INHERITANCE OF YIELD AND RESISTANCE TO SHOOT AND FRUIT BORER (*Leucinodes orbonalis* GUEN.) IN BRINJAL (*Solanum melongena* L.)

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DECLARATION

I, hereby declare that this thesis entitled **"INHERITANCE OF YIELD AND RESISTANCE TO SHOOT AND FRUIT BORER (*Leucinodes Orbonalis* GUEN.) IN BRINJAL (*Solanum melongena* L.)"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled **"INHERITANCE OF YIELD AND RESISTANCE TO SHOOT AND FRUIT BORER (*Leucinodes orbonalis* GUEN.) IN BRINJAL (*Solanum melongena* L.)"** is a record of research work done independently by **Mr. Gangadhara, K.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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LIST OF ABBREVIATIONS

%	-	per cent
&	-	and
σ^2A	-	Additive variance
σ^2D	-	Dominant variance
ANOVA	-	Analysis of variance
a.m.	-	Anti meridian
BP	-	Better parent
CD (0.05)	-	Critical difference at 5 % level
cm	-	centimeter
d.f	-	Degrees of freedom
DAT	-	Days After Transplanting
et al.	-	and co-workers/co-authors
Fig.	-	Figure
F_1	-	First filial generation
g	-	gram
GCA	-	General combining ability
ha	-	hectare
HB	-	Heterobeltiosis

i.e.	-	that is
kg	-	kilogram
KAU	-	Kerala Agricultural University
MP	-	Mid parent
NBPGR	-	National Bureau of Plant Genetic Resources
per se	-	mean
RH	-	Relative heterosis
SFB	-	Shoot and fruit borer
SCA	-	Specific combining ability
SE	-	Standard error
S.E.D	-	Standard error difference
S.E.M	-	Standard error mean
SH	-	Standard heterosis
viz.	-	namely

Introduction

1. INTRODUCTION

Brinjal (*Solanum melongena* L.) belongs to the family *Solanaceae,* with a chromosome number n=x=12. It is referred by different names *viz.* Eggplant (English), Aubergine (French), Baingan (Hindi), Badanekai (Kannada), Vangi (Marathi) and Vankai (Telugu), Katharikai (Tamil) *etc.* According to Vavilov (1928), centre of origin of brinjal is the Indo-Burma region. The centre of diversity of brinjal is believed to be in the region of Bangladesh and Myanmar (Former India-Burma border) as per Isshiki *et al.* (1994) based on the iso-enzyme and morphological variation studied. According to Zeven and Zhukovsky (1975), brinjal has originated in India but the domestication has rapidly increased in East China and is now a secondary centre of variation.

It is named as "poor man's vegetable" because of its low cost of production, ease of cultivation and availability throughout the year. Fruits are widely used in various culinary preparations *viz.,* sliced baji, stuffed curry, bartha, chutni, pickles etc. According to USDA data base, it is having 5.7 g of carbohydrates, 1 g of protein and 3.40 g of dietary fiber per 100 g of edible portion. Due to its low calorific value (24 kcal per 100 g) and high potassium content (200 mg per 100 g), it is suitable for diabetes, hypertensive and obese patients (Prabhu *et al.*, 2009).

Currently brinjal is growing in many countries like India, Japan, Indonesia, China, Bulgaria, Italy, France, USA and several African countries. India is the second largest producer of brinjal after China with an area and production of 0.71 million hectare and 13.5 million tonnes respectively. In India, West Bengal occupies first place with an area and production of 0.16 million hectare and 0.29 million tonnes respectively (Anonymous, 2015).

In brinjal, very limited attempt has been made for genetic improvement of available indigenous types. Genetic improvement of any crop mainly depends upon the amount of genetic variability present in the population and the germplasm serves as a valuable source of base population and provide scope for wide variability (Ramya and

Senthilkumar, 2009). The phenotypic expression of the plant is mainly controlled by the genetic makeup of the plant and the environment in which it is growing. Therefore, it becomes necessary to partition the observed phenotypic variability into its heritable and non-heritable components with suitable parameters such as phenotypic and genotypic coefficient of variation, heritability and genetic advance.

The yield parameter can be increased by heterosis or hybrid vigor. Identification of potential parents on the basis of progeny performance requires a large number of crosses, which is laborious. Line × Tester is a mating design whereby the selected parents are crossed in a certain order to predict the combining ability of the parents and elucidate the nature of gene action involved in the inheritance of the traits (Abhinav and Nandan, 2010). Heterosis of F_1 hybrids can also reveal the specific combining ability (SCA) and general combining ability (GCA) of parental lines. The combining ability works as the basic tool for improved production of crops in the form of F_1 hybrids (Dhillon, 1975). Heterotic studies can also provide the basis for exploitation of valuable hybrid combinations and their commercial utilization in future breeding programes (Chowdhury *et al.*, 2010). Recently, it has been understood that the utilization of hybrid vigour is most effective for the improvement of different characters and the combining ability is the fundamental tool for enhancing the productivity/yield of different crops in the form of F_1 hybrids (Pachiyappan *et al.*, 2012).

Despite of its economic importance, production per unit area of brinjal is still low in the country. There are certain constraints like low yielding varieties, poor acclimatization of varieties under different environmental conditions and susceptibility to different biotic and abiotic stresses which affect the optimum production and result in low productivity (Adarsh *et al.,* 2017). Among biotic stresses, brinjal fruit and shoot borer is the most important and major pest affecting successful brinjal production throughout the year.

Brinjal fruit and shoot borer (BFSB), *Leucinodes orbonalis* (Guen.) is known to damage shoots and fruits of brinjal in all stages of its growth. The yield loss due to the pest is to the extent of 70-92 per cent (Jat and Pareek, 2003; Eswarareddy and Srinivas, 2004).The young larvae of the pest bore in to petioles and midribs of large leaves and tender shoots causing shoot tips to wilt and later they bore in to flower buds and fruits. The affected fruits lose their market value besides producing considerable reduction in yield. The pest poses a serious problem because of its high reproductive potential, rapid turnover of generations and intensive cultivation of brinjal both in wet and dry seasons of the year. Farmers use large quantities of chemical insecticides singly or in combination to get blemish free fruits, which fetches premium price in the market. This practice of indiscriminate use of insecticides leads to build up of pesticide residues in the produce, destruction of beneficial insects, pest resurgence, pesticide exposure to farm workers and environmental pollution. To reduce pest-linked damage in brinjal crop as well as to protect the environment from adverse effects of pesticides. Hence development of resistance /tolerance varieties against this pest is an ideal choice.

Identification of resistant/tolerant plants is traditionally done in the field or greenhouse. This is often a laborious method which also involves handling and maintenance of the infective agent. Genetic markers may provide an attractive and more reliable alternative to fruit and shoot borer resistance/ tolerance selection, making the breeding process more precise, efficient and less resource demanding (Adarsh *et al.,* 2017). Once molecular markers that are closely linked to fruit and shoot borer resistance/ tolerance have been identified, marker-assisted selection (MAS) can be performed at early stages of plant development, thus avoiding selection through disease exposure (Rakshit *et al*., 2001).

In view of the above findings, the present investigation on "Inheritance of yield and resistance to shoot and fruit borer (*Leucinodes orbonalis* Guen.) in brinjal (*Solanum melongena* L.)" has been under taken with the following objectives:

Objectives:

1. To study the genetic basis of yield, yield attributes and developing high yielding shoot and fruit borer resistant varieties of brinjal.

    a) To study genetic variability and to determine the degree of association among growth, morphological and yield characters

    b) To screen the genotypes for high yield and resistance to shoot and fruit borer

    c) To assess the magnitude and direction of heterosis for growth and yield parameters

    d) To study the combining ability (general and specific combiners) and gene action for growth and yield parameters

2. To study the molecular comparison of resistant and susceptible segregants in F_2 generation

Review of Literature

2. REVIEW OF LITERATURE

A critical comprehensive review of literature is inevitable for any scientific investigation. A proper understanding of the problem requires thorough review of the existing knowledge of the problem. Several research workers evaluated brinjal genotypes generated as well as collected from different sources in various seasons, which exhibited immense range of variation in morphological, yield, quality and shoot and fruit borer resistance traits. Keeping in view of the objectives of the problem, the available review of literature is presented under the following sub-headings based on experiment I, II and experiment III.

2.1 COLLECTION AND EVALUATION OF GERMPLASM

Reviews relating to the experiment are presented under the following headings.

2.1.1 Genetic Parameters

Two basic requirements for any trait improvement are variation and selection. For effective selection information on the nature and the magnitude of variation is available in the material with regard to component characters contributing to yield and the part played by the environment in the expression of these characters is essential. The magnitude of variability is measured in terms of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and environmental coefficient of variation (ECV). Burton (1952) suggested that genetic variability with heritability should be considered for assessing the maximum and accurate effect of selection. There is of prime importance to estimate genotypic coefficient of variation, heritability and genetic advance for a successful breeding programme. The range of genetic variability for a character is measured with the help of the genotypic coefficient of variation and this also provides a measure to compare the genetic variability present in various characters. It has been suggested by many workers that the heritable variation cannot be measured with the help of genotypic coefficient of variation alone. To the plant breeders, heritability is important, primarily as a measure of the value of selection for a particular character in various progenies and as an index of transmissibility was given by Hayes *et al*., (1955). Heritability is an important to evaluate the relative magnitude of the effect of genes and environments on total phenotypic variability.

The concept of heritability has been given by Lush, (1940). Heritability is the ratio of the variance due to hereditary difference (genotypic variance) to the total observed variance (phenotypic variance). Robinson *et al*. (1949) defined heritability as the additive genetic variance in per cent of the total variance. The concept of heritability is based on relative magnitude of the effect of environments on total phenotypic variability i.e. in broadsense, heritability is the portion of total phenotypic variance that occurs due to genetic reason. Genetic advance is the improvement in the mean genotypic performance of selected lines over the original base population. Johnson *et al*. (1955) suggested that heritability estimate with genetic advance could be more reliable than heritability alone for predicting the effect of selection. According to Comstock and Robinson (1952) genetic advance or genetic gain depends on the amount of genetic variability, the magnitude of masking effect of the genetic diversity and the intensity of selection. Heritability and genetic gain are complementary to each other and heritability estimate in broad sense accompanied by high genetic advance is a reliable combination for a rewarding selection (Ramanujam and Tirumalachar, 1967). Below is given a brief review of earlier works done in these aspects in brinjal.

2.1.1.1 Genetic Variability

Thirty strains of brinjal for 14 characters were evaluated and genetic variability was observed for total fruit yield as well as other characters also. High genotypic and error variance were recorded for total fruit yield, number of fruits, weight of fruit, length and girth of fruit, days to 50 per cent flowering and branches per plant (Dhankar and Singh, 1983). Sinha (1983) studied fruits per plant and ratio of fruit length to circumference recorded high GCV. Genetic variability and correlation studies by Chadha and Paul (1984) reported high genetic coefficient of variation for fruits per plant. Genetic variability was studied for 27 brinjal varieties and reported that yield had the highest PCV (98.95%) while for single fruit weight had highest GCV (98.2%) (Gopimony *et al*., 1984). A wide range of phenotypic variation was observed by Vadivel and Bapu (1989) for days to first flowering, plant height, fruits per plant and fruit yield per plant while genetic coefficient of variation was high for yield per plant, fruit length, girth and weight of fruits. Vadivel and Bapu (1991) evaluated 19 brinjal genotypes and reported that the genotypic variances were high for fruit length, fruit girth, fruit weight and fruit yield per plant. Varma (1995) reported considerable variation for plant height, primary branches and fruit yield per plant. GCV was high for fruit yield, yield per plant, total fruits per plant and average fruit weight. Eight eggplant genotypes and four *Solanum* spp., *viz., S. gilo, S. anomalum, S. incanum and S. indicum* by Behera *et al*. (1999) and observed high genotypic and phenotypic coefficients of variation for length and diameter of fruits and yield per plant. Rai *et al*. (1999) observed variability in long shaped brinjal hybrids and found high coefficient of variation for average fruit weight, total fruits, fruit length and yield. Rajyalakshmi *et al*. (1999) reported lowest genotypic and phenotypic variance for fruit diameter whereas highest PCV and GCV were observed for fruits per plant and yield per plant. Seventy eight genotypes were evaluated by Singh and Gopalakrishnan (1999) reported high PCV (60.90%) for fruits per plant followed by yield per plant (57.12%) and GCV was also maximum for the same characters 54.8% and 52.67% respectively. For all the characters under study the coefficients of variation were below 50% except yield per plant and genotypic coefficients of variation of fruits per plant, mean fruit weight and yield per plant were high in a study conducted by Sharma and Swaroop (2000) using 27 brinjal genotypes. Patel *et al*. (2004) reported Fruit length, yield per plant and fruit weight exhibited highest values of genotypic and phenotypic coefficients of variation, high estimates of heritability, and genetic advance. Rai *et al*. (1995) observed that non additive gene effect was prominent in expression of fruit and shoot borer resistance whereas Lohakare *et al*. (2008) reported high genotypic and phenotypic coefficients of variation for fruits per cluster.

High phenotypic and genotypic co-efficient of variation values were found previously for various characters indicating that selection was effective in an often cross pollinated crop like brinjal based on those characters. Singh and Kumar

(2005) showed that number of flowers per cluster, number of fruits, fruit weight and fruit yield per plant were having high GCV and PCV values. High coefficient of variation was observed for fruit length, number of fruits per plant, fruit weight and fruit yield per plant (Sherly and Shanthi, 2009). Genotypic and phenotypic variance were high for plant height, number of fruits per plant and yield per hectare (Nayak *et al*., 2009). In an another investigation by Kumar *et al*. (2012), number of primary branches per plant, internodal length, number of fruits per plant, fruit weight and fruit yield per plant were found to have high co-efficient of variation values while Karak *et al.* (2012) observed high GCV and PCV values for fruit length, fruit girth, fruit weight, number of fruits per plant, total sugar, total phenol and fruit yield per plant. High GCV and PCV values for fruit length, calyx length, number of fruits per plant, total phenol content and fruit yield per plant was observed by (Kumar and Arumugam, 2013). Similarly number of branches per plant, fruit length, fruit girth, number of fruits per plant, fruit weight and fruit yield per plant were found to exhibit high co-efficient of variation values as per Arunkumar *et al.* (2013).Yadav *et al*. (2014) recorded high GCV and PCV values for plant height, number of primary branches per plant, plant spread, number of long styled flowers per plant, number of fruits per plant, fruit length, fruit girth, fruit weight and fruit yield per plant. Gavade and Ghadage (2015) observed high coefficient of variation values for fruit width, fruit weight and fruit yield per plant. High GCV and PCV values were observed during autumn-winter season in Bangladesh by Solaimana *et al.* (2015) for fruit length, fruit width, fruit weight, number of fruit per plant and fruit yield, High PCV and GCV were recorded for the plant height, number of primary branches, intra cluster distance, number of fruits per plant, length of fruits, girth of fruits, fruit weight, fruit yield per plant, shoot infestation by shoot and fruit borer and fruit infestation by shoot and fruit borer was reported by Gangadhara and Abraham (2016a).

2.1.1.2 Heritability and Genetic Advance

Rai *et al*. (1998) observed high estimate of heritability (0.935) along with genetic advance (64.48 per cent of mean) for fruit weight. However, primary branches, and fruit length recorded low heritability and low genetic advance. High heritability and genetic advance was observed for fruit diameter, length of fruit and fruit yield (Behera *et al*., 1999). Characters like fruit weight, fruit volume, plant height and seed to pulp ratio had high H^2 coupled with high GA as percentage of mean (Patel *et al*., 1999) whereas Rai *et al*. (1999) reported high value of heritability coupled with GA for fruit weight, yield, equatorial fruit length and total number of fruits. In another study by Rajyalakshmi *et al*., (1999) shown high heritability values for fruit weight, fruit diameter, plant height and fruits per plant but high heritability coupled with high genetic advance was observed for fruits per plant and fruit weight. Singh and Gopalakrishnan (1999) evaluated 78 brinjal accessions and observed high heritability for fruit weight as well as days to last harvest. Yield per plant both in number and weight of fruits had high values of H^2 and GA whereas low GA was observed for days to flower and fruit set but high heritability was reported for length of fruit, fruits per plant, fruit weight and yield per plant (Sharma and Swaroop, 2000). Singh and Kumar (2005) observed that heritability estimates were high (above 87%) for all the characters and reported maximum heritability for average fruit weight closely followed by yield per plant. The genetic advance as percentage of mean was high for average fruit weight, fruits per plant and yield per plant whereas high heritability coupled with high genetic advance was observed for fruits per plant, average fruit weight and yield per plant. Lohakare *et al*. (2008b) observed almost all the characters exhibited high heritability except yield per hectare which recorded moderate heritability (46.15% to 98.87%) and Prabhu *et al*. (2009) reported high heritability with moderate genetic advance in F_5 and F_6 generations of CO 2 x *Solanum viarum*, F_5 generation of EP 65 x *S. viarum* and EP 45 x *S. viarum* for marketable yield per plant but high heritability with moderate or high genetic advance was observed for shoot borer infestation in EP 45 x *S. viarum* and EP 65 x *S. viarum*.

Total phenols, polyphenoloxidase activity and total soluble sugars had high genetic advance coupled with high heritability, which suggested that these traits are under the control of additive gene action and can be improved through simple selection procedures (Doshi *et al*, 1999). Plant height, days to first fruit harvest, number of fruits per cluster, number of fruits, average fruit weight and yield per plant had high heritability coupled with high genetic advance as per cent of mean (Singh and Kumar, 2005). Plant height, girth of fruit and number of fruits per plant exhibited high levels of heritability and genetic advance, indicating the importance of additive gene effect for these traits. Thus, simple selection will be effective for these traits (Mishra *et al*., 2008). High heritability coupled with high genetic advance as per cent of mean was registered for fruit length, number of fruits per plant, fruit weight and fruit yield per plant. These characters can be effectively improved through selection (Sherly and Shanthi, 2009). High values of genetic advance over mean (GAM) coupled with high estimates of heritability was observed for characters fruit length, number of fruits per cluster, number of fruits per plant and total yield per plant. This indicates additive component is predominant and hence direct selection would be more effective in improving these traits (Nayak *et al*., 2009). High values of heritability coupled with high PCV, GCV and genetic advance as per cent of mean were reported for average fruit weight, fruit yield per plant, fruit diameter, fruit length, number of fruits per plant, plant height and number of primary branches per plant (Tripathi *et al*., 2009). Three characters namely, fruit weight, plant height and days to 50% of flowering exhibited high heritability and genetic advance indicating that such situation may arise due to the action of additive genes controlling the characters (Chattopadhyay *et al*. 2011). Heritability estimates were highest for fruit weight, plant height, days to first fruit set, total yield per plant, fruit length, days to 50% flowering, number of flowers per cluster, long styled flowers per cluster, number of short styled flowers per cluster, number of medium styled flowers per cluster, number of primary branches per plant and number of fruits per cluster. The highest genetic gain was observed for total yield per plant, followed by fruit weight, long styled flowers per cluster, medium styled flowers per cluster, number of short styled flowers per cluster, number of flower per cluster and fruit length (Kumar *et al.* 2011). High values of genetic advance with high heritability for plant height, number of primary branches per plant leaves per plant, mean area of leaf, leaf area/ plant, fruit length, fruit girth, fruit weight, number of fruits per plant, total sugar, crude protein, total phenol and fruit yield per plant (Karak *et al.* 2012). The high estimates of heritability coupled with high genetic advance as per cent of mean estimated for the number of primary branches per plant, internodal length, fruit length, average fruit weight, number of fruits per plant and fruit yield per plant (Kumar *et al.*, 2012).

Fruit length, fruit pedicel length, fruit circumference, calyx length, number of fruit per plant, average fruit weight, shoot borer infestation, little leaf incidence, ascorbic acid content, total phenols content and fruit yield per plant were found to have high heritability and high genetic advance (Kumar and Arumugam, 2013). Plant height, number of branches per plant, fruit length, fruit girth, number of fruits per plant, fruit weight and fruit yield per plant were having high heritability coupled with high genetic advance as per cent of mean as per Arunkumar *et al.* (2013). Plant height, number of primary branches per plant, plant spread, number of long styled flowers per plant, number of fruits per plant, fruit length, fruit girth, fruit stalk length, average fruit weight and fruit yield per plant were found to be controlled by additive gene action by Yadav *et al.* (2014). Gavade and Ghadage (2015) also reported that days to initiation of flowering, length of fruit, breadth of fruit, weight of fruit, fruits per plant and fruit yield per plant were under strong additive gene action. Days to 50% flowering, days to 1st harvest, plant height at 1st harvest, number of branches, fruit length, fruit width, single fruit weight, number of fruit per plant and fruit yield were noticed with high heritability and high genetic advance (Solaimana *et al.*, 2015). High heritability coupled with high genetic advance as per cent mean was observed for plant height, number of primary branches, intra cluster distance, inter cluster distance, number of fruits per plant, length of fruits, girth of fruits, fruit weight, fruit yield per plant, shoot infestation by shoot and fruit borer and fruit infestation by shoot and fruit borer was reported by Gangadhara and Abraham (2016a).

2.1.2 Character Association and Path Analysis

Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement in yield. The magnitude and direction of association is measured by correlation coefficients. Correlation studies provide information such that selection for one character results in progress for all positively correlated characters. Simple correlations are of three types viz., phenotypic genotypic and environmental. Phenotypic correlation is the observable correlation between variables, measures the environmental deviation together with non-additive gene action. Genotypic correlation on the other hand is the inherent association between two variables. Estimation of phenotypic and genotypic correlations between different characters is helpful in a breeding programme as it supplies different information regarding the characters, which may be used as the criteria for selection. The intensity and direction of association among characters may be measured by genotypic and phenotypic coefficients of correlation depending on the type of material under study and experimental design used (Mode and Robinson, 1959). Studies on correlation co efficient merely provide an exact picture of relative importance of direct and indirect influence of each component character towards dependent variable. Therefore, the knowledge of direct and indirect influence of components on yield is of prime importance to select high yielding genotypes. The utility of path co efficient analysis in plant breeding was demonstrated by Deway and Lu (1959). The path coefficient technique is more useful than stepwise multiple regression in establishing the direct and indirect relationships among different variables (Ogunbodede, 1989). High yield depends on those yield components which are highly heritable and strongly correlated with yield and show positive correlations with other yield components. A brief review of previous works on correlation and path analysis in brinjal were described beneath.

Mak and Vijayarungam (1980) studied the interrelationships of some characters in 27 varieties of brinjal. Yield per plant was positively correlated with primary branches and seeds per fruit. The yield per plant is positively associated with plant height, fruit weight, primary branches, flowers and fruits per plant. Mishra and Mishra (1990a) reported positive correlation between fruit length, fruit girth and fruit weight, while fruits per plant was negatively correlated with fruit girth and weight. Nainar *et al*. (1990) shown that in path coefficient analysis, fruit per plant, fruit weight and fruit length showed positive association with yield and in another study, fruits per plant and branches per plant had the highest direct effect on yield (Randhawa *et al*., 1993). Plant spread and fruits per plant showed significant positive correlation with yield (Gautham and Srinivas, 1992). Ushakumari and Subramanian (1993) reported the genotypic and phenotypic correlation among ten yield components in 54 genotypes of aubergine and found that the number of fruits had the highest positive correlation followed by number of branches with yield. In a study had a seventeen brinjal genotypes were evaluated by Ponnuswami and Irulappan (1994) and found that yield per plant had significant as well as positive correlation with plant height, branches per plant, fruit weight, fruit length and fruits per plant. Narendrakumar (1995) evaluated 21 genotypes for correlation analysis and found that yield per plant had significant positive association with fruit length, primary branches per plant and fruits per plant, but no significant correlation with fruit diameter. Most of the environmental correlations were not significant. Varma (1995) analysed significant positive correlation of yield with total fruits per plant and average fruit weight while it showed significant negative correlation with days to first flowering. Behera *et al*. (1998) reported that diameter of fruit was positively correlated with infested fruit yield at genotypic level which indicated that round/oblong fruits are more affected by borer attack. The positive correlation of infested yield and infested fruits per plant with total yield was mainly due to its direct effect via diameter of fruit. Kumar and Ram (1998) have given the data on correlation coefficients indicated that fruit size components namely, fruit diameter, fruit weight and fruit volume were effective indirect negative selection criteria for improving resistance to the shoot and fruit borer. Vadivel and Bapu, (1998) showed results on path analysis for yield components suggested the importance in the order of fruits per plant, branches per plant, plant height and fruit weight on fruit yield. Sharma and Swaroop (2000) evaluated 27 brinjal accessions and reported that fruits per plant, mean fruit weight and diameter of fruits were positively correlated with yield, while days to 50 per cent flowering showed no correlation. Path analysis revealed that fruits per plant had maximum direct effect at genotypic level while maximum direct effect at phenotypic level was showed by fruits per plant, mean fruit weight and diameter of fruits. Branches per plant, plant height and length of fruit had positive indirect effect towards yield per plant via fruits per plant. Hazra *et al.* (2004) studied morphological characters namely thick terminal shoot, long and wide calyx and plump fruits of high weight were highly correlated with susceptibility to shoot and fruit borer. The total phenol content of fruit was markedly and negatively correlated with susceptibility to borer attack. Furthermore, sugar and protein contents in the fruits were associated with less susceptibility to shoot and fruit borer infestation. In another study, the number of fruits per plant, fruit length and weight per fruit exhibited significant positive correlations with the fruit yield per plant. Path coefficient analysis revealed that the number of fruits per plant, fruit length and weight per fruit had the highest direct effects on fruit yield per plant (Patel and Sarnaik, 2004). Marketable yield per plant was positively and significantly associated with number of marketable fruits, gross yield and total number of fruits per plant. Path analysis revealed that purposeful and balanced selection on the basis of fruit diameter, number of fruits (total and marketable), fruit length and days to first picking would be more rewarding for improvement of brinjal (Pathania *et al.*, 2005). Kushwah and Bandhyopandhya (2005) observed that genotypic and phenotypic correlation coefficients were estimated to measure the degree of association between yield and its contributing characters. Fruits per plant and fruit diameter had significant positive correlation with yield per plant both at genotypic and phenotypic level. In another study, fruit yield per plant was positively correlated with fruit number per plant at both genotypic and phenotypic levels. The negative association of fruit number per plant with days to flowering indicated that selection should be based on these traits. Path coefficient analysis shown that maximum emphasis must be given to fruit number per plant and indices for improvement of fruit yield (Singh *et al.*, 2005). Senapathi and senapathi (2006) studied that fruit yield was significantly and positively correlated with fruit number and ratio of length of peripheral seed ring. It had negative correlation with fruit diameter and mesocarp thickness. Bansal and Mehta (2008) carried out correlation and path analysis using 26 genotypes of brinjal and showed that yield per plant had strong positive association with plant height, plant spread, branches per plant and fruits per plant at the genotypic level. Path analysis revealed that fruits per plant had maximum direct positive effect on yield, followed by fruit weight and days to 50 per cent flowering. Fruit yield displayed significant and positive genotypic as phenotypic correlations only with fruit weight. Path coefficient studies explained that fruit length, fruit weight exerted higher positive direct effect on fruit yield (Naliyadhara *et al.*, 2007). Lohakare *et al.* (2008a) evaluated 23 genotypes of green fruited brinjal and found yield per plant was closely associated with fruits per cluster, average fruit weight and fruits per plant. Path analysis revealed that positive direct effect on yield per plant through fruits per plant, average fruit weight, days to first harvest and primary branches. Marketable yield per plant significant positive correlation with plant height, number of branches per plant, fruit length and fruit weight whereas it was having significant negative correlation with shoot borer infestation. Considerable positive direct effect was exerted by branches per plant, mean fruit weight, fruit length and number of fruits per plant on marketable yield whereas negative direct effect on marketable yield by plant height, fruit girth, shoot and fruit borer infestation was observed (Prabhu and Natarajan, 2008).

Strong correlation of number of branches per plant, fruit weight and weak association of days to flowering with fruit yield. Path analysis revealed high direct contribution of fruits per plant, and fruit weight on fruit yield, while days to flowering exhibited negative direct effect (Dharwad *et al.*, 2009). Jadhao *et al.* (2009) reported that the yield contributing characters *viz.*, plant height, primary branches per plant, days to last picking, fruit weight and fruits per plant showed positive significant correlation with fruit yield per plant and path coefficient analysis revealed that plant height, primary branches per plant, days to first flowering, days to first picking, days to last picking, fruit length and fruit weight showed positive direct relation with yield per plant. In an another study, the correlation with various physical character revealed 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. The per cent fruit infestation had significant positive correlation with total sugars (Shinde *et al.*, 2009). Fruit weight and fruit girth exhibited significantly positive correlations with marketable fruit yield per plant. Among the eleven yield component traits, fruit weight and number of marketable fruits per plant showed highly positive direct effect on marketable fruit yield per plant (Chattopadhyay *et al.*, 2011). The fruit yield per hectare exhibited highly significant and positive correlation with days to first flowering, fruit set per cent, fruit yield per plant, number of fruits and fruits length at both genotypic and phenotypic levels. These results indicate that simultaneous selection for these characters would be rewarding in improving the fruit yield (Kafytullah *et al.*, 2011). The earliness showed positive association with fruit borer infestation whereas marketable yield per plant had significant negative association both at genotypic and phenotypic level with shoot and fruit borer infestation (Praneetha *et al.*, 2011). Fruit yield showed positive significant genotypic and phenotypic correlations with number of fruits per plant, fruit weight, fruit length and fruit diameter. The characters viz., number of fruits per plant, average fruit weight, fruit diameter, fruit length and number of branches per plant had positive and significantly high direct effect on fruit yield (Singh *et al.*, 2011). Fruit number per plant, fruit weight fruit girth and leaves per plant emerged as the most important fruit yield contributing characters of brinjal and these characters may be used as important selection parameters because of their probable conditioning by additive gene action (Karak *et al.*, 2012).Yield per plant showed positive correlation with number of branches per plant, percentage of long styled flowers and number of fruits per plant. A significant negative correlation of yield was observed with days to first flowering, fruit girth and fruit weight. Characters viz., number of branches per plant, number of fruits per plant, fruit length, fruit girth, exerted positive direct effect on yield. The characters like plant height, days to first flowering, percentage of long styled flowers, fruit weight, calyx length and fruit borer incidence had negative direct effect on fruit yield per plant (Thangamani and Jansirani, 2012). In a study, yield per plant had strong positive association with fruits/plant and primary branches per plant at both phenotypic and genotypic levels. Path analysis indicated fruit weight was one of the major contributory factors to yield, fruit girth and leaves per plant being the others. Kranthirekha and Celine (2013) reported that, yield per plant recorded positive correlation with per cent of long and medium styled flowers, number of primary branches, fruit length, number of secondary branches, plant height and fruits per plant. Negative correlation with fruit and shoot borer infestation. Percentage of long and medium styled flowers showed high and positive direct effect on yield. Fruit length, fruits per plant and number of primary branches showed positive direct effect on yield. Arunkumar *et al*. (2013) found that number of primary branches, fruit girth, fruit weight and number of fruits per plant had significant positive correlation with fruit yield per plant and fruits per plant followed by fruit weight had positive direct effect on fruit yield per plant whereas fruit length had negative direct effect on fruit yield per plant. In an experiment in Bangladesh, significant negative correlations were observed between fruit yield and fruit length; fruit yield and earliness parameters such as days to 50% flowering and days to first harvest while fruit width, fruit weight and number of fruits per plant had positive correlation with fruit yield (Solaimana *et al*., 2015). In a recent study (Gangadhara and Abraham, 2016b) given fruit yield per plant showed significant positive correlation with fruits per plant, fruit weight, fruit girth, plant height, number of primary branches per plant, fruit length and long styled flowers both at genotypic and phenotypic level. Path coefficient revealed that fruits per plant showed high and positive direct effect on yield followed by fruit weight long styled flowers, medium styled flowers and days to first harvest.

