“VARIABILITY AND ASSOCIATION STUDIES IN LONG FRUITED BRINJAL (*Solanum melongena* L.)”

M. Sc. (Hort.) Thesis

by

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DEPARTMENT OF VEGETABLE SCIENCE
COLLEGE OF AGRICUTURE
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“VARIABILITY AND ASSOCIATION ANALYSIS IN LONG FRUITED BRINJAL (*Solanum melongena* L.)”

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CERTIFICATE – I

This is to certify that the thesis entitled **"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)"** submitted in partial fulfillment of the requirements for the degree of **Master of Science in Horticulture (Vegetable Science)** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Anurag Dasmohapatra** under my/our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or certificate course. All the assistance and help received during the course of the investigations have been duly acknowledged.

Chairman

Date: 14/08/18

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

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Co-Chairman	(Dr. Jitendra Singh)	________
Member	(Dr. Sunil Kumar Nair)	________
Member	(Dr. Ravi R. Saxena)	________

CERTIFICATE - II

This is to certify that the thesis entitled **"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)"** submitted by **Anurag Dasmohapatra** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfilment of the requirements for the degree of **Master of Science in Horticulture (Vegetable Science)** in the **Department of Vegetable Science** has been approved by the external examiner and Student's Advisory Committee after oral examination.

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Faculty Dean __________________

Approved/Not approved

Director of Instructions __________________

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Anurag Dasmohapatra

Place: Raipur *ANURAG DASMOHAPATRA*

Date:

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LIST OF SYMBOLS

%	percent
@	at the rate
˚C	Degree Celsius
Cal.	Calories
cm	Centimeter
df	Degree of freedom
et al.	and co-workers/ and others
g	Gram
ha	Hectare
h^2 b	Heritability in broad sense
hrs	Hours
i.e.	That is
kg	Kilogram
l	Liter
mm	Millimeter
mg	Milligram
m^2	Square meter
q	Quintal
var	Variety
via	Through
viz.	For example

LIST OF ABBREVIATIONS

CD	Critical Diffrence
CV	Coefficient of Variation
DAS	Days After Sowing
DAT	Days After Transplanting
Df	Degree of freedom
EMS	Error mean of squares
FYM	Farm yard manures
Fig.	Figure
GA	Genetic Advance
GCV	Genotypic Coefficient of Variation
IIVR	Indian Institute of Vegetable Research
PCV	Phenotypic Coefficient of Variation
RSS	Replication Sum of Square
RBD	Randomized Block Design
SE	Standard Error
SE (d)	Standard error of difference between two means
NPK	Nitrogen Phosphorus Potassium

THESIS ABSTRACT

a) Title of the Thesis	:	"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)",
b) Full Name of the Student	:	Anurag Dasmohapatra
c) Major Subject:	:	Vegetable Science
d) Name and Address of the Major Advisor		Dr. Dhananjay Sharma, Sr. Scientist, Department of Vegetable Science, CoA, IGKV, Raipur
e) Degree to be Awarded:	:	M.Sc. (Hort.) Vegetable Science

Anurag Dasmohapatra

Signature of the Student

Signature of Major Advisor

Date: 14/08/18

Signature of Head of the Department

ABSTRACT

The investigation was conducted at Horticultural Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the *rabi* season of 2017-2018.

The experiment was laid out in randomized block design in three replications with seventeen genotypes to estimate the mean performance of those genotypes, genetic variability, heritability, genetic advance, character association, path analysis and to identify best genotype suitable for Chhattisgarh plains among them.

From the mean performance of the brinjal genotypes it was found that 2017/BRLVAR-8 (846.67q/ha) and 2017/BRLVAR-9 (783.21q/ha) were most promising with respect to yield per hectare.

The magnitude of PCV was higher than the concurrent GCV for all the characters. This might be due to the interaction of the genotypes with the environment to some degree or due to environmental factors stimulating the expression of these traits. High heritability coupled with high genetic advance was observed for the characters like number of primary branches per plant, number of flowers per inflorescence, average fruit wt. (g), fruit yield per plant (kg) and fruit yield per hectare (q).

In the analysis of correlation coefficient of all the attributes it was found that plant height, days to 50% flowering, number of cluster per plant, fruit length, first marketable fruit maturity and fruit yield per plant have preponderated effect on fruit yield per hectare (q).

In path coefficient analysis it was found that plant height (cm), number of flowers per cluster, number of primary branches per plant, pedicel length (cm), pericarp thickness (mm), days to first marketable fruit, showed positive and direct effect and had significant positive correlation with fruit yield per hectare (q).

Hence after complete investigation the attributes plant height (cm), number of primary branches per plant, pedicel length (cm), pericarp thickness (mm), fruit length (cm) and number of flowers per cluster, days to first marketable fruit are found to be superior yield component.

शोध सारांश

अ) शोध रिपोर्ट का शीर्षक	लम्बी बैगन (सोलानम मेलोनजेना एल.) में विभिन्नता और सहसम्बन्ध का अधययन
ब) बिद्यार्थी का पूरा नाम	अनुराग दासमोहापात्रा
स) प्रमुख विषय	सब्जी विज्ञान
द) प्रमुख सलाहकार का नाम व पता	डॉ. धनन्जय शर्मा, सीनियर वैज्ञानिक, सब्जी विज्ञान, कृषि महाविद्यालय, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर, छत्तीसगढ़
इ) सम्मानित किया जाने वाला उपाधि	एम. एससी. उद्यानिकी (सब्जी विज्ञान)

Anurag Dasmohapatra

बिद्यार्थी का हस्ताक्षर

प्रमुख सलाहकार के हस्ताक्षर

दिनांक

विभागाध्यक्ष के हस्ताक्षर

सारांश

वर्तमान शोध 2017–2018 के रबी सत्र के दौरान उद्यानिकी अनुसंधान–सह–अनुदेशक प्रक्षेत्र, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छ. ग.) में किया गया।

प्रयोग जीनप्ररूपों, अनुवांशिक विविधता, अनुवांशिकता, अनुवांशिक अग्रिम, लक्षण सहसम्बन्ध, पथ विश्लेषण का औसत प्रदर्शन और छत्तीसगढ़ मैदानी इलाकों के लिए उपयुक्त सर्वश्रेष्ठ जीनप्ररूप की पहचान करने के लिए सत्रह जीनप्ररूप के साथ तीन प्रतिकृतियों में यादृच्छिक खंड डिजाइन का प्रयोग किया गया।

बैंगन जीनप्ररूप के औसत प्रदर्शन से यह पाया गया कि 2017/बीआरएलवीएआर–8 (846.67 वर्गहेक्टेयर) और 2017/बीआरएलवीएआर–9 (783.21 वर्गहेक्टेयर) प्रति हेक्टेयर उपज के लिए उत्कृष्ट पाए गए।

प्ररूपी बिचरण गुणांक का परिमाण सभी लक्षणों के लिए समवर्ती अनुवांशिक रूप गुणांक से अधिक पाया गया, जो सामान्यतः पर्यावरण और जीनप्ररूपों की पारस्परिक क्रिया के कारण अथवा पर्यावरणीय कारकों प्रभाब के कारण हो सकता है। उच्च आनुवंशिक अग्रिम के साथ उच्च आनुवांशिकता प्रति पौधे की प्राथमिक शाखाओं की संख्या, प्रति पुष्पक्रम में फूलों की संख्या, औसत फल वजन (ग्रा.), प्रति पौधे फल उपज (किग्रा.) और फलों की पैदावार प्रति हेक्टेयर (क्वी) जैसे लक्षणों के लिए अवलोकन किया गया।

सभी लक्षण के सहसंबंध गुणांक के विश्लेषण में यह पाया गया कि पौधे की ऊचाई, 50% पुष्पन हेतु दिन, प्रति पौधे गुच्छों की संख्या, फल की लंबाई, पहले बिक्री योग्य फल परिपक्वता के लिए दिन, प्रति पौधे फल उपज और प्रति हेक्टेयर फल उपज (क्वी) पर सीधा प्रभाव डालता है।

पथ गुणांक विश्लेषण में यह पाया गया कि पौधों की ऊचाई (सेमी), प्रति पुष्पक्रम में फूलों की संख्या, प्रति पौधे की प्राथमिक शाखाओं की संख्या, पुष्पबृंत लंबाई (सेमी), फलभित्ति मोटाई (मिमी), पहले बिक्री योग्य फल परिपक्वता के लिए दिन, प्रति हेक्टेयर फल उपज (क्वी) पर सकारात्मक और प्रत्यक्ष प्रभाव दिखाते तथा इनका प्रति हेक्टेयर फल उपज (क्वी) के साथ धनात्मक एवं सार्थक सह–सम्बन्ध पाया गया ।

इसलिए पूर्ण जांच के बाद यह पाया गया की, पौधों की ऊचाई (सेमी), प्रति पौधे की प्राथमिक शाखाओं की संख्या, प्रति पुष्पक्रम में फूलों की संख्या, पुष्पबृंत लंबाई (सेमी), फलभित्ति मोटाई (मिमी), फल लंबाई (सेमी) और पहले बिक्री योग्य फल के लिए दिन, उपज के लिए बेहतर घटक हैं।

CHAPTER I
INTRODUCTION

Brinjal (*Solanum melongena* L. 2n = 24), one of the important vegetable crops, belongs to the family Solanaceae referred as egg plant or Aubergine. According to De Candolle (1883), egg plant was known to India from ancient times and is probably a native of India (Vavilov, 1928). Its primary centre of origin lies in Indo-Burma whereas China is the secondary centre of origin. Brinjal belongs to the very large genus *Solanum*, as well as its largest subgenus, *Leptostemonum*, which includes many wild relatives, as well as other cultivated species, such as the Gboma (*Solanum macrocarpon* L.) and the Ethiopian eggplant (*Solanum aethiopicum* L.) grown mostly in Africa for their fruits and leaves. More than 200 *Solanum* species are known in Africa, with about 25 species indigenous in Nigeria (Gbile and Adesina, 1988; Burkill, 2000).

Brinjal plant is polymorphous, erect, aculeate or unarmed herb, woody at the base and 0.5- 1.5 m in height, flowers are rather large, stalked lateral or leaf opposed. The flowers borne solitarily or in cluster. Calyx is tubular-campanulate,5-lobed far less than half way down, on the outside grayish-green, often strongly tinged with purple, on both sides densely stellate - tomentose and 1.5-2.0 cm long. Corolla is gamopetalous, deeply 5-lobed, stellately spreading, on outside light violet, densely white stellate tomentose, within dark violet, glabrous, rugose and 2.5-4.0 em in diameter. Though brinjal is self-pollinated crop, but there is high degree of cross-pollination due to heteromorphic flower structure (called as heterostyly). Extent of cross pollination has been reported as high as 29% (Ram, 1999). The flower types of brinjal are: (a) long-styled, big ovaries (b) medium-styled, oval (c) short styled, rudimentary ovary and (d) pseudo short styled. Only long and medium-styled flowers are set fruit.

In India brinjal is an important vegetable crop and is grown throughout the year. However, it is widely cultivated in both temperate and tropical regions of the globe mainly for its immature fruits as vegetable (Rai *et al.,* 1995), but in the temperate regions it is cultivated mainly during warm season. In the Ayurvedic, a

Hindi system of medicine, Contrary to the common belief, it is quite rich in nutritive value and can be compared with tomato (Chaudhury, 1976).The fruits are excellent remedies for those suffering from liver troubles. White coloured ones are good for diabetic patients (Singh *et al.,* 1963). Roots are very useful for the treatment of asthma (Khan, 1979).Extracts of brinjal are known to have significant effect in reducing blood and liver cholesterol rates. The peel of brinjal has significant amounts of anthocyanin with antioxidant activity and protects against cancer, ageing, inflammation and neurological diseases (Hanur *et al.*, 2006).

Brinjal is a stable vegetable high in nutritive value. It is low in fat and high in dietary fibre. Brinjal fruits mainly unripe are widely used in various culinary preparations *viz*., sliced bhaji, stuffed curry, bharta, chatni, pickles *etc*. It has also got much potential as raw material in pickle making and dehydration industries (Singh *et al.,* 1963). It is rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients. Bitterness in brinjal is due to presence of glycoalkaloids. Glycoalkaloids content vary from 0.4 to 0.5 mg per 100 g of fresh weight. It contains mostly water, some protein and carbohydrates besides it is a good source of nutrients such as ascorbic acid, vitamin K, niacin, vitamin B6, pantothenic acid and rich in minerals like Ca, Mg, P, K and Fe. Purple varieties have higher copper content, amino acid content and polyphenol oxidase activity where as catalase and iron activity is highest in green cultivars. Analysis of edible parts of fruit (except stalk and calyx) gave the following values (per 100g fresh weight): moisture 92.7 g; protein 1.4 g; fat 0.3 g; mineral 0.3 g; fiber 1.3 g and carbohydrates 4.0 g. The mineral constituents per 100g edible portions are: phosphorus (47 mg), Mg 16 mg; Ca 18 mg; potassium (200.0 mg); iron (0.9 mg), sodium (3.0 mg), copper (0.17 mg); Na 3 mg; Cu 0.17 mg; S 44 mg; Cl 52 mg and Mn 2.4 mg; Fe 0.9 mg (ionisable Fe 0.8 mg);. A small quantity of Iodine (7 μg/ kg) is also present. The vitamins present per 100g edible portions are Vitamin A 124 IU; riboflavin 0.47 mg; Thiamin (B1) 0.4 mg; Nicotinic acid (niacin) 0.9 mg; Vitamin C 12 mg and Choline 25 mg.

India is the second largest producer of brinjal in the world after China. It has a positive role in both summer and winter to fulfill the market demand of vegetables. Based on its highest production potential and availability of the produce to consumers, it is also termed as poor man's vegetable and due to its versatility use in Indian food, brinjal is often described as the "*King of vegetables*". It is commercially cultivated in West Bengal, Odisha, Gujarat, Bihar, Madhya Pradesh, Chhattisgarh, Karnataka and Maharashtra. In India, brinjal production was 12400 thousand metric tonnes during 20015-16 from an area of 668.7 thousand hectare with a productivity of 18.5 tonnes per ha (Anon, 2017). Whereas, in Chhattisgarh, during 2015-16 brinjal occupied an area of 36.76 thousand hectare with the production and productivity of 670.40 thousand tonnes and 18.23 tonnes per ha respectively (Anon, 2017).

India being the primary centre of origin, it is bestowed with a number of genotypes. There is also a wide range of variability present for different characters of brinjal. Especially in Chhattisgarh there is a lot of potential for improvement of brinjal by analyzing the genetic diversity of this crop. In Chhattishgarh, people prefer to eat brinjal as fry curry, bharta more than other and for those they prefered oblong to long fruits with purple/white/dark purple colour. So there is urgent need to improve the yield, so that it can meet the national productivity. Thorough evaluation of the germplasm is needed to know the performance in terms of yield and its attributing characters based on which promising lines can be identified. Yield is a complex variable trait which depends upon a large number of factors and their interactions. Knowledge of association of these characters with yield is pre-requisite to isolate desirable genotypes.

Keeping in view of the different aspects discussed above and realizing the need for a comprehensive study in brinjal, the present investigation entitled **"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)"** is formulated with the following objectives:

1. To select the best brinjal genotypes suitable for Chhattisgarh plain.
2. To study the genetic variability in brinjal genotypes for yield and component characters.
3. To find out association (correlation and path analysis) among the yield and component characters.

CHAPTER II
REVIEW OF LITERATURE

Various literature pertaining to the present investigation "**Variability and association studies in long fruited brinjal (*Solanum melongena* L.)**", were reviewed in this section. Taking the objectives of this study into consideration, available literature is presented under following headings in multiple paragraphs:

2.1 Genetic variability

2.2 Correlation coefficient analysis

2.3 Path coefficient analysis

2.1 Genetic Variability

Genetic variability for yield and its attribute components is essential in the base population for successful crop improvement (Allard, 1960). Yield and yield constituents are quantitative characters and are polygenically inherited which are greatly altered by the environment. The phenotype of a character is the consequence of reciprocal action between genotype and environment. Separation of observed variability into heritable and non-heritable components is essential to get a comprehensive indication of genetic variation of the traits. Genetic specifications such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance (GA) are frequently used in distinguishing the variability and genetics of a character. The study of genetic variability was carried out for the first time by great biologist Fisher (1918) and subsequently the estimation of genotypic and phenotypic variations were used to anticipate the expected genetic behavior.

