

Original Research Article

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## Studies on Variability and Correlation for Nutrients, Biochemicals and Yield Contributing traits in Brinjal (*Solanum melongena* L.)

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### ABSTRACT

Vegetables are defined as the fresh parts of plants that provide suitable nutrition for humans, raw, cooked, canned, or processed in some other way. Brinjal is a commonly grown economically valuable crop, is an important solanaceous crop in India is a high genotypic diversity. In this study of variability and correlation of nutrient, biochemical parameters, and yield traits of diverse brinjal genotypes. Brinjal is a Wide variability was present among all the nutrients under study suggesting ample scope of selection. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was high in most of the characters except moisture content, radical scavenging activity, and yield/plant. High heritability was observed for iron (99.70 %), copper (99.01 %), total anthocyanin (99.12 %), total phenol (98.59 %), total chlorophyll content (92.61 %), average fruit weight (98.82 %), number of fruits/plant (97.86), suggesting that selection for these traits would be effective for the selection. Correlation study shows that Moisture, P, Ca, TSS, total chlorophyll, fruit length, fruit girth, and a number of fruits per plant showed high significant positive correlation and Fe and Zn significant negative correlation with yield per plant at the genotypic level. This study shows that sufficient variability exists in all the cultivars for nutrients, biochemical parameters, and yield traits.

#### Keywords

Brinjal, Variability, Heritability, Genetic advance, and correlation

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### Introduction

Brinjal (*Solanum melongena* L.) is one of the most common and popular vegetable crops grown in India and other parts of the globe

(Nandi *et al.*, 2020; Sulaiman *et al.*, 2020 and Bhanushree *et al.*, 2018). In Asia and the Mediterranean Region, Brinjal is among the top five most important vegetable crops (Frery *et al.*, 2007). It is an ancient species of the

world and originates in the Indo-Chinese center (Vavilov, 1951). The history of eggplant domestication has long been debated, with the most widely accepted hypothesis that eggplants were first domesticated in South-East Asia over 4000 years ago (Meyer *et al.*, 2012). It is a potential source of income and nutrients which contribute to the balance of nutrition intake in the local population (Boukare, K. *et al.*, 2019). The different regions of India give a variety of historically recorded accounts of the availability of brinjal and ancient brinjal food preparations during medieval times (Bhat and Vasanthi, 2008). On a worldwide basis, the fruit of most commercial eggplant varieties are purple (Nothmann *et al.*, 1976) Colored dark purple fruit is preferred Consumer with a high content of anthocyanins eggplant varieties are highly variable for fruit color, as well as fruit shape and size (Bhanushree, N. *et al.*, 2018). Varieties of purple, green, or white fruit color in a wide range of color intensities are common in different parts of India (Prasad *et al.*, 2015; Chattopadhyay *et al.*, 2009; Kantharajah, Golegaonkar, 2004). There are about 28 *Solanum* species found growing as wild in India exhibiting maximum species diversity in the western, eastern peninsular, and northeastern region (Chattopadhyay *et al.*, 2009; Devi *et al.*, 2015; Taher *et al.*, 2017). Brinjal exhibits extensive variation in morphological and biochemical traits (Arivalagan *et al.*, 2012).

Brinjal is nutritionally very important due to its composition, which includes minerals like potassium, calcium, sodium, and iron (Mohamed *et al.*, 2003, Raigon *et al.*, 2008). The fruits possessing high anthocyanin content, low glycoalkaloids, high dry matter, and low levels of phenol are considered excellent for the processing purpose (Bajaj *et al.*, 1979). It has been a high amount of vitamins, phenolics, antioxidants, provides significant nutritional benefits, and has