2.1.3 Selection Index

Selection index helps in selecting plants for crop improvement based on several characters of economic importance. This method aims at simultaneous improvement of several or multiple characters.

Vadivel and Bapu (1991) conducted an index score character analysis of some exotic eggplants. The types Murena (Netherlands), Solara (Netherland), Nagpur type and Annamalai recorded the highest index score value and proved to be excellent source for hybridization programme. The local types from Maharashtra had higher scores from secondary branches and fruits per plant, whereas Black Beauty (USA) was superior for fruit length, girth and weight. Such genotypes may prove useful for the breeder, as the hybridization programme between them will result in more variability for further selection and improvement. Chaattopadyay *et al.* (2011) evaluated thirty five diverse genotypes of brinjal for their morphological and yield component characters and selection indices was worked based on marketable fruit weight and number of marketable fruits per plant for marketable yield improvement. Bashar *et al.* (2015) have given selection index for 21 brinjal genotypes and highest selection score was observed for Debjhuri Hajari followed by Kajla, Sada Begun, BARI-9 regarded as elite genotypes because of their well response for yield and other yield enhancing traits. Kranthirekha (2011) has been studied thirty four brinjal accessions collected from different parts of the country were screened for yield. Selection index was worked out and the top ranking accessions SM 49, SM 44, SM 23 and SM 41were reported based on the highest selection score.

2.1.4 Screening for Brinjal Shoot and fruit borer Incidence

2.1.4.1 About Shoot and fruit borer (Leucinodes orbonalis) (Lepidoptera)

Brinjal shoot and fruit borer (*Lucinodes orbonalis* Guenee) which reduces the yield and inflicts colossal loss in production. The losses caused by pest vary from season to season because moderate temperature and high humidity favour the population build-up of brinjal shoot and fruit borer (Shukla and Khatri., 2010), (Bhushan *et al*., 2011). It is the most noxious and ubiquitous pest of brinjal (Naik *et al*., 2008). The yield loss caused by this pest has been estimated up to 60- 70% (Singh and Nath, 2010) and up to 100% if no control measures are applied (Rahman, 2007). Hampson (1896) first reported the occurrence of this pest on eggplant in India. Its infestation is the main constraint in brinjal production not only in Indian subcontinent but also in other Asiatic regions, Africa and North America (CSL, 2006). At vegetative phase, the newly hatched larvae borer in to petioles (Regupathy *et al*., 1997) and midrib of large leaves and young tender shoots they feed on the internal tissue causing the shoot drooped down and withered. At the reproductive phase the larvae prefers to bore into flower buds and also enter into the infested fruits through the calyx. Observing the boring holes, the infested fruits can easily be identified. Besides, the dark coloured excreta can easily be seen to the hole of infested fruits. Single caterpillar may infest 4-6 fruits (Atwal and Dhaliwal, 1999). Secondary infestations by certain microorganisms may cause further deterioration of the fruits and make them ultimately unfit for human consumption. Indiscriminate use of insecticides to control this pest contributed to the development of insecticide resistance in *Leucinodes orbonalis* and resurgence of whiteflies and mites in brinjal (Mishra and Mishra, 1996). Use of resistant varieties is recognized as an important tool in bio intensive pest management system.

2.1.4.2 Per cent Shoot and Fruit Infestation by Shoot and fruit borer

Significant differences among genotypes were found for per cent shoot and fruit infestation in brinjal by shoot and fruit borer (BSFB) in earlier reports are as fallows. The average percentage of infestation for the total picking ranged from 33.65 to 53.02% among cultivars (Kumar and Shukla, 2002). Jat *et al*. (2003) reported 3.28 to12.71% variations in shoot infestation and 20.23 to 45.61% in fruit infestation among 10 different varieties of aubergine. The lowest shoot infestation (3.28%) was observed in Arka Kasumkar. Another study by Senapati (2003) also recorded very low shoot infestation (4 to 11.1%) during screening of twelve aubergine cultivars against BSFB. In another study, the mean shoot infestation ranged between 3.01-7.81 and 1.18-5.88 per cent in various genotypes in 2003 and 2004 respectively in Palampur, Himachal Pradesh. Less fruit damage by shoot and fruit borer was recorded as 2.26 and 5.14% during 2003 and 2004, respectively while maximum fruit damage was recorded as 72.9 and 63.5% during 2003 and 2004, respectively (Patial *et al*., 2008). The yield losses by this pest ranged from 0.22 to 2.22 q/ha as estimated on the basis of inconsumable part of the damaged fruits and 0.74 to 8.14 q/ha when the whole part of the damaged fruits was taken into consideration. The average losses due to this pest on brinjal fruits were 7.30% inconsumable, 18.02% consumable and 25.33% of total yield was given by Haseeb *et al.* (2009). BSFB infestation commenced first on shoots in Pusa Purple Round with 9.7% in 2003 and 11.6% in 2004 and reached its peak on shoot with 25.80% in 2003 and 31.4% infestation in 2004, respectively. The infestation of the borer on brinjal fruit was noticed as 24.64% in 2003 and 12.50% in 2004 (Singh *et al.*, 2009). Javed *et al.* (2011) recorded a range of shoot infestation 19.27 to 43.15% in 2007 and 15.81 to 33.75% in 2008 as well as fruit infestation 24.75 to 58.60% in 2007 and 21.57 to 48.09% in 2008. Similarly, the mean per cent shoot infestation ranged from 2.22 to 9.42% during *kharif* (rainy) season and 1.33 to 8.77 % during *rabi* (winter) season. The pooled percentage of infected fruits per plant ranged from 8.94% to 44.67% on number basis whereas 9.01 to 44.52 % on weight basis was reported by Wagh *et al.* (2012). Shinde *et al.* (2012) studied shoot and fruit borer incidence and recorded 25.28 to 40.21% fruit infestation on weight basis and 27.12 to 37.85% on number basis during kharif season. Kumar *et al.* (2013) conducted an experiment with 14 lines of brinjal during kharif season and found that the mean per cent shoot infestation was 22.90% that ranged from 17.89 to 27.87% while mean per cent fruit infestation was 38.45% with a range of 28.89 to 41.29%. During autumn-winter season the per cent shoot infestation was found between 17.89 and 4.69% with a mean value of 28.49% whereas mean per cent fruit infestation was 41.89 % with a range of 37.59-8.86% (Kumar and Arumugam, 2013). Mean shoot infestation was noticed to be 14.37, 9.19, 3.75, 1.42 and 1.92 % in 43, 45, 46 and 47th standard weeks irrespective of genotypes respectively. Shoot infestation showed a decreasing trend in these weeks. The fruit infestation during first three weeks i.e., 43, 44 and 45th standard weeks remained below 30%, the values being 18.59, 25.77 and 28.80% in respective standard weeks indicating that during these weeks, major infestation was on shoots, which shifted gradually to fruits (Malik and Pal, 2013). In mid altitude hills of Meghalaya, the highest shoot and fruit damage were recorded by shoot and fruit borer with 20.43 and 32.76%, respectively (Bhumita *et al.*, 2014). Payal *et al.* (2015) observed that variety Swarnamani (35.58

%) can be rated as more susceptible to shoot and fruit borer with heavy damage than other varieties and 2010/BRLVAR-1 was less susceptible (5.20%) to shoot and fruit borer. Nirmala and Irene (2016) reported that, genotypes ABSR-2 has shown least infestation (14.51%) to shoot and fruit borer attack.

2.1.4.3 Field Screening of Genotypes for Shoot and fruit borer Susceptibility and Resistance

Research at AVRDC identified an eggplant accession (EG058) that consistently suffered less damage to shoots and fruits (AVRDC, 1999). Pusa purple long and Pundibari were under focus in a two year study to check their susceptibility against brinjal shoot and fruit borer, degree of damage and crop yield. Ghosh and Senapati (2001) found both of them to be highly susceptible to this pest. Singh and Singh (2001) screened twenty-nine aubergine cultivars for resistance to BSFB in a field experiment during the *kharif* season of 1994 and 1995, in Meghalaya, India. None of the cultivars was resistant to the pest, but 3 (Kuchia (HRS-4) followed by Pithoria and Lata Begun), 5 and 8 cultivars were highly tolerant, tolerant and moderately tolerant, respectively. Eleven and 2 cultivars were susceptible and highly susceptible. Kumar and Shukla (2002) carried out an experiment during *kharif* season in Rajasthan, India, to investigate the varietal preference of BSFB on brinjal. Pusa Purple Round showed the lowest percentage of infestation (33.65%), which was at par with those of 6 other cultivars, namely, MHB 2 (36.53%), Pusa Purple Long (37.07%), Eggolesster (37.46%), Jhumka (41.04%), F_1 Hybrid (41.15%) and MHB-3 (41.85%). They also mentioned that local cultivar recorded the highest percentage of infestation than the released cultivars. Another experiment the AVRDC accession EG058 was tested with a known susceptible check (EG075) in Bangladesh, India, Sri Lanka and Thailand. In most places except Bangladesh, it was less damaged than EG075 (Alam *et al.*, 2003). A field experiment was conducted by Yadav and Sharma (2005) to evaluate eleven brinjal cultivars for their resistance to BSFB. They categorized those cultivars into three classes; Pusa Purple Long, Brinjal Green Long, and Selection Puja as less susceptible with <25% infestation, Pusa Hybrid-5, Pusa Kranti, Kokila, Pusa Upkar and Aarti moderately susceptible (25-35% infestation) and Narkiran, Pusa Uttam and Pusa Hybrid-6 were highly susceptible (more than 35% infestation). Hazra *et al*. (2007) screened brinjal genotypes for shoot and fruit borer resistance in West Bengal and reported that out of 70 genotypes 40 were most susceptible, 13 were highly susceptible, 9 were susceptible, 7 were moderately susceptible and 1was least susceptible. Brinjal commercial F_1 hybrid Turbo was grown in Thailand and two Bangladesh accessions viz., BL009 and ISD006 possessed appreciable levels of resistance in Taiwan (Srinivasan, 2008). On the basis of mean shoot infestation was stuied and recorded seven genotypes were rated as moderately resistant, sixteen as susceptible and five as highly susceptible but the wild brinjal genotypes, *Solanum uporo* exhibited minimum shoot infestation. Among the genotypes, the least fruit damage was recorded in *Solanum integrifolium* (2.26 and 5.14% during 2003 and 2004, respectively). The highest fruit damage (72.90%) was recorded in CH-309 followed by JC-7 (57.50%) during 2003. However, fruit damage was the highest in Pusa Kranti (63.51%) followed by Jamun Gola (62.21%) during 2004. Based on the mean fruit infestation, five genotypes were rated as resistant, eleven as moderately resistant, eight as susceptible and four as highly susceptible to fruit infestation by shoot and fruit borer (Patial *et al*., 2008). Significantly less fruit infestation (29%) by shoot and fruit borer was exhibited by the resistant genotype HLB-12 than the highly susceptible genotypes (42.00 to 61.50%) as per Chandrasekhar *et al*. (2008). Cultivar Naeelam showed maximum fruit damage (58.60 and 48.09%) followed by Black long (47.93 and 33.31%), while minimum was noticed in Nirala with 24.75 and 21.57% fruit infestation during 2007-08 and 2008-09 respectively. Similarly, shoot infestation was found to be maximum in Naeelam (43.15 and 33.75%) followed by Kanha-091 (37.72 and 28.73 %) and Nirala was least attacked by the pest shown 19.27 and 15.81% shoot infestation during 2007-08 and 2008-09, respectively (Javed *et al*., 2011). The maximum per cent fruit damage by BSFB was recorded on the cultivars such as Krishna (35.32), Pusa Anmol (33.27), Pusa Purple Cluster (32.18) while the minimum recorded on the Navkiran (13.72) and Pusa Purple Long-74 (17.63) whereas the maximum per cent shoot damage was recorded on Krishna (5.82), Pusa Anmol (4.74) and Pusa Purple Cluster (3.73) whereas the minimum was recorded on the Navkiran (2.81) and Pusa Purple Long-74 (2.13). So the Krishna was the susceptible cultivar than other cultivar whereas the Navkiran was showed as the resistant cultivar against the brinjal fruit and shoot borer (Kumar and Raghuraman, 2014).

Panda *et al*. (1971) screened 19 brinjal varieties for resistance to shoot and fruit borer (*L. orbonalis*) and found that varieties like 'Thorn Pendy', Black Pendy, H- 407 were highly resistant. Dhankar *et al*. (1977) observed some varieties of brinjal along with its wild types and found that the varieties Aushey and PPC-2 and wild type *Solanum sisymbrifolium* are resistant to shoot and fruit borer. They also found that this pest cause about 63% yield loss. Raut and Sonone (1980) reported that the varieties H-4, PPL, Pusa Kranti and SM-41 showed tolerance to shoot and fruit borer. A-61, Arka Kususmakar, AC 3698, Kalyanpur, T-2, Long Green, Muktakeshi, Nimbkar Green, Pusa Kranti, SM-2 and SM-213 showed resistance to shoot and fruit borer (Mote, 1981). Relative tolerance was found in Pusa Kranti, H-4 and A-61 and Arka Kusumakar (Subbratnam and Butani, 1981). 13 brinjal cultivars studied by Baksha and Ali (1982), none was resistant to *L. orbonalis*. Moderate tolerance to shoot infestation was noticed in Baromashi, Jhumki, Indian and Bogra special whereas fruit infestation was noticed in Noyankajal, Singnata, Japani, Jhumki, Indian and Baromashi. Tolerance to both shoot as well as fruit infestation was highest in Jhumki, Indian and Baromashi. Nair (1983) evaluated 40 accessions and reported that SM-88, *Solanum indicum* and *S. incanum* were resistant. SM-1, SM-45, SM-48 and SM-71 were moderately susceptible. SM-6, SM-56, SM-72 and SM-74 were highly susceptible. Nathani (1983) reported that ringan giant, PPC and SM-62 were tolerant to shoot and fruit borer. Kabir *et al*. (1984) evaluated 12 brinjal varieties of which the variety Singnath had shown lowest infestation whereas, Duodo (1986) found that fruits of Black Beauty and Florida Market were significantly least infested. Pawar *et al*. (1987) screened 32 varieties and 22 local accessions of brinjal against fruit borer and identified Banaras giant, S-34, Arka Kususmakar, SM-125, S-258, SM-62, P 5-8, SM-2, S 2070 and Six Seer as most resistant varieties to *Leucinodes orbonalis*. Among the local accessions, Malkapuri, Shirur, Khandala, Khamapur were resistant to fruit borer. Studies on 150 eggplant cultivars by Singh and Sindhu (1988) showed that the variety Punjab Chamkila was the most susceptible to *Leucinodes orbonalis*. SM-17-4 was the most resistant. PPC and PBR-129-5 were fairly resistant. Darekar *et al*. (1991) screened nine varieties of brinjal against shoot and fruit borer and identified PBR-129-5, Arka kususmakar and wild brinjal as resistant varieties. Mukhopadhyay and Mandal (1994) exposed the experimental plots to natural infestation of major insect pests and found that Nischindipur Local, Muktajhuri, Shyamala Dhepa, Banaras Long Purple and BBI were tolerant to shoot and fruit borer. Nazir *et al*. (1995) studied 13 varieties and none of them were shown tolerance to fruit borer and all were severely infested. The lowest attack of 19.20% was observed in genotype 88066-2, while the highest value of 38.54% in genotype White Egg Round. Srinivas and Peter (1995) conducted an experiment on 18 brinjal cultivars and shown that Arka Kusumakar, Arka Shirish and Neelam were significantly less infested by *L. orbonaslis* than Early Long Fellow and Nagpur Round. In another study was done by Ram (1997) and reported brinjal varieties *viz*., Annamalai, Pant Samrat, Bhagyamati, Aushay, PPC, AM 62, *Solanum gilo* and *S. anomalum* were tolerant shoot and furit borer. Awasthi (2000) studied the susceptibility of 12 brinjal genotypes to *L. orbonalis* and lowest fruit infestation values were recorded for the genotypes Nurki (27%) and CH-150-16-4-1 (20%). Elanchezyan *et al*. (2008) screened 25 genotypes and categorized as highly resistant, fairly resistant, tolerant, susceptible and highly susceptible. Out of 25 genotypes, Sweta and Ravaiya recorded the lowest shoot and fruit damage and designated as highly resistant to *L. orbonalis* based on the fruit damage (1-10%). Eighteen eggplant accessions were evaluated for resistance to shoot and fruit borer. Minimum mean infestation in fruits was found in genotype Punjab Sadabahar, 2010/ BRLVAR-3, 2010/BRLVAR-1, 2010/BRLVAR- 4 while maximum mean infestation in fruits was recorded in Swarnamani (Payal *et al.*, 2015). Nirmala and Irene (2016) studied influence of biophysical and biochemical characters of brinjal genotypes on the infestation to shoot and fruit borer. Among the genotypes, ABSR-

2 was found least attacked by the borers recording minimum percentage of fruit infestation with maximum marketable yield.

2.1.4.4 Morphological and Biochemical Basis of Resistance

Resistance shown by *Solanum incanum, S. integrifolium* and *S. khasianum* are due to tightly arranged seeds in mesocarp of fruit (Lal *et al.*, 1976). Dhooria and Chadha (1981) reported that round fruited varieties are more attacked than long fruited varieties. According to Ahmed *et al*. (1985) long narrow fruits had less infestation. Mishra *et al*. (1988) also observed shoot and fruit borer resistance in long fruited variety Katrain – 4. Anatomical characters like tightly arranged seeds in mesocarp, thick fruit skin. Long fruited varieties were less infested than those with spherical fruits (Pradhan, 1994).

Gupta and Kauntey (2008) reported that varieties with dark purple or white coloured fruits were more susceptible (damage 54.65- 64.00 per cent) and those with light purple, purple or green colours were less susceptible (24.38-36.05 %) and also reported that the varieties with less RLPS (Gulabi Dorla, Punjab Chamkila, Baingan Sada Bahar) suffered more fruit damage (36.05 %) and Varieties (SM 17-4, PPC) with less RLSA (0.30) suffered less fruit damage as compared to other varieties (damage > 28.06%). In another study revealed that compact seed ring with closely arranged seeds in mesocarp were found to be resistant/tolerant to brinjal shoot and fruit borer (Hossain *et al*., 2002; Javed *et al*., 2011; Amin *et al*., 2014). Several workers like Kalloo (1988), Doshi *et al*. (1998), Hazra *et al*. (2004), Asati *et al*. (2004), Chandrasekhar *et al*. (2008), Shinde *et al*. (2009), Padgilwar *et al*. (2009), Bhattacharya *et al*. (2009) and Praneetha *et al*. (2011) reported that resistance to BFSB is attributed to biochemical constituents like glycoalkaloid (solasodine), phenols, tannins, fibre, ash, silica, minerals like Cu, Mn and Fe and phenolic oxidase enzymes namely poly phenol oxidase and peroxidase. Thus, both morphological and biochemical characteristics were playing major role in brinjal shoot and fruit borer management. Doshi *et al*. (1998) suggested that selection of genotypes with higher glycoalkaloid (solasodine) content, total phenols and polyphenol oxidase activity would help improve resistance to shoot and fruit borer infestation without compromising yield potential. The per cent of fruit infestation decreases with the increases in number of seed per gram flesh of brinjal fruit. The variety having compact seed ring (BL009 and wild *S. torvum*) with closely arranged seeds in mesocarp showed less infestation while variety with less compact seed ring with distantly arranged seed (BARI Brinjal-1) suffered more fruit infestation (Amin *et al*. 2014).

Bajaj *et al*. (1989) suggested that low incidence of fruit borer infestation is associated with higher levels of glycoalkaloids, peroxidase and polyphenol in fruits. Hazra *et al*. (2004) observed that thick terminal shoot, long and wide calyx and plumpy fruits of high weight imparts susceptibility while low moisture, sugar and protein content were associated with tolerance. Doshi *et al.* (1999) reported that amino acids and sugar content (total and reducing sugars) showed a highly positive and poly phenol oxidase, phenylalanine ammonialyase, peroxidase and glycoalkaloids showed a highly negative correlation with shoot and fruit borer infestation. Elanchezhyan *et al*. (2009) reported that hybrid Swetha as highly resistant to borer and recorded the total phenols (7.6 mg/g) and total sugars (5.8 mg/g) while Bejo Sheetal, recorded the lowest total phenols (1.9 mg per g) and highest total sugars (18.0%). Prabhu *et al*. (2009) investigated the biochemical basis of host plant resistance for shoot and fruit borer of brinjal using selected genotypes from the back crosses involving cultivated brinjal varieties and *S. viarum.* The different levels of biochemical constituents namely peroxidase, poly phenol oxidase, total phenols and solasodine contents were observed and reported that clear correlation exists between the levels of biochemical constituents of superior genotypes and resistance to shoot and fruit borer.

Imtiaz *et al.* (2015) has observed positive association of total sugars and negative association of total phenols with shoot and fruit borer infestation. Payal *et al.* (2015) and Niranjana *et al.* (2015) reported that calyx length had positive association with SFB fruit infestation. Nirmala and Irene (2016) reported that, fruit infestation was positively but not significantly correlated with calyx length and total sugars. Phenols had significantly negative correlation with fruit infestation.

2.2. EXPERIMENT II: LINE X TESTER ANALYSIS

2.2.1 Heterosis

In the history of the development of the scientific concepts and their applications for the benefit of agriculture, heterosis deserves a prominent position. The term heterosis refers to the phenomenon in which F_1 shows increased or decreased vigour over the parent. Shull (1908) referred to this phenomenon as the stimulus of heterozygosity. The occurrence of heterosis is common in plant species but its level of expression is highly variable. Heterosis (hybrid vigour) is the superiority of hybrid over its parents when mean of the two parents is considered, it is called heterosis over mid parent. Generally the term hybrid vigour is used to denote heterosis in the dissimilar direction and the heterosis over mid parent, better parent and standard check (ruling variety/hybrids) is designated as heterosis, heterobeltiosis and standard heterosis, respectively.

The earliest recorded instances of artificial hybridization in eggplant were evidently those carried out by Bailey and Munson in 1892. However none of the hybrids exhibited heterosis but were intermediate between the parents. Subsequently Halsted (1901) reported that one of his crosses had double the size of the parents and also yielded more. In the Philippines Bayla (1918) hybridized some local varieties and found that the hybrids were more vigorous, stronger and healthier than the respective parental lines. In Japan, Nagai and Kida (1926) studied certain quantitative characteristics in the hybrids and found that heterosis was manifested in total yield and its traits. Tatesi (1927) observed higher productivity in certain crosses between Japanese brinjal varieties. Kakizaki (1928) reported the occurrence of remarkable hybrid vigour in the crosses with regard to seed weight, stem diameter and height in brinjal.

Heterosis being a complex phenomenon, no conclusive or clear-cut explanation is available to account for its manifestation. However, several theories have been put forth to explain heterosis like dominance (Davenport, 1908; Keeble and Pellew, 1910; Bruce, 1910 and Jones, 1917), over dominance (East, 1908 and Shull, 1909), epistasis (Jinks, 1955; Hayman, 1957; Bauman, 1959; Sprague *et al*., 1962; Gamble, 1962 and Sprague and Thomas, 1967) and mitochondrial complementation (Hanson *et al*., 1960; McDaniel, 1972 and Shrivastava, 1972).

In India, the first attempt to hybridize eggplant appears to have been made by Rao in 1934, however, in the cross between two wide varieties, a high degree of partial sterility due to abortive pollen was observed. Venkataramani (1946) reported that hybrid egg plants were taller, spread more, flowered earlier than the early parent and yielded more than either parent. In the same year, Pal and Singh (1946) reported that majority of the hybrids exhibited heterosis with respect to seed germination, plant height, plant spread, number of branches, early flowering, number of fruits per plant, fruit size and fruit yield. Heterosis reported for yield and its components by various workers are presented in Table1.

2.2.2 Combining Ability

A detailed knowledge on the magnitude and nature of genetic variances in breeding material is of prime importance for formulating a sound breeding programme for any crop. Combining ability is the ultimate factor in determining its usefulness for hybrids. The importance of combining ability has been well emphasized because often phenotypically promising parents don't give desired cross combinations and produce superior offspring in segregating generations whereas some combinations may give promising segregants. Allard (1960) explained that the ability of the parents to combine well depends on complex interaction among genes and cannot be adjudged by mere yield performance and adaptation of parents alone. The ability of a parent to combine well and to produce promising segregants in succeeding generation is an important criteria in selection of parents for successful hybridization programme. The concept of combining ability first proposed by Sprague and Tatum (1942) in corn is useful for selection of parents which can produce superior hybrids. The superiority of the F_1 hybrids depend on the parent material used to produce F_1 which involves the action and interaction of dissimilar gametes in the heterozygotes. Hence information on the general combining ability (*gca*) of the parents and their gene action and specific combining ability (*sca*) of the crosses and their magnitude of heterosis is vital for the selection of parents in the breeding programmes.

The general combining ability (*gca*) is the average performance of a genotype in cross combinations involving a set of other genotypes. It is the deviation of the mean performance of all crosses involving a parent from overall mean. Specific combining ability (*sca*) is the relative performance of a specific cross combination. It is the deviation in the performance of a specific cross from the performance expected on the basis of general combining ability effects of parents involved in the cross. The *gca* variance is due to additive variance, whereas, *sca* variance is due to dominance and epistatic (additive x additive, additive x dominance and dominance x dominance) variance. In other words, the *gca* and *sca* variances act as diagnostic tools to detect the additive (linear) and non-additive (non-linear) gene action. This helps in selection of suitable parents or cross combination(s).

Earliest studies on combining ability in brinjal were reported by Odland and Noll (1948). They reported that, the hybrid combination between lower yielding parents produced more yields. General combining ability (*gca*) is "the average performance of a line in a series of hybrid combinations and specific combining ability is "the deviation of certain crosses from the average performance of the lines". Henderson (1952) defined specific combining ability as deviation of an average value which would be expected on the basis of known general combining ability of two lines. Regarding the combining ability of parental lines in brinjal, two aspects were worth considering. One is that in several cases the best hybrids were obtained by crossing widely different varieties (Kakizaki, 1928), while only in a few instances wide crosses resulted in partial sterility in the hybrids (Rao, 1934 and Jasmin, 1954). This should be of particular interest to workers in India, where a great number of varieties possessing considerable genetic variability exist. The other aspect is that the hybrids of high productivity may result from parents of very low productivity (Sambandam, 1962).

The choice of parental material in a breeding programme is very important, since it puts a limitation on the possibility of isolating the genotypes outside the frame work of the genetic makeup of the parents. Hence the selection of parents must be done very precisely. In order to fulfil this goal, combining ability studies become useful. As it provides information or nicking ability pertaining to gene actions of parents for various traits. Several methods have been developed to estimate the general and specific combining ability of different genetic material *viz.,* inbred variety cross or top cross technique (Jenkins and Brunson, 1932), polycross (Tsydal *et al.*, 1942), diallel cross (Griffing, 1956), line x tester analysis (Kempthorne, 1957), partial diallel cross (Kempthorne and Curnow, 1961) and triallel cross (Rawlings and Cockerham, 1962).It is essential to understand the types of gene action and their importance in determining the traits of interest to the breeders for increasing the efficiency of the breeding programme. The knowledge of various types of gene action and their relative magnitude in controlling the trait is important in deciding proper breeding techniques (Miller *et al.,* 1980). The available literature pertaining to combining ability in brinjal is presented in Table 2.

2.3 EXPERIMENT III

2.3.1 Molecular Analysis of F_2 Segregants

Michelmore *et al.* (1991) used bulked segregant analysis to identify markers linked to downy mildew resistance gene in nature using RAPD and RFLP. The two bulked DNA samples were generated from the segregating population from a single cross. The two bulk were genetically dissimilar in the selected region but heterozygous at all other regions. One bulk was having the lettuce plant showing the resistance while the other was having the susceptible plants. Both the bulks were screened for difference using RAPD and RFLP probes. By BSA, was identified that 3 random amplified polymorphic DNA markers in lettuce linked to a gene for resistance to downy mildew. Markers (OPF-12, OPH-04 and OPH-15) were found to be 25 cM on either side of target locus.

Karthikeyan *et al.* (2005) studied six different populations of *L. orbonalis* were collected and subjected to analysis of genetic variability in terms of carboxylesterase isozyme pattern and DNA polymorphism using RAPD-PCR. Pattern of carboxylesterase revealed a similar isozyme cluster in the populations namely, sivaganga (population-3), dindigal (population-4), virudhunagar (population-5) and coimbatore (population-6). Similarly, the populations of L. (lrbollaiis recorded 3 distinct randomly amplified polymorphic DNA markers in all populations grouped above. This pattern of genetic variability in the populations was also supported by the analysis of the similarity indices and UPGMA dendrogram.

Marimuthu *et al.* (2009) analysed shoot and fruit borer, *Leucinodes orbonalis* (Guenee) (Pyraustidae: Lepidoptera), has become a production constraint in all eggplant (*Solanum melongena* Linn. [*Solanaceae*]) growing countries. In India, transgenic eggplants expressing *Bacillus thuringiensis* Cry toxins have been tested in fields by private- and public-sector agencies. Understanding population diversity is important in designing strategies for better pest management. In the present investigation, random-amplified polymorphic DNA markers were used to assess the genetic diversity of *L. orbonalis* population collected from different field locations in the Tamilnadu State of India. Of 17 random-amplified polymorphic DNA primers screened, only 11 primers generated polymorphic bands (up to 14 bands). According to their level of similarities, only two major clusters with no variation among population were deduced. Our results indicated that there is a steady genetic flow among the present population of *L. orbonalis* alleviating genetic variation, which may be attributed to passive and active dispersal of the insect besides absence of host-induced variations among the population. As molecular variability of *L. orbonalis* population is an important consideration for shoot and fruit damage of the eggplant, constant monitoring is essential to study the possible development of Cry protein resistance in *L. orbonalis*.

Shashank *et al.* (2015) foresighted shoot and fruit borer, *Leucinodes orbonalis* is an important insect pest infesting brinjal or eggplant in India. Molecular characterization of nine different populations belonging to various brinjal growing regions was done using Cytochorome C Oxidase I (COI) gene.

Nucleotide analysis of genetic diversity and phylogenetic analysis of the COI indicate that the *L. orbonalis* from different geographical regions are homogenous. The results showed less nucleotide diversity (π = 0.007895) and overall mean distance (0.008 ± 0.003). Topologies of neighbour-joining (NJ) trees indicate all the populations belong to single major clade. Therefore, it is inferred that there was no significant molecular diversity within *L. orbonalis* of different geographical locations of India with respect to COI.

Geetharajalakshmi *et al.* (2006) studied the genomic DNA of different populations belonging to different eggplant growing regions for RAPD profiles, for understanding the intraspecific variation among them. Twenty-five "lepidopteran specific random primers" were used in this analysis, which generated a lotal of 279 markers revealing an average of 10-12 markers per primer in each popliialio. The primers generated polymorphic markers (249), monomorphic markers (35) wilh a percentage of polymorphism (87.6). The per cent of polymorphism ranged from 46.15-100 for different primers. The results are discussed in relation to the genetic relation~hjp among the ten populations.

