towards producing more yield. It also shows that by reducing the values of these traits (Plant height, leaf length, Leaf width and Fruit diameter) below average but increasing the values of Fruit length also reduces Fruit yield, so for a Brinjal plant ideotype it is recommended that the value of morphological traits like (Plant height, leaf length, Leaf width, Fruit length and Fruit diameter) should be kept at average to obtain maximum Fruit Yield.

Table 1: Mean squares table of different traits of brinjal crop

SOV	DF	Plant height	Leaf length	Leaf width	Fruit length	Fruit diameter	Fruit Yield
Genotype	14	261.85**	26.24**	5.57**	42.72**	729.97**	3925.11**
Rep	2	10.87	0.07	0.371	0.665	150.652	253.563
Error	28	12.31	0.895	0.476	1.472	27.88	138.83

Table 2: Genotypic and Phenotypic Correlation Coefficients of All Possible Pairing of Some Characters of Brinjal plant

		Plant height	Leaf length	Leaf width	Fruit length	Fruit diameter	Fruit Yield
Plant height	r_g	1					
	r_p	1					
Leaf length	r_g	.6393 *	1				
	r_p	.5828 *	1				
Leaf width	r_g	.6194 *	.9583 **	1			
	r_p	.5259 *	.8491 **	1			
Fruit length	r_g	-0.0845	-0.2539	-0.2747	1		
	r_p	-0.0734	-0.2186	-0.2038	1		
Fruit diameter	r_g	0.3253	.6678 **	0.5534 *	-0.6623 **	1	
	r_p	0.2948	.629 *	0.4822 *	-0.5444 *	1	
Fruit Yield	r_g	0.1753	0.5071	0.3723	-0.0885	0.7175 **	1
	r_p	0.1366	0.4692	0.2805	-0.0217	0.7079 **	1

Table 3: Direct and Indirect Effects of Plant Traits on Fruit yield (Fruit yield as a dependent variable).

	Plant height	Leaf length	Leaf width	Fruit length	Fruit diameter	rg
Plant height	(-.1097)	-0.511	0.3684	-0.075	0.5022	0.1753
Leaf length	-0.07	(-.7989)	0.57	-0.225	1.0308	0.5071
Leaf width	-0.06	-0.766	(0.59)	-0.243	0.8543	0.3723
Fruit length	0.0093	0.2028	-0.1634	(0.89)	-1.022	-0.0885
Fruit diameter	-0.0357	-0.534	0.3292	-0.586	(1.54)	0.7175

Table 4: Eigenvalue, percentage variance and cumulative variance values of Principal component analysis (PCA)

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	3.3341	1.1849	0.9194	0.4312	0.0794	0.051
Proportion	0.556	0.197	0.153	0.072	0.013	0.008
Cumulative	0.556	0.753	0.906	0.978	0.992	1

Table 5: Principal component analysis of morphological traits of Brinjal

Variable	PC1	PC2	PC3	PC4	PC5	PC6
Plant height	0.347	-0.512	-0.227	-0.746	0.099	-0.015
Leaf length	0.507	-0.231	0.005	0.324	-0.426	0.635
Leaf width	0.469	-0.293	-0.139	0.528	0.42	-0.468
Fruit length	-0.248	-0.598	0.623	0.067	-0.331	-0.281
Fruit diameter	0.468	0.425	0.088	-0.165	-0.555	-0.507
Fruit yield	0.349	0.246	0.73	-0.17	0.463	0.203

Table 6: Mean value for each cluster against all the traits studied

Cluster	No. of accessions	Plant height	Leaf length	Leaf width	Fruit length	Fruit diameter	Fruit Yield
1	3	87.4	22.3	11.6	11.4	61.90	95.61
2	7	80.8	17.8	9.3	12.3	55.84	105.18
3	5	75.6	15.6	8.5	17.8	27.81	58.75