Estimation of heritability values had a significant reference in adjusting the relative degree to which, a character is transmitted from parent to progeny or from one generation to the next. Hence, partitioning of total variation into heritable and non-heritable components is necessary in order to assess the true breeding nature of the character. Heritability in broad sense may be defined as the ratio of genetic variance to phenotypic variance (Lush, 1949). Characters with high estimates of heritability are of great importance to the plant breeder as it will enable the plant breeder to formulate criteria based on phenotypic performance. If heritability of a character is very high, a selection for the character is fairly easy. This is because there would be a close relation between genotype and phenotype due to a relatively smaller contribution of environment to the phenotype. But for the character with low heritability, a selection may be considerably difficult due to masking effect of environment on the genotype.

Singh and Gopalakrishnan (1999) evaluated 78 brinjal accessions for seventeen traits and highest genotypic and phenotypic coefficient of variation was recorded for number of fruits per plant and fruit yield per plant, whereas, highest heritability estimate was observed in plant spread, average fruit weight, and days to 50% harvest, while number of fruits per plant and fruit yield per plant gave the highest genetic advance.

Prasad *et al*. (2004) studied 52 aubergine genotypes for all characters except fruit yield and estimated moderate to high heritability and genetic advance for average fruit weight, fruit yield, fruit girth, number of fruits per plant and fruit length, indicating the potential of simple selection for the improvement of these characters. The low genetic advance was observed for days to first flowering, fruit set and number of primary branches. Moderate genetic advance and heritability were observed for plant height, days to first flowering and days to first fruit set, indicating the potential for the improvement of these characters through selection in the germplasm.

Sao (2006) predicted the genetic variability and its component and found that the PCV was higher than the GCV for the characters under study. The GCV and PCV were higher for average fruit weight, fruit length, fruit girth, number of flower per inflorescence, number of fruit per clusters, marketable fruit yield per plant, and total fruit yield per plant, moderate was recorded for number of primary branches per plant, total soluble solids, rind thickness, while, low was recorded for days to first fruiting, days to first flowering, and plant height. The number of fruit per cluster recorded high GA followed by fruit yield per plant, average fruit weight, total fruit yield per plant, number of flowers per inflorescence and fruit length.

Naik (2006) carried out an experiment to study genetic variability of 62 genotypes of brinjal and results revealed that GCV and PCV were high for fruit length, number of fruits per cluster, number of fruits per plant, total yield per plant, and fruit length to diameter ratio. High heritability coupled with high genetic advance over mean was observed for fruit length, number of fruits per cluster, number of fruits per plant, total yield per plant, and fruit length to diameter ratio, indicating predominance of additive gene action for these traits.

Pathania *et al*. (2007) considered 19 genotypes showing highly significant differences for most of the traits. High estimates of GCV, heritability and genetic advance were observed for marketable fruits per plant, total number of fruits per plant, average fruit weight and fruit diameter indicating effectiveness of simple selection for improvement of these characters.

Ram *et al.* (2007) reported genetic variability in brinjal at Kalyanpur and observed high genotypic and phenotypic coefficient of variation for yield per plant, number of fruits per plant and plant spread in parents. High heritability coupled with high genetic advance indicating additive gene action was exhibited by characters, plant height, days to marketable maturity, plant spread, days to flowering, fruit yield per plant, fruit weight and number of branches per plant in F_1s, F_2s and parent populations.

Naliyadhara *et al*. (2007) surveyed 21 genotypes of brinjal during late kharif season and revealed that PCV greater than GCV for all the traits. High heritability with moderate to high GCV and genetic advance was observed for plant height, number of branches per plant, fruit length, fruit girth except fruit yield per plant.

Mishra *et al.* (2008) discovered high PCV and GCV for average weight of fruit and moderate for length of fruit, number of fruits per plant and yield per plant. The estimates of heritability were found high for fruit shape, fruit girth, plant height and average weight of fruits. High heritability coupled with genetic advance indicating the additive gene action will be effective for plant height, plant spread, girth of fruit and number of fruits per plant.

Ambade (2008) noticed high genotypic as well as phenotypic coefficient of variations for traits *viz*; number of flowers per inflorescence, fruit length, fruit girth, number of primary branches per plant, total number of fruits per plant etc.

Moderate PCV and GCV were found for stalk length, total fruit yield per plant and plant height whereas low PCV and GCV were found for days to first flowering and days to first fruiting. All characters showed high heritability and recorded highest GA for total fruit yield per plant, average fruit weight, plant height and fruit girth.

Ansari (2010) revealed high genotypic and phenotypic coefficients of variation for number of flower/inflorescence, number of fruit/picking and fruit girth. High heritability with high genetic advance was observed for average fruit weight and total number of fruits/plant. Higher genetic advance coupled with moderate heritability were recorded for number of fruits/cluster. Moderate genetic advance coupled with moderate heritability were observed for days to 50% flowering.

Katre (2010) found that the mean sum of squares for all the characters are highly significant. High estimates of PCV coupled with GCV were recorded in average fruit weight, number of fruits per plant, number of fruits per cluster, number of flowers per cluster, fruit length and fruit girth. High heritability coupled with high genetic advance as per cent of mean were observed for average fruit weight, fruit length, fruit girth, number of fruits per plant, number of fruits per cluster, number of flowers per cluster.

Muniappan et al. (2010) carried out a study to assess the variability for eight morphological characters in 34 eggplant genotypes. They recorded high PCV and GCV by the characters viz., number of branches per plant, fruit breadth, number of fruits per plant, average fruit weight, and fruit yield per plant nd also recorded high heritability and genetic advance for characters viz., number of branches per plant, fruit breadth, number of fruit per plant, average fruit weight and fruit yield per plant except days to fifty per cent flowering.

Ansari *et al*. (2011) observed genetic variability in seven parents and 21 hybrids of brinjal. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for number of fruits per cluster, average fruit weight, total number of fruits per plant, fruit length. Maximum genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for number of flowers per inflorescence, number of fruits per picking and fruit girth, indicating that selection can be predicted to improve the brinjal genotypes for these characters.

Chattopadhyay *et al.* (2011) surveyed 35 diverse genotypes of brinjal and observed high heritability and GA for fruit weight, plant height and days to 50% of flowering indicating that such situation may arise due to the action of additive genes controlling the characters and can be improved through simple selection.

Dhaka and Soni (2012) recorded high heritability for all characters including number of fruits per plant and average fruit weight. Genetic advance as percentage of mean was found high for average fruit weight, yield per plant, number of fruits per plant and number of leaves per plant. High GCV and heritability coupled with high genetic advance for yield per plant followed by number of fruits per plant indicating that they are governed by additive genes and could be effectively improved through selection.

Kumar *et al.* (2013) measured high phenotypic and genotypic co-efficient of variations for fruit length, calyx length, number of fruits per plant, little leaf incidence, total phenol content and fruit yield per plant. The characters *viz.,* fruit length, calyx length, number of fruits per plant, little leaf incidence, total phenol content and fruit yield per plant also recorded high magnitude of heritability coupled with genetic advance.

Lokesh *et al*. (2013) studied 60 brinjal genotypes and observed that high PCV and GCV for plant height, plant spread, number of branches per plant, number of fruits per cluster, average fruit diameter, average fruit weight, shoot and fruit borer incidence on shoot and fruit and fruit yield per plant indicating high variability in the germplasm.

Singh *et al.* (2013) recorded high PCV and GCV for fruits per plant, average fruit weight, fruit index, fruit length, fruit diameter, primary branches per plant, whereas, fruit yield per plant, plant spread, plant height, days to first flowering, days to first fruit set and days to first harvest observed moderate PCV. The heritability estimates were high for all the characters. High expected genetic advance was observed for number of fruits per plant, average fruit weight, fruit index, fruit length, fruit diameter, primer branches per plant, yield per plant, plant spread and plant height however moderate genetic advance was observed for days to first flowering, days to first fruit set and days to first harvest.

Arunkumar *et al*. (2014) studied the genetic components to assess the variability of eight morpho-economic characters in 34 brinjal genotypes. High PCV and GCV were recorded by the characters *viz.,* number of branches per plant, fruit length, fruit breadth, number of fruits per plant, average fruit weight and fruit yield per plant. All the characters were accompanied by high heritability and high genetic advance except for the trait days to 50 per cent flowering.

Chaitnya (2015) recorded high PCV, GCV, high heritability coupled with high genetic advance as per cent of mean were recorded for fruit length, fruit width, average fruit weight, total number of fruits per plant, number of marketable fruits per plant, total yield per plant, marketable yield per plant and ascorbic acid content.

Vidhya and Kumar (2015) estimated high genotypic and phenotypic coefficients of variations for fruit girth followed by number of fruits per plant. The high heritability and high genetic advance has been observed for fruit girth, single fruit weight and marketable yield per plant.

Madhukar *et al.* (2015) recorded high PCV and GCV for yield per plant, borer infestation percentage, fruits per plant, fruits per cluster, fruit length, seed weight and calyx length indicating the presence of high variability in the germplasm. High heritability coupled with high genetic advance as percentage of mean was observed for all the characters.

Madhavi *et al.* (2015) carried out experiment with 21 diverse genotypes for sixteen plant growth and fruit yield related characters viz., days to 50% flowering, plant height at 50% flowering (cm), number of branches per plant, leaf area (cm2), flowers per cluster, fruits per cluster, fruit setting percentage (%), fruit length (cm), fruit diameter (cm), fruit volume (cm3), number of fruits per plant, average fruit weight (g), plant height at last picking (cm), dry matter content (%), number of pickings and fruit yield per plant (kg) and observed high heritability and genetic advance for number of fruits per plant, average fruit weight, fruit yield per plant, fruit volume, fruits per cluster, number of pickings, flowers per cluster, fruit diameter and dry matter content.

Mohammad *et al*. (2015) estimated a significant difference between the studied cultivars in terms of average fruit weight, fruit length, fruit diameter, ratio of fruit length to its diameter, the relative number of seeds per fruit, and each plant yield.

Singh and Singh (2016) reported high phenotypic and genotypic co-efficient of variation for average fruit yield of plant, fruit weight, number of fruits per plant, fruit length, and fruit width. High heritability and high genetic advance was observed for average fruit yield per plant and fruit weight, which indicates participation of additive genetic variance.

Sujin *et al.* (2017) recorded maximum phenotypic and genotypic variation for fruit yield per plant followed by fruit weight, fruit girth, number of fruits per plant and shoot and fruit borer incidence. High heritability along with high estimates of GCV, genetic advance and genetic gain were observed for fruit yield per plant, fruit weight, number of secondary branches per plant and shoot and fruit borer incidence.

2.2 Correlation coefficient analysis

Correlation coefficient analysis demarcates the mutual relationship between various plant characters and determines the component characters on which selection can be based for enhancement in yield. Correlations are of three types *viz.,* phenotypic, genotypic and environmental. Phenotypic correlation is the noticeable correlation between attributes, measures the environmental aberration together with non additive gene action. Genotypic correlation on the other hand is the innate association between two variables. They can only be predicted from replicated data. Genetic correlation among the characters contributing to the yield accompanies to the most effective method of selection.

Yield component characters exhibits association among themselves and with yield. Ominous associations between the desired characters under selection may limit genetic advance. Hence, study of association of integral characters with yield would assist in planning of an adequate selection programme.

Sarnaik *et al.* (1999) observed phenotypic and genotypic correlation coefficient of 12 yield and its contributing characters in 35 genotypes of aubergine at Raipur. The fruit yield per plant was positively correlated with number of fruits per plant, fruit length, plant height, plant spread and number of primary branches, while it was negatively correlated with stalk length and days to first picking.

Asati (2001) carried out correlation studies on 12 varieties of brinjal at Raipur, concluded that the number of primary branches per plant, percentage of long-styled flowers, number of fruits per plant, number of secondary branches per plant, percentage of medium-styled flowers and plant spread were found most important characters which may be given due consideration while making selection for high-yielding varieties in brinjal for Chhattisgarh plains.

Mohanty (2001) surveyed on 15 genotypes of brinjal in experiments conducted at Bhawanipatna and revealed that the genotypic correlation coefficients were higher than corresponding phenotypic ones for most characters. Fruit yield per plant displayed positive and significant phenotypic association with plant height and number of fruits per plant.

Prabhu and Nataranjan (2008) carried out an experiment with 13 genotypes (five F_1 hybrids, six varieties and two accessions) in order to study the genotypic correlation coefficients between marketable yield and branches per plant and number of fruits per plant and they reported positive and significant correlation for these traits. The traits like plant height, fruit length, fruit girth and mean fruit weight showed positive relationship with marketable yield.

Bansal and Mehta (2008) revealed that yield per plant had strong positive association with plant height, plant spread, branches per plant, leaves per plant at genotypic level. However, yield showed significantly negative correlation with days to fruit set.

Dharwad, *et al.* (2009) carried out correlation studies in thirty six brinjal genotypes of comprising 8 parents and 28 F_1 hybrids during summer season of 2006 and indicated strong correlation of number of branches per plant, fruit weight and flower per inflorescence with fruit yield. However, it exhibited weak association with days to flowering and fruit per cluster.

Muniappan *et al.* (2010) steered a study to assess the variability for eight morphological characters in 34 eggplant genotypes. They recorded high PCV and GCV by the characters viz., number of branches per plant, fruit breadth, number of fruits per plant, average fruit weight, and fruit yield per plant and also recorded high heritability and genetic advance for characters viz., number of branches per plant, fruit breadth, number of fruit per plant, average fruit weight and fruit yield per plant except days to fifty per cent flowering.

Katre (2010) revealed that fruit yield per plant exhibited highly significant positive association with days to first flower, days to 50% flowering, average fruit weight, fruit girth and days to maturity at both the genotypic and phenotypic levels. Fruit girth, number of fruits per plant, days to first flower, number of flowers per cluster and fruit stalk length exhibited positive direct effect on fruit yield at genotypic level whereas, at phenotypic level, fruit girth, number of fruits per plant, days to first flower, days to maturity, number of flowers per cluster, average fruit weight and fruit length showed positive direct effect on fruit yield.

Ansari *et al*. (2011) studied the association analysis of total fruit yield per plant and reported positive and significant correlation with marketable fruit yield per plant, number of primary branches per plant, number of fruit per picking and total number of fruits per plant in both the seasons; number of fruits per cluster in rainy season only. Whereas, found negative significant correlation with days to first picking, days to flowering, days to first fruiting in both the seasons.

Thangamani and Jansirani (2012) carried out correlation studies with 25 F_1 hybrids in brinjal which revealed that yield per plant showed positive correlation with number of branches per plant, percentage of long styled flowers, number of fruits per plant, fruit dry matter content and ascorbic acid content. A significant negative correlation of yield was observed with days to first flowering. Fruit borer incidence had a significant positive association with calyx length and fruit girth however, significant negative correlation with total phenols, ascorbic acid content and dry matter content.

Shinde *et al.* (2012) registered that yield per plant had significant positive correlation with fruit length, average fruit weight, plant height, yield per hectare at both genotypic and phenotypic level and with days to first harvest, fruit girth, number of primary branches at genotypic level while it had negative correlation with days to 50% flowering.

Chandrasekhar *et al.* (2013) discovered that fruit yield per plant was positively and significantly associated with number of leaves per plant, number of fruit per plant, average fruit weight, and total number of harvests at phenotypic and genotypic correlation levels.

Nayak and Nagre (2013) examined 20 genotypes along with one check of brinjal to determine the variability and revealed that highly significant differences were recorded among the varieties for all the characters. Correlation and path analysis revealed that fruit length, diameter, weight influenced the fruit yield in plant with high direct effect and significant positive correlation.

Arunkumar *et al.* (2014) compared the genetic components to assess association of eight morpho-economic characters in 34 brinjal (*Solanum melongena* L.) genotypes. He revealed that characters such as number of branches per plant, fruit breadth, number of fruits per plant and average fruit weight exhibited positive and significant association with fruit yield per plant.