Khorsheduzzaman *et al.* (2008) investigated five brinjal (*Solanum melongena* L.) genotypes were selected for characterization using Simple Sequence Repeats (SSR) markers. All the genotypes showed considerable variation in respect of morphological, anatomical and biochemical aspects. For study of relatedness, plant genomic DNA was extracted by CTAB based method using 11 randomly selected primers produced from Calgene Inc. USA. The primers developed 22 bands through PCR amplification out of which 15 from 3 primers and were polymorphic. Genetic similarities of SSR profiles were estimated based on Jaccard's coefficient value. The dendrogram generated two clusters and they were clearly distinct and separated from each other. Cluster-I consisted of genotypes TURBO and BL009; and cluster-II comprised of genotypes EG058, EG075 and ISD006. Genotype TURBO and BL009 were identified as the diverse genotype and showed a maximum of 17% dissimilarity from EG058, EG075 and ISD006. The similarity value ranged from 0.83 to 1.00 which indicated the presence of narrow range of genetic diversity at molecular level but have still a possibility of crossing among the genotypes of two clusters. The banding pattern of different genotypes could be utilized as reference for further comparisons.

Ghante *et al.* (2013) analysed genomic DNA of ten different populations of *Leucinodes orbonalis* G. from North Karnataka for genetic variation among them. Fourty decamer primers were used in this analysis, which generated a total of 244 markers revealing an average of 14.35 markers per primer in each population. Genetic relationships between the populations were evaluated by generating similarity matrix (based on Jaccard's index) and phonetic dendrogram was generated (by UPGMA method). Principal component analysis separated 12 populations into different groups based on band-sharing data. Populations showed varied degrees of genetic similarity within the range of 0.04 -0.52.

Chang *et al.* (2014) studied and helped to reduce the impact of this pest, population genetic diversity and structure of *L. orbonalis* in eight populations from six countries using mitochondrial cytochrome c oxidase subunit I DNA sequences. No correlation between genetic diversity and geographic distance was detected among populations. Low levels of haplotype and nucleotide diversities were observed in the Philippines population, suggesting recent colonization. No significant gene flow was found among local populations in different countries. The Vietnam population is highly differentiated, indicated by significant pairwise FST values, and may be ascribed to a new subspecies or race. India was confirmed to be the source of genetic variation in *L. orbonalis* populations. Our study showed that *L. orbonalis* formed subpopulations for each local region, and the corresponding pest management technology should be developed at the country scale.

Table 1. Heterosis for different traits in brinjal as reported by different authors

Type of materials studied	Range of heterosis (%) over			Authors
	Mid parent	Better parent	Standard check	
Plant Height (cm)				
10 F_1 hybrids	-11.56 to 23.65	0.7 to 23.7	--	Peter and Singh (1974)
12 parents and 12 F_1 hybrids	--	-23.47 to 31.27	--	Mishra (1977)
10 F_1 hybrids	--	26.1	--	Singh and Kumar (1978)
15 x 4 Line x Tester	--	20.69 to 38.34	--	Singh *et al.* (1978)
72 F_1hybrids	-31.39 to 61.19	-19.17 to 28.30	--	Dharmegowda *et al.* (1979)
6 x 6 Diallel (Excluding reciprocals)	-12.00 to 30.30	-19.71 to 28.30	6.96 to 14.44	Bhutani *et al.* (1980)
4 F_1 hybrids	--	2.46 to 30.92	--	Dhankar *et al.* (1980)
11 parents and 11 F_1 hybrids	--	-3.44 to 14.94	8.18 to 20.18	Ram *et al.* (1981)
22 F_1 hybrids	3.36 to 40.96	4.79 to 14.88	--	Chadha and Sidhu (1982)
7 x 7 Diallel (Excluding reciprocals)	-14.05 to 43.17	-17.37 to 30.68	-31.66 to 26.07	Patel (1984)
15 F_1 hybrids	--	4.91 to 23.64	-	Patil and Shinde (1984)
3 x 3 Line x Tester	--	-31.38	8.96 to 29.50	Rajput *et al.* (1984)
15 parents and 15 F_1 hybrids	--	14.95 to 23.64	--	Sidhu and Chadha (1985)
6 x 6 Diallel (Excluding reciprocals)	--	-5.75 to -4.46	--	Verma *et al.* (1986)
9 x 9 Diallel (Excluding reciprocals)	--	16.50 to 25.34	--	Chadha and Hegde (1988)
7 x 7 Diallel (Excluding reciprocals)	--	-7.87 to 9.76	--	Chaudhary and Mishra (1988)
20 F_1 hybrids	--	-50.16 to 36.44	--	Singh *et al.* (1988)
21 F_1 hybrids	--	-1.40 to 44.67	20.96 to 75.04	Chadha *et al.* (1990)
5 x 5 Diallel	--	-4.1 to 13.1	--	Shankaraiah and Rao (1990)
14 F_1 hybrids	0.2 to 20.2	0.86 to 30.22	--	Sawant *et al.* (1991)
18 F_1hybrids	9.41 to 43.51	-4.30 to 43.51	--	Prakash *et al.* (1993)
6 x 6 Diallel (Including reciprocals)	-8.07 to 45.54	-19.67 to 37.24	--	Patel (1994)
55 F_1 hybrids	--	0.17 to 8.93	--	Mankar *et al.* (1995)
45 F_1 hybrids	24.1 to 45.9	-41.80 to 43.10	--	Ingale and Patil (1997a)

7 x 5 Line x Tester	--	-17.44 to 46.98	-26.96 to 25.84	Kaur (1998)
60 F_1 hybrids	--	--	-20.58 to 18.69	Patil (1998)
12 F_1 hybrids	-1.00 to 26.5	-11.90 to 24.80	--	Kumar *et al.* (1999)
30 F_1 hybrids	-11.39 to 19.46	--	-13.28 to 8.14	Bulgundi (2000)
3 x 14 Line x Tester	-72.11 to 6.64	-75.88 to 4.38	--	Indiresh and Kulkarni (2002)
8 x 8 Diallel (Excluding reciprocals)	--	-13.91 to 17.69	-9.41 to 22.88	Patel (2003)
4 x 4 Diallel	2.41 to 21.06	-7.86 to 11.62	--	Das and Barua (2001)
28 F_1 hybrids	-20.93 to 16.25	-25.55 to 10.95	-12.43 to 30.47	Mallikarjun (2002)
28 F_1 hybrids	--	-17.15	--	Harshavardhan *et al.* (2003)
36 F_1 hybrids	-59.35 to 28.65	-63.10 to 21.81	--	Singh *et al.* (2004)
24 F_1 hybrids	0.83 to 47.47	-2.70 to 45.27	-4.14 to 2.547	Shafeeq (2005)
27 F_1 hybrids	-22.66 to 56.33	-23.64 to 55.00	-14.79 to 60.17	Singh and Maurya (2005)
10 x 10 Diallel	--	-46.77 to 42.76	-42.59 to 23.38	Suneetha and Kathiria (2006)
10 x 10 Diallel	47.48	45.94	--	Bisht *et al.* (2009)
8 x 3 Line x Tester	--	-17.43 to -8.56	--	Shanmugapriya *et al.* (2009)
6 x 6 Diallel	--	2.12 to 22.36	-16.96 to 1.91	Chowdhury *et al.* (2010)
48 hybrids	20.45 to 22.38	--	--	Abhinav and Nandan (2010)
15 hybrids	8.12 to 22.36	--	-16.96 to 1.91	Chowdhury *et al.* (2011)
8 x 6 Line x Tester	--	22.38	--	Sao and Mehta (2010)
8 x 8 Diallel (Excluding reciprocals)	-24.11 to 42.19	-9.89 to 53.82	-19.21 to 40.53	Makani (2013)
20 F1 Hybrids	--	--	-21.85 to12.61	Ajjappalavara *et al.* (2013)
5 x 4 Line x Tester	--	--	4.36 to 61.66	Reddy and Patel (2014)
28 F1 Hybrids	-8.98 to 59.63	-22.37 to 45.84	-14.01 to 26.54	Rajasekhar (2014)
7 x 3 Line x Tester	-13.26 to 18.53	-15.61 to 8.73	-15.86 to 13.22	Sivakumar (2015)
Primary branches per plant				
15 F_1 hybrids	--	0 to 5.44	--	Chadha and Sidhu (1982)
22 F_1 hybrids	7.46 to 148.79	1.18 to 138.89	--	Dhankar and Singh (1983)
18 F_1 hybrids	0.0 to 55.56	-10.53 to 23.53	--	Prakash *et al.* (1993)

3 F_1 hybrids	4.97 to 14.96	-8.32 to 4.37	--	Ponnuswami *et al.* (1994)
55 F_1 hybrids	--	0.91 to 94.94	--	Mankar *et al.* (1995)
60 F_1 hybrids	-16.04 to 37.48	--	-27.88 to 20.06	Patil (1998)
12 F_1 hybrids	-17.3 to 21.4	-20.4 to 18.7	--	Kumar *et al.* (1999)
30 F_1 hybrids	-36.75 to -5.25		-9.30 to 37.46	Bulgundi (2000)
36 F_1 hybrids	--	-8.57 to 28.57	--	Chadha *et al.* (2001)
28 F_1 hybrids	-35.23 to 76.68	-35.60 to 62.31	--	Mallikarjun (2002)
36 F_1 hybrids	53.98 to 40.66	-52.75 to 50.68	--	Singh *et al.* (2004)
24 F_1 hybrids	-29.04 to 26.62	-40.68 to 22.76	-13.07 to 23.07	Shafeeq (2005)
5 F_1 hybrids	-5.88 to 31.03	-15.79 to 23.44	-18.90 to 0.11	Ajjappalavara (2006)
10 x 10 Diallel (Excluding reciprocals)	58.22	51.34	--	Bisht *et al.* (2009)
5 F_1 Hybrids	-2.06 to 55.52	-5.91 to 32.63	34.76 to 82.13	Prabhu *et al.* (2005)
24 F_1 Hybrids	-29.04 to 26.62	-40.68 to 22.76	-13.07 to 23.07	Shafeeq *et al.* (2007)
33 F_1 Hybrids	-43.75 to 70.00	-43.75 to 142.86	-30.76 to 38.47	Neelima *et al.* (2008)
15 F_1 Hybrids	5.00 to 36.00	-4.56 to 17.02	--	Das *et al.* (2009)
12 F_1 Hybrids	-79.09 to 41.28	-59.46 to 26.67	-82.76 to 29.89	Murthy *et al.* (2011)
48 F_1 Hybrids	--	-27.13 to 67.69	-34.34 to 41.69	Abhinav and Mehta (2011)
8 x 8 Diallel (Excluding reciprocals)	--	--	-28.0 to 14.2	Nalini *et al.* (2011)
5 x 4 Line x Tester	--	--	-8.87 to 23.74	Reddy and Patel (2014)
28 F1 Hybrids	-8.80 to 33.82	-12.99 to 31.88	--	Rajasekhar (2014)
7 x 3 Line x Tester	-21.55 to 15.87	-28.08 to 9.78	-23.79 to 20.66	Sivakumar (2015)
Days to first flowering				
10 F_1 hybrids	-19.60 to 2.36	-25.95 to 16.81	--	Peter and Singh (1974)
6 x 6 Diallel	--	-4.7 to 17.0	--	Vijay and Nath (1978)
72 F_1 hybrids	-13.02 to 5.61	-71.71 to 13.02	--	Dharmegowda *et al.* (1979)
5 F_1 hybrids	--	-52.06 to 9.51	--	Dhankhar *et al.* (1980)

19 F_1 hybrids	-4.3 to 1.2	-3.3 to 3.7	--	Shankaraiah and Rao (1990)
42 F_1 hybrids	-14.75 to 15.18	--	--	Patil (1991)
14 F_1 hybrids	--	-29.33 to 24.28	--	Sawant *et al.* (1991)
10 F_1 hybrids	--	-16.23 to 18.04	--	Mandal *et al.* (1994)
60 F_1 hybrids	-37.79 to 43.07	--	-49.14 to 27.43	Patil (1998)
12 F_1 hybrids	-13.4 to 5.6	-11.1 to 6.8	--	Kumar *et al.* (1999)
30 F_1 hybrids	-19.23 to 19.05	--	-13.40 to 13.04	Bulgundi (2000)
36 F_1 hybrids	--	0.00 to 16.28	--	Chadha *et al.* (2001)
4 x 4 Diallel	-0.42 to -9.51	-9.51 to 1.69	--	Das and Barua (2001)
28 F_1 hybrids	-18.00 to 11.81	--	--	Mallikarjun (2002)
27 F_1 hybrids	-10.39 to 38.99	-10.39 to 38.99	-15.35 to 27.59	Singh and Maurya (2005)
10 x 10 Diallel (Excluding reciprocals)	-17.61	-16.14	--	Bisht *et al.* (2009)
6 x 6 Diallel	--	-27.59 to 1.21	-7.83 to 32.24	Chowdhury *et al.* (2010)
8 x 8 Diallel (Excluding reciprocals)	--	--	-7.09 to 14.18	Nalini *et al.* (2011)
8 x 8 Diallel (Excluding reciprocals)	-12.59 to 14.83	-9.46 to 22.45	-9.36 to 18.22	Makani (2013)
5 x 4 Line x Tester	--	--	-29.44 to -7.22	Reddy and Patel (2014)
28 F1 Hybrids	-5.50 to 19.30	-13.68 to 14.66	-3.51 to 12.87	Rajasekhar (2014)
Days to First Harvest				
12 x 12 Diallel	--	-16.49 to 0.69	--	Mishra (1977)
6 x 6 Diallel	-12.15 to 2.80	-16.80 to 10.50	--	Bhutani *et al.* (1980)
15 parents and 22 F_1 hybrids	--	1.40 to 16.62	0.29 to 4.01	Chadha and Sidhu (1982)
15 parents and 15 F_1 hybrids	--	1.49 to 4.84	--	Sidhu and Chadha (1985)
6 x 6 half diallel	--	-31.97 to -0.66	--	Verma *et al.* (1986)
21 F_1 hybrids	--	-16.49 to 15.25	-0.21 to 29.66	Chadha *et al.* (1990)
6 x 6 Diallel	-17.31 to 4.88	-12.06 to 29.43	--	Patel (1994)
55 F_1 hybrids	--	-35.64 to 20.98	--	Mankar *et al.* (1995)
7 x 5 Line x Tester	--	-4.53 to 18.14	-25.19 to 19.34	Kaur (1998)

8 x 8 Diallel (Excluding reciprocals)	--	-9.06 to 19.79	-8.75 to 16.16	Patel (2003)
10 x 10 Half diallel	--	-5.42 to 29.20 (E_1) -8.61 to 8.35 (E_2) -8.59 to 14.38 (E_3)	--	Rao (2003)
7 x 3 Line x Tester	--	-1.47 to -9.96	--	Kamal *et al*. (2006)
10 x 10 Diallel	--	-8.59 to 14.38	-2.82 to 11.96	Suneetha and Kathiria (2006)
10 x 10 Diallel	-9.78	-8.82	--	Bisht *et al*. (2009)
6 x 6 Diallel	--	-25.27 to 2.26	-18.29 to 21.40	Chowdhury *et al*. (2010)
8 x 8 Diallel (Excluding reciprocals)	-14.71 to 17.92	-12.64 to 29.37	-4.44 to 26.28	Makani (2013)
28 F1 Hybrids	-6.09 to 11.13	-9.28 to 10.71	-5.01 to 9.45	Rajasekhar (2014)
7 x 3 Line x Tester	-10.50 to 7.35	-12.11 to 1.86	5.95 to 18.38	Sivakumar (2015)
Days to last harvest				
7 x 3 Line x Tester	-3.91 to 9.18	-1.61 to 5.90	-1.70 to 6.24	Sivakumar (2015)
Number of fruits per plant				
21 F_1 hybrids	-63.14 to 49.25	--	--	Lal *et al*. (1974)
12 Parents and 12 F_1 hybrids	--	2.11 to 85.08	--	Mishra (1977)
15 x 4 Line x Tester	0.00 to 11.88	59.36 to 81.95	--	Singh *et al*. (1978)
10 F_1 hybrids	--	53.8	--	Singh and Kumar (1978)
15 F_1 hybrids	-35.4 to 66.6	-52.3 to 36.0	--	Vijay *et al*. (1978)
72 F_1 hybrids	-65.86 to 105.21	-79.80 to 72.22	--	Dharmegowda *et al*. (1979)
15 F_1 hybrids	-47.67 to 52.09	-61.65 to 47.66	28.45	Bhutani *et al*. (1980)
4 F_1 hybrids	--	-34.67 to 78.54	--	Dhankhar *et al*. (1980)
11 Parents and 11 F_1 hybrids	--	-5.26 to 36.84	5.25 to 69.23	Ram *et al*. (1981)
15 Parents and 22 F_1 hybrids	--	1.78 to 176.62	46.07 to 86.37	Chadha and Sidhu (1982)
7 x 7 Diallel (Excluding reciprocals)	-22.43 to 64.86	-50.84 to 24.80	-56.45 to -14.97	Patel (1984)
40 F_1 hybrids	--	27.94	--	Dahiya *et al*. (1984)

15 F_1 hybrids	--	4.25 to 48.73	--	Patil and Shinde (1984)
3 x 3 Line x Tester	35.41 to 107.79	107.79	18.46 to 95.91	Rajput *et al.* (1984)
15 parents and 15 F_1 hybrids	0.00 to 27.41	0.00 to 22.87	--	Sidhu and Chadha (1985)
6 x 6 Diallel (Excluding reciprocals)	--	4.18 to 7.56	--	Verma *et al.* (1986)
12 Parents and 30 F_1 hybrids	--	3.80 to 60.1	--	Dixit and Gautam (1987)
9 x 9 Diallel (Excluding reciprocals)	10.15 to 17.50	11.28 to 18.84	--	Chadha and Hegde (1988)
20 F_1 hybrids	--	13.5 to 54.4	--	Singh *et al.* (1988)
4 Varieties along with 105 crosses	--	-46.36 to 239.81	--	Kalloo *et al.* (1989)
21 F_1 hybrids	--	-28.31 to 29.97	35.0 to 210.51	Chadha *et al.* (1990)
14 F_1 hybrids	--	-13.29 to 44.07	--	Sawant *et al.* (1991)
18 F_1 hybrids	-13.33 to 129.34	-37.24 to 118.59	--	Prakash *et al.* (1993)
6 x 6 Diallel (Including reciprocals)	--	-73.47 to 3.14	--	Patel (1994)
10 F_1 hybrids	--	69.98 to 96.49	--	Mandal *et al.* (1994)
55 F_1 hybrids	--	1.40 to 45.48	--	Mankar *et al.* (1995)
45 F_1 hybrids	-42.1 to 45.4	-63.1 to 40.6	--	Ingale and Patil (1997a)
7 x 5 Line x Tester	--	-51.49 to 93.25	-56.83 to 24.38	Kaur (1998)
60 F_1 hybrids	--	--	-47.77 to 83.20	Patil (1998)
12 F_1 hybrids	-30.72 to 81.1	-35.1 to 66.3	-	Kumar *et al.* (1999)
30 F_1 hybrids	-57.28 to 102.41	--	-46.94 to 87.07	Bulgundi (2000)
4 x 4 Diallel	4.11 to 40.29	-13.37 to 27.79	-	Das and Barua (2001)
28 F_1 hybrids	-45.16 to 37.41	-50.75 to 15.55	-41.82 to 56.53	Mallikarjun (2002)
3 x 14 Line x Tester	-45.19 to 24.82	-58.40 to 4.63	--	Indiresh and Kulkarni (2002)
8 x 8 Diallel (Excluding reciprocals)	--	-66.42 to 22.22	-50.54 to 81.70	Patel (2003)
28 F_1 hybrids	--	14.12	--	Harshavardhan *et al.* (2003)
24 F_1 hybrids	-42.18 to 22.91	-43.62 to 4.56	-26.98 to 33.95	Shafeeq (2005)
54 F_1 hybrids	-22.06 to 35.72	-24.40 to 34.27	26.98 to 33.95	Bugali *et al.* (2007)
25 hybrids	-51.44 to 30.64	--	-3.85 to 70.77	Prakash *et al.* (2008)
33 hybrids	-65.51 to 138	--	-30.17 to 26.42	Joshi *et al.* (2008)

48 hybrids	45.42 to 102	--	-77.19 to 53.03	Abhinav and Nandan (2010)
27 F_1 hybrids	-41.12 to 172.99	-223.07 to 247.00	-79.31 to 114.94	Singh and Maurya (2005)
7 x 3 Line x Tester	--	1.46 to 64.84	--	Kamal *et al*. (2006)
45 F_1 hybrids	--	-63.18 to 134.53	-77.19 to 53.03	Suneetha *et al*. (2008)
25 F_1 hybrids	--	-61.61 to 30.6	-80.17 to -30.82	Timmapur *et al*. (2008)
10 x 10 Diallel	66.08	58.83	--	Bisht *et al*. (2009)
8 x 3 Line x Tester	--	42.64 to 83.69	--	Shanmugapriya *et al*. (2009)
6 x 6 Diallel	--	-72.81 to 105.00	-60.97 to 253.65	Chowdhury *et al*. (2010)
8 x 6 Line x Tester	--	102.79	--	Sao and Mehta (2010)
28 F_1 hybrids	--	--	-30.17 to 26.42	Nalini *et al*. (2011)
8 x 8 Diallel (Excluding reciprocals)	-5.10 to 168.45	-40.10 to 190.34	-35.22 to 65.11	Makani (2013)
5 x 4 Line x Tester	--	--	-21.68 to 245.26	Reddy and Patel (2014)
28 F1 Hybrids	-35.63 to 71.28	-41.73 to 32.38	-17.91 to 95.27	Rajasekhar (2014)
7 x 3 Line x Tester	-16.15 to 137.56	-31.04 to 106.09	-5.98 to 156.21	Sivakumar (2015)
Length of fruit (cm)				
21 F_1 hybrids	-28.51 to 16.90	-26.99 to 16.90	--	Lal *et al*. (1974)
12 Parents and 12 F_1 hybrids	--	-2.37 to 26.31	--	Mishra (1977)
10 F_1 hybrids	--	-30.3 to 19.0	--	Singh and Kumar (1978)
15 F_1 hybrids	-32.80 to 68.80	-37.93 to -5.21	4.12	Bhutani *et al*. (1980)
4 F_1 hybrids	--	1.29 to 70.00	--	Dhankhar *et al*. (1980)
11 Parents and 11 F_1 hybrids	--	-41.31 to -14.15	-32.85 to 29.82	Ram *et al*. (1981)
22 F_1 hybrids	6.92 to 70.00	33.92	--	Chadha and Sidhu (1982)
40 F_1 hybrids	--	0.52 to 13.82	--	Dahiya *et al*. (1984)
7 x 7 Diallel (Excluding reciprocals)	-2.63 to 22.94	-10.87 to 22.84	-32.78 to 9.97	Patel (1984)
15 F_1 hybrids	--	10.87 to 121.-80	--	Patil and Shinde (1984)
3 x 3 Line x Tester	36.68 to 54.97	--	6.16 to 27.17	Rajput *et al*. (1984)

15 F_1 hybrids	26.32 to 126.54	19.54 to 121.80	--	Sidhu and Chadha (1985)
12 Parents and 30 F_1 hybrids	--	5.20 to 12.10	--	Dixit and Gautam (1987)
20 F_1 hybrids	--	4.3 to 48.6	--	Singh *et al.* (1988)
9 x 9 Diallel (Excluding reciprocals)	-5.29 to 4.37	-3.39 to 4.60	--	Chadha and Hegde (1988)
18 F_1 hybrids	-25.77 to 26.18	-33.88 to 11.14	--	Prakash *et al.* (1993)
6 x 6 Diallel (Including reciprocals)	--	-56.14 to 32.55	--	Patel (1994)
66 F_1 hybrids	--	-0.74 to 31.13	--	Mankar *et al.* (1995)
10 x 10 Diallel (Excluding reciprocals)	-39.1 to 28.3	-51.90 to 19.20	-64.50 to -6.00	Ingale and Patil (1996)
7 x 5 Line x Tester	--	-19.40 to 38.04	-24.11 to 31.25	Kaur (1998)
60 F_1 hybrids	--	--	-18.84 to 28.56	Patil (1998)
12 F_1 hybrids	-18.4 to 36.1	-29.9 to 19.1	--	Kumar *et al.* (1999)
30 F_1 hybrids	-19.23 to 33.72	--	-22.27 to 23.64	Bulgundi (2000)
36 F_1 hybrids	--	-41.95 to 17.92	--	Chadha *et al.* (2001)
3 x 14 Line x Tester	-41.94 to 6.54	-59.26 to 4.59	--	Indiresh and Kulkarni (2002)
24 F_1 hybrids	-24.87 to 29.82	-50.0 to 18.46	-3.45 to 112.07	Shafeeq (2005)
4 x 4 Diallel	6.64 to 28.35	-15.23 to 8.92	--	Das and Barua (2001)
8 x 8 Diallel (Excluding reciprocals)	--	-27.40 to 2.43	-3.27 to 31.73	Patel (2003)
24 F_1 hybrids	-24.87 to 29.82	-50.0 to 18.46	-3.45 to 112.07	Shafeeq (2005)
28 F_1 hybrids	-11.90 to 40.69	-10.59 to 52.24	-5.85 to 47.82	Mallikarjun (2002)
28 F_1 hybrids	--	8.30	--	Harshavardhan *et al.* (2003)
28 F_1 hybrids	--	--	-37.9 to 41.4	Pratibha *et al.* (2004)
36 F_1 hybrids	16.58 to 33.95	-33.38 to 40.50	--	Singh *et al.* (2004)
27 F_1 hybrids	-26.48 to 79.12	-43.33 to 39.31	-66.07 to 28.33	Singh and Maurya (2005)
33	-17.57 to 53.33	--	-33.87 to 51.82	Joshi *et al.* (2008)
25	-27.91 to 10.66	--	-37.03 to-16.14	Prakash *et al.* (2008)
10 x 10 Diallel	36.92	24.95	--	Bisht *et al.* (2009)

8 x 3 Line x Tester	--	-15.89 to 33.44	--	Shanmugapriya *et al*. (2009)
6 x 6 Diallel	--	-34.04 to 32.35	-7.85 to 93.17	Chowdhury *et al*. (2010)
8 x 6 Line x Tester	--	13.55	--	Sao and Mehta (2010)
40 F_1 Hybrids	--	-57.23 to 56.67	--	Singh *et al*. (2012)
40 F_1 Hybrids	-53.46 to 63.75	-62.41 to 42.09	-62.41 to 1.16	Rameshkumar *et al*. (2012)
12 F_1 Hybrids	-2.55 to 1.16	--	--	Al-Hubaity and Teli (2013)
8 x 8 Diallel (Excluding reciprocals)	-19.30 to 21.11	-19.82 to 12.11	-19.83 to 12.09	Makani (2013)
24 F_1 Hybrids	35.97 to 76.80	19.79 to 23.66	22.90 to 73.04	Bhushan *et al*. (2013)
16 F_1 Hybrids	--	-69.94 to 27.55	-43.18 to 80.46	Leena *et al*. (2013)
5 x 4 Line x Tester	--	--	4.66 to 84.33	Reddy and Patel (2014)
28 F1 Hybrids	-20.01 to 48.40	-40.08 to 37.13	0.51 to 80.23	Rajasekhar (2014)
7 x 3 Line x Tester	-24.47 to 35.89	-42.51 to 27.16	9.06 to 135.38	Sivakumar (2015)
Girth of fruit (cm)				
21 F_1 hybrids	--	-44.03 to -1.75	--	Lal *et al*. (1974)
15 F_1 hybrids	-18.15 to 6.66	-33.79 to 0.06	--	Bhutani *et al*. (1980)
4 F_1 hybrids	--	-32.43 to 15.57	--	Dhankhar *et al*. (1980)
11 Parents and 11 F_1 hybrids	--	-56.88 to -7.68	-39.10 to -2.57	Ram *et al*. (1981)
22 F_1 hybrids	5.26 to 199.40	38.10 to 177.37	--	Chadha and Sidhu (1982)
15 F_1 hybrids	--	0.05 to 15.44	--	Patil and Shinde (1984)
7 x 7 Diallel (Excluding reciprocals)	-19.22 to 17.42	-33.25 to 13.65	-51.30 to -7.00	Patel (1984)
15 F_1 hybrids	--	10.44 to 50.00	--	Sidhu and Chadha (1985)
12 Parents and 30 F_1 hybrids	--	9.70 to 11.20	--	Dixit and Gautam (1987)
18 F_1 hybrids	-27.79 to 32.78	-51.12 to 11.88	--	Prakash *et al*. (1993)
6 x 6 Diallel (Including reciprocals)	--	-52.03 to 17.93	--	Patel (1994)
55 F_1 hybrids	--	0.00 to 58.41	--	Mankar *et al*. (1995)
10 x 10 Diallel (Excluding reciprocals)	-21.5 to 27.2	-26.90 to 15.70	-38.70 to 0.90	Ingale and Patil (1996)
7 x 5 Line x Tester	--	-31.96 to 12.90	-17.53 to 29.22	Kaur (1998)

60 F_1 hybrids	-39.31 to 21.97	--	-43.60 to 8.49	Patil (1998)
12 F_1 hybrids	-38.8 to 48.6	-40.2 to 46.6	-43.60 to 8.49	Kumar *et al.* (1999)
30 F_1 hybrids	-13.13 to 26.02	--	-5.93 to 28.66	Bulgundi (2000)
8 x 8 Diallel (Excluding reciprocals)	--	-27.61 to 18.48	-16.69 to 41.00	Patel (2003)
4 x 4 Diallel	-19.31 to 8.07	-36.45 to 5.49	--	Das and Barua (2001)
28 F_1 hybrids	-14.97 to 23.91	-16.90 to 22.48	-13.14 to 13.58	Mallikarjun (2002)
3 x 14 Line x Tester	-30.15 to 38.16	-46.63 to 32.54	--	Indiresh and Kulkarni (2002)
28 F_1 hybrids	--	7.91	--	Harshavardhan *et al.* (2003)
22 F_1 hybrids	--	--	-1.7 to 96.8	Pratibha *et al.* (2004)
36 F_1 hybrids	-33.45 to 30.31	-40.50 to 11.07	--	Singh *et al.* (2004)
24 F_1 hybrids	-17.05 to 12.28	-24.37 to 1.98	-0.25 to 60.0	Shafeeq (2005)
27 F_1 hybrids	-23.89 to 17.68	-35.29 to 9.73	-23.89 to 17.68	Singh and Maurya (2005)
10 x 10 Diallel	--	-29.61 to 25.51	-33.69 to 10.50	Suneetha and Kathiria (2006)
10 x 10 Diallel	36.22	33.26	--	Bisht *et al.* (2009)
8 x 3 Line x Tester	--	-22.12 to -6.79	--	Shanmugapriya *et al.* (2009)
6 x 6 Diallel	--	-56.82 to 24.14	-65.33 to 22.11	Chowdhury *et al.* (2010)
28 F_1 Hybrids	--	--	-22.53 to 30.33	Nalini *et al.* (2011)
8 x 6 Line x Tester	--	50.96	--	Sao and Mehta (2010)
40 F_1 Hybrids	-22.47 to 35.65	-37.34 to 23.13	-24.79 to 24.31	Rameshkumar *et al.* (2012)
40 F_1 Hybrids	--	-42.35 to 44.83	--	Singh *et al.* (2012)
20 F_1 Hybrids	--	--	-45.34 to 9.83	Ajjappalavara *et al.* (2013)
12 F_1 Hybrids	-2.71 to 0.96	--	--	Al-Hubaity and Teli (2013)
24 F_1 Hybrids	21.83 to 37.19	-8.46 to 72.89	23.67 to 28.74	Bhushan *et al.* (2013)
8 x 8 Diallel (Excluding reciprocals)	-15.39 to 34.58	-32.16 to 28.83	-34.16 to 26.05	Makani (2013)
16 F_1 Hybrids	--	-69.91 to147.7	-64.95 to 71.13	Leena *et al.* (2013)
5 x 4 Line x Tester	--	--	-30.78 to 13.17	Reddy and Patel (2014)
28 F1 Hybrids	-39.51 to 26.66	-46.87 to 12.06	-47.91 to 9.87	Rajasekhar (2014)
7 x 3 Line x Tester	-15.95 to 33.10	-21.95 to 30.13	4.25 to 79.72	Sivakumar (2015)