potential pharmaceutical uses as well (Gurbuz *et al.*, 2018). In traditional medicine, Aubergines were also used to treat many diseases. For example, vegetative aerial parts of *S. americanum / nigrum* are found in parts of Asia. It was traditionally been used to treat skin problems and as a purgative, to relieve urination and increase sex drive (Meyer *et al.*, 2014.) Development of high yield as well as high nutritional brinjal cultivar requires knowledge of existing genetic variation and also the extent of association between characters contributing to yield (Nandi *et al.*, 2020). Direct and indirect effects further will give a clear understanding of their association with yield as well as nutrition. Assessment of variation made on truly diverge germplasm provides an idea about the extent of genetic variation. Greater genetic variability is better for the chances of improvement of the crop (Balas *et al.*, 2019). The study of the variability of crops is not essential for crop improvement, but also effective resource management and germplasm conservation, (Nandi *et al.*, 2020). The present study was conducted to determine the magnitude of the genetic coefficient of variation, phenotypic coefficient of variation, heritability estimates, and expected genetic advancement of genotypes, Along with the nature and extent of the coefficients of correlation.

## **Materials and Methods**

### **Plant Materials**

The field experiment at Vegetable Research Farm, BAU, Sabour, and Bhagalpur was carried out. All the nutrients and biochemical analyses were conducted in the well-equipped laboratory of the Department of Horticulture (Vegetable and floriculture) and Department of Soil Science and Agricultural Chemistry, BAC, Sabour. Department of Horticulture (Vegetable and floriculture) at the BAU Sabour, farm, and laboratory in the *Kharif*

season during 2016-17 with twenty brinjal genotypes and genetic variability as well as direct and indirect associations among the biochemical and nutrient composition with yield and attributing traits were studied.

### Statistical analysis

Burton and Devine's (1953) suggested method calculated the phenotypic and genotypical coefficients of variation. Sivasubramanian and Menon (1973) classified PCV and GCV as low, moderate, or high; as given (0 – 10 %: Low, 10 – 20 %: Moderate, 20 % and above: High). Heritability in a broad sense (0 – 30 %, Low: 30 – 60 %, Moderate and 60 % and above High) Is the ratio of genotypical variance to total variance and is calculated by Lush (1940). Genetic advance estimates were obtained through the formula given by Lush (1949) and Johnson *et al.*, (1955). (0 – 10 %: Low, 10 – 20 %: Moderate and 20 % and above: High). The coefficient of correlation is the mutual association of variables without implying any relationship between cause and effect. Studies on the association between pairs of characters taking formula were determined at genotypical and phenotypic rates by Johnson *et al.*, 1955 and Al-Jibouri *et al.*, 1958.

### Results and Discussion

In India, Brinjal has a broad variability, but the success of the crop enhancement program depends on the genetic variability of germplasm. The magnitude of genetic variability will decide the rate and amount of genetic improvement by hybridization followed by selection. The selection of desirable genotypes is primarily based on mean performance. The mean sum of squares of genotypes for all the proximate nutrients, biochemicals, and yield traits under this study was significant which indicated that wide variability was present among the genotypes

for the different characters included in the study. The variability is a combined estimate of genetic and environmental causes. The value of the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation indicating the influence of environmental factors. A better idea can be gained by comparing the relative amount of coefficient of phenotypic and genotypic variance for the actual strength of variability (Sujin *et al.*, 2019; Baswana *et al.*, 2002; Nayak and Nagre, 2013). GCV and PCV were high in Cu, Mn, Fe, K, and carbohydrate, total anthocyanin, total chlorophyll, total phenolic content, TSS, number of fruits/plant, average fruit weight, fruit girth, and fruit length (Table:01 and Fig: 01). It has obtained Moderate GCV and PCV in crude protein, N, total sugar content, total antioxidants, and radical scavenging activity, whereas low GCV and PCV were observed for Zn and moisture content For these characters PCV had been marginally higher than GCV, it indicates that lesser role of the environment in the express of these characters according to Burton and Devine's 1953. It gives Moderate GCV and high PCV was observed in Ca, P, and yield/plant (Table:01 and Fig: 01), suggesting a high influence of environment on these traits. Wide variability was present among all the proximate nutrients under study suggesting ample scope of selection by Sivasubramanian and Menon 1973. In most characters, the genotypic coefficient of variation (GCV) and the phenotypic coefficient of variation (PCV) was high, except for moisture content, yield/plant, radical scavenging activity, and yield/plant (Table:01 and Fig: 01). These are in agreement with previous findings (Chaudhary *et al.*, 2014; Karak *et al.*, 2012; Kumar *et al.*, 2011; Shekar *et al.*, 2012; Bende *et al.*, 2019; Number of fruits per plant (Rani *et al.*, 2017; Ravali *et al.*, 2017); fruit weight (Ravali *et al.*, 2017; Divya and Sharma, 2018); fruit length (Ravali *et al.*, 2017; Divya and Sharma, 2018);