Lakshmi *et al*. (2014) revealed that fruit yield had significant positive correlation number of flowers per cluster, number of fruit per cluster, average fruit length and number of fruits per plant and these traits were identified as yield components.

Chaitanya (2015) informed that positive correlation and direct effect on marketable fruit yield per plant exhibited through fruit length, average fruit weight, total number of fruits per plant and number of marketable fruits per plant.

Bashar *et al*. (2015) carried out character association studies in 21 brinjal genotypes and observed strong positive correlation for yield with fruits/plant followed by fresh weight/fruit (g), fruit circumference (cm), no. of fruits in inflorescence/plant, no. of secondary branches/plant, No. of fruits in solitary/plant, no. of primary branches/plant and fruit length (cm) at both genotypic and phenotypic level..

Singh and Singh (2016) recorded that average fruit yield had positive and significant correlation with fruit width, number of fruits per plant and average fruit weight at phenotypic as well as genotypic levels.

Shivkumar *et al.* (2016) discovered correlation and path analysis of 34 genotypes and recorded that yield per plant showed high positive correlation with fruits per plant and average fruit weight while negative correlation with days to first harvest and fruit borer infestation.

Dash (2017) found high magnitude of genotypic as well as phenotypic coefficient of variations were recorded for all characters except number of primary branches per plant, days to 50 per cent flowering and days to first fruit harvest. Pericarp thickness contributed maximum towards diversity followed by number of fruits per plant per picking, fruit yield per plant, fruit length, number of fruits per plant, days to 50 per cent flowering, average fruit weight. The association study revealed that selection for fruit yield should be based on plant height, number of primary branches per plant, number of fruits per cluster, fruit girth, average fruit weight, pericarp thickness and number of fruits per plant per picking.

Sujin *et al.* (2017) revealed that average fruit weight, fruit girth, fruit set percentage and number of fruits per plant had significant positive correlation with yield per plant at both genotypic and phenotypic level. A negative significant association of fruit yield per plant was observed with days to first harvest, number of short styled flowers per plant and days to first flowering at genotypic and phenotypic level.

2.3 Path coefficient analysis

Yield being a complex polygenic character, direct selection is not a reliable approach as it is highly influenced by environmental factors. Therefore, it becomes mandatory to identify the attributes through which yield improvement could be obtained. Although correlations give information about the components of a complex character like yield, but it is not reliable to get an exact picture of the direct and indirect contributions of the component characters to yield. In this context, path coefficient analysis is an important method in separating the correlation coefficients into direct and indirect effects of an independent variable on dependence variable (generally yield is taken as dependent variable). Thus, correlation in concomitance with path analysis would give a better insight into cause and effect relationship between different pairs of characters (Wright, 1921).

Path coefficient is simply a standardized partial regression coefficient and as such, measures the direct influence of one variable upon another and allows the separation of correlation coefficient into components of direct and indirect effects (Dewey and Lu, 1959).

Sharma and Swaroop (2000) discovered that number of fruits per plant, mean weight of fruits and diameter of fruits had maximum direct effect at genotypic level and hence, direct selection could be made effective for these characters for improving the fruit yield per plant, while maximum direct effect at phenotypic level showed by number of fruits per cluster, plant height, number of fruits per plant, mean weight of fruits and diameter of fruit. The number of fruits per cluster showed maximum indirect positive effect on fruit yield per plant. Number of flowers per cluster, number of branches per plant, plant height and length of fruit had positive indirect effect towards fruit yield per plant via number of fruits per plant and hence simultaneous selection for these characters can be made for the improvement of fruit yield per plant.

Nair and Mehta (2007) observed that yield per plant was significantly and positively associated with number of fruits per plant, percentage fruit set, leaf area index and plant height.

Bansal and Mehta (2008) examined that fruits per plant had maximum direct positive effect on yield, followed by fruit weight, days to 50% flowering, leaves per plant and per cent of fruit set.

Lohakare *et al*. (2008) carried out an experiment on 23 genotypes of green fruited brinjal for path analysis and revealed that positive direct effect on yield per plant through number of fruits per plant, average fruit weight, fruit index, days to first fruit harvest, number of primary branches and plant spread. Hence, these characters may be given consideration while making selection for the improvement of brinjal.

Dharwad *et al.* (2009) analyzed eight parent and 28 F_1 hybrids in brinjal for path analysis and revealed that fruits per plant, fruit weight and flowers per inflorescence on fruit yield give high direct effect.

Shinde *et al.* (2009) informed that the per cent infested fruits had significant positive correlation with per cent infested fruit weight, total fruit weight, fruit length, calyx length and fruit girth, whereas, the per cent infested shoots had significant positive correlation with shoot thickness. The per cent fruit infestation had significant positive correlation with total sugars, potassium whereas significant negative correlation with total phenols, copper, manganese, calcium and ash.

Thangamani and Jansirani (2012) notified that the number of fruits per plant is the most important yield determinant, because of its high direct effect and indirectly influence the yield through number of branches per plant and fruit weight.

Shinde *et al.* (2012) enumerated that the characters viz; fruit breadth, plant spread (NS) and fruit length had positive direct effect on yield, while fruit girth, plant spread (EW), days to 50% flowering, days to first harvest and duration of harvest had negative direct effect on yield per plant.

Chandrasekhar *et al.* (2013) registered that number of fruit per plant and average fruit weight had direct effects on fruit yield per plant.

Arunkumar *et al*. (2014) analyzed the genetic components to study the direct and indirect effects of eight morpho-economic characters in 34 brinjal genotypes. Path analysis indicated that the number of fruits per plant and average fruit weight had high direct effects and were the major factors that determine fruit yield per plant.

Lakshmi *et al*. (2014) investigated path coefficient analysis in brinjal and revealed that characters viz., fruit set percentage, fruit weight, number of fruits per plant, relative style length, and number of flowers per cluster had high direct and correlation values

Shande *et al.* (2014) examined path coefficient analysis and revealed that length of fruit, number of fruits per cluster, plant height, days to last picking, average weight of fruit and number of fruits per plant would be selection criteria for yield improvement in brinjal.

Shekar *et al.* (2014) studied 31 brinjal genotypes for path coefficient analysis which revealed that number of fruits per plant and average fruit weight had high direct effect on fruit yield per plant, while the remaining characters had high negligible to low indirect effect through other component characters.

Singh and Singh (2016) revealed that the total fruit yield per plant was positively dependent on traits like fruit weight, number of fruits per plant, leaf width and plant height.

Shivakumar *et al.* (2016) recorded that fruits per plant and average fruit weight had high direct effect on yield per plant. Hence selection based on these characters can be effective for developing high yielding brinjal varieties.

Sujin *et al.* (2017) subscribed that number of long styled flowers per plant, number of short styled flowers per plant, number of fruits per plant, fruit weight, days to first harvest and shoot and fruit borer incidence showed positive direct effect, Whereas, number of flowers per plant recorded the maximum negative direct effect followed by fruit set percentage and plant height.

CHAPTER-III
MATERIALS AND METHODS

The present investigation of **"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)"** was carried out at the field of AICRP on Vegetable Crops at Horticultural Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during 2017-18. The details of materials used and methods employed in the present study to find out the genetic variability and the association (correlation and path analysis) among the yield and component characters by analysis of brinjal germplasm. The materials used and the methodologies adopted in the investigation are described below:

3.1 General description of the experimental site

The present investigation was carried out at the field of AICRP on Vegetable Crops at Horticultural Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Raipur situated in the south eastern part of Chhattisgarh of 21°16' N latitude and 81°31'E longitude with an altitude of 289.56 meter above the mean sea level characterized by sub-tropical climate with an annual rainfall range of 1200-1400 mm. The soil of experimental site was clay loam with average fertility. Weekly average meteorological data during the span of experimentation *rabi* (2017-18), as recorded at Meteorological Observatory, IGKV, Raipur are presented in Appendix-A and Fig. 3.1.

3.2 Details of experimental materials

The experimental material of present study comprised of a set of seventeen genotypes out of which sixteen genotypes were obtained from AICRP on Vegetable crops, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh and one variety from Varanasi (Kashi Taru). The list of genotypes studied in the present investigation is presented in Table 3.1 and 3.2. The sowing of experimental material was done on 17th October, 2017 in *rabi* season.

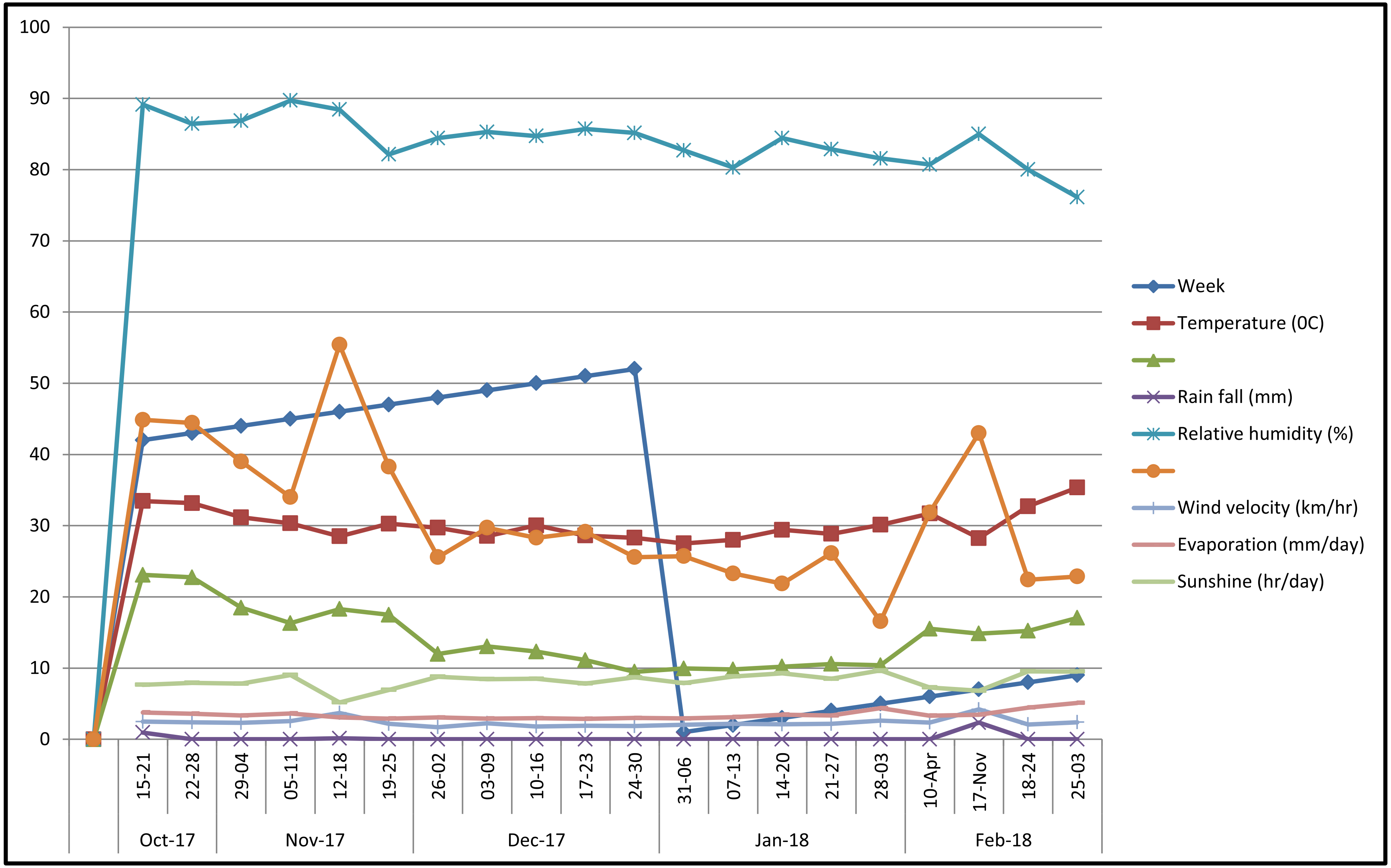


Fig. 3.1 Weekly meteorological data during crop growth period of tomato (*rabi* 2017-2018)

Table 3.1 Details of the brinjal genotypes / varieties

S. No	Genotype	Source
1	2016/BRLVAR-1	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
2	2016/BRLVAR-2	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
3	2016/BRLVAR-3	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
4	2016/BRLVAR-4	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
5	2016/BRLVAR-5	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
6	2016/BRLVAR-6	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
7	2016/BRLVAR-7	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
8	2016/BRLVAR-9	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
9	2017/BRLVAR-1	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
10	2017/BRLVAR-2	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
11	2017/BRLVAR-4	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
12	2017/BRLVAR-5	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
13	2017/BRLVAR-6	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
14	2017/BRLVAR-7	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
15	2017/BRLVAR-8	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
16	2017/BRLVAR-9	AICRP of Vegetable Crops, I.G.K.V., Raipur (C.G.)
17	Kashi Taru	IIVR, Varanasi, U.P.

Table 3.2 Details of the genotypes used in the study

S.No	Genotypes	Characters
01	2016/BRLVAR-1	Medium to large green leaves, veins white, fruits are long and light green in colour, no prickles, flower colour light violet, anthers 5-6 in number, stigma light green
02	2016/BRLVAR-2	Small to medium green leaves, veins white, fruits are oblong in shape and purple in colour, no prickles, flowers white in colour, 5-6 anthers, stigma light green

03	2016/BRLVAR-3	Small to medium leaves, veins violet in colour, no prickles, fruits are long and light purple in colour, flowers violet in colour, anthers 5 in number, stigma light green
04	2016/BRLVAR-4	Small to medium green leaves, veins white, long purple fruits, no prickles, flower colour light violet, 5 number of anthers, light green stigma
05	2016/BRLVAR-5	Small green leaves, white veins, long dark purple fruits, no prickles, flowers light violet, 5 anthers, light green stigma
06	2016/BRLVAR-6	Large leaves with violet pigmentation, veins violet, large oblong dark purple fruits, 2-3 prickles on calyx,violet flowers, 2-3 prickles on pedicel, 6-7 anthers, purple stigma
07	2016/BRLVAR-7	Small to medium leaves with violet pigmentation, veins violet, long purple fruits, no prickles, pale violet flowers, 5 anthers light green stigma.
08	2016/BRLVAR-9	Small to medium green leaves, veins violet, long purple fruits, prickles on calyx and pedicel, violet flowers, 5 anthers, light green stigma
09	2017/BRLVAR-1	Medium to large green leaves, veins white, long dark purple fruits, prickles on calyx and pedicel, violet flowers, 5-6 anthers, light green stigma

10	2017/BRLVAR-2	Small to medium green leaves, veins violet, oblong light green fruits with white patches, no prickles, pale violet flowers, 5-6 anthers, light green stigma
11	2017/BRLVAR-4	Medium to large green leaves, veins white, medium long light green fruits with white patches, prickles on calyx and pedicel, pale violet flowers, 5-7 anthers, light green stigma
12	2017/BRLVAR-5	Medium to large green leaves, veins white, medium long dark purple fruits, prickles on calyx and pedicel, pale violet flowers, 5-7 anthers, light green stigma
13	2017/BRLVAR-6	Small to medium green leaves, veins violet, long dark purple fruits, no prickles, pale violet flowers, 5 anthers, light green stigma
14	2017/BRLVAR-7	Small to medium green leaves, veins white, medium long milky white fruits, no prickles, pale violet flowers, 5-6 anthers, light green stigma
15	2017/BRLVAR-8	Medium to large green leaves, veins white, long purple fruits, no prickles, pale violet flowers, 5-6 anthers, light green stigma
16	2017/BRLVAR-9	Small to medium green leaves, veins violet, long dark purple fruits, no prickles, pale violet flowers, 5 anthers, light green stigma
17	Kashi Taru	Small to medium green leaves, veins white, long black fruits, no prickles, pale violet flower, 5 anthers, light green stigma

3.3 Details of experiments

1. Crop	:	Brinjal (*Solanum melongena* L.)
2. No. of Treatments	:	17 (genotypes)
3. Design of experiment	:	Randomized Block Design (RBD)
4. No. of replications	:	03
5. Plot size	:	4.5 x 4.2 m^2
6. No. of plots	:	51
7. Spacing	:	75 cm (Row to row) X 60 cm (Plant to plant)
8. Date of sowing	:	17^{th} October, 2017

3.4 Details of cultural practices

3.4.1 Raising of crop nursery

Individual seed beds were prepared for different varieties following standard method of bed preparation. Seed were sown in lines in well prepared seed beds in the evening of 17^{th} October, 2017. The seeds after treating with Bavistin @ 3g/kg were sown at about 1.5 cm depth and were covered uniformly with light soil for uninterrupted germination. Chlorpyriphos was dusted over the seedbed to prevent the seedling mainly from ant attack. Adequate measures were taken to avoid varietal mixture. The seed bed was watered as and when necessary for proper germination and normal growth of the seedling. After germination shading was arranged to protect the young seedling from scorching sunshine and was kept exposed during night. Proper nursing was done for developing healthy seedlings. Seedlings became ready for transplanting in 35 days.