Fruit weight (g)				
10 F_1 hybrids	-66.30 to 494.26	--	--	Peter and Singh (1974)
7 x 7 Diallel	71.11	0.00 to 63.83	--	Mital *et al*. (1976)
6 x 6 Diallel (Excluding reciprocals)	-32.00 to 75.00	-61.30 to 66.60	--	Vijay and Nath (1978)
15 F_1 hybrids	-25.71 to 11.42	-36.25 to 0.06	--	Bhutani *et al*. (1980)
11 Parents and 11 F_1 hybrids	--	-27.27 to -4.54	-27.27 to 40.00	Ram *et al*. (1981)
22 F_1 hybrids	4.79 to 135.10	0.32 to 125.0	--	Chadha and Sidhu (1982)
7 x 7 Diallel (Excluding reciprocals)	-27.09 to 38.92	-37.19 to 19.34	-62.19 to -0.36	Patel (1984)
40 F_1 hybrids	--	44.84	--	Dahiya *et al*. (1984)
15 F_1 hybrids	--	12.09 to 58.96	--	Patil and Shinde (1984)
15 F_1 hybrids	31.28 to 82.91	7.42 to 45.71	--	Sidhu and Chadha (1985)
6 x 6 Diallel (Excluding reciprocals)	--	10.94 to 16.32	--	Verma *et al*. (1986)
12 Parents and 30 F_1 hybrids	--	6.70 to 46.40	--	Dixit and Gautam (1987)
21 F_1 hybrids	--	-48.11 to 25.57	--	Chadha *et al*. (1990)
14 F_1 hybrids	--	-45.02 to 23.61	-59.65 to 63.90	Sawant *et al*. (1991)
18 F_1 hybrids	-71.44 to 32.99	-82.42 to 24.37	--	Prakash *et al*. (1993)
6 x 6 Diallel (Including reciprocals)	-14.17 to 86.80	-42.86 to 59.89	--	Patel (1994)
55 F_1 hybrids	--	0.77 to 41.36	--	Mankar *et al*. (1995)
10 x 10 Diallel (Excluding reciprocals)	-19.8 to 62.6	-36.20 to 34.40	-52.90 to 22.20	Ingale and Patil (1996)
7 x 5 Line x Tester	--	-57.80 to 15.55	-29.36 to 51.42	Kaur (1998)
60 F_1 hybrids	-26.50 to 40.77	--	-34.95 to 43.52	Patil (1998)
12 F_1 hybrids	-36.2 to 17.0	-40.5 to 2.2	-34.95 to 43.52	Kumar *et al*., (1999)
30 F_1 hybrids	-13.47 to 60.43	--	-41.50 to 14.07	Bulgundi (2000)
4 x 4 Diallel	-17.88 to 25.29	-32.45 to 11.07	--	Das and Barua (2001)
28 F_1 hybrids	-35.39 to 75.75	--	-19.81 to 88.25	Mallikarjun (2002)
3 x 14 Line x Tester	-64.34 to 44.53	-70.86 to 0.90	--	Indiresh and Kulkarni (2002)
8 x 8 Diallel (Excluding reciprocals)	--	-62.12 to 64.32	-43.54 to 110.97	Patel (2003)

28 F_1 hybrids	--	20.69	--	Harshavardhan *et al.* (2003)
36 F_1 hybrids	-58.06 to 160.87	-61.54 to 67.44	--	Singh *et al.* (2004)
24 F_1 hybrids	-17.18 to 96.21	-20.18 to 69.22	-11.84 to 137.73	Shafeeq (2005)
5 F_1 Hybrids	-8.82 to 27.75	-24.06 to 5.37	-32.79 to -9.55	Prabhu *et al.* (2005)
45 F_1 Hybrids	--	-10.86 to 54.77	-19.62 to 95.84	Baig *et al.* (2005)
7 x 3 Line x Tester	--	0.06 to 53.87	--	Kamal *et al.* (2006)
25 F_1 Hybrids	-44.34 to 16.68	--	-43.46 to -19.95	Prakash *et al.* (2008)
10 x 10 Diallel	59.36	46.95	--	Bisht *et al.* (2009)
8 x 3 Line x Tester	--	-27.47 to 3.53	--	Shanmugapriya *et al.* (2009)
6 x 6 Diallel	--	-49.56 to 10.09	-57.1 to 72.5	Chowdhury *et al.* (2010)
8 x 6 Line x Tester	--	83.27	--	Sao and Mehta (2010)
28 F_1 hybrids	--	--	-22.53 to 30.33	Nalini *et al.* (2011)
8 x 8 Diallel (Excluding reciprocals)	-64.71 to 46.79	-75.97 to 32.24	-58.47 to 81.73	Makani (2013)
5 x 4 Line x Tester	--	--	-36.69 to 17.53	Reddy and Patel (2014)
28 F1 Hybrids	-16.44 to 48.70	-33.52 to 43.51	-43.02 to 7.82	Rajasekhar (2014)
7 x 3 Line x Tester	-27.51 to 21.48	-34.59 to 3.50	4.25 to 79.72	Sivakumar (2015)
Fruit yield per plant (g)				
7 x 7 Diallel	-36.92 to 112.37	--	--	Lal *et al.* (1974)
5 x5 Diallel	-66.30 to 494.26	-79.01 to 357.8	--	Peter and Singh (1974)
7 x 7 Diallel	92.5	48.64 to 90.21	--	Mital *et al.* (1976)
15 x 4 Line x Tester	0.00 to 9.26	59.36 to 81.95	--	Singh *et al.* (1978)
6 x 6 Diallel (Excluding reciprocals)	-0.2 to 161.5	-12.00 to 156.90	--	Vijay and Nath (1978)
72 F_1 hybrids	-32.23 to 97.13	-42.36 to 74.03	--	Dharmegowda *et al.* (1979)
15 F_1 hybrids	-56.16 to 66.29	-59.66 to 39.36	0.25 to 12.02	Bhutani *et al.* (1980)
4 F_1 hybrids	--	-29.03 to 62.20	--	Dhankhar *et al.* (1980)
11 Parents and 11 F_1 hybrids	--	-43.69 to -16.90	-29.54 to 89.36	Ram *et al.* (1981)
15 Parents and 22 F_1 hybrids	0.00 to 172.09	6.50 to 142.19	6.50 to 83.58	Chadha and Sidhu (1982)

7 x 7 Diallel (Excluding reciprocals)	23.38 to 66.93	-23.86 to 66.91	-35.81 to -13.70	Patel (1984)
15 F_1 hybrids	--	2.04 to 60.00	--	Patil and Shinde (1984)
40 F_1 hybrids	--	83.16	--	Dahiya *et al.* (1984)
3 x 3 Line x Tester	62.90 to 126	--	32.90 to 99.19	Rajput *et al.* (1984)
15 parents and 15 F_1 hybrids	8.63 to 79.27	7.42 to 45.71	--	Sidhu and Chadha (1985)
6 x 6 Diallel (Excluding reciprocals)	--	6.70 to 12.98	--	Verma *et al.* (1986)
12 Parents and 30 F_1 hybrids	--	0.10 to 90.00	0.20 to 47.70	Dixit and Gautam (1987)
9 x 9 Diallel (Excluding reciprocals)	1.00 to 1.51	1.28 to 1.77	--	Chadha and Hegde (1988)
4 Varieties along with 105 crosses	164.56	-64.00 to 164.56	--	Kalloo *et al.* (1989)
33 F_1 hybrids	0.00 to 56.41	--	1.80 to 56.49	Singh and Kalda (1989)
21 F_1 hybrids	--	-10.74 to 42.93	-7.30 to 31.75	Chadha *et al.* (1990)
14 F_1 hybrids	--	-31.33 to 59.43	--	Sawant *et al.* (1991)
18 F_1 hybrids	-43.45 to 48.0	49.89 to 41.59	--	Prakash *et al.* (1993)
10 F_1 hybrids	--	60.25 to 136.82	--	Mandal *et al.* (1994)
6 x 6 Diallel (Including reciprocals)	-14.96 to 98.56	-35.56 to 90. 80	--	Patel (1994)
55 F_1 hybrids	--	2.29 to 89.9	--	Mankar *et al.* (1995)
10 x 10 Diallel (Excluding reciprocals)	-17.5 to 82.7	-28.20 to 72.30	-29.90 to 72.30	Ingale and Patil (1996)
7 x 5 Line x Tester	--	-14.83 to 151.50	-47.61 to 50.95	Kaur (1998)
60 F_1 hybrids	--	--	-35.78 to 78.35	Patil (1998)
12 F_1 hybrids	-30.2 to 69.4	-42.9 to 66.3	--	Kumar *et al.* (1999)
30 F_1 hybrids	-37.81 to 156.58	--	-41.62 to 59.96	Bulgundi (2000)
36 F_1 hybrids	--	-70.34 to 90.63	--	Chadha *et al.* (2001)
4 x 4 Diallel	9.19 to 63.54	-70.70 to 54.95	--	Das and Barua (2001)
3 x 14 Line x Tester	-60.25 to 28.07	-73.23 to 23.02	--	Indiresh and Kulkarni (2002)
8 x 8 Diallel (Excluding reciprocals)	--	-37.56 to 37.34	-27.39 to 52.02	Patel (2003)
28 F_1 hybrids	-50.58 to 64.42	-53.17 to 55.92	-58.94 to 59.74	Mallikarjun (2002)
28 F_1 hybrids	--	36.58	--	Harshavardhan *et al.* (2003)

36 F_1 hybrids	-72.16 to 333.75	-68.80 to 275.22	--	Singh *et al.* (2004)
24 F_1 hybrids	-37.99 to 162.89	-41.94 to 153.01	-46.17 to 75.87	Shafeeq (2005)
7 x 3 Line x Tester	--	1.00 to 83.92	--	Kamal *et al.* (2006)
54 F_1 hybrids	-3.51 to 80.72	-30.36 to 70.98	-32.52 to 66.52	Bugali *et al.* (2007)
10 x 10 Diallel	--	-50.54 to 114.43	-68.07 to 38.77	Suneetha and Kathiria (2006)
25 F_1 hybrids	--	-51.40 to 50.66	-49.42 to 27.74	Timmapur *et al.* (2008)
28 F_1 hybrids	-54.01 to 50.66	--	-49.42 to 27.74	Prakash *et al.* (2008)
25 F_1 hybrids	-50.54 to 114.4	--	-68.07 to 30.77	Suneetha *et al.* (2008)
10 x 10 Diallel	132.34	99.97	--	Bisht *et al.* (2009)
6 x 6 Diallel	--	-34.62 to 74.89	-58.06 to 72.60	Chowdhury *et al.* (2010)
8 x 6 Line x Tester	--	115.84	--	Sao and Mehta (2010)
28 F_1 hybrids	--	--	-33.97 to 31.07	Nalini *et al.* (2011)
48 F1 Hybrids	-39.55 to 162.98	-47.59 to 139.12	-46.03 to 127.41	Abhinav and Mehta (2011)
12 F1 Hybrids	-47.20 to 84.93	-61.33 to 60.71	-58.89 to 31.02	Murthy *et al.* (2011)
40 F1 Hybrids	-42.25 to 75.36	-47.25 to 59.04	-56.36 to 34.07	Rameshkumar *et al.* (2012)
8 x 8 Diallel (Excluding reciprocals)	-36.34 to 136.39	-54.19 to 125.78	-57.38 to 50.41	Makani (2013)
20 F1 Hybrids	--	--	-65.81 to 3.76	Ajjappalavara *et al.* (2013)
12 F1 Hybrids	-0.61 to 0.54	--	--	Al-Hubaity and Teli (2013)
24 F1 Hybrids	71.41 to 72. 63	43.40 to 66.89	79.75 to 116.84	Bhushan and Singh (2013)
5 x 4 Line x Tester	--	--	-12.69 to 103.59	Reddy and Patel (2014)
28 F1 Hybrids	-46.07 to 133.55	-54.37 to 97.61	-54.27 to 67.12	Rajasekhar (2014)
7 x 3 Line x Tester	-14.32 to 108.11	-17.84 to 79.85	-3.45 to 126.05	Sivakumar (2015)

Table 2. Combining ability variances and effects for different traits in brinjal as given by different authors

Types of materials studied	Combining ability variances and gene action	Authors
Plant height (cm)		
36 F_1 hybrids (Diallel)	Additive and non-additive variances present	Dharmegowda (1976)
21 F_1 hybrids (Diallel)	Predominance of additive and non-additive gene actions	Singh *et al*. (1988)
45 F_1 hybrids (Diallel)	Additive variance predominant	Srivastava and Bajpai (1977)
6 x 6 Diallel (Excluding reciprocals)	Additive and non-additive variances present	Bhutani *et al*. (1980)
15 x 4 Line x Tester	Predominance of non-additive gene effect	Singh *et al*. (1981)
21 F_1 hybrids	Additive variance predominant	Patel (1984)
5 x 3 Line x Tester	Predominance of non-additive genetic variance	Shinde and Patil (1984)
21 F_1 hybrids	Additive variance predominant	Patil and Shinde (1984)
6 x 6 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene effects	Verma (1986)
6 x 6 Diallel (Excluding reciprocals)	Predominance of additive variance	Narendrakumar and Hari Har Ram (1987a)
5 x 3 Line x Tester	Additive variance predominant	Narendrakumar and Hari Har Ram (1987b)
12 x 12 Diallel (Excluding reciprocals)	Predominance of non-additive variance	Singh and Mital (1988)
7 x 7 Diallel (Excluding reciprocals)	Predominance of additive gene action	Patil and Shinde (1989)
36 F_1 hybrids	Significant *gca* and *sca* effects	Chadha and Hegde (1989)
28 F_1 hybrids	Predominance of additive gene action	Mishra and Mishra (1990b)
6 x 6 Diallel (Excluding reciprocals)	Additive gene action present	Singh *et al*. (1991)
7 x 2 Line x Tester	Significant *GCA* and *SCA* variance	Sawant *et al*. (1991)
6 x 6 Diallel (Including reciprocals)	Additive gene action predominant	Patel (1994)
7 x 7 Diallel (Excluding reciprocals)	Non- additive gene action predominant	Patel *et al*. (1994)
2 x 9 Line x Tester	Significant *gca* effects	Prakash *et al*. (1994)

28 F_1 hybrids	Both additive and non-additive gene actions were observed	Padmanabham and Jagadish (1996)
60 F_1 hybrids	Significant *GCA* and *SCA* variance	Patil (1998)
10 x 4 Line x Tester	Presence of both additive and non-additive gene actions	Varshney *et al.*(1999)
28 F_1 hybrids	Predominance of non-additive gene action	Chaudhary and Pathania (2000)
5 x 5 Diallel	Additive x Additive	Chezhiah *et al*. (2000)
4 x 4 Diallel	Important of both additive and non-additive gene actions	Das and Barua (2001)
10 x 10 Diallel (Excluding reciprocals)	Important of both additive and non-additive gene effects	Baig and Patil (2002)
8 x 8 Half diallel	Predominance of non-additive gene action	Patel (2003)
10 x 10 Half diallel	Important of both additive and non-additive gene effects	Rao (2003)
12 x 3 Line x Tester	Non-additive gene action	Singh and Singh (2004)
12 x 4 Line x Tester	Preponderance of additive gene action	Vadodaria *et al*. (2004)
6 x 4 Line x Tester	Significant *gca* effects	Shafeeq (2005)
8 x 8 Half diallel	Important of both additive and non-additive gene effects	Bendale *et al*. (2005)
45 F_1 hybrids	Predominance of additive gene action	Aswani and Khandelwal (2005)
45 F_1 hybrids	Importance of both additive and non-additive gene action	Bisht *et al*. (2006)
10 x 10 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene actions	Suneetha *et al*. (2008)
8 x 3 Line x Tester	Preponderance of non-additive gene action	Shanmugapriya *et al*. (2009)
8 x 6 Line x Tester	Important of both additive and non-additive components	Sao and Mehta (2010)
7 x 7 Diallel (Excluding reciprocals)	Preponderance of additive and non-additive gene action	Rai and Asati (2011)

8 x 8 Diallel (Excluding reciprocals)	Preponderance of non-additive gene action	Sane *et al.* (2011)
7 x 3 Line x Tester	Predominance of additive gene action	Pachiyappan *et al.* (2012)
4 x 4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Non-additive gene action	Sivakumar (2015)
	Primary branches per plant	
10 F_1 hybrids	Significant *sca* effects	Singh and Kumar (1978)
28 F_1 hybrids	Significant *GCA* and *SCA* variance	Mishra and Mishra (1990b)
28 F_1 hybrids	Significant *gca* and *sca* effects	Mishra and Mishra (1990)
2 x Line x Tester	Significant *sca* effects	Prakash *et al.* (1994)
8 x 8 Diallel (Excluding reciprocals)	Significant *GCA* and *SCA* variance	Padmanabham and Jagadish (1996)
8 x 8 Diallel (Excluding reciprocals)	Significant *gca* and *sca* effects	Padmanabham and Jagadish (1996)
60 F_1 hybrids	Significant *GCA* and *SCA* variance	Patil (1998)
60 F_1 hybrids	Significant *gca* and *sca* effects	Patil (1998)
10 x 4 Line x Tester	Significant *GCA* variance	Varshney *et al.* (1999)
10 x 4 Line x Tester	Significant *gca* and *sca* effects	Varshney *et al.* (1999)
28 F_1 hybrids	Significant *gca* and *sca* effects	Mallikarjun (2002)
7x 7 Diallel (Excluding reciprocals)	Preponderance of additive and non-additive gene action	Rai and Asati (2011)
7 x 3 Line x Tester	Preponderance of non-additive gene action	Pachiyappan *et al.* (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Non-additive gene action	Sivakumar (2015)
	Days to first flower	
36 F_1 hybrids (Diallel)	Significant *GCA* and *SCA* variance	Dharmegowda (1976)

6 x 6 Diallel (Excluding reciprocals)	Significant *GCA* and *SCA* variance	Vijay *et al*. (1978)
6 x 6 Diallel (Excluding reciprocals)	Significant *GCA* and *SCA* variance	Bhutani *et al*. (1980)
36 F_1 hybrids	Significant *GCA* and *SCA* variance	Chadha and Hegde (1989)
28 F_1 hybrids	Significant *GCA* and *SCA* variance	Mishra and Mishra (1990b)
7 x 2 Line x Tester	Significant *GCA* and *SCA* variance	Sawant *et al*. (1991)
2 x 9 Line x Tester	Significant *GCA* and *SCA* effects	Prakash *et al*. (1994)
8 x 8 Diallel (Excluding reciprocals)	Significant *GCA* and *SCA* variance	Padmanabham and Jagadish (1996)
60 F_1 hybrids	Significant *GCA* and *SCA* variance	Patil (1998)
10 x 2 Line x Tester	Presence of both additive and non-additive gene actions	Varshney *et al*. (1999)
30 F_1 hybrids	Significant *GCA* and *SCA* variance	Bulgundi (2000)
8 x 8 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Chaudhary and Pathania (2000)
10 x 10 Diallel (Excluding reciprocals)	Non-additive gene action was predominant	Baig and Patil (2002)
12 x 3 Line x Tester	Predominance of additive gene action	Singh and Singh (2004)
12 x 4 Line x Tester	Non-additive gene action was predominant	Vadodaria *et al*. (2004)
8 x 3 Line x Tester	Preponderance of non-additive gene action	Shanmugapriya *et al*. (2009)
8 x 6 Line x Tester	Important of both additive and non-additive components	Sao and Mehta (2010)
8 × 8 Half Diallel	Significant *GCA* and *SCA* effects	Nalini *et al*. (2011)
7 x 3 Line x Tester	Predominance of additive gene action	Pachiyappan *et al*. (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
	Days to fist harvest	
7 x 7 Line x Tester	Preponderance of additive gene action	Lal *et al*. (1974)
36 F_1 hybrids (Diallel)	Preponderance of non-additive gene action	Dharmegowda (1976)
6 x 6 Diallel	Both additive and non-additive gene actions	Srivastava and Bajpai (1977)
6 x 6 Diallel	Both additive and non-additive gene actions	Vijay and Nath (1978)
6 x 6 Diallel	Non-additive gene action	Bhutani *et al*. (1980)

6 x 6 Diallel	Over dominance	Sidhu *et al*. (1980)
15 x 4 Line x Tester	Preponderance of non-additive gene action	Singh *et al*. (1981)
5 x 3 Line x Tester	Preponderance of non-additive gene action	Shinde and Patil (1984)
10 x 4 Line x Tester	Both additive and non-additive gene actions	Dahiya *et al*. (1985)
6 x 6 Diallel (Excluding reciprocals)	Importance of both additive and non-additive genetic variances	Verma (1986)
9 x 9 Diallel	Preponderance of additive gene action	Chadha and Hegde (1987)
12 x 3 Line x Tester	Preponderance of non-additive gene action	Singh and Mital (1988)
36 F_1 hybrids	Preponderance of additive gene action	Chadha and Hegde (1989)
21 F_1 hybrids	Both additive and non-additive gene actions	Patil and Shinde (1989)
18 x 3 Line x Tester	Both additive and non-additive gene actions	Randhawa *et al*. (1991)
7 x 2 Line x Tester	Preponderance of non-additive gene action	Sawant *et al*. (1991)
6 x 6 Diallel (Excluding reciprocals)	Only additive gene effect was important	Singh *et al*. (1991)
6 x 6 Diallel	Only additive gene effect was important	Ramar and Pappaiah (1993)
6 x 6 Full diallel	Only additive gene effect was important	Patel (1994)
8 x 8 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Chaudhary and Pathania (2000)
8 x 8 Half diallel	Predominance of non-additive gene action	Patel (2003)
10 x 10 Half diallel	Additive and non-additive gene effects were important	Rao (2003)
12 x 3 Line x tester	Predominance of additive gene action	Singh and Singh (2004)
12 x 4 Line x tester	Predominance of additive gene action	Vadodaria *et al*. (2004)
8 x 8 Half diallel	Additive and non-additive gene effects were important	Bendale *et al*. (2005)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene action	Aswani and Khandelwal (2005)
10 x 10 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene actions	Suneetha *et al*. (2008)
8 x 8 Diallel (Excluding reciprocals)	Preponderance of non-additive gene action	Sane *et al*. (2011)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Non-additive gene action	Sivakumar (2015)

Days to last harvest		
7 x 3 Line x Tester	Predominance of additive gene action	Sivakumar (2015)
Number of fruits per plant		
10 Line x Tester	Significant *gca* and *sca* effects	Peter and Singh (1974)
36 F_1 hybrids (Diallel)	Additive and non-additive variances present	Dharmegowda (1976)
45 F_1 hybrids (Diallel)	Higher magnitude of additive variance	Srivastava and Bajpai (1977)
6 x 6 Diallel (Including reciprocals)	Additive and non-additive variances significant	Vijay *et al*. (1978)
6 x 6 Diallel (Excluding reciprocals)	Presence of additive and non-additive gene actions	Bhutani *et al*. (1980)
15 x 4 Line x Tester	Predominance of non-additive gene effect	Singh *et al*. (1981)
21 F_1 hybrids	Additive variance predominant	Patel (1984)
5 x 3 Line x Tester	Predominance of non-additive genetic effect	Shinde and Patil (1984)
10 x 4 Line x Tester	Additive variance present	Dahiya *et al*. (1985)
7 x 7 Diallel (Excluding reciprocals)	Additive variance predominant	Patil and Shinde (1984)
6 x 6 Diallel (Excluding reciprocals)	Significant additive as well as non-additive variances	Verma (1986)
6 x 6 Diallel (Excluding reciprocals)	Additive variance predominant	Narendrakumar and Hari Har Ram (1987a)
5 x 3 Line x Tester	Predominance of additive genetic variance	Narendrakumar and Hari Har Ram (1987b)
5 x 5 Diallel	Significant additive and non-additive gene actions	Singh and Kumar (1978)
12 x 12 Diallel (Excluding reciprocals)	Additive variance predominant	Singh and Mital (1988)
21 F_1 hybrids	Additive variance predominant	Patil and Shinde (1989)
36 F_1 hybrids	Significant *SCA* variance and *GCA* variance	Chadha and Hegde (1989)
28 F_1 hybrids	Predominance of additive gene action	Mishra and Mishra (1990b)
7 x 2 Line x Tester	Significant *SCA* variance and *GCA* variance	Sawant *et al*. (1991)
6 x 6 Diallel (Including reciprocals)	Predominance of additive gene action	Patel (1994)
7 x 7 Diallel (Excluding reciprocals)	Additive gene effect predominant	Patel *et al*. (1994)
8 x 8 Diallel (Excluding reciprocals)	Both additive and non-additive gene actions were observed	Padmanabham and Jagadish (1996)

60 F_1 hybrids	Significant *GCA* and *SCA* variance	Patil (1998)
7 x 5 Line x Tester	Presence of non-additive gene action	Kaur (1998)
10 x 4 Line x Tester	Presence of both additive and non-additive gene actions	Varshney *et al*. (1999)
8 x 8 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Chaudhary and Pathania (2000)
5 x 5 Diallel	Additive x Additive	Chezhiah *et al*. (2000)
4 x 4 Diallel	Important of both additive and non-additive gene actions	Das and Barua (2001)
10 x 10 Diallel (Excluding reciprocals)	Important of both additive and non-additive gene effects	Baig and Patil (2002)
10 x 10 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Rao (2003)
8 x 8 Diallel	Both additive and non-additive gene actions	Patel (2003)
Six generations in six crosses	Additive as well as non-additive gene effects	Patil *et al*. (2003)
12 x 3 Line x Tester	Predominance of additive gene action	Singh and Singh (2004)
12 x 4 Line x Tester	Non-additive gene action was preponderant	Vadodaria *et al*. (2004)
6 x 4 Line x Tester	Significant *gca* and *sca* effects	Shafeeq (2005)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene action	Aswani and Khandelwal (2005)
8 x 3 Line x Tester	Predominance of additive gene action	Kamalakkannan *et al*. (2007)
10 x 10 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene action	Suneetha *et al*. (2008)
8 x 3 Line x Tester	Preponderance of non-additive gene action	Shanmugapriya *et al*. (2009)
8 × 6 L × T	Significant *gca* and *sca* effects	Abhinav and Nandan (2010)
8 x 6 Line x Tester	Importance of both additive as well as non-additive component	Sao and Mehta (2010)
7 x 7 Diallel (Excluding reciprocals)	Preponderance of additive and non-additive gene action	Rai and Asati (2011)
8 x 8 Diallel (Excluding reciprocals)	Preponderance of non-additive gene action	Sane *et al*. (2011)
7 x 3 Line x Tester	Preponderance of non-additive gene action	Pachiyappan *et al*. (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)

28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Non-additive gene action	Sivakumar (2015)
Length of fruits (cm)		
45 F_1 hybrids (Diallel)	Additive variance predominant	Srivastava and Bajpai (1977)
6 x 6 Diallel (Excluding reciprocals)	Additive and non-additive gene actions	Bhutani *et al*. (1980)
15 x 4 Line x Tester	Predominance of non-additive gene effect	Singh *et al.* (1981)
21 F_1 hybrids	Additive variance predominant	Patel (1984)
5 x 3 Line x Tester	Predominance of additive genetic variance	Shinde and Patil (1984)
10 x 4 Line x Tester	Additive variance present	Dahiya *et al.* (1985)
7 x 7 Diallel (Excluding reciprocals)	Additive variance predominant	Patil and Shinde (1985)
6 x 6 Diallel (Excluding reciprocals)	Additive variance present	Verma (1986)
6 x 6 Diallel (Excluding reciprocals)	Additive variance predominant	Narendrakumar and Hari Har Ram (1987a)
5 x 3 Line x Tester	Additive variance predominant	Narendrakumar and Hari Har Ram (1987b)
5 x 5 Diallel (Excluding reciprocals)	Significant of additive and non-additive genetic variances	Singh and Kumar (1978)
12 x 12 Diallel (Excluding reciprocals)	Additive variance predominant	Singh and Mital (1988)
28 F_1 hybrids	Predominance of additive gene action	Mishra and Mishra (1990b)
6 x 6 Diallel (Excluding reciprocals)	Only additive gene effect was important	Singh *et al.* (1991)
6 x 6 Diallel (Including reciprocals)	Predominance of non-additive gene action	Patel (1994)
7 x 7 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Patel *et al.* (1994)
7 x 5 Line x Tester	Predominance of non-additive gene action	Kaur (1998)
10 x 4 Line x Tester	Presence of both additive and non-additive gene actions	Varshney *et al*. (1999)
8 x 8 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Chaudhary and Pathania (2000)
4 x 4 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene actions	Das and Barua (2001)
10 x 10 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Rao (2003)

8 x 8 Half diallel	Both additive and non-additive gene action	Patel (2003)
12 x 3 Line x Tester	Predominance of additive gene action	Singh and Singh (2004)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene action	Aswani and Khandelwal (2005)
10 x 10 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene action	Bisht *et al.* (2006)
8 x 3 Line x tester	Preponderance of non-additive gene action	Shanmugapriya *et al.* (2009)
7 x 7 Diallel (Excluding reciprocals)	Preponderance of additive gene action	Rai and Asati (2011)
7 x 3 Line x Tester	Predominance of additive gene action	Pachiyappan *et al.* (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Predominance of additive gene action	Sivakumar (2015)
	Girth of fruits (cm)	
6 x 6 Diallel (Excluding reciprocals)	Additive and non-additive variances present	Bhutani *et al*. (1980)
15 x 4 Line x Tester	Predominance of non-additive gene effect	Singh *et al*. (1981)
21 F_1 hybrids	Additive variance predominant	Patel (1984)
5 x 3 Line x Tester	Predominance of additive genetic variance	Shinde and Patil (1984)
10 x 4 Line x Tester	Additive variance predominant	Dahiya *et al*. (1985)
7 x 7 Diallel (Excluding reciprocals)	Predominance of additive variance	Patil and Shinde (1985)
6 x 6 Diallel (Excluding reciprocals	Additive variance predominant	Narendrakumar and Hari Har Ram (1987a)
5 x 3 Line x Tester	Predominance of additive genetic variance	Narendrakumar and Hari Har Ram (1987b)
9 x 9 Diallel (Excluding reciprocals)	Significant *GCA* and *SCA* variance	Chadha and Hegde (1989)
28 F_1 hybrids	Predominance of additive gene action	Mishra and Mishra (1990b)
6 x 6 Diallel (Excluding reciprocals)	Preponderance of additive gene effect	Singh *et al.* (1991)
6 x 6 Diallel (Including reciprocals)	Predominance of additive gene action	Patel (1994)
7 x 7 Diallel (Excluding reciprocals)	Non- additive gene effect was of greater magnitude	Patel *et al.* (1994)
8 x 8 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene actions	Padmanabham and Jagadish (1996)