total fruit yield per plant (Tripathi *et al.*, 2009; Ansari, 2010) number of fruits per plant, fruit weight, fruit length, total fruit yield per plant Balas *et al.*, 2019; a number of fruits per plant (Lohakare *et al.*, 2008; Sherly and Santhi, 2008; Naik *et al.*, 2010; Muniappan *et al.*, 2010; Kumar *et al.*, 2011; Sabeena *et al.*, 2011; Dhaka and Soni, 2012 and Kumar *et al.*, 2013) and moderate for fruit yield per plant (Lohakare *et al.*, 2008 and Dhaka and Soni, 2012), for plant height (Sherly and Santhi, 2008 and Tripathi *et al.*, 2009). Heritability is the proportion of the total variability due to the genetic causes and is an index of transmission of the characters from the parents to their offspring (Falconer, 1960). In this study, high heritability was observed for iron, copper, total anthocyanin, total phenol, total chlorophyll content, average fruit weight, and a number of fruits/plants.

Genetic advance as a percent of mean is high for all proximate nutrients except moisture, P, Ca, and Zn, all biochemical compounds, and all yield traits under study except yield/plant. To have clear predictability of the breeding value, heritability coupled with genetic advance as of mean was found to be effective and more reliable in predicting the result and effect of selection, since high heritability coupled with high genetic advance reflects the preponderance of additive gene action and indicates that selection for the trait may be effective (Falconer, 1960; Panse, 1957).

Moisture content and Zn showed high heritability with moderate genetic advance, suggesting that mass selection based on these traits could be useful. Moderate values of heritability and genetic advance for P and yield/plant indicated that deferring selection to later generations may help in improving this trait. Low heritability and moderate genetic advance were observed in Ca content which suggested a high influence of environment on this trait and that selection would not be much

rewarding for the trait. In the present investigation, high heritability coupled with high genetic advance was noticed in all proximate nutrients except moisture, P, Ca, and Zn, all biochemical compounds, and all yield traits under study except yield/plant. Selection based on these traits would be effective due to the governance of additive gene action. These findings corroborated with the findings of Ramesh Kumar *et al.*, (2013) for fruit length, number of fruits per plant, total phenol content, and fruit yield per plant, Shekar *et al.*, (2012) for fruit length, average fruit diameter, fruit per plant, Naik *et al.*, (2010) for fruit length, number of fruits per plant, yield per plant, Mohanty (2003) for fruit weight and number of fruits, Kumar *et al.*, (2013) for total phenol content and Mili and Bora (2014) for fruits/ per plant. number of fruits per plant (Sabeena *et al.*, 2011; Dhaka and Soni, 2012; Kumar *et al.*, 2013 and Meena and Bahadur, 2014), fruit yield per plant (Kumar *et al.*, 2011; Dhaka and Soni, 2012 and Kumar *et al.*, 2013), average fruit weight, number of branches per plant, length of the peduncle, fruit length, fruit diameter, fruit length: diameter ratio, fresh weight of fruit and phenol. Chaudhary *et al.*, (2014) for fruit weight, fruit yield per plant, fruit length, and total reducing sugar.