3.4.2 Field Operation

The field was ploughed thrice to make a fine tilth with incorporation of FYM @10t/ha during final land preparation and leveled properly. Then the individual plots of proper size were laid out as per the plan of layout with required irrigation channel.

3.4.3 Fertilizer application

The recommended fertilizer dose of 100 kg N, 50 kg P_2O_5 and 50 kg K_2O per hectare was applied. The total amount of phosphorous, potash and 50% nitrogen were applied to the soil before planting. Remaining amount of nitrogen applied in two splits. The top dressing was done at 30 and 60 days after transplanting respectively.

3.4.4 Irrigation

A light irrigation was given immediately after transplanting of seedlings in main field. Subsequently, irrigation was provided in the irrigation channel at an interval of 8-10 days during the cropping season.

3.4.5 Inter-cultural operations and plant protection

Intercultural operations such as weeding, mulching, irrigation etc. were done when necessary for proper growth and development of the plants. Gap filling was done twice, firstly 11 days after transplanting and 2nd time 23 days after transplanting. Weeding was done for the first time 18 days after transplanting. Weeding was also done in several times by two weeks interval. In the early stage of transplanting watering was done twice a daily by water cane. In mature stage, flood irrigation was done to the field. Adequate plant protection measures were taken by spraying insecticides and fungicides as and when needed to raise the crop successfully.

3.4.6 Harvesting

Fruits were harvested when they attained marketable size *i.e.* firm and soft. Care was taken so that the fruits didn't over mature to avoid mature seeds. Picking of fruits was done till the last marketable produce was obtained.

3.5 Recording of observations

The experimental data was recorded on five randomly selected competitive plants in each of the genotypes from each replication for all the characters excluding observations such as days to 50 percent flowering and days to first marketable fruit maturity which were observed on plot basis. Observations were recorded for the following characters:

3.5.1 Days to 50 per cent flowering

Number of days taken from the date of transplanting to the day when 50 per cent of the plants in a plot flowered was counted at flowering stage.

3.5.2 Plant height (cm)

The height of five randomly selected plants from each plot was measured from the ground level to the apical bud of the plants at last harvest. The mean plant height was computed by taking average of all five plants in each plot.

3.5.3 Plant spread (cm)

Spreading of plant was measured in five randomly selected plants with the help of meter scale in two directions i.e. North-South and East-West and average value was calculated per plant. Considering canopy spread >75 cm as spreading type and <75 cm will be non-spreading type.

3.5.4 Number of primary branches per plant

Number of primary branches per plant was counted from the sample plants at last harvest and treatment wise mean number of primary branches per plant was determined.

3.5.5 Number of flower per inflorescence

Number of flowers was counted from five inflorescence per plant which were randomly selected and counted for five plants.

3.5.6 Number of fruits per cluster

Number of fruits per clusters at a single fruiting position was recorded from five randomly selected clusters (one cluster from each selected plant) was counted at three stages i.*e.* after first, second and third picking. Average number of fruits per cluster was calculated at each stage and finally mean values was calculated by dividing summation of averages with three.

3.5.7 Number of clusters per plant

Number of clusters per plant at a single fruiting position was recorded from five randomly selected plants and was counted at three stages i.e. before first, second and third picking. Average number of clusters per plant was calculated at each stage and finally mean values was worked out.

3.5.8 Calyx length (cm)

The calyx length of five randomly selected fruits at uniform stage from each plot was recorded at marketable fruit stage.

3.5.9 Pedicel length (cm)

The pedicel length of five randomly selected fruits at uniform stage from each plot was recorded at marketable fruit stage.

3.5.10 Fruit length (cm)

The length of fruit from joint of calyx to the apex was measured in centimeters for five fruits at marketable stage from randomly selected plant from each plot at the time of peak harvest and average values were taken.

3.5.11 Fruit diameter (cm)

The diameter of five randomly selected fruits at uniform stage from each plot was recorded at the point of maximum thickness in centimeters by using slide calipers at marketable fruit stage and then average values were taken.

3.5.12 Pericarp thickness (mm)

Pericarp thickness of five randomly selected uniform fruits from each plot was measured in millimeters, at the time of peak harvest, with help of scale. The average pericarp thickness was calculated by taking average value.

3.5.13 Average fruit weight (g)

The weight of twenty fruits from each plot was measured at marketable stage from randomly selected plants from each plot at the time of peak harvest and average value was computed.

3.5.14 Days to first marketable fruit maturity

Number of days taken from the date of transplanting to the date of first picking of the marketable fruits was counted.

3.5.15 Fruit yield per plant (g)

Total weight of marketable fruits of each plot was recorded under full range of pickings was summed and averaged by dividing with the number of plants to get total yield per plant.

3.5.16 Fruit yield per hectare (q)

The total yield of fruits of all the pickings from each plot was calculated in kilogram and converted to quintals per hectare the help of the following formula-

$$\text{Fruit yield (q/ha)} = \frac{\text{Weight of fruit (kg per plot)}}{\text{Net plot area (sq. m)}} \times \frac{10000}{100}$$

3.6 Statistical Analysis

3.6.1 Analysis of variance

The data were subjected to the analysis of variance for Randomized Block Design as suggested by Panse and Sukhatme (1967). Partitioning the total variance into replications and treatments represented the expectations of the variance and the appropriate degrees of freedom in each case. The computation of analysis of variance is as follows

The model of ANOVA used is presented below:

$$Y_{ij} = \mu + r_i + t_j + e_{ij}$$

Where,

Y_{ij} = Phenotypic observation of i^{th} genotype in j^{th} replication

μ = General mean

r_i = Effect of i^{th} replication

t_j = Effect of t^{th} treatment

e_{ij} = Error effect due to i^{th} replication and t^{th} treatment with restrictions that eij ~ N $(0, \sigma^2)$ has normal distribution.

The analysis of variance (ANOVA) was carried out for each character as indicated below:

Source of variation	Degree of freedom	Sum of squares	Mean sum of squares	F value	
				Calculated	Tabulated
Replication	(r-1)	RSS			
Treatment	(t-1)	TrSS	M_t	M_1/M_2 *Significant at 5%, **Significant at 1%	
Error	(r-1) (t-1)	ESS	M_e		
Total	rt-1				

Where,

r = number of replications

t = number of genotypes (treatments)

RSS = sum of squares due to replications

TrSS = sum of squares due to genotypes (treatments)

ESS = sum of squares due to error

Mt = mean sum of squares of genotypes (treatments)

Mr = mean sum of squares of replications

Me = mean sum of squares of error

To test the significance of treatment, the calculated value of ‘F’ was compared with tabular value of ‘F’ at 5 and 1 per cent levels of probability against error degree of freedom.

a. Critical difference

CD = SE (d) x t value at 5 % at error degree of freedom

$$\mathrm{SE\ (d)} = \sqrt{\frac{2\mathrm{EMS}}{\mathrm{r}}}$$

Where,

SE (d) = standard error of difference between two treatment means

EMS = Error mean of square

r = Number of replications

b. Standard error of mean

$$\text{SEm}\pm = \sqrt{\frac{\text{EMS}}{\text{r}}}$$

c. Coefficient of variation (CV) (%)

Coefficient of variation is standard deviation expressed as percentage of mean

$$\text{CV}\ \% = \frac{\text{SD}}{\overline{\text{X}}} \times 100$$

Where,

SD = standard deviation

$\overline{\text{X}}$ = Mean of character

3.6.2 Variability parameters

3.6.2.1 Range

The range of the distribution was expressed by the limit of the smallest and the largest value of each observation.

3.6.2.2 Mean

The mean was recorded by summing up all the observation and then dividing by the total number of observations.

$$(\overline{\text{X}}) = \frac{\sum \text{Xi}}{\text{N}}$$

Where,

ΣXi = Sum of all observations

n = Total number of observations

3.6.2.3 Coefficient of variation

Genotypic and phenotypic coefficient variations were computed according to Burton and Devane (1953) based on the estimate of genotypic and phenotypic variance as follows:

$$\mathrm{GCV(\%)} = \frac{\sqrt{\sigma 2g}}{\bar{X}} \times 100$$

$$\mathrm{PCV(\%)} = \frac{\sqrt{\sigma 2p}}{\bar{X}} \times 100$$

Where,

GCV = Genotypic coefficient of variation

PCV = Phenotypic coefficient of variation

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

$\bar{X}$ = General mean of character

The estimates of PCV and GCV were classified as low (< 10 %), moderate (10-20%) and high (>20%) according to Sivasubramanian and Madhavamenon (1973).

3.6.2.4 Heritability

Heritability in broad sense refers to the proportion of genetic variation to the total observed variance in the population. It has been estimated as per the formula given by Allard (1960). Heritability in broad sense is the ratio of genotypic variance to the phenotypic variance and is expressed in percentage and calculated as per the formula suggested by Burton and De Vane (1953).

$$h^2\ (\mathrm{bs})\% = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

The broad sense heritability estimates were classified as low (<50%), moderate (50-70%) and high (>70%) as suggested by Robinson (1966).

3.6.2.5 Genetic advance (GA)

Genetic advance is the expected genetic gain of superior individual under certain amount of selection pressure. Genetic advance for each character was worked out by adopting the formula given by Johnson *et al*. (1955).

$$GA = K \times \sigma p \times h^2 (b)$$

Where,

GA = Genetic advance.

h^2 (b) = Heritability in broad sense.

k = Selection differential which is equal to 2.06 at 5 % intensity of selection (Lush, 1949)

σp = Phenotypic standard deviation

Further, the genetic advance as per cent of mean was computed by using the following formula

$$\text{Genetic advance as percent of mean} = \frac{\text{Genetic advance}}{\text{General mean}} \times 100$$

The magnitude of genetic advance as percent of mean was categorized as high (>20%), moderate (20% - 10%) and low (<10%) by Johnson *et al.* (1955).

3.6.3 Estimation of correlation coefficient

Correlation coefficient analysis reveals the association of characters *i.e.,* a change in one character brought about by a change in the other character. To determine the degree of association of characters with yield and also among the yield components, the correlation coefficients were calculated with the help of formula suggested by Miller *et al*. (1958).

1. Phenotypic correlation between characters x and y

$$r_{xy(p)} = \frac{\mathrm{Cov}_{xy\,(p)}}{\sqrt{\mathrm{var}_{x(p)} \times \mathrm{var}_{y(p)}}}$$

2. Genotypic correlation between characters x and y

$$r_{xy(g)} = \frac{\mathrm{Cov}_{xy\,(g)}}{\sqrt{\mathrm{var}_{x(g)} \times \mathrm{var}_{y(g)}}}$$

3. Environmental correlation between characters x and y

$$r_{xy(e)} = \frac{\mathrm{Cov}_{xy\,(e)}}{\sqrt{\mathrm{var}_{x(e)} \times \mathrm{var}_{y(e)}}}$$

Where,

Cov xy(p), cov xy(g), cov xy(e) = phenotypic, genotypic & environmental co-variances between characters x and y, respectively.

Var x(p), Var x(g), Var x(e) = phenotypic, genotypic & environmental variance of character x, respectively.

Var y(p), Var y(g), Var y(e) = phenotypic, genotypic & environmental variance for character y, respectively.

If calculated 'r' is greater than tabulated 'r' at (n-2) degree of freedom at given probability level, the coefficient of correlation is taken as significant. If 'r' value is not available than significance of correlation coefficient (r) was tested by comparing 't' value.

$$t = \sqrt{r\,(n-2 / 1-r^2)}$$

If calculated 't' is greater than tabulated 't' at (n-2) degree of freedom at given probability level, the coefficient of correlation is taken as significant.

3.6.4 Path coefficient analysis

The direct and indirect contribution of various characters to yield were calculated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The following simultaneous equations were formed and solved for estimating various direct and indirect effects.

Path coefficients were obtained by solving the following equations.

$$r_{ly} = P_{ly} + r_{12}P_{2y} + r_{13}\,P_{3y} + \ldots\ldots\ldots + r_{lk}\,P_{ky}$$

Where,

r_{ly} = Simple correlation coefficient between x_1 and y, the dependent character

P_{ly} = Direct effect of x_1 on y, the dependent character

$r_{12}P_{2y}$ = Indirect effect of x_1 on y through x_2.

r_{12} = Correlation coefficient between x_1 and x_2.

$r_{lk}\,P_{ky}$ = Indirect effect of x_1 only through k^{th} variable.

In the same way, equations for r_{2y}, r_{3y}, r_{4y}, upto r_{ky} were obtained. The direct and indirect effects were calculated by solving the simultaneous equations. Besides the direct and indirect effects, the residual effect was computed by using the formula Singh and Chaudhary (1985).

$R = \sqrt{1 - \Sigma di \times r_{ij}}$

Where,

Di = direct effect of i^{th} character

rij = correlation coefficient of i^{th} character with j^{th} character

A direct and indirect effect of different characters on yield was calculated at genotypic level.