60 F_1 hybrids	Significant *GCA* and *SCA* variance	Patil (1998)
7 x 5 Line x Tester	Predominance of non-additive gene action	Kaur (1998)
10 x 4 Line x Tester	Presence of both additive and non-additive gene actions	Varshney *et al*. (1999)
8 x 8 Diallel (Excluding reciprocals)	Both additive and non-additive gene action was important	Chaudhary and Pathania (2000)
4 x 4 Diallel	Presence of additive gene action	Das and Barua (2001)
10 x 10 Diallel (Excluding reciprocals)	Presence of non-additive gene action	Baig and Patil (2002)
10 x 10 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Rao (2003)
8 x 8 Half diallel	Both additive and non-additive gene action was important	Patel (2003)
12 x 3 Line x Tester	Predominance of additive gene action	Singh and Singh (2004)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene action	Aswani and Khandelwal (2005)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene effect	Bisht *et al*. (2006)
8 x 3 Line x Tester	Preponderance of non-additive gene action	Shanmugapriya *et al*. (2009)
7 x 3 Line x Tester	Predominance of additive gene action	Pachiyappan *et al.* (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Predominance of additive gene action	Sivakumar (2015)
Fruit weight (g)		
7 x 7 Diallel	Significant additive and non-additive variances	Mital *et al.* (1976)
6 x 6 Diallel (Including reciprocals)	Significant additive and non-additive variances	Vijay *et al.* (1978)
6 x 6 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene actions	Bhutani *et al*. (1980)
15 x 4 Line x Tester	Predominance of non-additive gene effect	Singh *et al*. (1981)
21 F_1 hybrids	Additive variance predominant	Patel (1984)
5 x 3 Line x Tester	Predominance of non-additive genetic variance	Shinde and Patil (1984)
7 x 7 Diallel (Excluding reciprocals)	Predominance of additive gene action	Patil and Shinde (1985)

6 x 6 Diallel (Excluding reciprocals	Additive variance predominant	Narendrakumar and Hari Har Ram (1987a)
5 x 3 Line x Tester	Additive variance predominant	Narendrakumar and Hari Har Ram (1987b)
28 F_1 hybrids	Predominance of additive gene action	Mishra and Mishra (1990b)
6 x 6 Diallel (Excluding reciprocals)	Additive variance present	Singh *et al.* (1991)
6 x 6 Diallel (Including reciprocals)	Predominance of additive gene action	Patel (1994)
7 x 7 Diallel (Excluding reciprocals)	Predominance of non- additive gene action	Patel *et al.* (1994)
8 x 8 Diallel (Excluding reciprocals)	Presence of both additive and non-additive gene actions	Padmanabham and Jagadish (1996)
60 F_1 hybrids	Significant *GCA* and *SCA* variance	Patil (1998)
7 x 5 Line x Tester	Presence of non-additive gene action	Kaur (1998)
Generation mean analysis (Six generations)	Predominance of additive and non-additive gene effects	Patil *et al*. (2000)
8 x 8 Diallel (Excluding reciprocals)	Additive action was important	Chaudhary and Pathania (2000)
5 x 5 Diallel	Additive x Additive	Chezhiah *et al*. (2000)
4 x 4 Diallel	Both additive and non-additive gene effects	Das and Barua (2001)
10 x 10 Diallel (Excluding reciprocals)	Both additive and non-additive gene effects	Baig and Patil (2002)
10 x 10 Diallel (Excluding reciprocals)	Predominance of non-additive gene actions	Rao (2003)
8 x 8 Half diallel	Both additive and non-additive gene action	Patel (2003)
12 x 3 Line x Tester	Predominance of additive gene action	Singh and Singh (2004)
6 x 4 Line x Tester	Significant *gca* and *sca* effects	Shafeeq (2005)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene action	Aswani and Khandelwal (2005)
10 x 10 Diallel (Excluding reciprocals)	Both additive and non-additive gene action	Bisht *et al*. (2006)
10 x 10 Diallel (Excluding reciprocals)	Both additive and non-additive gene actions	Suneetha *et al*. (2008)
8 x 3 Line x Tester	Preponderance of non-additive gene action	Shanmugapriya *et al*. (2009)
7 x 7 Diallel (Excluding reciprocals)	Preponderance of additive and non-additive gene action	Rai and Asati (2011)

7 x 3 Line x Tester	Preponderance of non-additive gene action	Pachiyappan *et al.* (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Predominance of additive gene action	Sivakumar (2015)
	Fruit yield per plant (g)	
10 Line x Tester	Significant *gca* and *sca* effects	Peter and Singh (1974)
36 F_1 hybrids (Diallel)	Additive and non-additive variances present	Dharmegowda (1976)
7 x 7 Diallel	Significant additive and non-additive variances	Mital *et al.* (1976)
45 F_1 hybrids (Diallel)	Additive variance predominant	Srivastava and Bajpai (1977)
6 x 6 Diallel (Including reciprocals)	Significant additive and non-additive variances	Vijay *et al.* (1978)
6 x 6 Diallel (Excluding reciprocals)	Non-additive variance present	Bhutani *et al.* (1980)
15 x 4 Line x Tester	Predominance of non-additive variance	Singh *et al.* (1981)
8 x 8 Diallel (Excluding reciprocals)	Additive variance present	Dixit *et al.* (1982)
21 F_1 hybrids	Additive variance predominant	Patel (1984)
5 x 3 Line x Tester	Both additive and non-additive genetic variances were operative	Shinde and Patil (1984)
10 x 4 Line x Tester	Additive variance present	Dahiya *et al.* (1985)
7 x 7 Diallel (Excluding reciprocals)	Predominance of additive gene action	Patil and Shinde (1984)
6 x 6 Diallel (Excluding reciprocals)	Significant additive and non-additive variances	Verma (1986)
6 x 6 Diallel (Excluding reciprocals)	Non-additive variance predominant	Narendrakumar and Hari Har Ram (1987a)
5 x 3 Line x Tester	Predominance of non-additive variance	Narendrakumar and Hari Har Ram (1987b)
6 x 6 Diallel (Excluding reciprocals)	Significant additive and non-additive gene actions	Rashid *et al.* (1988)
5 x 5 Diallel	Significant additive and non-additive gene actions	Singh and Kumar (1978)
12 x 12 Diallel (Excluding reciprocals)	Non-additive variance predominant	Singh and Mital (1988)
21 F_1 hybrids	Additive variance predominant	Patil and Shinde (1989)
36 F_1 hybrids	Significant *SCA* variance and *GCA* variance	Chadha and Hegde (1989)

28 F_1 hybrids	Predominance of additive gene action	Mishra and Mishra (1990b)
7 x 2 Line x Tester	Significant *GCA* variance and *SCA* variance	Sawant *et al.* (1991)
6 x 6 Diallel (Including reciprocals)	Predominance of additive gene action	Patel (1994)
7 x 7 Diallel (Excluding reciprocals)	Predominant of non-additive gene effect	Patel *et al.* (1994)
8 x 8 Diallel (Excluding reciprocals)	Non-additive gene effect	Padmanabham and Jagadish (1996)
10 x 10 Diallel (Excluding reciprocals)	Predominant of non-additive gene action	Ingale *et al.* (1997)
60 F_1 hybrids	Significant *SCA* variance and *GCA* variance	Patil (1998)
7 x 5 Line x Tester	Predominance of non-additive gene action	Kaur (1998)
10 x 4 Line x Tester	Presence of both additive and non-additive gene actions	Varshney *et al.* (1999)
8 x 8 Diallel (Excluding reciprocals)	Presence of non-additive gene action	Chaudhary and Malhotra (2000)
Generation mean analysis (Six generations)	Predominant of additive and non-additive gene effects	Patil *et al.* (2000)
8 x 8 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Chaudhary and Pathania (2000)
5 x 5 Diallel	Additive x Additive type of interaction	Chezhiah *et al.* (2000)
4 x 4 Diallel	Important of both additive and non-additive gene actions	Das and Barua (2001)
12 parents and 35 hybrids	Over dominance	Kaur *et al.* (2001)
10 x 10 Diallel (Excluding reciprocals)	Important of both additive and non-additive gene effects	Baig and Patil (2002)
10 x 10 Diallel (Excluding reciprocals)	Predominance of non-additive gene action	Rao (2003)
8 x 8 Half diallel	Both additive and non-additive gene actions	Patel (2003)
12 x 3 Line x Tester	Predominance of non-additive gene action	Singh and Singh (2004)
6 x 4 Line x Tester	Significant *gca* and *sca* effects	Shafeeq (2005)
8 x 8 Half diallel	Additive and non-additive	Bendale *et al.* (2005)
10 x 10 Diallel (Excluding reciprocals)	Predominance of additive gene action	Aswani and Khandelwal (2005)
10 x 10 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene action	Bisht *et al.* (2006)
8 x 3 Line x Tester	Predominance of additive gene action	Kamalakkannan *et al.* (2007)

10 x 10 Diallel (Excluding reciprocals)	Importance of both additive and non-additive gene action	Suneetha *et al*. (2008)
12 x 4 Line x Tester	Predominance of non-additive gene action	Vadodaria *et al*. (2008)
8 x 3 Line x Tester	Preponderance of non-additive gene action	Shanmugapriya *et al*. (2009)
8 x 6 Line x Tester	Importance of both additive as well as non-additive component	Sao and Mehta (2010)
7 x 7 Diallel (Excluding reciprocals)	Preponderance of additive and non-additive gene action	Rai and Asati (2011)
8 x 8 Diallel (Excluding reciprocals)	Preponderance of non-additive gene action	Sane *et al*., (2011)
7 x 3 Line x Tester	Preponderance of non-additive gene action	Pachiyappan *et al*. (2012)
4 x4 Diallel (Including reciprocals)	Predominance of additive gene action	Al-Hubaity and Teli (2013)
28 F_1 hybrids	Non-additive gene action	Rajasekhar (2014)
7 x 3 Line x Tester	Non-additive gene action	Sivakumar (2015)

Materials and Methods

3. MATERIALS AND METHODS

The materials used and methods followed during the course of present investigation are briefly described here.

3.1 GENERAL DESCRIPTION

3.1.1 Experimental Site

The experiment entitled "Inheritance of yield and resistance to shoot and fruit borer (*Leucinodes orbonalis* Guen.) in brinjal (*Solanum melongena* L.)" was conducted at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during the period 2012-2015.

3.1.2 Experimental Location

The experimental site was located at 8° 5' N latitude and 77° 1' E longitude at an altitude of 29 m above mean sea level. Predominant soil type of the experimental site was red loam belonging to Vellayani series, texturally classified as sandy clay loam.

The study was conducted in three separate experiments.

Experiment I: Collection and evaluation of germplasm

Experiment II: Line x Tester analysis

a) Raising parents and development of hybrids

b) Field experiment for evaluation of F_1s and parents

Experiment III:

a) Field Screening of F_2 segregants for resistance to shoot and fruit borer.

b) Molecular analysis of F_2 segregants

3.2 EXPERIMENT I: COLLECTION AND EVALUATION OF GERMPLASM

3.2.1 Materials

The experimental material comprised of sixty germplasm lines of brinjal, which were collected from different parts of the country. The list of the evaluated genotypes along with their sources has been illustrated in Table 3.

3.2.2 Methods

3.2.2.1 Design and Layout

The experiment was laid out in a randomized block design with sixty treatments and two replications in two parallel experiments in two seasons (kharif and rabi - 2013). Thirty days old seedlings having 8-10 cm height were transplanted into the main field at a spacing of 60 x 75 cm. The crop received timely management practices as per package of practices recommendations of Kerala Agricultural University (KAU, 2011). Since main thrust was given for screening of the accessions for yield and tolerance to shoot and fruit borer under field conditions, pesticide application was avoided to allow natural infestation.

3.2.2.2 Biometric Observations

Five randomly selected plants were tagged in each entry to record the observations and the average from these five plants was worked out for statistical analysis.

3.2.2.2.1 Plant Height (cm)

Height of five randomly selected healthy plants was measured in centimeter from collar region to the tip of the main stem at the time of final harvest and average height was calculated.

3.2.2.2.2 Number of Primary Branches

Number of branches arising from the main stem was recorded from all the sample plants at the peak harvest stage and average was worked out.

Table 3: Brinjal accessions used for evaluation

S.N	Name of the genotype	Place of collection	Colour
1	IC-89986	NBPGR, New Delhi	Deep purple
2	IC-345271	NBPGR, New Delhi	Pale green
3	IC-90933	NBPGR, New Delhi	Green
4	IC-261839	NBPGR, New Delhi	Green with white stripe
5	IC-343738	NBPGR, New Delhi	Light green
6	IC-89910 K	NBPGR, New Delhi	Purple
7	IC-421197	NBPGR, New Delhi	Pale green white stripe
8	IC-89910-B	NBPGR, New Delhi	Brown
9	Raidurga Local	Andra Pradesh	Purple
10	EC-384606	NBPGR, New Delhi	Greenish white
11	EC-305013	NBPGR, New Delhi	Purple
12	EC-305105	NBPGR, New Delhi	Purple
13	EC-467273	NBPGR, New Delhi	Light green
14	Jagalur Local	Karnataka	Pale green
15	EC316225	NBPGR, New Delhi	Light purple
16	Hiriyur Local	Karnataka	Light green
17	Kolar local	Karnataka	Purple
18	Selam local	TamilNadu	Purple
19	Hosur local	TamilNadu	Purple
20	Nagendra	Karnataka	Green
21	Tiptur local	Karnataka	Green
22	Rampur Local	Karnataka	Purple white stripe
23	Brinjal H-8	Hissar	Purple
24	BR-112	Hissar	Light purple
25	Mallapura Local (P)	Dharwad (KA)	Purple
26	Mallapura Local (G)	Dharwad (KA)	Green with white stripe
27	Manjarigotta	Karnataka	Purple with white stripes
28	IC-169084	NBPGR, New Delhi	Green with white stripe
29	Early round market	Karnataka	Light green
30	Gunthu vankaya	Andra Pradesh	Green
31	Kasaragodu Local	Kerala	Green
32	IC-345275	NBPGR, New Delhi	Purple
33	MDU-1	TamilNadu	Purple
34	Hiriyur Local	Karnataka	Green white stripes
35	Bhagyamathi	Andra Pradesh	Deep Purple
36	IC-433678	NBPGR, New Delhi	Green
37	White Brinjal	Kerala	White
38	IC-90099	NBPGR, New Delhi	Purple
39	IC-90910	NBPGR, New Delhi	Light green
40	K -90036	NBPGR, New Delhi	Pale purple
41	K -35455	NBPGR, New Delhi	Pale purple

42	IC -354227	NBPGR, New Delhi	Green
43	IC -354647	NBPGR, New Delhi	Purple
44	IC-374927	NBPGR, New Delhi	Deep purple
45	IC -383099	NBPGR, New Delhi	Purple
46	K -90068	NBPGR, New Delhi	Purple
47	IC -90917	NBPGR, New Delhi	Purple
48	IC -99677	NBPGR, New Delhi	Purple
49	IC -99719	NBPGR, New Delhi	Purple
50	IC -332998	NBPGR, New Delhi	Deep purple
51	IC -383103	NBPGR, New Delhi	Light green
52	Mullu badane	Karnataka	Green
53	Rampur local	Karnataka	Green with white stripes
54	Brinjal long Black	Maharashtra	Deep purple
55	Nagapur Local	Maharashtra	Purple with white stripes
56	Nagendra	Maharashtra	Light purple
57	Pune Local	Maharashtra	Green
58	Molakalmur Local	Karnataka	Green with white stripes
59	Vellayani Local	Kerala	Light purple
60	Pusa purple cluster	IARI, New Delhi	Deep purple

Plate: 1. General field view of germplasm evaluation with insecticide spray in kharif season

Plate: 2. General field view of germplasm evaluation without insecticide spray in kharif season

Plate: 3. General field view of germplasm evaluation with insecticide spray in rabi season

Plate: 4. General field view of germplasm evaluation without insecticide spray in rabi season

3.2.2.2.3. Days to First Flowering

Number of days from the date of transplanting to the first flowering of observational plants was recorded and the average was obtained.

3.2.2.2.4 Total Number of Flowers

Number of long, medium and short styled flowers were counted starting from the commencement of flowering till its completion and expressed as percentage of total number of flowers.

$$\text{Percentage of long styled flowers} = \frac{\text{Number of long styled flowers}}{\text{Total number of flower}} \times 100$$

$$\text{Percentage of medium styled flowers} = \frac{\text{Number of medium styled flowers}}{\text{Total number of flower}} \times 100$$

$$\text{Percentage of short styled flowers} = \frac{\text{Number of short styled flowers}}{\text{Total number of flower}} \times 100$$

3.2.2.2.5 Intra and Inter Cluster Distance (cm)

Five fruit clusters were randomly selected per plant and distance of within the fruit clusters was measured for intra cluster distance whereas distance of between the fruit clusters was measured for inter cluster distance.

3.2.2.2.6 Days to First Harvest

Number of days from the date of transplanting to the first fruit harvest of observational plants was recorded and the average was obtained.

3.2.2.2.7 Days to Last Harvest

Number of days from the date of transplanting to the last fruit harvest of observational plants was recorded and the average obtained.

3.2.2.2.8 Length of Fruit (cm)

Five fruits were selected at randomly from the observational plants. Length of the fruits was measured as the distance from pedicel attachment of the fruit to the apex using twine and scale. Average was taken and expressed in centimeters.

3.2.2.2.9 Girth of Fruit (cm)

Girth of the fruits was taken at broadest part from the same fruits used for recording the fruit length. Average was taken and expressed in centimeters.

3.2.2.2.10 Fruit Weight (g)

Five fruits were selected at randomly from the observational plants in each genotype in each replication and individual fruit weight was measured by using electronic weighing machine. Average of Five fruits were worked out and expressed in grams.

3.2.2.2.11 Fruit Colour

Dominant pigmentation on fruits of individual genotypes was recorded.

3.2.2.2.12 Calyx Length (cm)

The length of calyx was recorded for each fruit selected at random from the observational plants and expressed in centimeters.

3.2.2.2.13 Number of Fruits per Plant

Total number of fruits produced per plant till last harvest was counted.

3.2.2.2.14 Fruit Yield per Plant (kg)

Weight of all fruits harvested from selected plants was recorded, average worked out and expressed in grams per plant.

3.2.2.2.15 Ratio of Peripheral Seed Ring to Total Length of Fruit (RLPS)

The ratio of the length of peripheral seed ring to total length of fruit was calculated by dividing the length of peripheral seed ring by the total length of fruit

3.2.2.2.16 Ratio of Seedless Area to Total Length of Fruit (RLSP)

The fruits used for measuring the length of peripheral seed ring were also used to measure the length of seed less area. It was measured both at the lower and upper end from the centre and added up. The total was divided by the total length of fruit to work out the ratio of length of seedless area to total length.

3.2.2.2.17 Screening of Shoot and fruit borer (*Leucinodes orbonalis* Guen.)

The observations were recorded on different damage parameters as described below.

3.2.2.2.17.1 Percentage of Infested Shoots per Plant

The total number of shoots, which showed the wilting symptoms, was recorded for calculating the percentage of young shoots infested. Observations recorded at 10 days interval from 30 DAT up to 90 DAT.

$$\text{Percentage of shoots infested} = \frac{\text{Number of shoots showing damage symptoms}}{\text{Total number of shoots}} \times 100$$

3.2.2.2.17.2 Percentage of Infested Fruits per Plant

The total number of fruits with bore holes was recorded and the percentage of damaged fruits was worked out. Observations were taken at 10 days interval from 60 DAT up to 100 DAT.

$$\text{Percentage of damaged fruit} = \frac{\text{Number of fruits with bore holes}}{\text{Total no. of fruits on sample plants}} \times 100$$

3.2.2.2.17.3 Weight of Infested Fruits per Plant

Five shoot and fruit borer infested fruits were selected at randomly from the observational plants in each genotype in each replication and individual infested fruit weight was measured by using electronic weighing machine. Average of five infested fruits were worked out and expressed in grams.

3.2.2.2.17.4 Scoring

Characterization of shoot and fruit borer incidence was done as suggested by Tewari and Krishnamoorthy (1985). The incidence of *L. orbonalis* on shoots was assessed in terms of the percentage of infested shoots out of the total number of shoots available in each plot. Incidence on fruits was assessed by calculating percentage of infested fruits at different pickings and pooled data was subjected for statistical analysis. Pest rating was done as per the following scale:

Percentage of fruit infestation		Rating
0	:	Immune (Immune)
1-10	:	Highly resistant (HR)
11-20	:	Moderately resistant (MR)
21-30	:	Tolerant (T)
31-40	:	Susceptible (S)
>40	:	Highly Susceptible (HS)

(Mishra *et al*. 1988)

3.2.2.2.18 Total Sugars

Estimation of total sugars in a fruit sample by using Anthrone method

Reagents

1. 2.5 N Hcl
2. Anthrone reagent: Dissolve 200 mg anthrone reagent in 100 ml of ice cold 95% H_2SO_4. Prepare fresh before use.
3. Standard glucose: Dissolve 100 mg in 100 ml water.
4. Working standard: 10 ml of stock diluted to 100 ml distilled water. Store refrigerated after adding a few drops toluene.

Procedure

Weigh 100 mg of the sample into a boiling tube. Hydrolyse by keeping it in a boiling water bath for 3 hours with 5ml of 2.5 N Hcl and cool to room temperature. Neutralize it with sodium carbonate until the effervescence ceases. Make up the volume to 100 ml and centrifuge. Collect the supernant and take 0.5 and 1 ml aliquots for analysis.

Prepare the standards by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard. 0 serves as blank. Make up the volume to 1 ml in all the tubes including the sample tubes by adding distilled water. Then add 4 ml anthrone reagent. Heat for 8 minutes in a boiling water bath. Cool rapidly and read the green to dark green colour at 630 nm. Draw a standard graph by plotting concentration of the standard on the X – axis versus absorbance on Y – axis. From the graph calculate the amount of carbohydrates present in the sample tube.

3.2.2.2.19 Total Phenols

Total phenol content of fruit was estimated by using Folin-Ciocalteau reagent (Sadasivam and Manickam, 1996).

Reagents

- 80% ethanol
- Folin-Ciocalteau Reagent
- Na_2CO_3 20%
- Standard (100 mg Catechol in 100 ml water)
- Dilute 10 times for a working standard.

Procedure:

Weigh exactly o.5 to 1.0g of the sample and grind it with a pestle and mortar in 10-time volume of 80% ethanol. Centrifuge the homogenate at 10,000rpm for 20 min. save the supernant. Reextract the residue with five times the volume of 80% ethanol, centrifuge and pool the supernants. Evaporate the supernant to dryness. Dissolve the residue in a known volume of distilled water (5 ml).

Pipette out different aliquots (0.2 to 2 ml) into test tubes. Make up the volume in each tube to 3mL with water. Add 0.5 ml of Folin-Ciocalteau reagent. After 3 minutes add 2 ml of 20 percent Na_2CO_3 solution to each test tube. Mix thoroughly; place the test tubes in boiling water for exactly one min. Cool and measure the absorbance at 650nm against a reagent blank. Prepare a standard curve using different concentrations of catechol.

Calculation: From the standard curve find out the concentration of phenols in the test sample and express as mg phenols/100 g material.

3.2.3 Statistical Analysis

The data collected on the quantitative characters were subjected for statistical analysis and following different statistical parameters were worked out.

3.2.3.1 Analysis of Variance (ANOVA)

Analysis of variance was done separately for each character as per RBD design.

3.2.3.2 Estimation of Genetic Variability Parameters

3.2.3.2.1 Genotypic, Phenotypic and Environmental Variance

The Variance due to genotype, phenotype and environment were computed as follows.

$$\text{Genotypic variance } (\sigma g^2) = \frac{\text{MS due to genotypes (adj)} - \text{MS due to error (intra block)}}{\text{r (replication)}}$$

Environmental variance (σe^2) = Error mean sum of squares

Phenotypic variance (σp^2) = $\sigma g^2 + \sigma e^2$ (MS due to error)

Where, 'r' is number of replications.

3.2.3.2.2 Genotypic and Phenotypic Coefficient of Variation

Genotypic and phenotypic coefficients of variance were estimated according to Burton and Devane (1953) based on estimate of genotypic and phenotypic variance.

Genotypic co-efficient of variation (GCV)

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

Phenotypic co-efficient of variation (PCV)

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

Where,

$\bar{X}$ = General mean

r = Number of replications

σ g = Genotypic standard deviation

σ p = Phenotypic standard deviation

GCV and PCV were classified as suggested by Burton and Devane (1953)

0-10% : Low

10-20% : Moderate

20% and above: High

3.2.3.2.3 Heritability

$$H^2 = \frac{\sigma^2_{gx}}{\sigma^2_{px}} \times 100$$

Where, H^2 is the heritability expressed in percentage (Jain, 1982). Heritability estimates were categorized as suggested by Jhonson *et al*. (1995).

0 – 30 per cent ⟶ Low

31 – 60 per cent ⟶ Moderate

>60 per cent ⟶ High

3.2.3.2.4 Genetic Advance as Percentage Mean

$$GA = \frac{k H^2 \sigma_p}{\overline{X}}$$

Where, k is the standard selection differential.

K = 2.06 at 5% selection intensity (Miller *et al.,* 1958)

The range of genetic advance as per cent of mean was classified according to Jhonson *et al.* (1995).

0- 10 per cent ⟶ Low

11- 20 per cent ⟶ Moderate

> 20 per cent ⟶ High

3.2.3.3 Correlation

The correlation co-efficient among all possible character combinations at phenotypic (rp) and genotypic (rg) level were estimated employing formula (Al-Jibouri *et al.*, 1958).

$$\text{Phenotypic correlation} = r_{xy}(p) = \frac{Cov_{xy}(p)}{\sqrt{V_x(p) \times V_y(p)}}$$

$$\text{Genotypic correlation} = r_{xy}(g) = \frac{Cov_{xy}(g)}{\sqrt{V_x(g) \times V_y(g)}}$$

Where,

$Cov_{xy}(G)$	=	Genotypic covariance between x and y
$Cov_{xy}(P)$	=	Phenotypic covariance between x and y
$V_x(G)$	=	Genotypic variance of character 'x'
$V_x(P)$	=	Phenotypic variance of character 'x'
$V_y(G)$	=	Genotypic variance of character 'y'
$V_y(P)$	=	Phenotypic variance of character 'y'

The test of significance for association between characters was done by comparing table 'r' values at n-2 error degrees of freedom for phenotypic and genotypic correlations with estimated values, respectively.

3.2.3.4. Path Co-efficient Analysis

Path co-efficient analysis suggested by Wright (1921) and Dewey and Lu (1959) was carried out to know the direct and indirect effect of the morphological traits on plant yield. The following set of simultaneous equations were formed and solved for estimating various direct and indirect effects.

$$r_{1y} = a + r_{12}b + r_{13}c + \ldots\ldots + r_{1Ii}$$

$$r_{2y} = a + r_{21}a + b + r_{23}c + \ldots\ldots + r_{2Ii}$$

$$r_{3y} = r_{31}a + r_{32}b + c + \ldots\ldots + r_{3Ii}$$

$$r_{1y} = r_{11}a + r_{12}b + r_{13}c + \ldots\ldots + I$$

Where,

r_{1y} to 1_{1y} = Co-efficient of correlation between causal factors 1 to I with dependent characters y.

r_{12} to r_{1I} = Co-efficient of correlation among causal factors

a, b, c……i = Direct effects of characters 'a' to 'I' on the dependent character 'y'

Residual effect (R) was computed as follows.

Residual effect (R) = $1 - \sqrt{a^2 + b^2 + c^2 + \ldots\ldots\ldots i^2 + 2abr_{12} + 2acr_{13} + \ldots}$

3.2.3.5 Selection Index

The selection index developed by Smith (1937) using discriminate function of Fisher (1936) was used to discriminate the genotypes based on all the characters. The selection index is described by the function, $I = b_1 x_1 + b_2 x_2 + \ldots\ldots\ldots + b_k x_k$ and the merit of a plant is described by the function, $H = a_1 G_1 + a_2 G_2 + \ldots\ldots\ldots + b_k G_k$ where $x_1, x_2 \ldots\ldots\ldots\ldots x_k$ are the phenotypic values and $G_1, G_2 \ldots\ldots\ldots\ldots G_k$ are the genotypic values of the plants with respect to characters, $x_1, x_2 \ldots\ldots\ldots\ldots x_k$ and H is the genetic worth of the plant. It is assumed that the economic weight assigned to each character is equal to unity i.e., $a_1, a_2 \ldots\ldots\ldots\ldots a_k = 1$. The regression coefficients (b) are determined such that the correlation between H and I is maximum. The procedure will reduce to an equation of the form, $b = P^{-1}Ga$ where, P is the phenotypic variance-covariance matrix and G is the genotypic variance-covariance matrix x.

3.3 EXPERIMENT II: LINE X TESTER ANALYSIS

3.3.1 Raising Parents and Development of F_1 Hybrids

3.3.1.1 Materials

The experimental material consisted of 8 parental lines. The five parental lines were selected based on high yield and three parental lines were selected based on shoot and fruit borer resistance as per the first experiment. A total of 15 F_1 hybrids were developed by crossing eight parents in Line X Tester fashion. The list of parental lines and F_1 hybrids were given in table (1 and 2).

Table 4. List of parents used in the Line X Tester analysis

S.No.	Accession Number	Name of the parent
1	Line 1	IC-345271
2	Line 2	IC-433678
3	Line 3	Jagaluru Local
4	Line 4	Tiptur Local
5	Line 5	Raidurg Local
6	Tester 1	IC-89986
7	Tester 2	Vellayani Local
8	Tester 3	Pusa Purple Cluster

3.3.1.2 Hybridization Programme

The crossing program was under taken as per LxT (Line X Tester) mating design. In brinjal anthesis occurs between 8 to 12 a.m. matured flower-buds likely to open next morning were emasculated during evening hours and bagged. On the next day morning (between 7 to 10 a.m.) emasculated buds were pollinated by the respective male parents. The pollinated buds were again bagged with paper bags and labelled. The mature crossed fruits were harvested and the seeds were collected separately from each cross. For maintenance of parental lines, flower buds of different parents were selfed by bagging the individual buds and properly tagged and later the seeds were collected from the mature fruits accordingly.

3.3.2 Field Experiment for Evaluation of F_1s and Parents

Table 5. List of hybrid combinations

S. N	**Parents**	**Cross combinations**	**Colour**
1	L_1 X T_1	IC-345271 X IC-89986	Purple
2	L_1 X T_2	IC-345271 X Vellayani Local	Green with white stripes
3	L_1 X T_3	IC-345271 X Pusa Purple Cluster	Pale Purple
4	L_2 X T_1	IC-433678 X IC-89986	Deep Purple
5	L_2 X T_2	IC-433678 X Vellayani Local	Pale Purple
6	L_2 X T_3	IC-433678 X Pusa Purple Cluster	Purple

7	$L_3 X T_1$	Jagaluru Local X IC-89986	Deep Purple
8	$L_3 X T_2$	Jagaluru Local X Vellayani Local	Pale Purple
9	$L_3 X T_3$	Jagaluru Local X Pusa Purple Cluster	Purple
10	$L_4 X T_1$	Tiptur Local X IC-89986	Green with white stripes
11	$L_4 X T_2$	Tiptur Local X Vellayani Local	Green with white stripes
12	$L_4 X T_3$	Tiptur Local X Pusa Purple Cluster	Green with white stripes
13	$L_5 X T_1$	Raidurg Local X IC-89986	Purple
14	$L_5 X T_2$	Raidurg Local X Vellayani Local	Pale Purple
15	$L_5 X T_3$	Raidurg Local X Pusa Purple Cluster	Purple

3.3.2.1 Materials

Eight parents, 15 hybrids and standard check Haritha from KAU were used for field experiment for analysis of heterosis and combining ability.

3.3.2.2 Methods

3.3.2.2.1 Design and Layout

The experiment was laid out in randomized block design with 23 treatments and one standard check (Haritha) in three replications. Thirty five days old seedlings having 8-10 cm height were transplanted into the main field at a spacing of 60 x 75 cm. The crop received timely management practices as per package of practices recommendations of Kerala Agricultural University (KAU, 2011).

3.3.2.2.2 Biometric Observations

Same biometrical observations were used as in the experiment I.

3.3.2.3 Statistical Analysis

The data obtained on the above characters were subjected to the analysis to estimate the following parameters.