### **Correlation studies**

The degree of association between yield and its components will be studied in correlation (Sujin *et al.*, 2017). The relationship between the dependent and the independent characters reflects the real relationship between the characters and can be performed for such characters to improve the dependent variable (Al-Jibouri *et al.*, 1958). Moisture content (Table: 2) had a highly significant positive association with N, P, K, Mn, TSS, total sugar content, total chlorophyll, fruit length, and a significant positive correlation with yield/plant.

**Table.1** Components of variability in proximate nutrient components, biochemical compounds, and fruit morphological and yield parameters in 20 brinjal genotypes

Characters	GCV	PCV	Heritability (Broad Sense)	Genetic Advancement 5%	Genetic Advancement as % of Mean (5%)
<b>Proximate nutrient components</b>					
Moisture ( % )	5.55	5.96	86.59	8.86	10.64
Carbohydrate (%)	22.47	23.12	94.44	2.37	44.98
Crude Protien (%)	18.29	18.55	97.19	9.30	37.15
Nitrogen (%)	15.00	15.94	88.54	1.04	29.07
Phosphorous (%)	12.13	21.22	32.68	0.06	14.28
Potassium (%)	23.65	24.92	90.11	1.51	46.25
Calcium (%)	17.00	33.02	26.50	0.11	18.03
Iron (mg/kg)	28.02	28.77	99.70	87.90	57.64
Manganese (mg/kg)	28.77	28.80	99.81	110.34	59.22
Copper (mg/kg)	53.77	53.81	99.84	66.07	110.67
Zinc (mg/kg)	5.84	6.54	79.89	7.47	10.76
<b>Biochemical parameters</b>					
TSS ( °Brix)	25.56	28.25	81.89	1.18	47.65
Total sugar (%)	19.86	20.67	92.31	1.39	39.31
Ascorbic acid (mg/100g)	37.10	37.43	98.22	1.72	75.74
Total anthocyanin (mg/100g)	89.01	89.41	99.12	13.99	182.56
Total chlorophyll(mg/100g)	72.48	75.31	92.61	1.37	143.69
Total phenol concentration(CE mg/100g)	50.67	51.03	98.59	6.73	103.64
Total antioxidant (µmol Trolox equivalent/g)	19.60	20.00	96.10	0.61	39.59
Radical scavenging activity (%)	14.48	15.47	87.57	22.84	27.91
<b>Morphological and yield parameters</b>					
Fruit length (cm)	27.23	29.10	87.52	7.51	52.47
Fruit girth (cm)	29.04	29.98	93.87	8.30	57.96
Average fruit weight (g)	33.60	33.80	98.82	60.27	68.81
Number of fruits/plant	41.16	41.60	97.86	17.66	83.87
Yield/plant (kg)	13.71	20.80	43.47	0.34	18.63