Scales for path coefficients

Values of direct (or) indirect effects	**Rate (or) scale**
0.00 to 0.09	Negligible
0.10 to 0.19	Low
0.20 to 0.29	Moderate
0.30 to 0.99	High
> 1.00	Very high

2016/BRLVAR-1

2016/BRLVAR-2

2016/BRLVAR-3

2016/BRLVAR-4

Fig. 3.1 Fruits of different brinjal genotypes

2016/BRLVAR-5

2016/BRLVAR-6

2016/BRLVAR-7

2016/BRLVAR-9

Fig. 3.2 Fruits of different brinjal genotypes

2017/BRLVAR-1

2017/BRLVAR-2

2017/BRLVAR-4

2017/BRLVAR-5

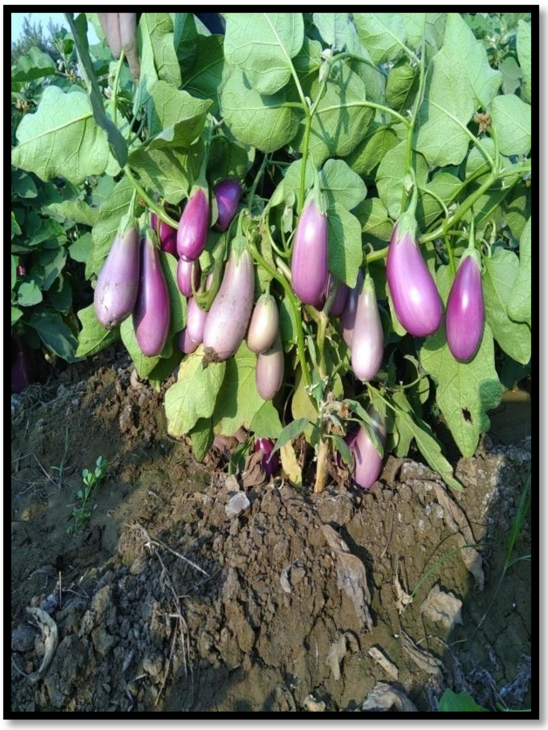
Fig. 3.3 Fruits of different brinjal genotypes

2017/BRLVAR-6 **2017/BRLVAR-7**

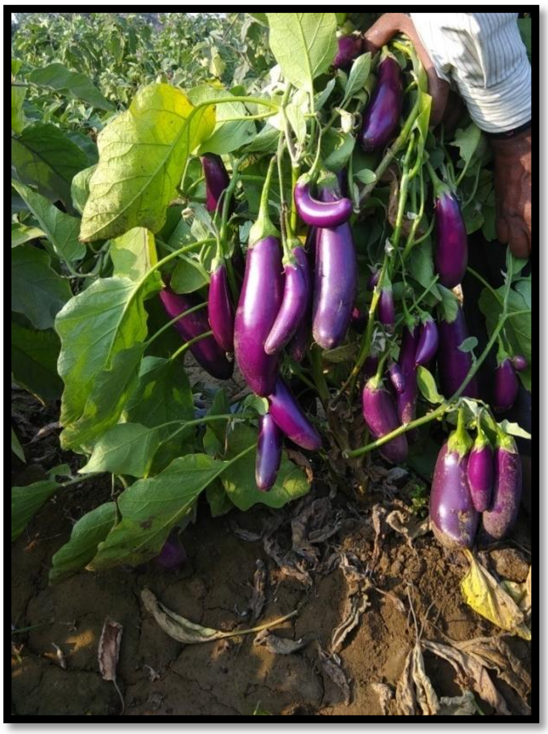
2017/BRLVAR-8 **2017/BRLVAR-9**

Fig. 3.4 Fruits of different brinjal genotypes

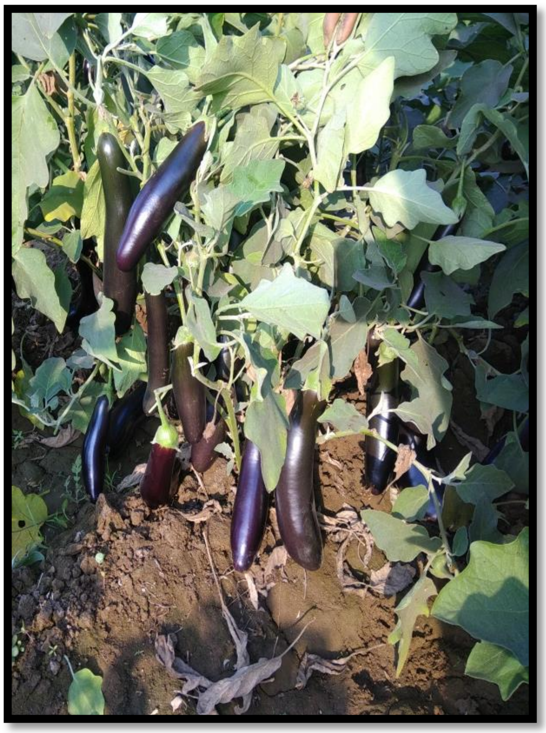
2016/BRLVAR-1



2016/BRLVAR-2



2016/BRLVAR-3



2016/BRLVAR-4

Fig. 3.5 Fruits bearing plants of different brinjal genotypes

2016/BRLVAR-5

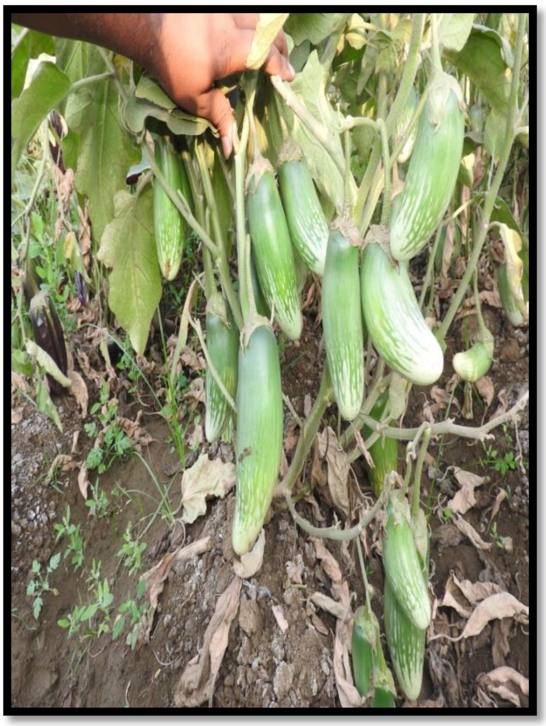
2016/BRLVAR-6

2016/BRLVAR-7

2016/BRLVAR-9

Fig. 3.6 Fruits bearing plants of different brinjal genotypes

2017/BRLVAR-1 **2017/BRLVAR-2**



2017/BRLVAR-4 **2017/BRLVAR-5**

Fig. 3.7 Fruits bearing plants of different brinjal genotypes

2017/BRLVAR-6

2017/BRLVAR-7

2017/BRLVAR-8

2017/BRLVAR-9

Fig. 3.8 Fruits bearing plants of different brinjal genotypes

KASHI TARU

KASHI TARU

Fig. 3.9 Fruits bearing plants of different brinjal genotypes

CHAPTER-IV

RESULTS AND DISSCUSSION

The present investigation entitled **"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)"** was undertaken to get information on variability and association studies of long fruited brinjal and carried out to explore the available diverse germplasm. The results obtained on the different aspects of present study have been presented and discussed below:

4.1 Analysis of variance

The analysis of variance for yield and its contributing characters of brinjal during *rabi* 2017-18 is presented in **Table 4.1**. The mean sum of squares for genotypes was found to be significant for most of the the traits *i.e.* days to 50% flowering, plant height (cm), plant spread (cm), number of primary branches, number of flower per inflorescence, calyx length (cm), fruit length (cm), fruit diameter (cm), pericarp thickness (cm), average fruit weight (g), days to first marketable fruit maturity, fruit yield per plant (kg) and fruit yield per hectare (q), except number of fruits per cluster, number of cluster per plant and pedicel length (cm) (which werenon-significant). Here it was also found that except fruit length (cm), pericarp thickness (mm) and calyx length (cm) all other traits are actually highly significant.

Isolation of superior genotypes depends mainly on the exploration of genetic variability to a greater extent. This emphasizes the importance of variability for crop improvement. Analysis of variance indicated that the mean sum of squares due to genotypes were highly significant for the traits indicated the presence of significant variation for most of the characters which are useful for brinjal improvement.

Table 4.1 Analysis of variance for fruit yield and its component in brinjal

S. No.	Character	Mean sums of square		
		Replication	Treatment	Error
	(df)	2	16	32
01	Days to 50% flowering	2.13	119.62**	14.76
02	Plant height(cm)	12.06	344.04**	52.05
03	Plant spread(cm)	0.98	263.53**	39.79
04	Number of primary branches per plant	0.08	4.18**	0.24
05	Number of flowers per cluster	0.34	10.34**	0.53
06	Number of fruits per cluster	0.01	0.91	0.38
07	Number of cluster per plant	80.90	102.88	78.65
08	Calyx length(cm)	0.35	2.33*	0.53
09	Pedicel length(cm)	0.03	2.67	0.93
10	Fruit length (cm)	3.84	25.73*	4.73
11	Fruit diameter (cm)	0.13	2.41**	0.36
12	Pericarp thickness (mm)	0.18	4.05*	1.10
13	Average fruit wt. (g)	200.81	6487.82**	342.70
14	Days to first marketable fruit maturity	4.84	125.64**	18.03
15	Fruit yield per plant (kg)	0.01	0.90**	0.01
16	Fruit yield per hectare (q)	2448.75	144619.77**	1906.08

***Significant at 5% and ** Significant at 1%**

4.2 Mean performance of brinjal genotypes

The observations were recorded on five plants from each genotype in all three replications for fruit yield and its component characters and used for calculating the mean performance. The observations were first averaged for five plants taken randomly for each genotype in each replication and were later averaged over all the replications. The data on mean performance of brinjal genotypes for fruit yield and component characters are presented character wise in **Table 4.2** and the results are described as below.

4.2.1 Days to 50 per cent flowering

The mean values for number of days taken to 50 per cent flowering ranged from 30 (2016/BRLVAR-5) to 57.67 (2016/BRLVAR-6) days with a general mean of 46.57 days. The genotype 2016/BRLVAR-5 took only 30 days to reach 50 percent flowering stage followed by 2016/BRLVAR-4 (40.67 days), 2016/BRLVAR-3 & 2017/BRLVAR-1 (42.67 days), while, 2016/BRLVAR-6 (57.67 days) was found to be late flowering among all the genotypes.

4.2.2 Plant height (cm)

Plant height ranged from 56.27 cm (2017/BRLVAR-6) to 101.27 cm (2017/BRLVAR-5) with the general mean 84.96 cm. Among genotypes, 2017/BRLVAR-5 (101.27 cm) showed maximum plant height followed by 2017/BRLVAR-8 (96.00 cm), while the minimum plant height was observed in 2017/BRLVAR- 6 (56.27 cm).

4.2.3 Plant spread (cm)

Plant spread ranged from 62.00cm (2017/BRLVAR-9) to 99.00 cm (2016/BRLVAR-7) with an overall mean 84.38 cm. The genotypes, 2016/BRLVAR-7 (99.00 cm) recorded maximum spreading types among all genotypes followed by 2017/BRLVAR-2 (90.73 cm) and 2016/BRLVAR-9 (90.60 cm) whereas, genotype 2017/BRLVAR-9 (62.00 cm) and 2017/BRLVAR-6 (73.27 cm) exhibited non-spreading type.

4.2.4 Number of primary branches per plant

The number of branches per plant in brinjal genotypes varied from 5.87 to 9.53 with a general mean of 7.82. The genotype 2017/BRLVAR-6 (5.87) recorded less number of primary branches per plant, whereas more number of primary branches per plant was recorded in 2017/BRLVAR-6 (9.53) followed by 2016/BRLVAR-7 (9.40), 2016/BRLVAR-4 (9.20) and Kashi Taru (8.87).

4.2.5 Number of flower per inflorescence

Number of flowers per inflorescence varied from 2.31 to 10.47 with an overall mean 4.27. Less number of flowers per inflorescence (2.31) was found in the genotype 2017/BRLVAR-5, whereas, more number of flowers per inflorescence (10.47) was found in the genotype 2017/BRLVAR-6.

4.2.6 Number of fruits per cluster

Number of fruits per cluster ranged from 1.13 to 3.33 with the general mean 2.40. Maximum number of fruit per cluster was record in the genotype 2016/BRLVAR-1 (3.33) followed by 2016/BRLVAR-9 (3.27), 2017/BRLVAR-4 (3.05), 2017/BRLVAR-6 (2.93), 2016/BRLVAR-2 (2.67) and 2016/BRLVAR-5 (2.60), whereas, minimum number of fruit per cluster (1.13) was found in the genotype Kashi Taru.

4.2.7 Number of clusters per plant

Number of clusters per plant ranged from 20.20 (2016/BRLVAR-1) to 43.87 (2017/BRLVAR-9) with an overall average 34.67. Maximum number of clusters per plant was found in the genotype 2016/BRLVAR-9 (43.87) followed by 2016/BRLVAR-7 (42.80), 2017/BRLVAR-2 (39.80), whereas, minimum number of clusters per plant was recorded in the genotype 2016/BRLVAR-1 (20.20).

4.2.8 Calyx length (cm)

Calyx length ranged from 2.01 cm (2017/BRLVAR-6) to 5.95 cm (2017/BRLVAR-1) with an average mean of 3.07cm. Longest calyx was found in 2017/BRLVAR-1 (5.95 cm) followed by 2017/BRLVAR-5 (6.87 cm) and 2017/BRLVAR-1 (6.63 cm), whereas shortest calyx was found in 2017/BRLVAR-6 (2.01 cm).

4.2.9 Pedicel length (cm)

Pedicel length ranged from 3.98 (2017/BRLVAR-4) to 6.95 cm (2017/BRLVAR-2) with an average mean of 5.66 cm. Longest pedicel was found in 2017/BRLVAR-2 (6.95 cm) followed by 2016/BRLVAR-6 (3.99 cm), 2017/BRLVAR-5 (3.80 cm) and Kashi Taru (3.52 cm), whereas shortest pedicel was found in 2017/BRLVAR-4 (3.98 cm).

4.2.10 Fruit length (cm)

Fruit length varied from 13.17 cm (2017/BRLVAR-4) to 25.27 cm (2017/BRLVAR-6) with a general mean of 19.82 cm. Among the genotypes, highest fruit length was recorded in 2017/BRLVAR-6 (25.27cm) subsequently 2017/BRLVAR-8 (23.63 cm) whereas, genotype 2017/BRLVAR-4 showed lowest fruit length 13.17 cm for this attribute.

4.2.11 Fruit diameter (cm)

The fruit diameter exhibited a range of 4.11 (Kashi Taru) to 7.17 (2017/BRLVAR-5) cm with a general mean of 5.24 cm. Maximum fruit diameter was found in the genotypes 2017/BRLVAR-5 (7.17 cm) followed by 2016/BRLVAR-6 (6.79 cm), 2017/BRLVAR-7 (6.23 cm), 2017/BRLVAR-2 (5.97 cm) and 2016/BRLVAR-3 (5.84 cm), whereas, minimum fruit diameter was found in the genotype Kahi Taru (4.11 cm).

4.2.12 Pericarp thickness (mm)

The pericarp thickness of fruit among genotypes ranged from 3.56 mm (2017/BRLVAR-4) to 8.71 mm (2017/BRLVAR-7) with a general mean of 6.00 mm. Maximum pericarp was measured in 2017/BRLVAR-7 (8.71 mm) which was followed by 2016/BRLVAR-9 (7.32 mm), 2017/BRLVAR-1 (7.26 mm) and 2016/BRLVAR (6.91 mm), whereas minimum in 2017/BRLVAR-4 (3.56 mm).

4.2.13 Average fruit weight (g)

The average fruit weight ranged from 112.00 g (2017/BRLVAR-4) to 264.00 g (2017/BRLVAR-5) with a general mean of 210.64 g. The highest fruit weight of 264.00 g was recorded in 2017/BRLVAR-5 followed by 2016/BRLVAR-1 (254.00 g) and the lowest were observed in 2017/BRLVAR-4 (112.00 g).

4.2.14 Days to first marketable fruit maturity

Days to first fruit harvest ranged from 45.67 (2016/BRLVAR-5) to 73.67 (2016/BRLVAR-6) days with a general mean of 63.02 days. Among the genotypes, earliest fruit was harvested at 45.67 days in 2016/BRLVAR-5 which was followed by 2016/BRLVAR-4 (57.33 days), 2016/BRLVAR-3 (58.00 days) and 2016/BRLVAR-2 (59.00 days) whereas delayed days to first fruit harvesting was recorded in 2016/BRLVAR-6 (73.67 days) followed by 2017/BRLVAR-8 (71.00 days) and Kashi Taru (70.67 days).

4.2.15 Fruit yield per plant (kg)

The mean fruit yield per plant was 1.47 kg with a wide range 0.70 (2016/BRLVAR-6) to 2.20 kg (Kashi Taru). The genotype Kashi Taru (2.20 kg) had the highest fruit yield per plant followed by 2017/BRLVAR-8 (2.19 kg), 2017/BRLVAR-4 (1.99 kg), 2017/BRLVAR-9 (1.95 kg) while, the lowest fruit yield per plant was recorded in 2016/BRLVAR-6 (0.70 kg).

4.2.16 Fruit yield per hectare (q)

Fruit yield per hectare ranged from 113.46 q (2017/BRLVAR-6) to 846.67 q (2017/BRLVAR-8) with an overall mean 256.11 q. The genotype 2017/BRLVAR-6 had highest yield (846.67 q) followed by 2017/BRLVAR-9 (783.21 q), 2017/BRLVAR-1 (345.43 q), 2016/BRLVAR-9 (281.97 q) while, the lowest fruit yield per hectare was recorded in 2017/BRLVAR-6 (113.46 q). The yield variation in brinjal genotypes observed by Shinde *et.al.* (2012) were different.

4.3 Genetic variability

The information based on the nature of extent of genetic variation is important for selection of desirable traits for crop improvement. The knowledge of genotypic and phenotypic coefficient of variation is being useful in designing selection criteria for variable population. The simple measure of variability like mean, range and the major components of variability such as phenotypic and genotypic coefficients of variation (PCV and GCV), heritability in broad sense and genetic advance as percent of mean are presented in **Table 4.3**. Most of the characters under study exhibited high variability as evident from the estimates of mean, range, coefficients of variation, heritability and genetic advance.