1. Analysis of variance
2. Combining ability analysis.

Plate: 8. General field view of line x tester crossing block

Plate: 9. General field view of evaluation of F_1 hybrids and parents

a. Estimation of general combining ability (gca) effects.

b. Estimation of specific combining ability (sca) effects.

c. Estimation of gca and sca variances.

3. Estimation of heterosis

a. Estimation of heterosis over the mid parental value.

b. Estimation of heterosis over the better parental value.

c. Estimation of standard heterosis.

3.2.2.3.1. Analysis of Variance

Analysis of variance was computed based on randomized block design for each of the character separately as per standard statistical procedure (Panse and Sukhatme, 1985). The significance was tested by referring to the values of 'F' table (Fisher and Yates, 1967).

$$Y_{ij} = u + g_i + r_j + e_{ij}$$

Where ,

Y_{ij}= phenotypic observation of i^{th} genotype and j^{th} replication

μ=general men

g_i =effect of i^{th} genotype

r_j =effect of j^{th} replication

e_{ij} = random error associated with i^{th} genotype and j^{th} replication

Table 6: Analysis of variance

Source	Degrees of freedom	Mean sum of squares	F-ratio
Replication	(r-1)	M's	M's/M'e
Treatment	(t-1)	M't	M't/M'e
Error	(r-1)(t-1)	M'e	
Total	(tr-1)	TMSS	

Where,

r and t = Number of replications and treatments, respectively

M's, M't and M'e = Mean sum of squares due to replications, treatments and error respectively.

3.2.2.3.2. Combining Ability Analysis

The combining ability analysis of parents and crosses was calculated for different characters using the L x T model as given by Kempthorne (1957).

Mathematical model for combining ability analysis

$$Y_{ijk} = \mu + g_i + g_j + s_{ij} + r_k + e_{ijk}$$

Where,

Y_{ijk} = Any measurable character of the cross ixj in the k^{th} replication

μ= population mean

g_i = General combining ability effect of the female patent

g_j= General combining ability effect of the male parent

s_{ij}= Specific combining ability effect of the cross.

r_k = Effect due to k^{th} replication

e_{ijk} = Environmental effect on (ijk)th individual.

Table 7: ANOVA of L x T mating design for combining ability

Source	**Df**	**MSS**	**Expected MSS**
Replications	(r-1)		
Lines	(s-1)	M_4	$\sigma^2+r\sigma^2s+rt\sigma^2f$
Testers	(t-1)	M_3	$\sigma^2+r\sigma^2s+rs\sigma^2m$
Line x testers	(s-1) (t-1)	M_2	$\sigma^2+r\sigma^2s$
Error	(r-1) (st-1)	M_1	σ^2

Where,

r = number of replications

s = number of male parents

t = number of female parents

σ^2 = random error

σ^2s = variance of interaction between lines and testers.

σ^2f = variance due to lines.

σ^2m = variance due to testers.

3.2.2.3.3 Estimation of Combining Ability Effects

(i) gca effect of line and tester

$$\text{Line } g_i = \frac{X_{i...}}{tr} - \frac{X_{...}}{str}$$

(ii) sca effect of cross

$$S_{ij} = \frac{X_{ij...}}{r} - \frac{Xi_{...}}{tr} - \frac{Xi_{...}}{sr} + \frac{X_{...}}{str}$$

where,

X .... = Grand total

X_i .... = Total of i^{ih} line over replicates and testers

X_j .... = Total of j^{th} tester over replicates and lines

X_{ij} .... = Total of j^{th} cross over replicates.

3.2.2.3.4 Standard Errors of Estimates

S.E (g_i) = $[M_1/rt]^{1/2}$

S.E (g_i) = $[M_1/rs]^{1/2}$

S.E (s_{ij}) = $[M_1/r]^{1/2}$

Where,

r = Number of replications

s = Number of female parents

t = Number of female parents

M_1= MSS due to error

3.2.2.3.5 Estimation of Genetic Components of Variation

The estimates of variance components were obtained from the algebraic manipulation of mean squares in the ANOVA of LxT mating design for combining ability as follows:

Since $\sigma^2 f = \sigma^2$ m in the absence of maternal effects, the line and tester mean squares were pooled mean as:

Pooled mean squares of lines and testers (M_o)

(i) $M_0 = \dfrac{(s-1)\, M_4 + (t-1)\, M_3}{S + t - 2}$

(ii) $\sigma^2 f = \sigma^2 m = \dfrac{(M_0 - M_1) \quad (s + t - 2)}{r\,[t(s-1) \; + (t-1)\,]}$

(iii) $\sigma^2 s = \dfrac{(M_3 - M_4)}{r}$

The genetic components of variation were estimated by relating to variance components to covariance of half sibs (Co v. HS) and full sibs (Co v. FS) as:

(i) $\sigma^2 f = \sigma^2 m$ = Co v. HS

(ii) $\sigma^2 s$ = Co v. FS – 2 Co v. HS

(iii) $\sigma^2 gca$ = Co v. HS =1/2 $\sigma^2 A$

(iv) $\sigma^2 sca$ = Co v. FS – 2 Co v. HS = $\sigma^2 D$

Where,

$\sigma^2 gca$ = General combining ability variance

$\sigma^2 sca$ = Specific combining ability variance

3.2.2.3.6 Estimation and Testing of Heterosis

The heterotic effects were measured as deviation of F_1 mean from mid parent (relative heterosis), the better parent (heterobeltiosis) mean and mean value of standard check.

3.2.2.3.6.1 Heterosis Over the Mid-Parent

Heterosis was expressed as percent increase or decrease in the value of F_1 over the mid parent as per the formula.

$$\text{Heterosis over mid parent} = \frac{\text{Mean of } F_1 - \text{Mean of parents}}{\text{Mean of parents}} \times 100$$

3.2.2.3.6.2 Heterobeltiosis

Heterobeltiosis was expressed as percent increase or decrease in the value of F_1 over the better parent as per the formula of Liang *et al.* (1971) and Mather and Jinks (1971).

$$\text{Heterobeltiosis} = \frac{\text{Mean of } F_1 - \text{Mean of BP}}{\text{Mean of B.P}} \times 100$$

3.2.2.3.6.3 Standard Heterosis

Standard heterosis was expressed as percent increase or decrease in the F_1 value over the high yielding standard check.

$$\text{Standard heterosis} = \frac{\text{Mean of } F_1 - \text{Mean of Std. check}}{\text{Mean of Std. check}} \times 100$$

Heterosis was considered significant if the difference between F_1 and parental means used for comparison was found significant. To test the significance of heterosis following formula given by Arunachalam (1976) were used.

$$\text{Heterosis, } \quad t = \frac{F_1 - MP}{\sqrt{2EMS/r}}$$

$$\text{Heterobeltiosis, } \quad t = \frac{F_1 - B.P}{\sqrt{2EMS/r}}$$

Where,

EMS= Error mean square

r= Number of replication

The calculated't' value was compared with table't' values at the error degrees of freedom.

3.4 EXPERIMENT III

3.4.1 Field Screening of F_2 Segregants for Resistance to Shoot and fruit borer

The screening methodology used is the same as in the first experiment.

3.4.2 Molecular Analysis of F_2 Segregants

3.4.2.1 Isolation of Genomic DNA

3.4.2.1.1 Extraction of DNA

DNA was extracted from all the parental lines namely, IC-345271, IC-433678, Jagaluru Local, Tiptur Local, Raidurg Local, IC-89986, Vellayani Local and Pusa Purple Cluster and also from their F_2 crosses between resistant and susceptible parents using modified method (Ravishankar 2000). For extracting DNA following reagents were used.

1. Extraction Buffer: 20 mM NaEDTA and 100 mM Tris HCl were prepared and mixed. pH was adjusted to 8. 1.4 M NaCl and 2 % w/v CTAB will beadded

For 500ml extraction buffer, the quantity of the chemical used as follows,

a. NaEDTA 3.7224 g
b. Tris HCl 6.0550 g
c. NaCl 40.9080 g
d. CTAB 10 g

CTAB was dissolved by heating to 60 ^{0}C and thus prepared extraction buffer was stored at 37 ^{0}C (Autoclaved). 0.5 % β-mercaptoethanol was added just before use.

2. Chloroform: Iso Amyl Alcohol: 24:1 v/v
3. 5M NaCl [Autoclaved]

4. TE Buffer: 10 mM Tris HCl and 1 mM EDTA were prepared and mixed. pH was adjusted to 8.For a volume of 250 ml buffer, Tris HCl 0.3025 g and NaEDTA 0.0931 g [Autoclave] were used
5. 7.5 M Ammonium Acetate: pH 7.7 [Autoclave]
6. Wash Solution: 76 % v/v ethanol; chilled
7. Absolute Alcohol: Stored at -20 ^{0}C
8. DNA was purified using RNAase (10mg/ml)
9. PVPP [Poly Vinyl Poly Pyrrolidone Powder]
10. TAE Buffer (Stock Solution)

50X TAE in 500 ml water
242.0 g Tris base
57.1 ml of Glacial acetic acid
100 ml of 0.5 M EDTA (pH 7.0)

[Autoclaved]

Working solution: 1Xdilute stock 10 times

11. 6X loading dye
12. Ethidium bromide: 10 mg/ml.

3.4.2.1.2 DNA Extraction Protocol

1. 10 ml extraction buffer was preheated with 100 µl of 0.5 mlβ-mercaptoethanol to 60 ^{0}C.

2. 2 g leaf tissue of brinjal genotypes was ground to fine powder with liquid nitrogen. 50 mg PVPP was added and mixed. The contents were transferred to centrifuge tube containing 10 ml CTAB buffer pre-heated to 60 ^{0}C and mixed gently.

3. Tubes were incubated for 1 hour at 60 ^{0}C, with intermittent shaking for every 10 min and later cooled to room temperature.

4. 10 ml of chloroform: Iso-amyl alcohol (24: 1) was added and mixed gently by inverting tubes about 25 times to form an emulsion.

5. Emulsion was spinned at 8000 rpm for 15 min and aqueous phase transferred to fresh centrifuge tubes using cut tips. If this was cloudy, 6 ml of chloroform was added and two step centrifugation was repeated.

6. To the transferred clear aqueous phase 2.5 ml of 5 M NaCl was added and mixed.

7. 10 ml cold ethanol was added and mixed gently, then, refrigerated overnight at –20 ^{0}C.

8. Tubes were centrifuged at 5000 rpm for 10 min and then speed increased to 8000 rpm for 3 min at RT. Supernatant poured off and pellet will be washed with 2 ml 76 % ethanol, centrifuged as above for 3 min.

9. Washing step was repeated twice.

10. Supernatant was drained out; DNA is completely dried to remove ethanol, by leaving tubes uncovered at 37 ^{0}C for 20-30 min.

11. The DNA pellet was dissolved in 1 ml TE and pooled by using cut tips.

RNase was added to a final concentration of 10 g/ml (3 µl of conc. RNase or 30 µl of diluted RNase). Later incubated at 37 ^{0}C for 30 min for immediate analysis or stored at –20 ^{0}C.

3.4.2.1.3 DNA Purification

1. The DNA was centrifuged to 8000 rpm for 15 min.
2. Supernatant was drained out; DNA is completely dried to remove ethanol, by leaving tubes uncovered at 37 ^{0}C for 20-30 min.
3. The DNA was diluted with 1 ml TE buffer. Then 1 ml of 7.5 M ammonium acetate followed by 10 ml of cold ethanol was added. Gently it was mixed to precipitate DNA and kept it overnight or 1 hr at -20 ^{0}C.
4. Centrifuged at 8000 rpm for 20 min at 4 ^{0}C and decanted the supernatant.
5. The DNA pellet was air dried at 37 ^{0}C for 15 min and dissolved in 1 ml of TE buffer.

6. RNase was added to the dissolved DNA.

3.4.2.2 DNA Quantification

DNA concentration in the sample is estimated by recording absorbance at 260 and 280 nm in a UV/ VIS spectrophotometer.

1. 10 µl of DNA sample taken in a quartz cuvette. The volume made to 1 ml with distilled water.
2. The absorbance was measured at 260 and 280 nm using the UV spectrophotometer.
3. Calculated the ratios of A260/A280.
4. Calculated DNA concentration using the relationship for double stranded DNA, O.D at 260 nm = 50 g/ ml.
5. Total quantity of DNA (ng /µl) = $\frac{\text{O.D. at 260 nm x 50 x Dilution factor}}{1000}$

$$\text{Dilution factor} = \frac{\text{Volume made}}{\text{Volume of the aliquot}}$$

$$\text{Therefore, Dilution factor} = \frac{1000\ \mu l}{10\ \mu l}$$

$$= 100\ \mu l.$$

3.4.2.3 Gel Electrophoresis

3.4.2.3.1 Casting of Agarose Gel

1. 5 µl of the DNA solution pippeted into a microfuge tube. 2.5 µl of bromophenol dye added and mixed for few seconds and this solution was used for gel electrophoresis.
2. 0.8 % agarose solution in 1 X TAE buffer was prepared for 100 ml. Heated it in a micro oven to dissolve agarose completely. Cooled to 40 ^{0}C, ethidium

bromide solution (0.5 g/ml) was added, gel was poured into boat and casted inserted the comb.

3. When the gel is set, the comb was removed and kept it in the Gel Electrophoresis unit.

3.4.2.3.2 Electrophoresis

1. The gel electrophoresis tray was filled with 0.5X TAE buffer, then gel boat was placed in the tank. DNA solution was loaded.
2. Electric current of 75 volts was applied for 1 ½ to 2 h.
3. The slab was removed and the DNA was observed under UV light. A zigzag pattern of a single band indicated intact plant DNA.

3.4.2.4 Characterization of Brinjal Genotypes using RAPD Markers for Shoot and fruit borer Resistance

Eight parental lines were taken for confirmation of their resistance to shoot and fruit borer in brinjal. The three resistant lines (IC-89986, Vellayani Local and Pusa Purple Cluster) and five susceptible lines namely (IC-345271, IC-433678, Jagaluru Local, Tiptur Local, Raidurg Local,) were screened using RAPD markers *viz.,* OPO-20, OPC-4 and OPL-9 by extracting DNA and running PCR. The banding pattern was studied using gel electrophoresis.

3.4.2.4.1 RAPD Marker

The following Reagents were used

1. Reaction buffer (10X in 100 ml):

pH was adjusted to 9.0

2. Primers: Stock 10 pmol
3. Taq DNA polymerase: Stock 3 u/μl
4. Template DNA: Stock 25 ng/μl
5. dNTP's: Stock 1 mM
6. 6X loading dye

Procedure:

1. The thermocycler was switched on at least 15 min before use.
2. The reagents were pipetted out accurately using appropriate auto pipettes into sterile 200 µl PCR tubes in the following order and master mix was prepared.
    a. $MgCl_2$ complete Reaction buffer 10X 2.5 µl
    b. Primer 2.5 µl
    c. dNTP's (1 mM) 2.5 µl
    d. Taq DNA polymerase (3 u/ul) 0.33 µl
    e. Template DNA (25 ng/µl) 2.5 µl
    f. Water 14.67 µl
    g. Total reaction volume 25 µl
3. Contents were mixed by repeated pipetting. Later contents were spinned down for 15 sec at 5000 rpm.
4. The PCR tubes were placed firmly in the wells of the thermocycler and the following temperature programme was set as detailed in Table 9.
5. At the end of the PCR, tubes were taken out. 2.5 µl of diluted bromophenol blue is added and spinned for 2-5 s at top speed in micro centrifuge. Then tubes were stored at 4 ^{0}C till electrophoresis.

3.4.2.4.2 Electrophoresis and Visualization of Amplified Products

The amplified products of PCR were separated by electrophoresis on 1.4 % agarose gel along with Ethidium bromide (0.5 mg/ ml) and the gel was visualized under UV light for detection of polymorphism.

Table 8.Molecular markers linked to brinjal shoot and fruit borer resistance

Marker	Primer sequences
OPO-20	ACACACGCTG
OPC-4	CCGCATCTAC
OPL-9	TGCGAGAGTC

Table 9. Stepwise PCR programme carried out for RAPD primers

S.N.	Step	Temperature	Time	
1	Initial Denaturation	94 ^{0}C	5 minutes	
2	Denaturation	94 ^{0}C	1minutes	36 cycles
3	Annealing	35^{0}C	1minutes	
4	Extension	72 ^{0}C	2 minutes	
5	Final Extension	72 ^{0}C	8 minutes	

Results

4. RESULTS

The experimental data collected on growth, morphological, yield and yield attributing characters were statistically analyzed and the results are presented under the following heads.

4.1 EXPERIMENT I. COLLECTION AND EVALUATION OF GERMPLASM

The sixty brinjal accessions were subjected to detailed study on variability, heritability, genetic advance, correlation, path analysis and screening for shoot and fruit borer resistance/tolerance.

4.1.1 Analysis of Variance

The analysis of variance revealed significant variation among the sixty accessions for all the characters studied.

4.1.2 Mean Performance of Accessions

The mean values of the accessions for growth, morphological, yield and yield attributing characters, biochemical and screening for brinjal shoot and fruit borer resistance/tolerance in both kharif and rabi seasons are given below.

4.1.2.1 Mean Performance of Accessions during Kharif Season.

The mean values for growth, morphological, yield and yield attributing parameters during kharif season were furnished in the Table 10.

Plant height varied from 42.20 cm (SM 29) to 119.00 cm (SM 59). None of the genotypes were on par with the highest value of plant height, while SM 42 (44.90) was on par with the shortest plant. The accession SM 60 had the highest number of primary branches (9.32) while, SM 46 (8.90) was on par with the highest value and the lowest (3.50) was observed in the genotypes of SM31, SM29 and SM26. The genotypes of SM 22(4.10), SM 34 (4.0), SM 41 (4.10), SM 42 (4.20), SM 45(4.30) and SM 47(4.20) were on par with the lowest primary branches of plant.

Days to first flower ranged from 33.30 to 50.50 days. SM 20 was the earliest to flower and SM 33 took the maximum number of days to flower. Highest percentage of medium styled flowers were observed in SM 8 (44.50) while the genotypes SM 5, SM 9, SM 10, SM 12, SM 13, SM 20, SM 21, SM 22, SM 26, SM 28, SM 31, SM 34, SM 35, SM 37, SM 38 and SM 53 were on par with highest value. The lowest percentage of medium styled flowers were observed in SM 52 (32.47) while SM 2, SM 16, SM 36, SM 45, SM 47 and SM 48 were on par with the lowest percentage of medium styled flowers.

Highest percentage of long styled flowers was observed in SM 60 (61.50) while the genotypes SM 2, SM 3, SM 6, SM 56, SM 57 and SM 59 were on par with highest value. The lowest percentage of long styled flowers was observed in SM 21 (51.14) while SM 5, SM 8, SM 10, SM 11, SM 13, SM 19, SM 20, SM 22, SM 23, SM 26, SM 28, SM 29, SM 31, SM 32, SM 34, SM 35, SM 37, SM 38, SM 39, SM 41, SM 42, SM 46, SM 49, SM 51, SM 53, SM 54, SM 55 and SM 58 were on par with the lowest percentage of long styled flowers. Highest percentage of short styled flowers was observed in SM 16 (8.84) and lowest was observed in SM 8 (3.49). Less number of short styled flowers per plant is helpful because these are unproductive.

Intra cluster distance varied from 0.77 cm (SM 56) to 2.30 cm (SM 28).The genotypes SM 8, SM 24, SM 25, SM 27, SM 53, and SM 58 were on par with highest value while the genotypes SM 14, SM 17, SM 18, SM 36, SM 39, SM 43, SM 49, SM 52 and SM 60 were on par with the lowest value. Inter cluster distance varied from 5.09 cm (SM 60) to 10.27 cm (SM 47).The genotypes SM 25 (10.10), SM 40 (10.17), SM 42 (10.21) and SM 54 (10.10) were on par with highest value. None of the genotypes were on par with the lowest value.

The genotypes differed significantly with respect to number of fruits per plant which ranged from 11.80 (SM 26) to 40.50 (SM 60). None of the genotypes were on par with the highest value while the genotypes SM 11, SM 16, SM 27, SM 32, SM 36, SM 38, SM 39, SM 41, SM 45, SM 49, SM 51, SM 55 and SM 58 were on par with

Table10. Mean performance of 60 brinjal accessions for yield and yield attributing characters in kharif season

Genotype	Plant Height (cm)	Number of Branches	Days to First Flower	Medium styled Flower (%)	Long Styled Flowers (%)	Short Styled Flowers (%)	Intra Cluster Distance(cm)	Inter Cluster Distance (cm)	NO. of Fruits/ Plant	Length of fruit (cm)	Girth of fruit (cm)
SM1	77.75	6.75	43.80	39.50	56.24	3.85	1.26	7.85	28.75	9.95	23.95
SM2	85.80	6.25	35.50	36.22	59.62	4.16	1.13	7.80	31.00	9.95	18.25
SM3	70.30	5.40	35.30	37.00	57.92	5.07	1.38	7.90	17.00	4.93	12.75
SM4	77.40	5.40	35.60	38.63	57.13	4.23	1.75	7.60	16.75	8.90	16.95
SM5	80.30	6.10	39.10	40.67	53.50	5.81	1.83	8.20	17.20	8.40	15.05
SM6	99.00	5.40	43.60	37.07	58.12	4.81	1.70	8.90	19.00	7.35	14.85
SM7	67.75	5.10	41.00	37.24	58.47	4.30	1.50	7.95	16.00	9.25	18.75
SM8	61.50	5.00	38.10	44.50	52.00	3.49	2.05	7.05	16.50	8.00	14.10
SM9	100.00	6.75	38.80	42.68	51.94	5.38	1.80	9.75	31.75	10.15	18.60
SM10	68.50	6.20	46.20	41.97	51.81	6.21	1.50	8.35	18.50	7.75	16.30
SM11	81.00	5.70	43.10	39.60	52.94	7.45	1.88	7.00	13.70	6.90	15.30
SM12	71.10	5.20	42.50	41.26	52.76	5.98	1.10	8.05	16.30	6.75	15.20
SM13	79.60	7.10	44.90	40.71	52.81	6.49	1.38	7.95	22.00	10.15	16.65
SM14	75.40	7.25	45.20	39.39	54.49	6.14	0.98	6.30	32.80	9.05	16.85
SM15	60.85	6.50	40.20	36.13	58.63	5.24	1.50	6.88	14.75	10.95	21.10
SM16	70.00	6.90	45.50	36.55	54.62	8.84	1.40	7.25	12.75	5.69	14.90
SM17	79.50	6.60	39.90	37.60	55.25	7.14	0.80	8.25	22.00	7.65	13.60
SM18	61.60	5.50	45.40	36.60	55.20	8.19	0.84	7.61	14.75	8.40	21.80
SM19	77.50	4.80	46.50	37.61	54.51	7.88	1.10	7.58	19.35	10.75	19.85
SM20	72.30	6.20	33.30	40.57	51.51	7.91	1.65	8.10	20.10	8.70	16.05

Genotype	Plant Height (cm)	Number of Branches	Days to First Flower	Medium styled Flower (%)	Long Styled Flowers (%)	Short Styled Flowers (%)	Intra Cluster Distance(cm)	Inter Cluster Distance (cm)	NO. of Fruits/ Plant	Length of fruit (cm)	Girth of fruit (cm)
SM21	95.90	6.40	46.00	42.24	51.14	6.63	1.38	7.90	33.15	8.20	15.35
SM22	60.50	4.10	45.90	40.90	53.11	5.99	1.23	7.95	22.55	7.65	15.10
SM23	64.70	5.50	40.20	37.61	54.15	8.23	1.75	9.10	13.90	10.55	21.65
SM24	56.70	4.40	46.20	36.61	55.15	8.24	2.05	9.55	20.00	9.75	15.95
SM25	82.85	6.40	40.60	38.06	54.10	7.84	2.05	10.10	21.40	16.90	11.95
SM26	51.40	3.50	47.60	40.90	52.68	6.41	1.83	9.18	11.80	20.07	10.60
SM27	71.20	6.10	41.00	36.68	55.53	7.78	2.10	9.60	12.55	18.55	10.10
SM28	73.50	5.90	47.80	40.61	51.53	7.86	2.30	8.53	18.55	12.50	14.70
SM29	42.20	3.50	43.90	39.54	52.25	8.22	1.75	6.95	16.00	6.25	10.80
SM30	52.80	3.90	40.80	37.49	56.17	6.34	1.35	7.75	17.85	9.00	26.35
SM31	58.00	3.50	45.90	40.31	52.53	7.16	1.80	8.61	15.00	8.25	26.45
SM32	61.80	5.40	46.30	38.63	52.84	8.53	1.65	9.09	12.90	7.70	12.35
SM33	52.50	4.60	50.50	37.76	55.91	6.34	1.94	8.47	19.10	6.90	21.60
SM34	53.80	4.00	41.10	40.54	52.63	6.82	1.95	7.76	15.30	8.05	14.05
SM35	64.30	7.10	46.10	40.72	53.65	5.63	1.30	9.05	36.50	15.75	17.95
SM36	93.50	7.50	41.80	36.24	57.74	6.02	0.98	8.85	40.25	14.75	11.45
SM37	66.30	8.00	45.25	41.21	52.23	6.56	1.10	8.25	25.50	10.25	15.85
SM38	82.05	7.30	48.15	40.32	52.03	7.65	1.00	8.22	13.50	10.00	12.65
SM39	71.70	6.60	46.75	39.10	52.13	8.76	0.94	9.15	14.25	11.05	13.25
SM40	62.40	4.60	46.00	38.24	55.62	6.14	1.20	10.17	15.00	10.25	11.10
SM41	85.50	4.10	40.85	38.43	54.21	7.36	1.39	9.26	14.00	6.90	9.90

Genotype	Plant Height (cm)	Number of Branches	Days to First Flower	Medium styled Flower (%)	Long Styled Flowers (%)	Short Styled Flowers (%)	Intra Cluster Distance(cm)	Inter Cluster Distance (cm)	NO. of Fruits/ Plant	Length of fruit (cm)	Girth of fruit (cm)
SM42	44.90	4.20	44.50	39.64	51.81	8.54	1.00	10.21	16.40	8.30	10.45
SM43	64.90	4.60	43.70	39.10	56.50	4.39	0.98	8.69	21.00	10.60	11.05
SM44	57.10	5.00	45.65	38.81	55.00	6.19	1.98	7.67	20.45	11.75	11.25
SM45	55.40	4.30	44.60	34.11	59.53	6.36	1.99	6.99	13.50	12.95	11.30
SM46	95.70	8.90	46.50	38.70	54.86	6.43	2.05	9.23	16.60	9.20	9.25
SM47	47.80	4.20	44.95	36.52	57.21	6.28	1.10	10.27	17.15	14.10	8.50
SM48	95.00	4.60	45.60	36.60	56.22	7.17	1.45	8.49	14.50	14.45	9.60
SM49	99.50	3.90	45.75	39.04	54.67	6.29	0.94	8.84	13.10	11.00	10.85
SM50	79.00	4.80	44.50	39.11	55.72	5.17	1.05	9.05	16.20	10.35	10.60
SM51	60.20	5.30	44.75	39.10	54.46	6.44	1.45	9.72	13.60	10.85	10.75
SM52	65.30	6.50	47.75	32.47	60.29	7.24	0.99	7.89	15.50	9.45	10.65
SM53	69.30	5.10	39.80	40.13	54.42	5.45	2.05	9.33	17.75	9.90	14.40
SM54	81.60	7.30	41.70	38.90	54.29	6.80	1.55	10.10	15.90	12.00	13.35
SM55	84.40	7.40	45.80	38.64	55.07	6.28	1.10	9.40	13.25	12.25	11.55
SM56	84.40	7.00	35.45	37.00	58.27	4.72	0.77	8.09	19.00	10.85	12.60
SM57	62.30	4.80	42.75	36.92	57.56	5.53	1.35	7.04	16.75	11.10	11.20
SM58	69.90	7.80	43.75	39.13	53.21	7.66	2.05	7.68	14.00	11.15	12.25
SM59	119.00	7.10	45.50	37.00	58.10	4.90	1.25	8.10	28.00	22.25	10.75
SM60	94.13	9.32	45.47	34.00	61.50	4.50	0.90	5.09	40.50	11.70	11.48
Mean	72.51	5.74	43.34	38.64	54.93	6.42	1.46	8.36	19.22	10.38	14.53
C.D. 5%	4.8984	0.9706	1.4020	4.4477	4.0038	2.0778	0.2647	0.3518	2.7394	0.8311	1.0510

Table10. Continued.