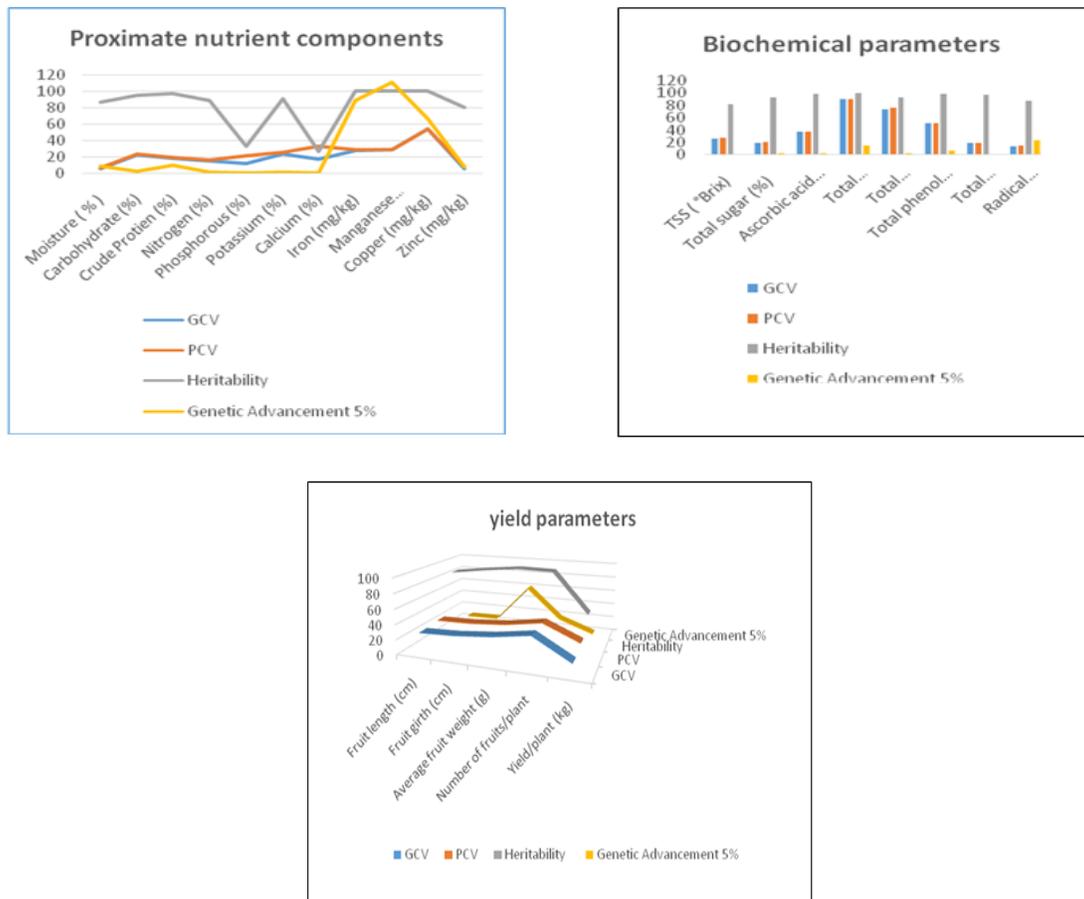
**Note:** GCV: Genotypic Coefficient Of Variation and PCV: Phenotypic Coefficient Of Variation

**Table.2** Estimation of the genotypic correlation coefficient for different characters under

	<b>M</b>	<b>P</b>	<b>Ca</b>	<b>Fe</b>	<b>Zn</b>	<b>TSS</b>	<b>TC</b>	<b>FL</b>	<b>FG</b>	<b>NFP</b>	<b>Y/P</b>
<b>M</b>	1	0.70*	0.19	0.22	-0.041	0.50**	0.41**	0.56**	0.16	0.27*	0.47**
<b>P</b>		1	-0.38**	0.76**	0.27*	0.52**	0.42**	0.47**	0.34**	0.33**	0.42**
<b>Ca</b>			1	0.04	-0.51**	0.34**	0.66**	0.67**	0.21	-0.14	0.57**
<b>Fe</b>				1	0.34**	0.16	0.13	0.31*	0.13	0.054	-0.35**
<b>Zn</b>					1	-0.06	-0.25	-0.04	-0.10	-0.43**	-0.50**
<b>TSS</b>						1	-0.03	0.49**	0.38**	0.06	0.46**
<b>TC</b>							1	0.75**	0.20	0.18	0.71**
<b>FL</b>								1	0.16	-0.009	0.54**
<b>FG</b>									1	-0.12	0.42**
<b>NFP</b>										1	0.36**
<b>Y/P</b>											1

**Note :** **M** : Moisture ( % ), **P** : Phosphorous (%), **K** : Potassium **Ca**: Calcium (%), **Fe**: Iron (mg/kg), **Zn**: Zinc (mg/kg) ,**TSS** : Total Soluble Solids ( °Brix), **TC** : Total chlorophyll content (mg/100g), **FL** : Fruit length (cm), **FG** : Fruit girth (cm), **NF/P** : Number of fruits/plant and **Y/P** : Yield/plant (kg)