4.3.1 Coefficient of variation (PCV and GCV)

The genotypic and phenotypic coefficients of variations are presented in **Table 4.3**. Highest magnitude of genotypic as well as phenotypic coefficient of variations were recorded for fruit yield per hectare (85.16 and 86.85) per cent) followed by number of flower per cluster (42.40 and 45.69 per cent), fruit yield per plant (36.96 and 37.82 per cent), calyx length (24.26 and 33.35 per cent) and average fruit weight (23.76 and 25.67 per cent) indicating high variability in the germplasm. Moderate GCV and PCV were found in case of fruit diameter (15.81 and 19.51 per cent), number of primary branches per plant (14.65 and 15.95 per cent), fruit length (13.35 and 17.28 per cent), days to 50 per cent flowering (12.70 and 15.14 percent), plant height (11.61 and 14.38 per cent) and plant spread (10.23 and 12.67 per cent). Moderate GCV and high PCV was recorded for number of fruits per cluster (17.54 and 30.97 percent), pericarp thickness (16.55 and 24.08 per cent), pedicel length (13.45 and 21.73 percent) and number of cluster per plant (8.20 and 26.86 per cent) respectively. Lastly low GCV and moderate PCV was recorded for days to first marketable fruit maturity (9.50 and 11.65 per cent).

The magnitude of PCV was higher than the concurrent GCV for all the characters. This might be due to the interaction of the genotypes with the environment to some degree or due to environmental factors stimulating the expression of these traits. Convenient resemblance between phenotypic and genotypic coefficient of variation were observed *i.e.* copius variability among the traits is present among the genotype. Hence, there is substantial scope of enhancement of these traits.

Singh and Gopalakrishnan (1999), Prasad *et al.* (2004), Mishra *et al.* (2008), Islam and Uddin (2009) , Sabeena *et al.* (2011), Lokesh *et al.* (2013) and Dash *et al.* (2017) found similar results for days to 50 per cent flowering, days to first fruit harvest, average fruit weight (g) and fruit yield per plant (kg). Prasad *et al*. (2004), Sao (2006), Chaitnya (2015) found similar results for plant height (cm).

Table 4.2 Mean performance of brinjal genotypes for fruit yield and its components

Characters / Genotypes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2016/BRLVAR-1	48.33	90.53	87.07	8.07	2.79	3.33	20.20	3.25	5.29	17.57	5.33	5.93	254.00	65.33	0.91	168.89
2016/BRLVAR-2	43.00	81.73	84.80	8.40	3.48	2.67	27.80	2.67	3.96	18.41	5.27	5.73	210.00	59.00	1.09	201.67
2016/BRLVAR-3	42.67	79.73	89.67	8.60	2.89	2.13	30.87	3.43	5.50	20.13	5.84	5.15	211.33	58.00	0.96	177.28
2016/BRLVAR-4	40.67	86.03	89.40	9.20	3.14	2.33	37.27	3.23	5.67	22.95	4.73	6.08	217.33	57.33	0.89	165.93
2016/BRLVAR-5	30.00	82.27	89.73	8.60	3.05	2.60	34.27	3.26	5.85	21.31	5.03	6.91	245.33	45.67	0.63	117.04
2016/BRLVAR-6	57.67	89.00	9.20	9.53	3.35	2.40	31.33	3.99	6.45	20.91	6.79	5.35	186.67	73.67	0.70	130.00
2016/BRLVAR-7	46.67	83.53	99.00	9.40	3.55	2.07	42.80	2.97	5.24	19.33	5.09	6.28	194.00	64.00	0.91	168.00
2016/BRLVAR-9	48.67	86.87	90.60	8.60	3.91	3.27	43.87	3.25	5.53	21.00	5.15	7.32	203.00	66.00	1.52	281.97
2017/BRLVAR-1	42.67	79.13	71.13	6.80	4.45	2.28	35.80	5.95	6.63	16.57	4.43	4.97	141.33	59.67	1.71	345.43
2017/BRLVAR-2	45.33	93.40	90.73	6.40	4.84	2.13	39.80	2.79	6.95	16.70	5.97	7.26	230.47	61.67	1.81	157.28
2017/BRLVAR-4	49.67	69.13	75.33	7.13	4.55	3.05	33.93	2.45	3.98	13.17	4.37	3.56	112.00	67.00	1.99	138.15
2017/BRLVAR-5	45.67	101.27	82.13	6.93	2.31	2.04	30.27	3.80	6.87	20.60	7.17	6.48	264.00	60.33	1.83	135.31
2017/BRLVAR-6	45.33	56.27	73.27	5.87	10.47	2.93	30.47	2.01	4.46	25.27	4.47	5.31	145.67	62.33	1.81	113.46
2017/BRLVAR-7	47.00	81.80	84.13	6.80	4.85	2.41	39.07	2.56	6.45	18.77	6.23	8.71	193.53	64.00	1.88	264.69
2017/BRLVAR-8	54.67	96.00	82.13	7.33	6.17	1.80	38.47	2.68	6.27	23.63	4.83	5.19	175.33	71.00	2.19	846.67
2017/BRLVAR-9	48.67	93.00	62.00	6.33	4.05	2.23	37.73	2.44	4.84	21.77	4.20	6.26	128.67	65.67	1.95	783.21
KASHI TARU	55.00	94.67	88.20	8.87	4.40	1.13	35.47	3.52	6.21	18.87	4.11	5.42	125.75	70.67	2.20	158.94
Mean (x)	46.57	84.96	84.38	7.82	4.27	2.40	34.67	3.07	5.66	19.82	5.24	6.00	210.64	63.02	1.47	256.11
SEm±	**4.44**	**8.33**	**7.28**	**0.57**	**0.84**	**0.71**	**10.24**	**0.84**	**1.11**	**2.50**	**0.69**	**1.21**	**21.38**	**4.90**	**0.13**	**50.41**
CD (p=0.05)	**5.30**	**9.95**	**8.70**	**0.68**	**1.00**	**0.85**	**12.24**	**1.01**	**1.34**	**3.00**	**0.83**	**1.45**	**25.55**	**5.86**	**0.17**	**60.24**
CV (%)	**8.25**	**8.49**	**7.47**	**6.32**	**17.03**	**25.53**	**25.58**	**22.88**	**17.06**	**10.98**	**11.44**	**17.49**	**9.72**	**6.74**	**8.00**	**17.04**

1. Days to 50% flowering 2. Plant height(cm) 3. Plant spread(cm) 4. Number of primary branches per plant
5. Number of flowers per cluster 6. Number of fruits per cluster 7. Number of fruit cluster per plant
8. Calyx length(cm) 9. Pedicel length(cm) 10. Fruit length (cm) 11. Fruit diameter (cm)
12. Pericarp thickness (mm) 13. Average fruit wt. (g) 14. Days to first fruit harvest 15. Fruit yield per plant (kg)
16. Fruit yield per hectare (q)

4.4 Heritability and Genetic Advance

The nature and extent of inherent capacity of a genotype for a character is an important parameter that determines the extent of any crop species. Genetic improvement of any character is difficult without having sufficient heritability, genetic advance and genetic variability, hence heritability and genetic advance are the important parameters for selecting a genotype that permits greater effectiveness of selection by separating out the environmental influence from total variability. Heritability estimation along with genetic advance are more useful in predicating the gain under selection rather than that heritability alone. However it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*. 1955).

Estimates of heritability gives some idea about the gene action involved in the expression of various polygenic traits. The selection should be effective if variance due to additive genes, estimated in terms of heritability. Heritability estimates remain extremely useful in the inheritance studies of quantitative traits. To facilitate the comparison of progress in various characters of different genotypes, Genetic advance was calculated as % of mean. Genetic advance and heritability are the major factors in the improvement of mean genotypic value of selected plants over the parental population. The success of genetic advance depends on genetic variability, heritability, selection intensity. The heritability and genetic advance of the experiment is being presented in **Table 4.3**.

The highest heritability were observed for fruit yield per hectare (96.1%) followed by fruit yield per plant (kg) (95.5%), number of flower per cluster (86.1%), average fruit weight (85.7%), number of primary branches per plant (84.3%), days to 50% flowering (70.3%). Moderate heritability found for days to first marketable fruit maturity (66.5%), fruit diameter (65.6%), plant height (65.2%), plant spread (65.2%), fruit length (59.6%), calyx length (52.9%) and low heritability for pericarp thickness (47.2%), pedicel length (38.3%), number of fruits per cluster (32.1%) and number of cluster per plant (9.3%).

High genetic advance as percent of mean was observed for fruit yield per hectare (93.93 %) followed by number of flower per cluster (81.03 %), fruit yield per plant (74.14 %), average fruit weight (40.97 %), calyx length (37.79 %), number of primary branches per plant (27.75%), fruit diameter (26.34 %), pericarp thickness (23.33 %), days to 50% flowering (21.92 %), fruit length (21.24 %), number of fruits per cluster (20.42 %), whereas, moderate genetic advance as percent of mean was observed for plant height (19.31 %), pedicel length (17.14 %), plant spread (17.03%) and days to first marketable fruit maturity (15.96 %) and low genetic advance as percent of mean was observed for number of cluster per plant (5.16 %).

Heritability estimates along with genetic advance are more useful than the heritability value alone for selecting the best individual. High heritability coupled with high genetic advance was observed for the characters like fruit yield per plant (kg), average fruit wt. (g), number of primary branches per plant, number of flowers per cluster and fruit yield per hectare (q). The results were different with the findings of Singh and Gopalakrishnan (1999), Prasad *et al*. (2004), Babu and Patil (2005), Mishra *et al.* (2008), Islam and Uddin (2009), Sabeena *et al.* (2011), Dhaka and Soni (2012), Kumar *et al.* (2013), Lokesh *et al.* (2013), Chaitnya (2015) and Singh and Singh (2016).

Table 4.3 Genetic parameters of variability for fruit yield and its component in brinjal

S. No.	Characters	Mean	Range		Coefficient of variation (%)		Heritability (h^2 %)	Genetic advance as % of mean
			Mini^{m}	Max^{m}	Genotypic	Phenotypic		
01	Days to 50% flowering	46.57	30.00	57.67	12.70	15.14	70.3	21.92
02	Plant height (cm)	84.96	56.27	101.27	11.61	14.38	65.2	19.31
03	Plant spread (cm)	84.38	62.00	99.00	10.23	12.67	65.2	17.03
04	Number of primary branches per plant	7.82	5.87	9.53	14.65	15.95	84.3	27.75
05	Number of flowers per cluster	4.27	2.31	10.47	42.40	45.69	86.1	81.03
06	Number of fruits per cluster	2.40	1.13	3.33	17.54	30.97	32.1	20.42
07	Number of cluster per plant	34.67	20.20	43.87	8.20	26.86	9.3	5.16
08	Calyx length (cm)	3.07	2.01	5.95	24.26	33.35	52.9	37.79
09	Pedicel length (cm)	5.66	3.98	6.95	13.45	21.73	38.3	17.14
10	Fruit length (cm)	19.82	13.17	25.27	13.35	17.28	59.6	21.24
11	Fruit diameter (cm)	5.24	4.11	7.17	15.81	19.51	65.6	26.34
12	Pericarp thickness (mm)	6.00	3.56	8.71	16.55	24.08	47.2	23.33
13	Average fruit wt. (g)	210.64	112.00	264.00	23.76	25.67	85.7	40.97
14	Fruit yield per plant (kg)	1.47	0.70	2.20	36.96	37.82	95.5	74.14
15	Days to first marketable fruit maturity	63.02	45.67	73.67	9.50	11.65	66.5	15.96
16	Fruit yield per hectare (q)	256.11	113.46	846.67	85.16	86.85	96.1	93.93

4.5 Correlation coefficient analysis

The phenotypic and genotypic correlation coefficients were brought off for sixteen characters in long fruited brinjal and the aftermaths are displayed in Table 4.4. In general, it was ascertained that genotypic correlation coefficients were higher than that of phenotypic correlation coefficients. This could be explained on the basis that there was a strong indispensable genotypic association between the attributes analyzed, but their phenotypic expression was interfered by the consequence of environmental factors.

4.5.1 Days to 50 per cent flowering

Days to 50 percent flowering showed positive and highly significant correlation with fruit yield per plant (0.439 and 0.423) at both genotypic and phenotypic levels, whereas, it showed positive and significant correlation with plant height (0.305) and yield per hectare (0.325) at only genotypic level. It exhibited negative and significant correlation with pericarp thickness (-0.346) at genotypic level only. It also exhibited negative and highly significant correlation with average fruit weight (-0.466 and -0.380) at both genotypic and phenotypic levels. Jadhao *et al.* (2009) and Chaitnya (2015) reported different result of association of this trait with others.

4.5.2 Plant height (cm)

Positive and highly significant ($P \leq 0.01$) correlations was shown by plant height only with fruit yield per hectare (0.359) at genotypic level. It also showed negative and highly significant correlation with number of flower per cluster (-0.595 and -0.409) and number of fruit per cluster (-0.658 and -0.520) at genotypic and phenotypic levels respectively, while fruit yield per hectare showed positively significant correlation at phenotypic level (0.291). Different results were reported by Praneetha *et al.* (2011), Thangamani and Jhansirani (2012), Nayak and Nagre (2013), Dhaka and Soni (2014) and Chaitnya (2015) in brinjal.

4.5.3 Plant spread (cm)

Plant spread exhibited highly significant positive correlation with number of primary branches per plant (0.814 and 0.700) at both genotypic and phenotypic levels and number of clusters per plant (0.669) at only genotypic level. It showed highly negative correlation with number of flowers per cluster (-0.386 and -0.411) and fruit yield per hectare (-0.554 and -0.442) at both genotypic and phenotypic levels respectively..

4.5.4 Number of primary branches per plant

Number of primary branches per plant exhibited highly negative and significant correlation with number of flowers per cluster (-0.588 and -0.514) at both genotypic and phenotypic level. Similarly it showed negative and significant correlation at both genotypic and phenotypic level with fruit yield per hectare(-0.334 and -0.310) Jadhao *et al*. (2009), Nalini *et al*. (2009), Praneetha *et al.* (2011) and Thangamani and Jhansirani (2012) reported different association of characters.

4.5.5 Number of flowers per cluster

Number of flowers per cluster showed highly significant ($P \leq 0.01$) and positive correlation with fruit yield per plant (0.499 and 0.455) at both genotypic and phenotypic levels and fruit length (0.403) at genotypic level. It also exhibited highly negative and significant correlation with average fruit weight (-0.527 and -0.439), fruit diameter (-0.402 and -0.362), calyx length (-0.408 and -0.377), plant height (-0.658 and -0.520), plant spread (-0.386 and -0.411) and number of fruit per cluster (-0.588 and -0.514) at both genotypic and phenotypic levels respectively.

4.5.6 Number of fruits per cluster

Number of fruits per cluster exhibited highly significant ($P \leq 0.01$) and negative correlation with number of cluster per plant (-0.975) at genotypic level. It also showed negatively significant correlation ($P \leq 0.05$) with fruit yield per plant (-0.312) at genotypic level.

4.5.7 Number of clusters per plant

Number of clusters per plant showed positive and highly significant ($P \leq 0.01$) correlation at only genotypic level with pedicel length (0.949), pericarp thickness

(0.831), plant spread (0.669), fruit yield per hectare (0.661) and fruit yield per plant (0.622). Similarly it exhibited positive and significant correlation with only calyx length (0.271) at only genotypic level. Highly significant and negative correlation was exhibited by number of cluster per plant with average fruit weight (-0.588) and number of fruits per cluster (-0.975) only at genotypic level.

4.5.8 Calyx length (cm)

Calyx length showed positively significant correlation with number of cluster per plant (0.271) at genotypic level and with plant height (0.326) at phenotypic level. Negatively and highly significant correlation was shown with number of flower per cluster (-0.408 and -0.377) at both genotypic and phenotypic level respectively.