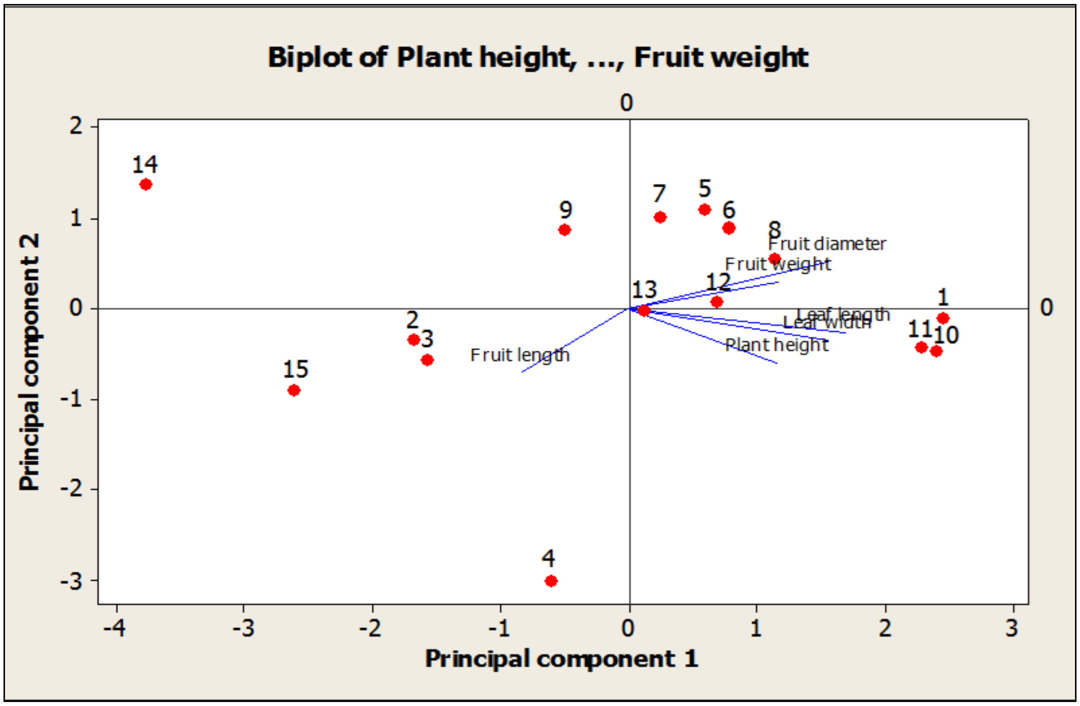

Fig 1: Biplot analysis of first two Principal components

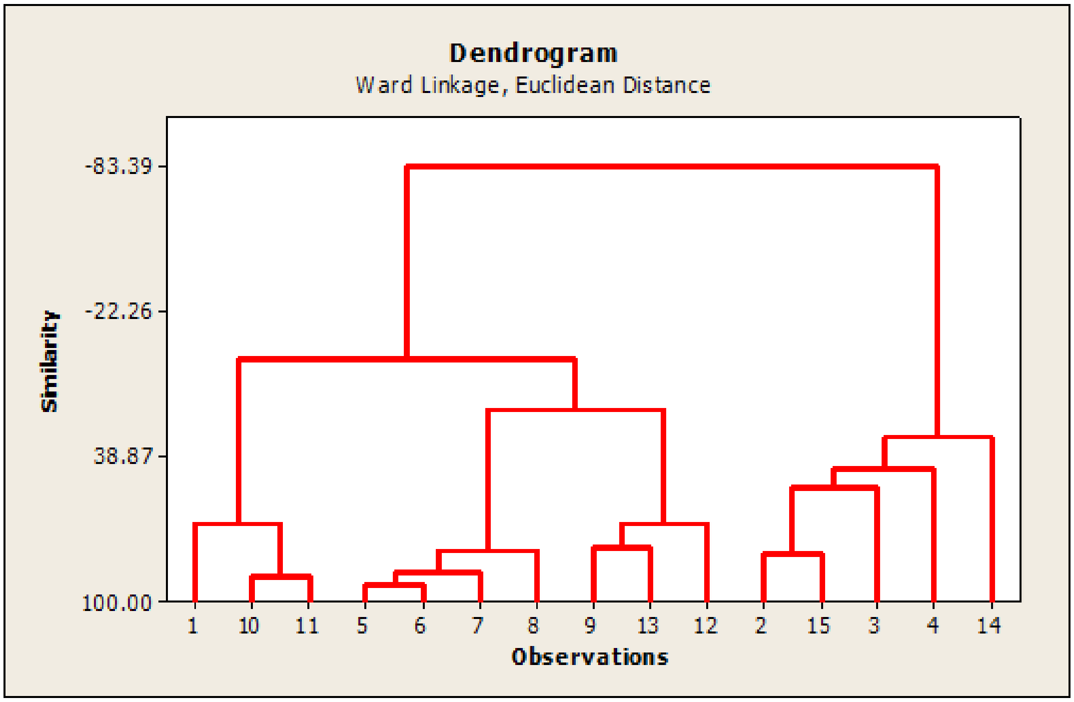

Fig 2: Dendrogram clustering similar Brinjal accessions

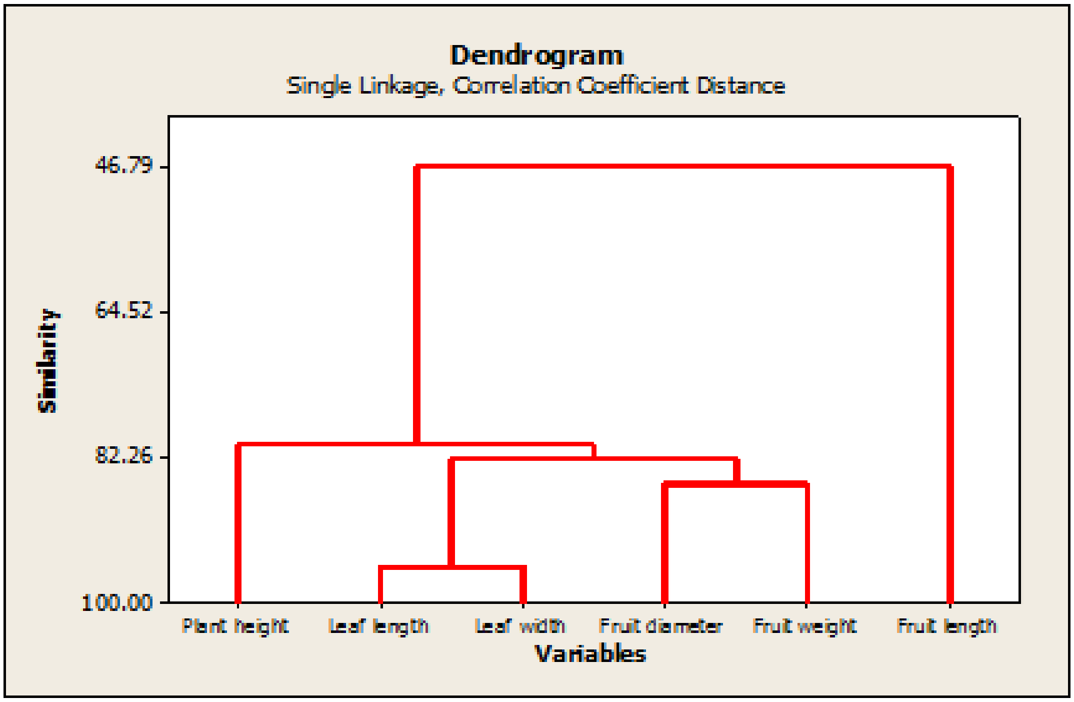

Fig 3: Dendrogram clustering similiar Brinjal variables

4. Conclusion

It can be concluded from the experiment that the highest correlation was found between Leaf length and Leaf width significant at both genotypic and phenotypic levels, also increasing leaf length wise has more strong correlation with Fruit yield than width wise. It was also found that Fruit length showed negative correlation with all of the other traits so decreased fruit length and increased Fruit diameter are desirable traits to increase overall yield. Path coefficient analysis shows that Fruit diameter exerts maximum direct effect on Fruit yield followed by Fruit length and Leaf width while Leaf length and Plant height showed negative direct effects on Fruit yield. Also we see that Fruit diameter exerts maximum indirect effect via Leaf width on Fruit yield and Leaf width has maximum indirect effects via Fruit diameter on Fruit yield, So direct selection of plants based on these two traits i.e., Fruit diameter and Leaf width would be effective to increase Fruit yield or in other words overall yield. Principal Component and cluster analysis performed on all 15 accessions revealed that by increasing the values of morphological traits like (Plant height, leaf length, Leaf width and Fruit diameter), overall yield do not increases by that proportion while taking the values of these traits to an average the plant becomes able to shift more of its energy towards producing more yield. It also shows that by reducing the values of these traits (Plant height, leaf length, Leaf width and Fruit diameter) below average but increasing the values of Fruit length also reduces Fruit yield, so for a Brinjal plant Ideotype it is recommended that the value of morphological traits like (Plant height, leaf length, Leaf width, Fruit length and Fruit diameter) should be kept at average to obtain maximum Fruit Yield.

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