**Fig.1** Graphical representation of proximate nutrient components, biochemical compounds and fruit morphological and yield traits



A study was carried out by Dhruve *et al.*, (2014) that moisture content in fruit was significantly positively related to fruit length and fruit weight, anthocyanin content. P showed a highly significant correlation with Fe and Mn, while it was significantly positively correlated with TSS, total anthocyanin, total chlorophyll, and fruit length. Ca exhibited a highly significant positive association with total chlorophyll content; significant positive correlation with fruit length, average fruit weight; significant negative correlation with total phenolic content, total antioxidants. Fe showed a highly significant positive association with Mn, significant positive association with Zn, radical scavenging activity, and fruit length.

TSS showed a highly significant positive association with total sugar content and fruit length; a significant positive correlation with fruit girth, yield/plant, and total anthocyanin; whereas, it was significantly negatively correlated with total antioxidants. Total sugar content exhibited a significant positive association with average fruit weight and significantly negatively correlated with ascorbic acid. Wang *et al.*, (2010) for positive correlation of sugar with anthocyanin and TSS with chlorophyll, Ascorbic acid was highly significantly positively correlated with of total chlorophyll content and fruit length. Thangamani and Jansirani (2012) that yield per plant exhibited a significant positive correlation with ascorbic acid content. Total

anthocyanin showed a highly significant positive association with fruit girth. Total chlorophyll content showed a highly significant positive correlation with fruit length and yield/plant, while it had a significant negative correlation with total phenolic content and total antioxidant. Total phenolic content had a highly significant positive correlation with total antioxidant; it was significantly negatively correlated with fruit length. Tripathi *et al.*, (2014) for linear relation between the total phenolic content and DPPH activities, Total antioxidant had a highly significant negative correlation with fruit length. Fruit Length was highly significantly positively correlated with yield/plant., Akanitapichat *et al.*, (2010) for a positive correlation between antioxidant activities with the total amounts of phenolics. Fruit girth showed a highly significant positive correlation with average fruit weight and a significant positive correlation with yield/plant. Average fruit weight had a highly significant negative correlation with a number of fruits. Chauhan *et al.*, (2017) Fruit yield showed a highly significant and positive association with a number of fruits per plant, Ahmed *et al.*, (2013) fruit yield was significantly positive with no. of fruits per plant, fruit weight. Karak *et al.*, (2012) for a negative correlation between fruit yield per plant and sugar and protein content of fruit and positive correlation between fruit yield per plant and total phenolic content of fruits. Matin *et al.*, (2001) for fruit weight and number fruits per plant, Singh *et al.*, (2010) for yield per hectare being positively correlated with a number of fruits per plant, fruit length, fruit weight, Sharma and Swarop (2000) for fruit yield per plant being positively and significantly associated with a number of fruits per plant and average fruit weight. To initiate an efficient selection program, it is necessary to determine the degree of association of the various quantitative characters. There were coefficients of

genotypic association higher than their phenotypic ones. This may be due to the masking effect of the atmosphere that modifies character expression and thereby decreases the phenotypical expression (Nandpuri *et al.*, 1977).

There is a broad range of variations for almost any economically important traits in this crop, and therefore there is an extensive range of improvements through different breeding methods. Fruit length, fruit girth, K, total sugar content, moisture content, P, and total chlorophyll emerged as the most important fruit yield contributing characters of brinjal and these characters may be used as important selection parameters because of their probable conditioning by additive gene action. This indicated the predominance of additive gene action and better scope for improvement of these characters for effective selection of genotype. The correlation may be suggested by Moisture, P, Ca, TSS, total chlorophyll, fruit length, fruit girth, and number of fruits per plant. These are the important corresponding characteristics that contribute to fruit yield in Brinjal and at the same time improve those characters.

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