4.5.9 Pedicel length (cm)

Pedicel length showed highly positive and significant correlation at indicated levels with calyx length (0.478 and 0.589), plant height (0.662 and 0.542) at both genotypic and phenotypic levels, whereas with number of cluster per plant (0.949) at genotypic level and with plant spread (0.406) at phenotypic level. It also showed highly negative and significant correlation with number of fruits per cluster (-0.672 and -0.398) at both genotypic and phenotypic levels.

4.5.10 Fruit length (cm)

Positive and highly significant correlations were registered by fruit length with number of flower per cluster (0.403) at genotypic level and positively significant (0.337) at phenotypic level, whereas with yield per hectare (0.318) fruit length is positively significant at genotypic level only.

4.5.11 Fruit diameter (cm)

Fruit diameter showed highly positive significant correlations with pedicel length (0.621 and 0.382), plant height (0.372 and 0.338) and plant spread (0.478 and 0.421) at both genotypic and phenotypic levels respectively, whereas with pericarp thickness fruit diameter is highly positively correlated (0.563) at genotypic level only, with number of flower per cluster negatively correlated at both genotypic and phenotypic levels (-0.527 and -0.439) and with number of cluster of plant it is highly negative and significantly correlated (-0.588) at genotypic level only. Jadhao *et al.*

(2009), Praneetha *et al.* (2011) and Chaitnya (2015) reported different character association of fruit width with average fruit weight in brinjal. Prabhu and Natarajan (2008), Prabhu *et al.* (2008) and Praneetha *et al.* (2011) stated different association of fruit width with marketable yield per plant.

4.5.12 Pericarp thickness (mm)

Pericarp thickness showed positive and highly significant correlation with pedicel length (0.476 and 0.363) at both genotypic and phenotypic levels, number of cluster per plant (0.831) at genotypic level and plant height (0.372) at genotypic level. It also shows positively significant correlation with plant spread (0.323) at genotypic level. It showed that pericarp thickness of long brinjal genotypes studied in this investigation have no negatively significant correlation with any attributes.

4.5.13 Average fruit weight (g)

The character average fruit weight showed highly positive ($P \leq 0.01$) and significant correlation with fruit diameter (0.730 and 0.581), plant spread (0.650 and 0.434) and pericarp thickness (0.619 and 0.396) at both genotypic and phenotypic levels, whereas with pedicel length (0.475) and plant height (0.459) at genotypic level only. It also shows positively significant correlation ($P \leq 0.05$) with number of primary branches (0.291) at genotypic level and with plant height (0.292) at phenotypic level. But average fruit weight showed highly negative correlation ($P \leq 0.01$) with number of flower per cluster (-0.527 and -0.439) at both genotypic and phenotypic levels, with number of cluster per plant (-0.588) genotypic level. It was also negatively significant ($P \leq 0.05$) with fruit yield per hectare (-0.343 and -0.318) at both genotypic and phenotypic levels. Prabhu and Natarajan (2008), Prabhu *et al.* (2008), Jadhao *et al.* (2009), Nalini *et al*. (2009) and Chaitnya (2015) reported different results with yield per hectare (q) in brinjal except for correlation with pericarp thickness.

4.5.14 Days to first marketable fruit maturity

Days to first marketable fruit maturity exhibited positive and highly significant ($P \leq 0.01$) correlation with days to 50% flowering (0.904 & 0.978) and fruit yield per plant (0.446 & 0.423) at both genotypic and phenotypic levels, whereas shows positive and significant correlation ($P \leq 0.05$) at only genotypic level with fruit yield per hectare

(0.349). Similarly it shows negative and significant correlation with pericarp thickness (-0.313) at only genotypic level. It also shows negative and highly significant correlation with average fruit weight at both genotypic (-0.525) and phenotypic (-0.401) levels. Chaitnya (2015) found different association results in these traits.

4.5.15 Fruit yield per plant (kg)

Fruit yield per plant revealed a highly significant positive correlation with number of flowers per cluster (0.499 and 0.455) and with fruit yield per hectare (0.458 and 0.438) at both genotypic and phenotypic level, with number of fruits per cluster (0.407) and number of cluster per plant (0.622) at genotypic level only. But average fruit weight (-0.587 and -0.509), plant spread (-0.624 and -0.522) and number of primary branches per plant (-0.711 and -0.658) showed highly negative significant correlation at both genotypic and phenotypic levels respectively. It also exhibit negative significant correlation at genotypic level with fruit diameter (-0.309). The results are in contradictory with the results of Prabhu *et al.* (2008), Praneetha *et al.* (2011), Nayak and Nagre (2013) and Chaitnya (2015).

4.5.16 Fruit yield per hectare (q)

Finally the data of all the attributes from above it can be said that days to 50% flowering, plant height, fruit length, number of cluster per plant, first marketable fruit maturity and fruit yield per plant have preponderated effect on fruit yield per hectare(q). So there is abundant scope in augmentation of yield by selecting a genotype having more plant height, more fruit yield per plant and also coupled with more number of clusters per plant. Because these three characters are highly correlated and taking all of them into consideration will eventually increase the yield in long fruited brinjal. Also from above data care should be taken that in case of long brinjal plant spread should be less as it affects the yield negatively at a higher rate than any other attributes.

Table 4.4: Correlation coefficient analysis (Phenotypic and genotypic) among fruit yield and its component in brinjal

S.NO.	Characters		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Days to 50% flowering	G	1.000	0.305*	0.017	0.032	0.164	-0.273	0.069	-0.077	0.146	-0.005	0.093	-0.346*	-0.466**	0.904**	0.439**	0.325*
		P	1.000	0.239	-0.029	0.020	0.148	-0.199	0.051	-0.062	0.052	-0.101	0.016	-0.158	-0.380**	0.978**	0.423**	0.254
2	Plant height(cm)	G		1.000	0.248	0.263	-0.658**	-0.595**	0.543**	0.138	0.662**	0.064	0.372**	0.372**	0.459**	0.256	0.080	0.359*
		P		1.000	0.252	0.145	-0.520**	-0.409**	-0.078	0.326*	0.542**	-0.065	0.338*	0.268	0.492**	0.168	0.069	0.291*
3	Plant spread(cm)	G			1.000	0.814**	-0.386**	-0.119	0.669**	-0.056	0.169	0.047	0.478**	0.323*	0.650**	-0.010	-0.624**	-0.554**
		P			1.000	0.700**	-0.411**	-0.086	-0.152	0.171	0.406**	-0.078	0.421**	0.240	0.434**	-0.058	-0.522**	-0.442**
4	Number of primary branches per plant	G				1.000	-0.588**	-0.137	0.059	0.243	-0.055	0.051	0.109	-0.051	0.291*	0.005	-0.711**	-0.334*
		P				1.000	-0.514**	-0.073	-0.014	0.164	0.044	0.045	0.095	-0.055	0.212	0.005	-0.658**	-0.310*
5	Number of flowers per cluster	G					1.000	0.077	-0.002	-0.408**	-0.189	0.403**	-0.402**	-0.215	-0.527**	0.215	0.599**	0.157
		P					1.000	0.083	0.197	-0.377**	-0.253	0.337*	-0.362*	-0.076	-0.439**	0.171	0.455**	0.138
6	Number of fruits per cluster	G						1.000	-0.975**	-0.257	-0.672**	-0.245	0.132	0.197	0.217	-0.205	-0.407**	-0.312*
		P						1.000	-0.089	-0.158	-0.398**	-0.022	-0.122	-0.123	0.150	-0.132	-0.246	-0.177
7	Number of cluster per plant	G							1.000	0.271	0.949**	-0.179	-0.118	0.831**	-0.588**	0.138	0.622**	0.661**
		P							1.000	-0.211	-0.138	0.236	-0.243	0.204	-0.138	0.083	0.180	0.177
8	Calyx length(cm)	G								1.000	0.478**	-0.270	0.143	-0.227	0.111	-0.103	-0.193	-0.126
		P								1.000	0.589**	-0.201	0.104	-0.091	-0.022	-0.082	-0.144	-0.101
9	Pedicel length(cm)	G									1.000	0.070	0.621**	0.476**	0.475**	0.117	0.180	0.054
		P									1.000	0.029	0.382*	0.363*	0.178	-0.021	0.054	0.005
10	Fruit length (cm)	G										1.000	0.099	0.216	0.152	-0.016	-0.083	0.325*
		P										1.000	-0.146	0.150	0.075	-0.131	-0.123	0.254
11	Fruit diameter (cm)	G											1.000	0.563**	0.730**	0.018	-0.309*	-0.346*
		P											1.000	0.242	0.581**	-0.031	-0.234	-0.278*
12	Pericarp thickness (mm)	G												1.000	0.619**	-0.313*	-0.086	-0.031
		P												1.000	0.396**	-0.182	-0.055	-0.019
13	Average fruit wt. (g)	G													1.000	-0.525**	-0.587**	-0.343*
		P													1.000	-0.401**	-0.509**	-0.318*
14	Days to first marketable fruit maturity	G														1.000	0.446**	0.349*
		P														1.000	0.423**	0.263
15	Fruit yield per plant (kg)	G															1.000	0.458**
		P															1.000	0.438**
16	Fruit yield per hectare (q)	G																1.000
		P																1.000

***Significant at 0.05, ** significant at 0.01**

4.6 Path coefficient analysis

Path coefficient analysis is simply a standardized partial regression coefficient, which splits the correlation into direct and indirect effects. In other words, it measures the direct and indirect contribution of various independent characters on a dependent character. The concept of path analysis was developed by Wright (1921) and the technique was first used by Dewey and Lu (1959) that helps in determining yield contributing characters thus, useful in indirect selection. Correlation coefficients along with path coefficients provide more reliable information, which can be effectively predicted in crop improvement programme. If the correlation between yield and a character is due to direct effect of a character, it reveals true relationship between them and direct selection for the trait will be rewarding for yield improvement. However, if the correlation coefficient is mainly due to indirect effect of the character through another component trait, indirect selection through such trait will be effective in yield improvement.

Path analysis was carried out at genotypic level considering fruit yield per hectare (q) as dependent variable and its attributes *viz.,* days to 50% flowering, plant height (cm), plant spread (cm), number of primary branches, number of flower per inflorescence, number of fruits per cluster, number of cluster per plant, calyx length (cm), pedicel length (cm), fruit length (cm), fruit diameter (cm), pericarp thickness (cm), average fruit weight (g), days to first marketable fruit maturity and fruit yield per plant (kg) as independent variables. Each component has two path actions *viz.,* direct effect on yield and indirect effect through components which are presented in **Table 4.6**.

4.6.1 Days to 50 percent flowering

Days to 50 per cent flowering showed very high direct negative effect (-1.201) on fruit yield per hectare (q) and showed very high indirect negative effect through fruit yield per plant (-1.205). It also showed high positive effect through average fruit weight (0.560), pericarp thickness (0.415), number of fruits per cluster (0.328), high negative indirect effect through days to first marketable fruit maturity (-0.527), plant height (-0.366) and number of cluster per plant (-0.308), low indirect negative effect number of flower per inflorescence (-0.197), fruit diameter (-0.111) and through all other traits it showed negligible indirect effect. These findings were diffrent than the results of Jadhao *et al*. (2009), Thangamani and Jansirani (2012) in brinjal.

4.6.2 Plant height (cm)

Plant height exhibited high direct positive effect (0.555) on fruit yield per hectare. It also showed high positive indirect effect through pedicel length (0.367), cluster per plant (0.301), moderate indirect positive effect through average fruit weight (0.255), fruit diameter (0.206), pericarp thickness (0.206), low indirect positive effect through days to 50% flowering (0.169), number of primary branches per plant (0.146), fruit yield per plant (0.142), plant spread (0.138), high indirect negative effect through number of flower per inflorescence (-0.365), number of fruit per cluster (-0.330), low indirect negative effect *via*. average fruit weight (-0.169), fruit diameter (-0.132) and negligible effect through all other characters on fruit yield per hectare

4.6.3 Plant spread (cm)

Plant spread showed a high direct negative effect (-1.172) on fruit yield per hectare. It showed high positive indirect effect through days to first marketable fruit maturity (0.731), number of flower per inflorescence (0.453), low positive indirect effect *via* number of fruit per cluster (0.140), high negative indirect effect through number of primary branches per plant (-0.955), number of cluster per plant (-0.785), average fruit weight (-0.762), fruit diameter (-0.560), pericarp thickness (-0.379), moderate negative effect *via* plant height (-0.291) and low indirect negative effect through pedicel length (-0.198) on fruit yield per plant. It exhibited negligible indirect effect through remaining characters on fruit yield per hectare (q). These findings were in contradiction with the results of Thangamani and Jansirani (2012) and Chaitnya (2015) in brinjal.

4.6.4 Number of primary branches per plant

This character recorded high direct positive effect (0.592) and high indirect positive effect *via* plant spread (0.482), low indirect positive through average fruit weight (0.172), plant height (0.156), calyx length (0.144), high indirect negative effect through days to first marketable fruit maturity (-0.421), number of flower per inflorescence (-0.348) on fruit yield per hectare. Through all other characters number of primary branches per plant showed negligible indirect effect on fruit yield per hectare (q).

4.6.5 Number of flower per inflorescence

Number of flower per inflorescence exhibited high direct positive effect (0.349) on fruit yield per hectare (q). It showed low indirect positive effect on fruit yield per hectare *via* days to first marketale fruit maturity (0.174), moderate indirect negative effect through number of primary branches per plant (-0.205), plant height (-0.230), low indirect negative effect through average fruit weight (-0.184), calyx length (-0.143), fruit diameter (-0.140), plant spread (-0.135) and negligible indirect effect through all other attributes on fruit yield per hectare(q).

4.6.6 Number of fruits per cluster

Number of fruits per cluster exhibited low direct negative effect (-0.117) on fruit yield per hectare and low indirect positive effect through number of cluster per plant (0.114) on fruit yield per hectare (q). Through all other attributes this character showed negligible indirect effect on fruit yield per hectare.

4.6.7 Number of clusters per plant

Number of clusters per plant showed low direct negative effect on fruit yield per hectare (-0.175). It showed low indirect positive effect through number of fruits per cluster (0.171) and average fruit weight (0.103), moderate indirect negative effct through pedicel length (-0.237), low indirect negative effect through days to first marketable fruit maturity (-0.109) plant spread (-0.117), pericarp thickness (-0.146) and through all other characters number of cluster per plant showed negligible indirect effect on fruit yield per hectare (q).

4.6.8 Calyx length (cm)

Calyx length showed high direct negative effect (-0.609) on fruit yield per hectare. It also exhibited moderate indirect positive effect through number of flowers per inflorescence (0.249), low indirect positive effect through fruit length (0.164), number of fruits per cluster (0.157), pericarp thickness (0.138), days to first marketable fruit maturity (0.118), moderate indirect negative effect through pedicel length (-0.237), low indirect negative effect through number of primary branches per plant and through all other attributes this character showed negligible indirect effect on fruit yield per hectare.

4.6.9 Pedicel length (cm)

Pedicel length exhibited high direct positive effect (0.834) on yield per hectare (q). It also exhibited very high indirect positive effect through number of cluster per plant (1.125) on fruit yield per hectare (q), high indirect positive effect through plant height (0.552), fruit diameter (0.518), calyx length (0.398), peicarp thickness (0.396), average fruit weight (0.396), low indirect positive effect *via* days to first marketable fruit maturity (0.150), plant spread (0.141), days to 50% flowering (0.121), high indirect negative effect through (-0.560), low indirect negative effect through number of flower per inflorescence (-0.148) and negligible indirect effect through all other characters on fruit yield per hectare(q).

4.6.10 Fruit length (cm)

Fruit length showed low direct negative effect (-0.128) and negligible indirect effect through all other attributes on fruit yield per hectare.

4.6.11 Fruit diameter (cm)

Fruit diameter recorded high direct negative effect (-0.355) on fruit yield per hectare (q). It also showed low indirect positive effect through number of flower per cluster (0.143), days to first marketable fruit maturity (0.110), moderate indirect negative effect through average fruit weight (-0.259), pedicel length (-0.220), pericarp thickness (-0.200), low indirect negative effect through plant spread (-0.169), plant height (-0.132) and negligible indirect effect through all other attributes on fruit yield per hectare (q).