Genotype	Fruit Weight(g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant(g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits(g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM1	198.60	62.20	144.50	3116.50	5.75	7.50	2.67	1.09	0.13	167.50	1.29	22.30
SM2	192.55	53.60	139.75	4133.50	34.50	34.65	3.40	0.45	0.44	125.00	4.01	11.30
SM3	46.65	53.40	137.50	762.10	40.30	44.00	3.15	0.33	0.32	18.90	3.28	12.52
SM4	136.55	53.50	136.60	1774.00	40.50	41.00	3.25	0.31	0.42	110.00	3.05	13.35
SM5	122.50	58.00	145.50	1729.70	40.80	42.25	3.00	0.22	0.51	111.00	2.80	14.35
SM6	119.40	62.00	149.50	1839.80	52.60	39.10	3.95	0.24	0.40	99.00	3.51	12.00
SM7	154.00	59.50	146.25	2349.70	38.00	42.75	4.15	0.25	0.46	115.00	2.03	15.15
SM8	113.75	58.50	146.75	1719.00	38.35	40.25	3.15	0.28	0.47	83.50	3.15	12.77
SM9	166.50	60.50	145.90	4013.00	35.15	34.20	3.90	0.30	0.44	89.50	4.20	11.45
SM10	109.60	64.45	152.50	1578.00	40.55	43.25	3.35	0.24	0.51	87.50	3.32	14.17
SM11	82.35	62.50	149.75	1223.30	47.75	52.60	3.04	0.25	0.41	33.50	3.08	13.00
SM12	79.00	62.45	147.25	1044.65	40.35	49.40	3.97	0.19	0.39	47.50	4.15	11.93
SM13	111.00	64.50	154.60	2486.80	39.80	41.50	3.65	0.37	0.31	56.50	4.11	11.76
SM14	156.50	62.50	149.00	3973.50	34.25	34.25	3.50	0.31	0.43	129.00	4.20	11.75
SM15	209.75	60.00	145.70	2528.50	40.75	39.75	4.10	0.16	0.36	137.00	4.01	12.35

Genotype	Fruit Weight(g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant(g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits(g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM16	57.00	65.60	156.00	793.90	40.50	51.00	3.36	0.46	0.51	37.50	4.11	12.16
SM17	105.80	62.10	150.50	1984.00	44.30	41.60	4.06	0.25	0.52	89.50	3.89	11.35
SM18	194.30	67.70	159.50	2385.10	51.70	40.20	4.26	0.36	0.43	132.00	4.19	10.95
SM19	174.80	68.00	167.25	2515.00	47.50	35.50	3.97	0.14	0.35	137.50	4.15	10.99
SM20	125.40	53.00	137.75	2116.50	45.30	42.50	3.99	0.24	0.30	97.50	4.03	12.18
SM21	120.50	62.10	146.25	3891.75	39.00	37.75	3.35	0.22	0.42	86.50	4.15	11.32
SM22	92.30	69.00	173.60	1886.40	37.60	36.50	3.60	0.34	0.31	51.00	3.22	13.88
SM23	190.00	60.90	147.75	2582.80	42.10	41.50	3.78	0.30	0.37	145.00	3.31	13.98
SM24	114.75	66.95	165.50	1653.30	45.35	52.00	3.60	0.30	0.53	79.50	3.51	12.43
SM25	124.60	59.90	146.50	2062.40	53.50	48.90	4.30	0.11	0.62	74.90	3.53	13.95
SM26	132.65	69.50	169.50	1740.80	40.00	40.40	4.40	0.19	0.41	89.75	4.01	12.57
SM27	104.00	65.25	169.00	1486.50	53.90	47.90	4.16	0.22	0.37	86.00	3.63	12.57
SM28	119.00	70.60	171.75	1920.40	50.50	48.00	4.25	0.18	0.35	84.95	2.89	14.55
SM29	71.00	64.60	157.40	1100.80	45.75	45.75	3.68	0.18	0.30	40.00	2.76	15.35
SM30	242.90	63.00	154.75	2939.50	51.60	41.90	3.87	0.25	0.32	181.50	3.14	12.66
SM31	239.70	65.10	153.60	2349.70	47.50	42.80	4.16	0.30	0.30	182.40	3.32	12.77

Genotype	Fruit Weight(g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant(g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits(g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM32	137.90	70.00	170.00	1728.40	42.20	45.00	3.95	0.37	0.35	88.00	3.49	12.94
SM33	128.00	70.60	168.50	2468.60	36.70	37.50	4.48	0.44	0.36	81.85	3.53	12.63
SM34	121.80	61.95	150.50	1706.45	50.65	56.00	4.65	0.51	0.51	76.00	2.94	15.73
SM35	127.00	66.00	156.25	2682.90	46.00	51.00	3.55	0.44	0.41	88.95	3.05	15.67
SM36	129.75	58.75	145.50	4343.50	33.85	35.30	3.21	0.30	0.43	96.50	4.23	11.32
SM37	124.00	63.00	151.60	1986.00	50.80	52.50	3.30	0.26	0.50	78.00	3.41	12.59
SM38	117.95	68.50	158.75	1759.90	50.40	50.25	3.92	0.34	0.44	70.15	3.66	13.20
SM39	119.65	65.55	157.45	1773.80	44.50	44.90	4.55	0.44	0.37	174.75	3.52	13.60
SM40	121.00	62.50	149.50	1705.10	51.65	53.00	5.15	0.53	0.32	84.50	3.26	15.10
SM41	116.55	58.95	146.25	2021.40	50.00	49.20	4.50	0.52	0.41	88.50	4.19	11.98
SM42	119.75	63.85	155.10	1892.00	40.60	35.40	3.05	0.57	0.33	80.00	4.06	11.74
SM43	125.30	63.05	150.75	2126.30	34.00	38.50	4.05	0.61	0.45	89.00	3.59	13.22
SM44	129.00	70.50	170.00	2135.75	36.95	34.90	3.90	0.59	0.31	92.50	3.40	12.10
SM45	139.00	64.20	155.75	2072.00	35.80	29.50	4.35	0.61	0.31	100.25	4.33	11.57
SM46	100.00	68.90	159.60	1693.50	32.10	28.95	4.51	0.48	0.41	59.00	3.70	13.59
SM47	126.70	63.95	152.50	1969.65	50.35	27.40	4.99	0.50	0.52	89.10	3.29	14.40

Genotype	Fruit Weight(g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant(g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits(g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM48	130.80	63.25	153.25	1696.95	35.90	29.75	3.03	0.61	0.51	89.45	3.84	11.26
SM49	109.00	65.00	152.25	1469.15	31.70	36.90	4.18	0.51	0.44	69.90	2.98	13.07
SM50	128.00	65.60	156.25	2113.20	33.35	29.70	3.53	0.33	0.43	89.00	3.15	12.49
SM51	141.50	62.45	152.10	1908.65	50.75	35.25	3.86	0.33	0.44	99.25	4.13	10.74
SM52	142.75	68.85	159.50	1808.35	34.95	35.00	4.43	0.65	0.36	101.10	2.99	14.85
SM53	98.25	58.85	142.50	1663.35	31.90	34.40	4.40	0.61	0.31	50.10	3.13	15.06
SM54	126.50	59.20	138.75	2117.80	48.90	37.00	4.25	0.57	0.32	87.25	3.23	13.27
SM55	113.65	63.35	151.60	1590.25	31.25	30.75	4.31	0.74	0.34	78.95	2.90	15.80
SM56	119.00	53.50	135.50	1873.50	51.35	29.05	5.04	0.69	0.42	84.60	3.53	11.59
SM57	143.50	59.70	143.50	2109.50	49.90	49.90	3.68	0.69	0.53	95.00	2.98	16.30
SM58	145.25	60.75	145.75	1889.25	46.10	52.25	3.74	0.61	0.53	105.00	3.13	12.94
SM59	153.50	62.50	151.50	3061.50	13.00	13.00	2.51	0.86	0.19	135.50	1.85	20.76
SM60	76.68	61.10	147.35	3490.95	9.00	7.85	2.36	0.88	0.13	58.90	1.55	21.08
Mean	130.32	62.92	152.42	2142.31	41.00	39.51	3.84	0.41	0.40	93.12	3.42	13.41
C.D. 5%	9.6342	1.8186	1.7606	246.3914	2.3629	3.7765	0.2312	0.0639	0.0618	7.0553	0.1205	0.4992

the lowest value. Fruit length exhibited significant variation among the genotypes with a range of 4.93 cm to 22.25cm. The longest fruits were produced by SM 59 (22.25cm) whereas SM 3 (4.93 cm) had the smallest fruits. Girth of fruit ranged from 8.50cm (SM 47) to 26.45cm (SM 31).The genotype SM 46 (9.25) was on par with lowest value. The highest fruit weight was recorded in SM 30 (242.90g) which was on par with SM 31 (239.70g) and lowest fruit weight as recorded in SM 3 (46.65g).

SM 20 (53.00) took the minimum number of days to first harvest and was on par with SM 2 (53.60), SM 3 (53.40), SM 4 (53.50) and SM 56 (53.50). SM 28 and SM 33 (70.60) took maximum days to first harvest while SM 22 (69.00), SM 26 (69.50), SM 32 (70.00), SM 44 (70.50) and SM 52 (68.85) on par with maximum days to first harvest. SM 56 (135.50) took the minimum number of days for last harvest and was on par with SM 4 (136.60). SM 22 (173.60) took maximum days for last harvest. Fruit yield per plant ranged from 762.10g (SM 3) to 4343.50g (SM 36). The highest fruit yield was recorded in SM 36 and it was followed by SM 2 (4133.50g), SM 9 (4013.00g), SM 14 (3973.50g) and SM 21 (3891.75g).

FSB shoot infestation varied from 5.75% (SM 1) to 53.90% (SM 27). Least shot infestation was observed in SM 1 (5.75%) followed by SM 60 (9%) and SM 59 (13%). FSB fruit infestation varied from 7.50% (SM 1) to 56.00% (SM 34). Least fruit infestation was observed in SM 1 (7.5%) followed by SM 60 (7.5%) and SM 59 (13%). Genotype SM 40 (5.15cm) produced longest calyx length which was on par with SM 47 (4.99cm) and SM 56 (5.04cm). The shortest calyx length was observed in the genotype SM 60 (2.36cm) which were on par with SM 1 (2.67cm) and SM 59 (2.51cm). The RLPS was varied from 0.11 (SM 25) to 1.09 (SM 1) and the RLSA was varied between 0.13 (SM 1) to 0.62 (SM 25).Weight of infested fruit weight was maximum in the genotype SM 31 (182.40g) and minimum in SM 3 (18.90g). Highest total sugar content was observed in genotype SM 45 (4.33g) and lowest was observed in SM 1(1.29g). The genotype SM 1 (22.30 mg/100 g) had the highest phenol content and SM 51 (10.74 mg/100 g) had the lowest.

4.1.2.2 Mean Performance of Accessions during Rabi Season.

The mean values for growth, morphological, yield and yield attributing parameters during rabi season were furnished in the Table 11.

Plant height varied from 41.40 cm (SM 29) to 119.90 cm (SM 59). None of the genotypes were on par with the highest value of plant height, while SM 42 (43.00) was on par with the shortest plant. The accession SM 60 had the highest number of primary branches (9.30) and the lowest (3.0) was observed in SM 29. SM 26(3.60), SM 31 (3.50) and SM 49 (3.70) were on par with the shortest primary branches of plant. Days to first flower ranged from 32.90 to 50.50 days. SM 20 was the earliest to flower and SM 33 took the maximum number of days to flower. Highest percentage of medium styled flowers was observed in SM 22 (47.85) while the genotypes SM 49 (45.00) and SM 50(46.45) were on par with highest value. The lowest percentage of medium styled flowers was observed in SM 52 (33.50) while SM 45 (35.62) was on par with the lowest percentage of medium styled flowers.

Highest percentage of long styled flowers was observed in SM 60 (59.15) while the genotypes SM (56.49), SM 2 (58.62), SM 45 (56.95) and SM (57.00) were on par with highest value. The lowest percentage of long styled flowers was observed in SM 50 (46.05) while SM 22 (46.20) and SM 49 (48.45) were on par with the lowest percentage of long styled flowers. Highest percentage of short styled flowers was observed in SM 43 (11.35) and lowest was observed in SM 36 (3.20). Less number of short styled flowers per plant is helpful because these are unproductive.

Intra cluster distance was varied from 0.80 cm (SM 60) to 2.30 cm (SM 28).The genotype SM 46 (2.30) was on par with highest value while the genotypes SM 3(0.98), SM 17 (0.82), SM 18 (0.88), SM 36 (0.99), SM 38 (0.95), SM 39 (0.98), SM 55 (0.99) and SM 56 (0.95) were on par with the lowest value. Inter cluster distance was varied from 5.05 cm (SM 60) to 10.37 cm (SM 40).The genotypes SM 42 (10.10),

Table11: Mean performance of 60 brinjal accessions for yield and yield attributing characters in rabi season

Character	Plant Height (cm)	No. of primary Branches/ plant	Days to First Flower	Medium styled flowers (%)	Long styled flowers (%)	Short styled flowers (%)	Intra cluster distance (cm)	Inter cluster distance (cm)	No. of Fruits/ Plant	Length of fruit (cm)	Girth of fruit (cm)
SM1	77.25	6.60	42.50	38.75	56.49	4.35	1.42	7.90	30.00	10.15	24.30
SM2	85.30	6.30	34.00	36.72	58.62	4.66	1.24	8.10	31.50	10.15	18.50
SM3	70.50	4.75	34.50	38.00	55.92	6.07	0.98	8.00	17.50	4.90	12.45
SM4	70.50	5.10	35.60	40.13	55.13	4.73	1.90	7.50	15.50	8.95	16.90
SM5	77.25	5.90	38.45	41.08	52.45	6.44	1.90	8.00	15.50	8.35	15.00
SM6	97.50	5.20	42.75	38.50	56.50	5.00	1.88	8.75	17.75	7.40	14.75
SM7	68.50	5.00	40.50	38.05	55.32	4.80	1.48	8.25	16.25	9.20	18.90
SM8	60.25	4.35	37.85	44.00	52.00	4.48	1.98	7.20	15.00	8.05	14.05
SM9	99.75	6.75	38.00	41.68	52.00	6.32	1.89	9.75	33.00	10.65	18.90
SM10	68.10	6.00	45.50	39.50	52.00	8.50	1.60	8.25	18.00	7.75	16.10
SM11	76.25	5.70	42.75	41.10	50.44	8.45	1.83	6.90	11.00	6.75	15.00
SM12	67.80	4.90	42.00	43.75	50.25	6.00	1.30	8.00	14.80	6.80	15.05
SM13	79.70	6.90	44.30	44.80	50.25	4.95	1.13	8.43	18.50	10.25	16.25
SM14	75.50	7.20	44.00	43.15	51.25	5.60	1.10	6.50	30.50	9.20	17.00
SM15	61.75	6.70	39.50	41.25	52.05	6.70	1.50	6.99	14.70	10.85	21.50
SM16	69.25	7.00	45.20	40.25	53.10	6.65	1.23	7.50	11.00	6.00	14.90
SM17	77.10	6.55	39.50	42.30	51.25	6.45	0.82	8.55	18.95	7.60	13.95
SM18	61.40	6.15	45.50	37.60	53.70	8.69	0.88	7.65	11.90	8.30	22.20
SM19	74.50	5.55	45.90	40.25	54.80	4.95	1.05	7.64	17.30	10.25	20.00
SM20	74.00	6.10	32.90	42.85	52.25	4.90	1.80	8.15	18.75	8.65	15.80

Character	Plant Height (cm)	No. of primary Branches/ plant	Days to First Flower	Medium styled flowers (%)	Long styled flowers (%)	Short styled flowers (%)	Intra cluster distance (cm)	Inter cluster distance (cm)	No. of Fruits/ Plant	Length of fruit (cm)	Girth of fruit (cm)
SM21	96.95	6.60	45.80	42.40	52.20	5.40	1.10	8.10	31.50	8.35	15.40
SM22	60.60	3.95	45.40	47.85	46.20	5.95	1.20	8.38	19.50	7.60	14.90
SM23	63.00	5.55	40.00	41.15	53.55	5.30	1.95	9.05	11.00	10.00	21.50
SM24	57.10	4.50	46.00	42.35	51.60	6.05	2.00	9.35	16.00	9.80	15.75
SM25	79.20	6.60	40.50	42.15	53.70	4.15	1.94	10.00	18.65	17.70	12.00
SM26	55.10	3.60	47.25	42.05	52.95	5.00	1.73	9.37	10.10	20.40	10.35
SM27	71.85	6.15	40.50	39.10	55.30	5.60	2.04	9.50	10.95	18.30	10.10
SM28	71.75	5.55	47.00	43.65	50.60	5.75	2.45	8.70	15.95	12.45	14.45
SM29	41.40	3.00	43.40	39.00	54.30	6.70	1.57	7.05	14.55	6.65	10.50
SM30	49.75	4.00	40.50	39.50	53.25	7.25	1.40	7.88	16.30	9.05	25.75
SM31	54.00	3.50	45.60	42.05	50.90	7.05	1.95	8.60	13.50	8.20	26.65
SM32	59.25	5.20	46.00	38.65	52.90	8.45	1.77	9.00	12.00	7.65	12.70
SM33	52.70	4.50	50.50	36.85	51.80	11.35	2.10	8.57	15.25	6.95	21.65
SM34	52.25	4.00	40.60	41.65	51.75	6.60	1.83	7.99	13.00	8.05	14.10
SM35	62.00	6.90	45.90	39.95	52.00	8.05	1.29	9.16	27.50	15.95	17.60
SM36	96.40	7.60	41.50	42.80	54.00	3.20	0.99	9.15	40.50	15.05	11.25
SM37	63.00	7.25	45.00	36.25	53.05	10.70	1.00	8.32	24.90	10.30	15.95
SM38	81.00	7.05	47.00	37.55	54.40	8.05	0.95	8.05	13.50	10.15	12.65
SM39	71.00	6.10	46.40	41.30	50.95	7.75	0.98	9.10	14.30	10.90	13.05
SM40	61.00	4.10	45.90	38.70	54.65	6.65	1.10	10.37	14.90	10.20	11.00
SM41	83.25	3.90	40.50	38.95	54.00	7.05	1.48	9.23	14.30	6.95	9.50
SM42	43.00	3.95	44.50	41.45	51.05	7.50	1.00	10.10	16.70	8.35	10.55

Character	Plant Height (cm)	No. of primary Branches/ plant	Days to First Flower	Medium styled flowers (%)	Long styled flowers (%)	Short styled flowers (%)	Intra cluster distance (cm)	Inter cluster distance (cm)	No. of Fruits/ Plant	Length of fruit (cm)	Girth of fruit (cm)
SM43	63.00	4.40	43.50	36.85	51.80	11.35	1.06	8.95	21.00	10.70	10.95
SM44	57.50	4.90	45.50	39.10	55.30	5.60	2.00	7.72	20.50	12.00	11.10
SM45	57.40	4.05	44.25	35.65	56.95	7.40	1.95	7.00	15.00	13.05	11.50
SM46	101.00	8.00	46.40	41.65	51.95	6.40	2.30	9.33	16.65	9.30	9.15
SM47	45.40	4.10	44.40	42.85	51.75	5.40	1.05	10.12	17.40	14.15	8.45
SM48	92.25	4.35	45.40	38.50	52.70	8.80	1.23	8.55	14.35	14.70	9.50
SM49	100.00	3.70	46.00	45.00	48.45	6.55	0.95	8.88	13.50	10.95	10.50
SM50	81.50	4.75	44.50	46.45	46.05	7.50	1.00	9.00	16.50	10.35	10.45
SM51	60.25	5.35	44.50	36.30	54.00	9.70	1.50	9.79	15.10	10.90	10.85
SM52	64.80	6.20	47.00	33.50	57.00	9.50	0.95	8.06	16.70	9.70	10.90
SM53	70.50	5.00	39.60	40.15	50.45	9.40	2.10	9.25	17.20	10.00	14.35
SM54	83.00	7.30	41.60	38.75	53.55	7.70	1.50	10.28	14.55	12.05	13.35
SM55	84.50	7.25	45.30	42.05	52.00	5.95	0.99	9.27	12.70	12.00	11.35
SM56	85.25	7.45	35.00	41.55	53.30	5.15	0.95	8.26	18.05	10.90	12.55
SM57	63.75	4.90	42.60	37.75	55.65	6.60	1.42	7.20	17.50	11.15	11.20
SM58	67.60	7.70	43.40	43.00	52.05	4.95	2.00	7.91	14.75	10.75	12.15
SM59	119.90	7.20	45.60	38.50	56.75	4.75	1.05	8.75	30.00	22.05	10.90
SM60	92.75	9.30	42.25	36.70	59.15	4.15	0.80	5.05	41.75	11.70	11.55
Mean	71.80	5.64	42.90	40.39	53.00	6.59	1.46	8.44	18.26	10.43	14.49
C.D. 5%	3.9228	0.8693	1.5269	2.3576	2.9719	2.9289	0.2208	0.3508	3.2040	0.5184	0.6392

Table11. Continued.

Character	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant (g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits (g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM1	199.75	62.25	144.25	3279.00	6.35	7.75	2.70	0.96	0.13	163.50	1.38	22.51
SM2	194.00	53.50	141.50	4306.00	37.65	34.00	3.25	0.40	0.40	125.50	4.05	11.14
SM3	47.25	52.70	138.70	801.00	38.90	44.50	3.05	0.30	0.37	26.50	3.27	12.55
SM4	139.00	52.90	136.50	1674.50	33.25	38.80	3.13	0.30	0.47	125.50	3.07	13.26
SM5	121.50	59.00	144.75	1669.50	41.70	39.90	3.06	0.21	0.50	104.00	2.85	14.39
SM6	117.50	61.60	150.50	1725.00	49.85	39.75	4.05	0.25	0.39	95.00	3.55	11.95
SM7	152.50	60.50	146.75	2350.00	35.50	38.50	4.15	0.25	0.45	119.00	2.05	15.35
SM8	114.50	58.60	145.65	1691.50	38.40	47.50	3.15	0.29	0.44	79.50	3.20	12.83
SM9	165.90	61.75	145.50	4102.50	32.95	35.90	3.65	0.30	0.45	87.50	4.09	10.86
SM10	112.50	64.50	152.75	1311.50	37.50	44.00	3.35	0.31	0.50	87.50	3.30	14.21
SM11	84.00	61.00	150.50	1124.00	46.90	50.00	2.95	0.28	0.44	41.00	3.09	13.05
SM12	77.00	62.00	146.00	1000.00	41.15	51.00	4.00	0.21	0.36	46.00	4.20	11.86
SM13	112.50	64.30	154.65	2193.00	35.20	37.90	3.50	0.42	0.37	50.00	4.19	11.65
SM14	154.60	62.70	148.25	4008.00	38.00	35.50	3.70	0.30	0.44	133.50	4.27	11.72
SM15	209.50	60.05	144.50	2054.50	40.10	37.25	4.10	0.19	0.41	132.50	4.01	12.32
SM16	57.50	64.50	156.10	774.00	40.80	46.70	3.50	0.51	0.49	34.00	4.18	12.22
SM17	109.00	62.20	150.40	2003.00	43.30	37.70	4.25	0.25	0.51	91.00	3.76	11.76
SM18	194.50	66.60	159.25	2077.50	57.50	36.85	4.35	0.38	0.44	143.00	4.20	11.05
SM19	172.00	67.40	166.40	2193.00	43.25	40.60	4.05	0.19	0.36	137.00	4.15	11.00
SM20	122.50	53.50	138.50	1790.00	39.60	40.50	3.95	0.27	0.31	93.00	4.04	12.25

Character	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant (g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits (g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM21	121.50	61.15	145.70	3968.00	40.70	34.50	3.55	0.25	0.43	85.00	4.18	11.25
SM22	87.50	68.70	174.60	1919.50	51.25	42.25	3.65	0.38	0.32	55.00	3.24	13.98
SM23	191.00	61.00	147.65	2102.50	40.75	36.00	3.89	0.31	0.39	141.00	3.32	14.11
SM24	117.00	65.50	167.50	1544.50	42.30	45.70	3.74	0.32	0.50	77.20	3.45	13.05
SM25	122.50	60.00	145.90	1999.50	52.20	48.25	4.37	0.18	0.60	79.80	3.47	14.35
SM26	137.00	69.20	169.50	1721.50	41.30	42.00	4.31	0.20	0.40	89.50	4.02	12.73
SM27	100.50	64.90	167.40	1403.00	51.90	47.85	4.26	0.24	0.39	85.50	3.57	13.10
SM28	119.00	70.30	170.50	1794.50	49.00	47.00	4.36	0.20	0.32	85.40	2.89	14.95
SM29	71.00	64.40	157.50	1082.00	40.25	38.25	3.85	0.17	0.37	39.75	2.80	15.19
SM30	246.50	62.50	155.00	2800.00	41.80	41.45	3.84	0.28	0.31	187.00	3.14	12.72
SM31	244.50	64.25	154.10	2069.50	45.10	42.50	4.10	0.33	0.34	183.50	3.29	12.80
SM32	139.00	70.00	170.75	1473.50	45.95	46.00	4.15	0.39	0.39	88.50	3.51	12.74
SM33	126.50	70.15	169.10	2237.50	35.00	37.50	4.36	0.48	0.37	87.00	3.54	12.98
SM34	128.50	61.50	151.25	1307.00	44.10	49.00	4.69	0.53	0.52	74.90	2.89	16.05
SM35	130.50	64.90	155.50	2379.50	46.00	50.00	3.59	0.45	0.47	87.25	3.13	15.51
SM36	130.50	58.60	145.90	4388.50	32.70	34.75	3.30	0.35	0.47	97.40	4.24	11.44
SM37	123.00	62.60	152.10	1838.00	46.25	47.50	3.36	0.30	0.53	80.10	3.51	11.91
SM38	117.50	66.70	160.25	1596.00	36.90	49.75	4.05	0.38	0.49	70.80	3.67	13.48
SM39	120.50	65.30	156.90	1566.50	44.75	45.65	4.42	0.47	0.39	172.45	3.59	13.00
SM40	122.50	61.50	148.60	1283.50	41.50	37.00	5.06	0.56	0.33	84.95	3.24	15.52
SM41	119.00	58.50	146.75	2004.50	36.90	49.00	4.42	0.59	0.45	87.95	4.22	12.19
SM42	119.00	63.25	154.50	1769.00	41.15	38.00	3.20	0.61	0.37	79.70	4.05	11.70

Character	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit Yield/ Plant (g)	FSB Shoot Infestation (%)	FSB Fruit Infestation (%)	Calyx length (cm)	RLPS	RLSA	Weight of infested fruits (g)	Total Sugars (g/100g)	Total Phenols (mg/100g)
SM43	126.00	62.50	150.70	2027.00	36.75	35.40	4.15	0.64	0.44	89.70	3.78	13.16
SM44	128.00	70.35	171.75	1958.00	33.40	31.00	3.88	0.63	0.35	92.25	3.43	11.93
SM45	139.50	63.80	155.10	1998.50	32.85	28.90	4.36	0.65	0.31	98.40	4.39	11.56
SM46	100.50	68.75	160.00	1447.00	31.90	30.10	4.46	0.53	0.47	58.25	3.70	13.77
SM47	126.50	62.40	151.60	1871.00	51.05	29.10	5.05	0.59	0.52	89.35	3.30	14.43
SM48	135.50	63.30	153.50	1598.00	35.90	29.15	3.00	0.62	0.55	87.00	3.80	11.20
SM49	113.50	64.00	153.10	1423.00	32.70	31.50	4.07	0.56	0.49	70.25	2.98	12.75
SM50	131.00	65.00	156.50	2018.00	31.50	28.70	3.67	0.36	0.43	87.40	3.20	12.15
SM51	138.00	60.75	150.50	1770.00	52.50	33.95	3.89	0.35	0.44	102.00	4.15	10.45
SM52	142.50	66.30	158.95	1787.50	32.30	32.75	4.28	0.63	0.38	105.75	3.05	14.00
SM53	99.25	58.60	143.60	1638.50	35.10	32.25	4.32	0.62	0.36	48.60	3.50	14.45
SM54	129.50	58.50	140.50	2024.50	52.25	36.00	4.25	0.63	0.32	85.50	3.27	13.25
SM55	114.00	63.00	152.50	1530.50	34.60	27.60	4.45	0.76	0.37	79.00	2.95	15.05
SM56	120.50	53.65	136.75	1696.00	52.90	27.75	5.05	0.70	0.46	85.70	3.59	11.10
SM57	144.00	59.70	145.60	1984.50	49.90	47.90	3.87	0.68	0.55	95.25	2.95	16.10
SM58	146.00	60.25	146.40	1794.50	45.75	45.00	3.65	0.62	0.56	108.00	3.32	12.37
SM59	155.00	61.95	151.35	3089.00	12.75	12.85	2.55	0.93	0.18	134.50	1.99	21.10
SM60	78.50	60.75	146.75	3426.50	8.75	7.60	2.36	1.00	0.16	59.00	1.60	21.31
Mean	131.00	62.50	152.56	2024.29	39.81	38.03	3.86	0.43	0.41	93.50	3.45	13.38
C.D. 5%	5.1131	1.3637	1.6056	169.3714	3.9375	4.0191	0.2026	0.0496	0.0515	4.8685	0.1831	0.3497

SM 47 (10.12) and SM 54 (10.28) were on par with highest value. None of the genotypes were on par with the lowest value.

The genotypes differed significantly with respect to number of fruits per plant which ranged from 10.10 (SM 26) to 41.75 (SM 60). SM 36 (40.50) was on par with the highest value while the genotypes SM 11 (11.00), SM 16 (11.00), SM 18 (11.90), SM 23 (11.00) and SM 32 (12.00) were on par with the lowest value. Fruit length exhibited significant variation among the genotypes with a range of 4.90 cm to 22.05 cm. The longest fruits were produced by SM 59 (22.05cm) whereas SM 3 (4.90 cm) had the smallest fruits. Girth of fruit ranged from 8.45 cm (SM 47) to 26.65 cm (SM 31). The highest fruit weight was recorded in SM 30 (246.50g) which was on par with SM 31 (244.50g) and lowest fruit weight as recorded in SM 3 (47.25g).

SM 03 (52.70) took the minimum number of days to first harvest and was on par with SM 2 (53.50), SM 4 (52.90), SM 20 (53.50) and SM 56 (53.65). SM 44 (70.35) took maximum days to first harvest while SM 26 (69.20), SM 28 (70.30), SM 32 (70.00) and SM 33 (70.15) on par with maximum days to first harvest. SM 4 (136.50) took the minimum number of days for last harvest and was on par with SM 56 (136.75). SM 22 (174.60) took maximum days for last harvest. Fruit yield per plant ranged from 774.00g (SM 16) to 4388.50g (SM 36). The highest fruit yield was recorded in SM 36 and it was followed by SM 2 (4306.00g).

FSB shoot infestation varied from 6.35 % (SM 1) to 57.50 % (SM 18). Least shot infestation was observed in SM 1 (5.75%) followed by SM 60 (9%) and SM 59 (12.75 %). FSB fruit infestation varied from 7.60 % (SM 60) to 51.00 % (SM 12). Least fruit infestation was observed in SM 60 (7.60 %) followed by SM 1 (7.75 %) and SM 59 (12.85%). Genotype SM 40 (5.06 cm) produced longest calyx length which was on par with SM 47 (5.05cm) and SM 56 (5.05cm). The shortest calyx length was observed in the genotype SM 60 (2.36cm) followed by SM 1 (2.70 cm) and SM 59 (2.55cm). The RLPS was varied from 0.17 (SM 29) to 1.00 (SM 60) and the RLSA was varied between 0.13 (SM 1) to 0.60 (SM 25). Weight of infested fruit weight was maximum in the genotype SM 30 (187.00g) followed by SM 31 (183.50g) and minimum in SM 3 (26.50g). Highest total sugar content was observed in genotype SM 45 (4.39g) and lowest was observed in SM 1(1.38g). SM 1 (22.51 mg/100 g) had the highest phenol content and SM 51 (10.45 mg/100 g) had the lowest.

4.1.3 Genetic Variability, Heritability and Genetic Advance

The population means, range, phenotypic coefficients of variation (PCV), genotypic coefficients of variation (GCV), heritability and genetic advance for the 23 characters were studied and are presented in table (12 and 13) and Figure (1 and 2).

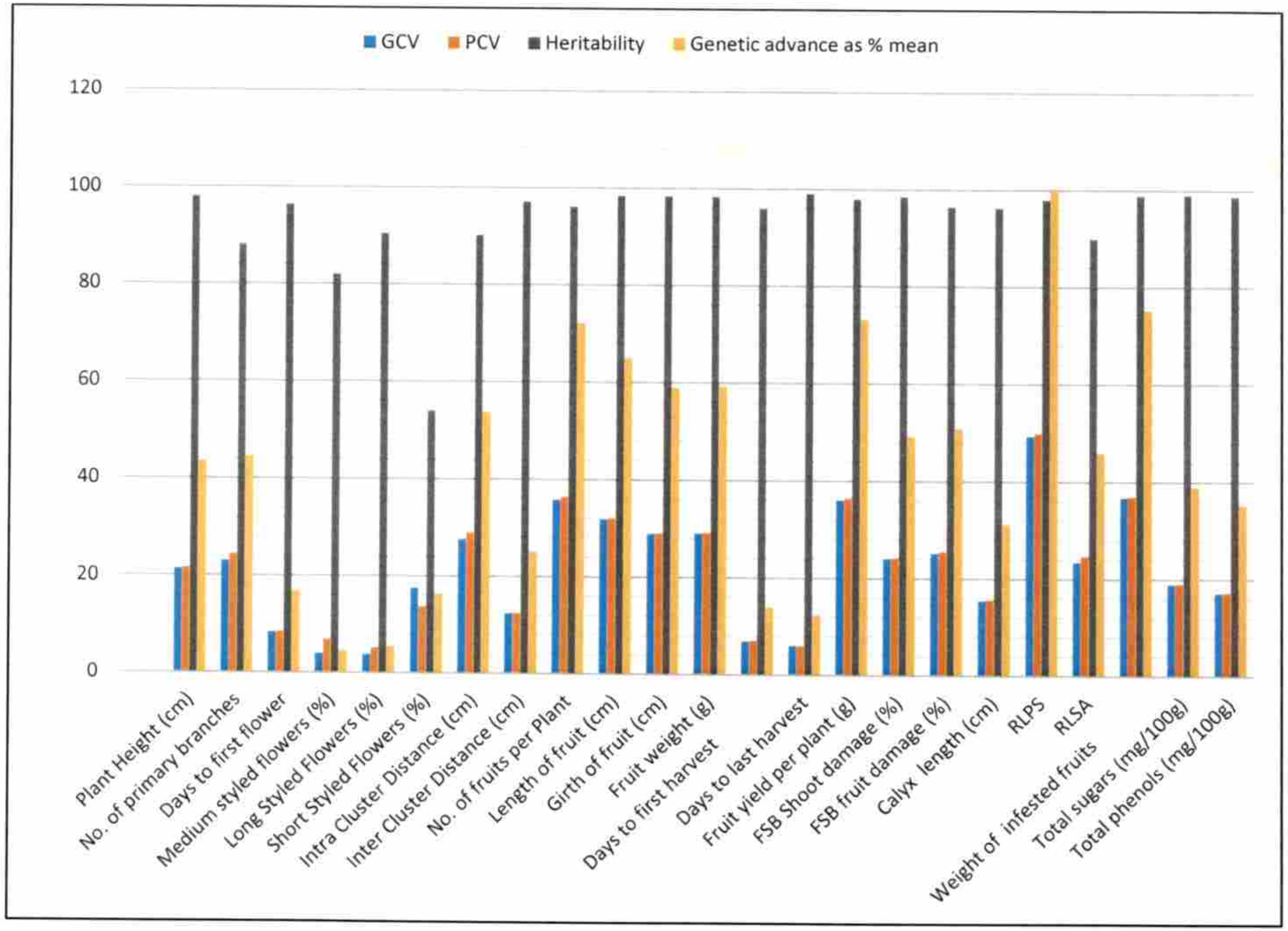
4.1.3.1 Genetic Variability, Heritability and Genetic Advance during Kharif Season.