4.6.12 Pericarp thickness (mm)

Pericarp thickness (mm) showed moderate direct positive effect (0.290) on fruit yield per hectare (q). It showed moderate indirect positive effect through number of cluster per plant (0.241), low indirect positive effect through average fruit weight (0.180), fruit diameter (0.164), pedicel length (0.138), plant height (0.108), low indirect negative effect through days to 50% flowering (-0.100) and through all other attribute showed negligible positive or negative indirect effect on fruit yield per hectare (q).

4.6.13 Average fruit weight (g)

This character showed high negative direct effect (-0.368) on fruit yield per hectare (q). It showed moderate positive indirect effect through number of fruit per cluster (0.216), days to first marketable fruit maturity (0.216), low indirect positive effect through number of flower per inflorescence (0.194), days to first marketable fruit maturity (0.193), days to 50% flowering (0.172), moderate indirect negative effect through fruit diameter (-0.269), plant spread (-0.239), pericarp thickness (-0.228), low indirect negative effect through pedicel length (-0.175), plant height (-0.169), number of primary branches per plant (-0.107) and negligible indirect effect through all other attributes on fruit yield per hectare. These findings are in contradiction with the results of Prabhu *et al.* (2008) in brinjal.

4.6.14 Days to first marketable fruit maturity

Days to first marketable fruit maturity exhibited very high direct positive effect (1.362) on fruit yield per per hectare (q). It also exhibited very high negative indirect effect *via* days to 50% flowering (-1.205). It had a low positive indirect effect *via* average fruit weight (0.193), plant height (0.142) and a high negative effect through fruit yield per plant (-0.298) on fruit yield per hectare. Through all other characters days to first marketable fruit maturity showed negligible indirect effect on fruit yield per hectare (q).

4.6.15 Fruit yield per plant (kg)

Fruit yield per plant exhibited very high direct negative effect on fruit yield per hectare (-0.668), high indirect positive effect *via* plant spread (0.731), days to first marketable fruit maturity (0.608), moderate indirect positive effect through average fruit weight (0.216), low positive indirect effect through number of flowers per cluster (0.174), pedicel length (0.150), calyx length (0.118), fruit diameter (0.110), high indirect negative effect through days to 50% flowering (-0.527), number of primary branches per plant (-0.421) low indirect negative effect through number of cluster per plant (-0.109) and negligible indirect effect through all other characters on fruit yoeld per hectare (q).

In present investigation plant height (cm), number of primary branches per plant, pedicel length (cm), pericarp thickness (mm), number of flowers per cluster**,** days to first marketable fruit showed positive and direct effect and had significant positive correlation with fruit yield per hectare (q). The residual factor determines how best the causal factors account for the variability of the dependent factor, the fruit yield per plant in this case. The residual effect was 0.027, which was of low magnitude at genotypic levels. From the foregoing discussion it can be concluded that plant height(cm), number of primary branches per plant, pedicel length(cm), pericarp thickness (mm), number of flowers per cluster, days to first marketable fruit maturity, showed positive correlation and positive direct effect on marketable yield per plant. Hence, these were identified as superior yield components.

Table 4.6 Genotypic path coefficient analysis for fruit yield and its components in brinjal

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	R
Days to 50% flowering	**-1.201**	-0.366	-0.020	-0.038	-0.197	0.328	-0.308	0.092	-0.175	0.006	-0.111	0.415	0.560	-1.205	-0.527	**0.325***
Plant height(cm)	0.169	**0.555**	0.138	0.146	-0.365	-0.330	0.301	0.077	0.367	0.036	0.206	0.206	0.255	0.142	0.044	**0.359***
Plant spread(cm)	-0.019	-0.291	**-1.172**	-0.955	0.453	0.140	-0.785	0.066	-0.198	-0.055	-0.560	-0.379	-0.762	0.012	0.731	**-0.554****
Number of primary branches per plant	0.019	0.156	0.482	**0.592**	-0.348	-0.081	0.035	0.144	-0.033	0.030	0.065	-0.030	0.172	0.003	-0.421	**-0.334***
Number of flowers per cluster	0.057	-0.230	-0.135	-0.205	**0.349**	0.027	-0.001	-0.143	-0.066	0.141	-0.140	-0.075	-0.184	0.075	0.174	**0.157**
Number of fruits per cluster	0.032	0.069	0.014	0.016	-0.009	**-0.117**	0.114	0.030	0.078	0.029	-0.015	-0.023	-0.025	0.024	0.048	**-0.312***
Number of cluster per plant	-0.012	-0.095	-0.117	-0.010	0.000	0.171	**-0.175**	-0.047	-0.237	0.031	0.021	-0.146	0.103	-0.024	-0.109	**0.661****
Calyx length(cm)	0.047	-0.084	0.034	-0.148	0.249	0.157	-0.165	**-0.609**	-0.291	0.164	-0.087	0.138	-0.067	0.063	0.118	**-0.126**
Pedicel length(cm)	0.121	0.552	0.141	-0.046	-0.158	-0.560	1.125	0.398	**0.834**	0.058	0.518	0.396	0.396	0.098	0.150	**0.054**
Fruit length (cm)	0.001	-0.008	-0.006	-0.007	0.052	0.031	0.023	0.035	-0.009	**-0.128**	-0.013	-0.028	-0.020	0.002	0.011	**0.318***
Fruit diameter (cm)	-0.033	-0.132	-0.169	-0.039	0.143	-0.047	0.042	-0.051	-0.220	-0.035	**-0.355**	-0.200	-0.259	-0.007	0.110	**-0.346***
Pericarp thickness (mm)	-0.100	0.108	0.094	-0.015	-0.062	0.057	0.241	-0.066	0.138	0.063	0.164	**0.290**	0.180	-0.091	-0.025	**-0.031**
Average fruit wt. (g)	0.172	-0.169	-0.239	-0.107	0.194	-0.080	0.216	-0.041	-0.175	-0.056	-0.269	-0.228	**-0.368**	0.193	0.216	**-0.343***
Days to first marketable fruit maturity	-1.205	0.142	0.012	0.003	0.075	0.024	-0.024	0.063	0.098	0.002	-0.007	-0.091	0.193	**1.362**	-0.298	**0.458****
Fruit yield per plant (kg)	-0.527	0.044	0.731	-0.421	0.174	0.048	-0.109	0.118	0.150	0.011	0.110	-0.025	0.216	0.608	**-0.668**	**0.349***

Residual= 0.027 **Significant at 0.01, *Significant at 0.05.

Bold value show direct effect on fruit yield per hectare (q)

CHAPTER-V

SUMMARY AND CONCLUSIONS

Aubergine or eggplant (*Solanum melongena* L.) is an important vegetable all round the globe. Being the primary centre of origin India is bestowed with a wide range of species and also all the people of India consume it in their diet. In Chhattisgarh, people prefer oblong to long glossy fruits with purple/white/dark purple colour. Various local cultivars are grown in this area which suffer from low productivity and susceptibility to insects-pest and diseases. So there is urgent need to improve the yield so that it can meet the national productivity. So it is necessary to improve these genotypes with respect to yield, maturity, better transportability, better fruit quality and other characters.

The present investigation entitled **"Variability and association studies in long fruited brinjal (*Solanum melongena* L.)"** was carried out at Horticultural research cum instructional farm, College of Agriculture, IGKV, Raipur (C.G.)during *Rabi* 2017-2018. The experimental material comprised of 1sixteen genotypes of brinjal *viz*., 2016/BRLVAR-1, 2016/BRLVAR-2, 2016/BRLVAR-3, 2016/BRLVAR-4, 2016/BRLVAR-5, 2016/BRLVAR-6, 2016/BRRVAR-7, 2016/BRRVAR-9, 2017/BRRVAR-1, 2017/BRRVAR-2, 2017/BRLVAR-4, 2017/BRLVAR-5, 2017/BRLVAR-6, 2017/BRLVAR-7, 2017/BRLVAR-8 and 2017/BRLVAR-9 along with one check variety *viz*., Kashi Taru. These were replicated three times in randomized block design under irrigated condition. One month old healthy seedlings were transplanted in the flat beds. Plants were planted in a plot of 4.5 m x 3.6 m. Transplanting was done at the spacing of 75 cm x 60 cm with one seedling per hill. Recommended cultural practices were followed.

Among the plots of all genotypes five randomly selected plants were identified to record the observations, excluding observations such as days to 50 percent flowering and days to first marketable fruit maturity which were observed on plot basis. The observations were days to 50% flowering, plant height (cm), plant spread (cm), number of primary branches, number of flower per inflorescence, number of fruits per cluster, number of cluster per plant, calyx length (cm), pedicel length (cm), fruit length (cm), fruit diameter (cm), pericarp thickness (cm), average fruit weight (g), days to first marketable fruit maturity and fruit yield per plant (kg) and fruit yield per hectare (q).

Analysis of variance showed that the mean sum of squares for genotypes was significant for most of the traits *i.e.* days to 50% flowering, plant height (cm), plant spread (cm), number of primary branches, number of flower per inflorescence, number of cluster per plant, calyx length (cm), fruit length (cm), fruit diameter (cm), pericarp thickness (cm), average fruit weight (g), days to first marketable fruit maturity and fruit yield per plant (kg) except pedicel length(cm) and number of fruits per cluster (which are non-significant). High magnitude of genotypic as well as phenotypic coefficient of variations(GCV & PCV) were recorded for fruit yield per plant, average fruit weight, calyx length , number of flower per cluster and fruit yield per hectare indicating high variability in the germplasm. Moderate GCV and PCV were found in case of days to 50 per cent flowering, fruit length, fruit diameter, plant height, plant spread, number of primary branches per plant. Moderate GCV and high PCV was recorded for pericarp thickness, pedicel length, number of fruits per cluster and number of cluster per plant. Lastly low GCV and moderate PCV was discovered for days to first marketable fruit maturity..

The highest heritability were observed for fruit yield per hectare followed by fruit yield per plant (kg), number of flower per cluster, average fruit weight, number of primary branches per plant, days to 50% flowering. Moderate heritability found for days to first marketable fruit maturity, fruit diameter, plant height, plant spread, fruit length, calyx length and low heritability for pericarp thickness, pedicel length, number of fruits per cluster and number of cluster per plant.

High genetic advance as percent of mean was observed for fruit yield per hectare followed by number of flower per cluster, fruit yield per plant, average fruit weight, calyx length, number of primary branches per plant, fruit diameter, pericarp thickness, days to 50% flowering, fruit length, number of fruits per cluster, whereas, moderate genetic advance as percent of mean was observed for plant height, pedicel length, plant spread and days to first marketable fruit maturity, and low genetic advance as percent of mean was observed for number of cluster per plant.

In correlation coefficient analysis it was investigated that first marketable fruit maturity, days to 50% flowering, fruit yield per plant, fruit length, plant height and number of cluster per plant have preponderated effect on fruit yield per hectare (q). Also in path coefficient analysis it was found that days to first marketable fruit, pericarp thickness (mm), pedicel length(cm), plant height(cm), number of primary branches per plant, number of flowers per cluster showed positive and direct effect and had significant positive correlation with fruit yield per hectare (q).

CONCLUSION

The experiment was carried out at the field of AICRP on Vegetable Crops at Horticultural Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

In this case the conducted experiment showed that the mean sum of squares for genotypes was found to be significant for most of the traits only except pedicel length (cm) and number of fruits per cluster. And when mean performance of the brinjal genotypes were considered it was found that var. 2017/BRLVAR-8 (846.67q/ha) and 2017/BRLVAR-9 (783.21q/ha) were most promising with respect to yield per hectare.

The magnitude of PCV was higher than the concurrent GCV for all the characters. This might be due to the interaction of the genotypes with the environment to some degree or due to environmental factors stimulating the expression of these traits. High heritability coupled with high genetic advance was observed for the characters like fruit yield per plant (kg), fruit yield per plant (kg), average fruit wt. (g), number of primary branches per plant, number of flowers per cluster and fruit yield per hectare (q).

In the analysis of correlation coefficient of all the attributes it was found that days to 50% flowering, plant height, number of cluster per plant, fruit yield per plant, fruit length and first marketable fruit maturity have preponderated effect on fruit yield per hectare(q). So we can increase the yield of selected long fruited brinjal by selecting a genotype having more fruit yield per plant, more plant height and also coupled with more number of clusters per plant. As these three characters are highly correlated taking all of them into consideration will eventually increase the yield in long fruited brinjal. But care should be taken that in case of long brinjal plant spread should be less as it affects the yield negatively at a higher rate than any other attributes.

From the foregoing discussion it can be concluded that plant height(cm), number of primary branches per plant, pedicel length(cm), pericarp thickness (mm), number of flowers per cluster, days to first marketable fruit maturity showed positive correlation and positive direct effect on marketable yield per plant. Hence, these were identified as superior yield components.

SUGGESTIONS FOR FUTURE RESEARCH WORK

On the basis of experience gained and results obtained after completion of the present investigation, following suggestions may be given to conduct further research:

1. The genotypes included under this investigation may be evaluated under different climatic conditions of Chhattisgarh to know the stability of these genotypes and to select promising genotypes for wider adaptability.
2. More number of genotypes may be collected from different untouched places of Chhattisgarh and evaluation should be done.
3. Quality analysis particularly for total phenol content, chlorophyll content, total soluble solids etc will be very useful for vegetable quality improvement work.
4. For hybridization programme, promising genotypes of brinjal should be selected from different clusters on the basis of fruit yield and study the combining ability effects.
5. Characterization of brinjal genotypes may be included for DUS (distinctness, uniformity and stability) testing and PVP (plant variety protection) legislation. Thus, this will enable to use in future crop improvement programme.
6. There is need to screen the genotypes against biotic stresses (disease and insect) particularly fusarium wilt and viral diseases complex.

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APPENDIX-A

Table: Weekly meteorological data during crop growth period of tomato (*rabi* 2017-2018)

Month/Year	Date	Week	Temperature (^{0}C)		Rain fall (mm)	Relative humidity (%)		Wind velocity (km/hr)	Evaporation (mm/day)	Sunshine (hr/day)
		no.	Max.	Min.		I	II			
October 2017	15-21	42	33.46	23.09	0.94	89.14	44.86	2.47	3.77	7.66
	22-28	43	33.17	22.74	0.00	86.43	44.43	2.39	3.60	7.93
November 2017	29-04	44	31.17	18.47	0.00	86.86	39.00	2.31	3.34	7.80
	05-11	45	30.33	16.30	0.00	89.71	34.00	2.57	3.63	9.03
	12-18	46	28.51	18.29	0.14	88.43	55.43	3.70	3.07	5.17
	19-25	47	30.27	17.47	0.00	82.14	38.29	2.17	2.91	6.93
	26-02	48	29.70	11.97	0.00	84.43	25.57	1.71	3.06	8.79
December 2017	03-09	49	28.54	13.03	0.00	85.29	29.71	2.26	2.90	8.44
	10-16	50	30.03	12.31	0.00	84.71	28.29	1.80	2.96	8.49
	17-23	51	28.61	11.11	0.00	85.71	29.14	1.89	2.87	7.83
	24-30	52	28.29	9.47	0.00	85.14	25.57	1.86	3.00	8.70
January 2018	31-06	01	27.50	9.94	0.00	82.71	25.71	2.03	2.93	7.89
	07-13	02	28.01	9.80	0.00	80.29	23.29	2.16	3.11	8.83
	14-20	03	29.41	10.20	0.00	84.43	21.86	2.10	3.46	9.27
	21-27	04	28.84	10.57	0.00	82.86	26.14	2.17	3.33	8.50
	28-03	05	30.12	10.39	0.00	81.57	16.57	2.63	4.36	9.66
February 2018	04-10	06	31.71	15.52	0.00	80.71	31.85	2.35	3.32	7.28
	11-17	07	28.24	14.85	2.34	85.00	43.00	4.20	3.45	6.81
	18-24	08	32.72	15.22	0.00	80.00	22.42	2.08	4.45	9.54
	25-03	09	35.34	17.04	0.00	76.14	22.86	2.39	5.11	9.51

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