The plant height ranged between 42.20 cm to 119 cm with a mean of 72.50 cm. The estimates of GCV and PCV were high (21.35 and 21.62, respectively). High heritability (98.00 %) was observed along with high genetic advance as per cent of mean (43.45%) and high GA (31.51%) for the trait was found. Number of primary branches per plant was varied from 3.5 to 9.32 with mean value of 5.74. The estimates of GCV and PCV were high (22.99 and 24.49, respectively). High heritability (88.11%) was observed along with high genetic advance as per cent of mean (44.46%) and low GA (2.55%). Days to first flower was varied from 33.30 to 50.50 with mean of 43.34. The estimates of GCV and PCV were low (8.34 and 8.49, respectively). High heritability (96.37%) was observed along with moderate genetic advance as per cent of mean (16.86%) and low GA (7.31%).

Percentage of medium styled flowers varied from 32.47 to 44.50 with a mean of 38.64. The estimates of GCV and PCV were low (3.91 and 6.95, respectively). High heritability (82.00%) was observed along with low genetic advance as per cent of mean (4.52%) and low GA (1.75%) for the trait was found. Percentage of long styled flowers varied from 51.13 to 61.50 with a mean of 54.93. The estimates of GCV and PCV were low (3.75 and 5.23, respectively). High heritability (90.45%) was observed along with low genetic advance as per cent of mean (5.54%) and low GA (3.04%). Percentage of

Table12: Estimates of genetic parameters for various characters of brinjal in kharif season

Character	Range		Mean	GCV	PCV	Heritability	Genetic advance at 5%	Genetic advance as % mean
	Min.	Max.						
Plant Height (cm)	42.20	119.00	72.51	21.35	21.62	98.00	31.51	43.45
No. of primary branches	3.50	9.320	5.74	22.99	24.49	88.11	2.55	44.46
Days to first flower	33.30	50.50	43.34	8.34	8.49	96.37	7.31	16.86
Medium styled flowers (%)	32.47	44.50	38.64	3.91	6.95	82.00	1.75	4.52
Long Styled Flowers (%)	51.13	61.50	54.93	3.75	5.23	90.45	3.04	5.54
Short Styled Flowers (%)	3.48	8.835	6.42	17.44	13.78	54.00	1.69	16.35
Intra Cluster Distance (cm)	0.77	2.3000	1.46	27.50	28.96	90.18	0.78	53.79
Inter Cluster Distance (cm)	5.08	10.2750	8.36	12.38	12.56	97.19	2.10	25.14
No. of fruits per Plant	11.80	40.500	19.22	35.69	36.39	96.16	13.86	72.10
Length of fruit (cm)	4.93	22.250	10.38	31.80	32.05	98.44	6.75	65.00
Girth of fruit (cm)	8.50	26.45	14.53	28.87	29.09	98.45	8.57	59.01
Fruit weight (g)	46.65	242.90	130.32	29.00	29.23	98.40	77.22	59.26
Days to first harvest	53.00	70.60	62.92	6.95	7.10	96.00	8.82	14.02
Days to last harvest	135.50	173.60	152.42	6.07	6.09	99.10	18.96	12.44
Fruit yield per plant (g)	762.10	4343.50	2142.31	35.98	36.44	98.00	1568.15	73.20
FSB Shoot damage (%)	5.75	53.90	41.00	24.05	24.22	98.58	20.17	49.20
FSB fruit damage (%)	7.50	56.00	39.51	25.14	25.59	96.51	20.10	50.88
Calyx length (cm)	2.35	5.1500	3.84	15.44	15.73	96.34	1.20	31.22
RLPS	0.11	1.0900	0.41	49.28	49.89	98.00	0.41	100.27
RLSA	0.12	0.6200	0.40	23.45	24.71	90.00	0.18	45.84
Weight of infested fruits	18.90	182.40	93.12	36.69	36.88	98.94	70.00	75.18
Total sugars (mg/100g)	1.29	4.3300	3.42	19.00	19.08	99.14	1.33	38.97
Total phenols (mg/100g)	10.74	22.3000	13.41	17.18	17.28	98.84	4.72	35.19



1. Estimates of genetic parameters for various characters of brinjal during kharif season

short styled flowers varied from 3.48 to 8.83 with a mean of 6.42. GCV and PCV was moderate (17.44 and 13.78, respectively). Moderate heritability (54.00%) was observed along with moderate genetic advance as per cent of mean (16.35%) and low GA (1.69%).

Intra cluster distance varied from 0.77 cm to 2.30 cm with mean of 1.46 cm. The estimates of GCV and PCV were high (27.50 and 28.96, respectively). High heritability (90.18%) was observed along with high genetic advance as per cent of mean (53.79%) and low GA (0.78%). Inter cluster distance varied from 5.08 cm to10.27 cm with mean of 8.36 cm. The estimates of GCV and PCV were moderate (12.38 and 12.56, respectively). High heritability (97.19%) was observed along with high genetic advance as per cent of mean (25.14%) and low GA (2.10%).

Number of fruits per plant varied from 11.80 to 40.50 with mean of 19.22. The estimates of GCV and PCV were high (35.69 and 36.39, respectively). High heritability (96.16%) was observed along with high genetic advance as per cent of mean (72.10%) and moderate GA (13.86%). Length of fruits varied from 4.93 cm to 22.25 cm with mean of 10.38 cm. The estimates of GCV and PCV were high (31.80 and 32.05, respectively). High heritability (98.44%) was observed along with high genetic advance as per cent of mean (65.00%) and low GA (6.75%).

Girth of fruits ranged between 8.50 cm to 26.45 cm with mean of 14.53 cm. The estimates of GCV and PCV were high (28.87 and 29.09, respectively). High heritability (98.45%) was observed along with high genetic advance as per cent of mean (59.01%) and low GA (8.57%). Fruit weight varied from 46.65 g to 242.90 g with mean of 130.32 g. The estimates of GCV and PCV were high (29.00 and 29.23, respectively). High heritability (98.40%) was observed along with high genetic advance as per cent of mean (59.26%) and high GA (77.22%).

Days to first harvest varied from 53.00 to 70.60 with mean of 62.92. The estimates of GCV and PCV were low (6.95 and 7.10, respectively). High heritability

(96.00%) was observed along with moderate genetic advance as per cent of mean (14.02%) and low GA (8.82%). Days to last harvest varied from 135.50 to 173.60 with mean of 152.42. The estimates of GCV and PCV were low (6.07 and 6.09, respectively). High heritability (99.10%) was observed along with moderate genetic advance as per cent of mean (12.44%) and moderate GA (18.96%). Fruit yield per plant varied from 762.10g to 4343.50g with mean of 2142.31g. The estimates of GCV and PCV were high (35.98 and 36.44, respectively). High heritability (98.00%) was observed along with high genetic advance as per cent of mean (73.20%) and high GA (1568.15%).

SFB shoot infestation varied from 5.75% to 53.90% with mean of 41.00%. The estimates of GCV and PCV were high (24.05 and 24.22, respectively). High heritability (98.58%) was observed along with high genetic advance as per cent of mean (49.20%) and moderate GA (20.17%). SFB fruit infestation varied from 7.50% to 56.00% with mean of 39.51%. The estimates of GCV and PCV were high (25.14 and 25.59, respectively). High heritability (96.51%) was observed along with high genetic advance as per cent of mean (50.88%) and moderate GA (20.10%).

Calyx length varied from 2.35 cm to 5.15 cm with mean of 3.84 cm. The estimates of GCV and PCV were moderate (15.44 and 15.73, respectively). High heritability (96.34%) was observed along with high genetic advance as per cent of mean (31.22%) and low GA (1.20%). RLPS varied from 0.11 cm to 1.09 cm with mean of 0.41 cm. The estimates of GCV and PCV were high (49.28 and 49.89, respectively). High heritability (98.00%) was observed along with high genetic advance as per cent of mean (100.27%) and low GA (0.41%). RLSA varied from 0.12 cm to 0.62 cm with mean of 0.40 cm. The estimates of GCV and PCV were high (23.45 and 24.71, respectively). High heritability (90.00%) was observed along with high genetic advance as per cent of mean (45.84%) and low GA (0.18%). Weight of infested fruits varied from 18.90g to 182.40g with mean of 93.12. The estimates of GCV and PCV were high (36.69 and 36.88, respectively). High heritability (98.94%) was observed along with high genetic advance as per cent of mean (75.18%) and high GA (70.00%).

Total sugars varied from 1.29g to 4.33g with mean of 3.42g. The estimates of GCV and PCV were moderate (19.00 and 19.08, respectively). High heritability (99.14%) was observed along with high genetic advance as per cent of mean (38.97%) and low GA (1.33%). Total phenols varied from 10.74mg/g to 22.30 mg/g with mean of 13.41mg/g. The estimates of GCV and PCV were moderate (17.18 and 17.28, respectively). High heritability (98.84%) was observed along with high genetic advance as per cent of mean (35.19%) and low GA (4.72%).

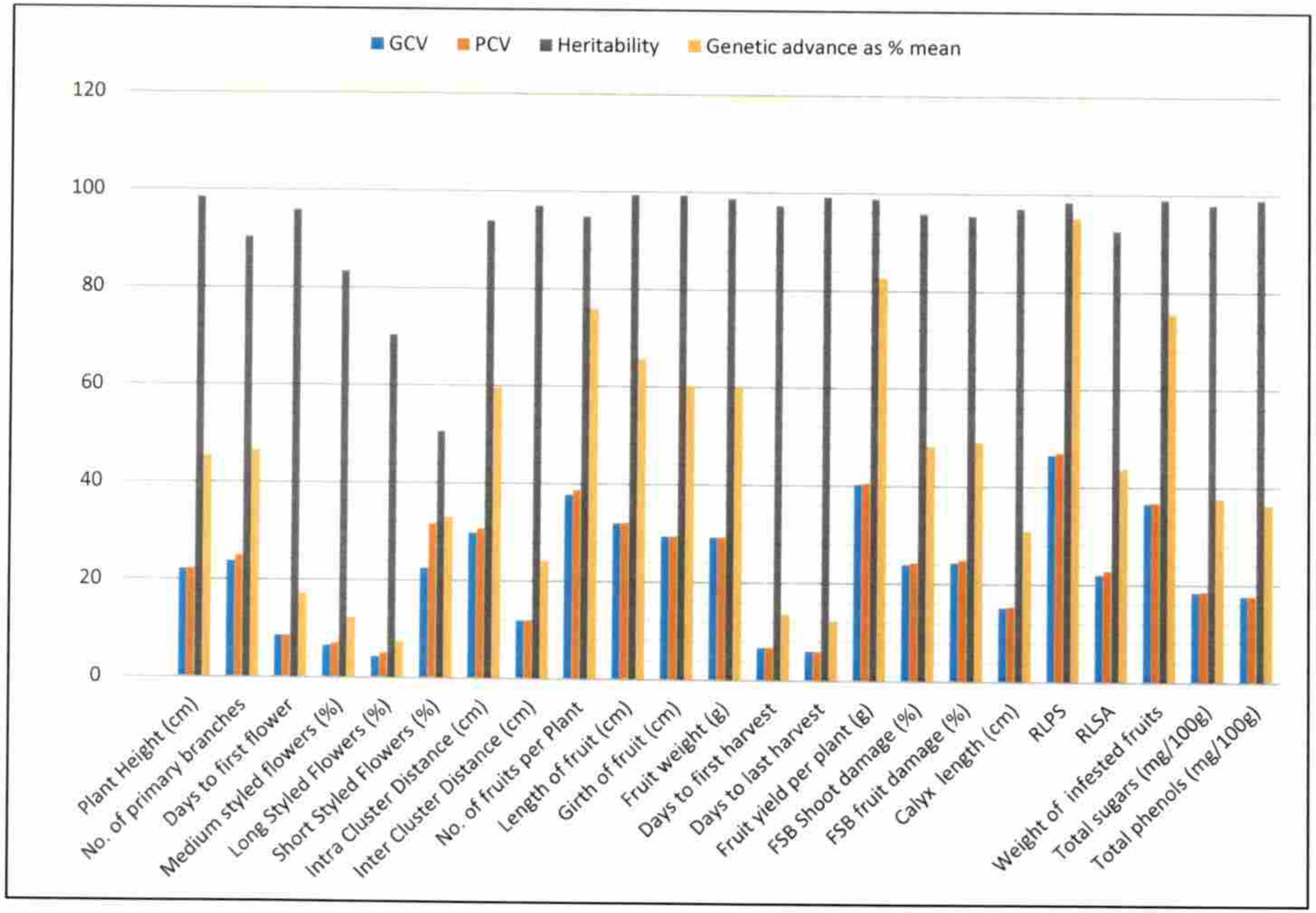
4.1.3.2 Genetic Variability, Heritability and Genetic Advance during Rabi Season.

The plant height ranged between 41.40 cm to 119.90 cm with a mean of 71.80 cm. The estimates of GCV and PCV were high (22.13 and 22.29, respectively). High heritability (98.49%) was observed along with high genetic advance as per cent of mean (45.24%) and high GA (32.48%) for the trait was found. Number of primary branches per plant was varied from 3.0 to 9.30 with mean of 5.64. The estimates of GCV and PCV were high (23.74 and 24.96, respectively). High heritability (90.45%) was observed along with high genetic advance as per cent of mean (46.51%) and low GA (2.62%). Days to first flower ranged from 32.90 to 50.50 with mean of 42.90. The estimates of GCV and PCV were low (8.55 and 8.73, respectively). High heritability (95.85%) was observed along with moderate genetic advance as per cent of mean (17.25%) and low GA (7.40%).

Percentage of medium styled flowers varied from 33.50 to 47.85 with a mean of 40.39. The estimates of GCV and PCV were low (6.56 and 7.18, respectively). High heritability (83.48%) was observed along with moderate genetic advance as per cent of mean (12.34%) and low GA (4.99%) for the trait was found. Percentage of long styled flowers varied from 46.05 to 59.15 with a mean of 53.00. The estimates of GCV and PCV were low (4.33 and 5.15, respectively). High heritability (70.43%) was observed

Table 13: Estimates of genetic parameters for various characters of brinjal in rabi season

Character	Range		Mean	GCV	PCV	Heritability	Genetic advance at 5%	Genetic advance as % mean
	Min.	Max.						
Plant Height (cm)	41.40	119.90	71.80	22.13	22.29	98.49	32.48	45.24
No. of primary branches	3.00	9.30	5.64	23.74	24.96	90.45	2.62	46.51
Days to first flower	32.9000	50.50	42.90	8.55	8.73	95.85	7.40	17.25
Medium styled flowers (%)	33.50	47.85	40.39	6.56	7.18	83.48	4.99	12.34
Long Styled Flowers (%)	46.05	59.15	53.00	4.33	5.15	70.43	3.96	7.48
Short Styled Flowers (%)	3.20	11.35	6.59	22.51	31.64	50.64	2.17	33.01
Intra Cluster Distance (cm)	0.80	2.45	1.46	29.80	30.75	93.94	0.87	59.50
Inter Cluster Distance (cm)	5.05	10.37	8.44	11.88	12.06	97.03	2.03	24.11
No. of fruits per Plant	10.10	41.75	18.26	37.76	38.76	94.88	13.83	75.77
Length of fruit (cm)	4.90	22.05	10.43	31.97	32.07	99.39	6.85	65.67
Girth of fruit (cm)	8.45	26.65	14.49	29.33	29.41	99.43	8.73	60.25
Fruit weight (g)	47.25	246.50	131.00	29.20	29.26	98.80	78.61	60.01
Days to first harvest	52.70	70.35	62.50	6.72	6.81	97.43	8.54	13.67
Days to last harvest	136.50	174.60	152.56	6.02	6.04	99.24	18.85	12.35
Fruit yield per plant (g)	774.00	4388.50	2024.29	40.30	40.52	98.93	1671.67	82.58
FSB Shoot damage (%)	6.35	57.50	39.81	23.83	24.34	95.87	19.13	48.06
FSB fruit damage (%)	7.60	51.00	38.03	24.35	24.92	95.50	18.65	49.03
Calyx length (cm)	2.36	5.06	3.86	15.20	15.43	97.11	1.19	30.87
RLPS	0.17	0.99	0.43	46.54	46.89	98.50	0.41	95.15
RLSA	0.13	0.60	0.41	22.00	22.87	92.57	0.18	43.61
Weight of infested fruits	26.50	187.00	93.50	36.74	36.83	99.00	70.58	75.49
Total sugars (mg/100g)	1.37	4.39	3.45	18.45	18.64	97.97	1.30	37.63
Total phenols (mg/100g)	10.45	22.51	13.38	17.71	17.76	99.00	4.87	36.38



2. Estimates of genetic parameters for various characters of brinjal during rabi season

along with low genetic advance as per cent of mean (7.48%) and low GA (3.96%). Percentage of short styled flowers varied from 3.20 to 11.35 with a mean of 6.59. GCV and PCV were moderate (12.51 and 18.64, respectively). Moderate heritability (50.64%) was observed along with moderate genetic advance as per cent of mean (15.01%) and low GA (2.17%).

Intra cluster distance varied from 0.80 cm to 2.45 cm with mean of 1.46 cm. The estimates of GCV and PCV were high (29.80 and 30.75, respectively). High heritability (93.94%) was observed along with high genetic advance as per cent of mean (59.50%) and low GA (0.87%). Inter cluster distance varied from 5.05 cm to10.37 cm with mean of 8.44 cm. The estimates of GCV and PCV were moderate (11.88 and 12.06, respectively). High heritability (97.03%) was observed along with high genetic advance as per cent of mean (24.11%) and low GA (2.03%).

Number of fruits per plant varied from 10.10 to 41.75 with mean of 18.26. The estimates of GCV and PCV were high (37.76 and 38.76, respectively). High heritability (94.88%) was observed along with high genetic advance as per cent of mean (75.77%) and moderate GA (13.83%). Length of fruits per plant varied from 4.90 cm to 22.05 cm with mean of 10.43 cm. The estimates of GCV and PCV were high (31.97 and 32.07, respectively). High heritability (99.39%) was observed along with high genetic advance as per cent of mean (65.67%) and low GA (6.85%). Girth of fruits ranged between 8.45 cm to 26.65 cm with mean of 14.49 cm. The estimates of GCV and PCV were high (29.33 and 29.41, respectively). High heritability (99.43%) was observed along with high genetic advance as per cent of mean (60.25%) and low GA (8.73%). Fruit weight varied from 47.25 g to 246.50 g with mean of 131.00 g. The estimates of GCV and PCV were high (29.20 and 29.26, respectively). High heritability (98.80%) was observed along with high genetic advance as per cent of mean (60.01%) and high GA (78.61%).

Days to first harvest varied from 52.70 to 70.35 with mean of 62.50. The estimates of GCV and PCV were low (6.72 and 6.81, respectively). High heritability

(97.43%) was observed along with moderate genetic advance as per cent of mean (13.67%) and low GA (8.54%). Days to last harvest varied from 136.50 to 174.60 with mean of 152.56. The estimates of GCV and PCV were low (6.02 and 6.04, respectively). High heritability (99.24%) was observed along with moderate genetic advance as per cent of mean (12.35%) and moderate GA (18.85%).

Fruit yield per plant varied from 774.00g to 4388.50g with mean of 2024.29g. The estimates of GCV and PCV were high (40.30 and 40.52, respectively). High heritability (98.93%) was observed along with high genetic advance as per cent of mean (82.58%) and high GA (1671.67%).

SFB Shoot infestation varied from 6.35% to 57.50% with mean of 39.81%. The estimates of GCV and PCV were high (23.83 and 24.34, respectively). High heritability (95.87%) was observed along with high genetic advance as per cent of mean (48.06%) and moderate GA (19.13%). SFB fruit infestation varied from 7.60% to 51.00% with mean of 38.03%. The estimates of GCV and PCV were high (24.35 and 24.92, respectively). High heritability (95.50%) was observed along with high genetic advance as per cent of mean (49.03%) and moderate GA (18.65%).

Calyx length varied from 2.36 cm to 5.06 cm with mean of 3.86 cm. The estimates of GCV and PCV were moderate (15.20 and 15.43, respectively). High heritability (97.11%) was observed along with high genetic advance as per cent of mean (30.87%) and low GA (1.19%). RLPS varied from 0.17 cm to 0.99 cm with mean of 0.43 cm. The estimates of GCV and PCV were high (46.54 and 46.89, respectively). High heritability (98.50%) was observed along with high genetic advance as per cent of mean (95.15%) and low GA (0.41%). RLSA varied from 0.13 cm to 0.60 cm with mean of 0.41 cm. The estimates of GCV and PCV were high (22.00 and 22.87, respectively). High heritability (92.57%) was observed along with high genetic advance as per cent of mean (43.61%) and low GA (0.18%). Weight of infested fruits varied from 26.50g to 187.00g with mean of 93.50. The estimates of GCV and PCV were high (36.74 and 36.83, respectively). High heritability (99.00%) was observed along with high genetic advance as per cent of mean (75.49%) and high GA (70.58%).

Total sugars varied from 1.37g to 4.39g with mean value of 3.45g. The estimates of GCV and PCV were moderate (18.45 and 18.64, respectively). High heritability (97.97%) was observed along with high genetic advance as per cent of mean (37.63%) and low GA (1.30%). Total phenols varied from 10.45mg/g to 22.51 mg/g with mean value of 13.38mg/g. The estimates of GCV and PCV were moderate (17.71 and 17.76, respectively). High heritability (99.00%) was observed along with high genetic advance as per cent of mean (36.38%) and low GA (4.87%).

4.1.4 Correlation Studies

The phenotypic and genotypic correlation coefficients were worked out for twenty three (morphological, yield and yield attributing) characters for sixty genotypes based on data obtained from kharif and rabi seasons. It was evident from the table that, the values of genotypic correlation coefficient were greater than the values of phenotypic correlation co efficient for most of the characters.

4.1.4.1 Phenotypic Correlation Coefficients

Phenotypic correlation coefficients of kharif and rabi seasons were presented in table 14 and 15 respectively.

Fruit yield per plant showed significant positive correlation with fruits per plant (0.7765 and 0.8217), fruit weight (0.5367 and 0.4654), weight of infested fruit (0.4646 and 0.4084), girth of fruit (0.3482 and 0.3053), plant height (0.3298 and 0.3877), number of primary branches per plant (0.3015 and 0.3684), percentage of medium styled flowers (0.2851 and 0.2778), length of fruits (0.2287 and 0.2396) and percentage of long styled flowers (0.2009 and 0.2297) respectively in both seasons. It exhibited significant negative correlation with fruit infestation by fruit and shoot borer (-0.4309 and -0.4283), SFB shoot infestation (-0.3657 and -0.3743), percentage of short styled flowers (-0.0445 and -0.0285), calyx length (-0.2584 and -0.3169), intra cluster

Table: 14.Phenotypic correlation coefficients for growth, yield and morphological characters in kharif season

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	1.00											
X2	0.53**	1.0000										
X3	-0.12	-0.0375	1.0000									
X4	-0.03	-0.0845	-0.0193	1.0000								
X5	0.15	0.1149	-0.1354	-0.804**	1.0000							
X6	-0.20*	-0.0998	0.3010**	0.1226	-0.572**	1.0000						
X7	-0.18*	-0.1717	-0.0757	0.1994*	-0.241**	0.1181	1.0000					
X8	-0.009	-0.1613	0.0823	0.1201	-0.2217*	0.2032*	0.1027	1.0000				
X9	0.3842**	0.4555**	-0.0508	0.0084	0.1660	-0.340**	-0.268**	-0.2247*	1.0000			
X10	0.2205*	0.1472	0.1523	-0.1443	0.1586	-0.0489	0.0559	0.2708**	0.1690	1.0000		
X11	-0.1537	-0.0542	-0.1130	0.1207	-0.079	-0.0698	0.0533	-0.235**	0.1503	-0.300**	1.0000	
X12	-0.0979	-0.1211	-0.0415	-0.1040	0.1455	-0.1087	-0.0386	-0.0086	0.0586	0.1593	0.6459**	1.0000
X13	-0.260**	-0.1544	0.8695**	0.0384	-0.248**	0.4070**	0.0751	0.1167	-0.1860*	0.1124	-0.0432	-0.0119
X14	-0.332**	-0.250**	0.7176**	-0.0040	-0.2050*	0.3952**	0.1741	0.1104	-0.1975*	0.1559	-0.0635	-0.0394
X15	0.329**	0.3015**	-0.0539	-0.0445	0.200*	-0.285**	-0.2241*	-0.1580	0.7765**	0.2287*	0.3482**	0.5367**
X16	-0.375**	-0.282**	-0.1030	0.0887	-0.294**	0.4119**	-0.1777	-0.303**	-0.449**	-0.1477	0.0102	0.0060
X17	-0.368**	-0.229*	-0.0504	0.2400**	-0.418**	0.4116**	0.2824**	0.1459	-0.384**	-0.273**	0.0414	-0.1750
X18	-0.291**	-0.261**	0.0721	-0.0761	-0.0426	0.2189*	0.0751	0.4306**	-0.453**	0.0238	-0.1101	0.0694
X19	0.1791	0.2014*	0.1388	-0.253**	0.3662**	-0.2369*	-0.261**	-0.0796	0.1348	0.1863	-0.2315*	0.0045
X20	-0.0543	-0.0657	-0.0898	0.0610	-0.1269	0.1079	0.0894	0.2059*	-0.1987*	-0.0508	-0.1824	-0.1003
X21	-0.0314	-0.0547	-0.0072	-0.1087	0.1177	-0.0404	-0.1264	-0.0122	0.0602	0.1986*	0.5502**	0.8743**
X22	-0.0967	-0.1131	-0.0464	0.0504	-0.2098*	0.3227**	-0.0436	0.2032*	-0.1194	-0.1224	-0.0502	0.0125
X23	0.1290	0.2142*	0.1427	-0.0584	0.1971*	-0.268**	-0.0236	-0.1775	0.2453**	0.2539**	-0.0164	-0.0235

Table: 14. Continued.

Character	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X13	1.0000										
X14	0.9132**	1.0000									
X15	-0.1596	-0.1843*	1.0000								
X16	0.0157	0.0988	-0.3657**	1.0000							
X17	0.0424	0.1051	-0.4309**	0.7741**	1.0000						
X18	0.1848*	0.1622	-0.2584**	-0.5143**	0.2916**	1.0000					
X19	-0.0453	-0.1779	0.1060	-0.5772**	0.5780**	-0.1031	1.0000				
X20	-0.0742	-0.0748	-0.1923*	-0.5177**	0.5343**	0.1769	-0.4000**	1.0000			
X21	-0.0200	-0.0362	0.4646**	-0.0484	-0.2218*	0.0336	0.0598	-0.1573	1.0000		
X22	0.0461	0.1029	0.0407	0.4622**	0.3399**	0.3003**	-0.4657**	0.3695**	-0.0872	1.0000	
X23	0.0040	-0.0916	0.0756	-0.5721**	-0.4207**	-0.2788**	0.5878**	-0.4612**	0.0815	-0.8847**	1.0000

X1. Plant height (cm) X6.Short styled flowers (%) X11.Girth of fruit (cm) X16. FSB Shoot damage (%) X21. Weight of infested fruits

X2. No.of Primary branches X7. Intra cluster distance (cm) X12.Fruit weight (g) X17. FSB Fruit damage (%) X22. Total sugars (mg/100g)

X3. Days to first flowering X8.Inter cluster distance (cm) X13.Days to first harvest X18. Calyx length (cm) X23. Total phenols(mg/100g)

X4. Medium styled flowers (%) X9. Fruits per plant X14.Days to last harvest X19. RLPS

X5.Long styled flowers (%) X10.Length of fruit (cm) X15. Fruit yield per plant(g) X20. RLSA

Table 15. Phenotypic correlation coefficients for growth, yield and morphological characters in rabi season

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	1.0000											
X2	0.5531**	1.0000										
X3	-0.1265	-0.0998	1.0000									
X4	0.0852	-0.0641	-0.0378	1.0000								
X5	0.1209	0.2319*	-0.2169*	-0.719**	1.0000							
X6	-0.277**	-0.2039*	0.3534**	-0.390**	-0.318**	1.0000						
X7	-0.1744	-0.1980*	-0.0789	0.0727	-0.0498	-0.0338	1.0000					
X8	0.0303	-0.1621	0.1499	0.1383	-0.2404	0.1307	0.0823	1.0000				
X9	0.4494**	0.4859**	-0.1358	-0.0543	0.2473**	-0.240**	-0.2936	-0.1901*	1.0000			
X10	0.2477**	0.1923*	0.1606	-0.0269	0.1870*	-0.2075*	-0.0009	0.3131**	0.2023*	1.0000		
X11	-0.1817*	0.0224	-0.1223	-0.0079	-0.0108	-0.0007	0.1409	-0.243**	0.0695	-0.307**	1.0000	
X12	-0.1036	-0.0473	-0.0316	-0.1183	0.1326	-0.0201	0.0681	0.0056	0.0753	0.1536	0.6572**	1.0000
X13	-0.2252*	-0.1433	0.8425**	0.0511	-0.255**	0.2587**	0.1110	0.1013	-0.2160*	0.1188	-0.0185	0.0036
X14	-0.304**	-0.254**	0.7166**	0.0540	-0.2111*	0.2101*	0.1602	0.1119	-0.274**	0.1338	-0.0688	-0.0573
X15	0.3877**	0.3684**	-0.1231	-0.0285	0.2297*	-0.277**	-0.1921	-0.1137	0.8217**	0.2396*	0.3053**	0.4654**
X16	-0.385**	-0.2117*	-0.0188	0.1537	-0.273**	0.1617	-0.1403	-0.288**	-0.492**	-0.1170	-0.0116	-0.0336
X17	-0.386**	-0.270**	-0.0213	0.1585	-0.294**	0.1730	0.2759**	0.1156	-0.468**	-0.267**	0.0554	-0.1719
X18	-0.287**	-0.247**	0.1523	0.0471	-0.1709	0.1493	0.1215	0.4179**	-0.480**	0.0199	-0.1338	0.0528
X19	0.2128*	0.2074*	0.1673	-0.271**	0.2515**	0.0607	-0.2622	-0.0310	0.2450**	0.2223*	-0.281**	-0.0230
X20	-0.0633	-0.0373	-0.0359	0.1291	-0.251**	0.1537	0.0595	0.1889*	-0.251**	-0.0510	-0.2236*	-0.1330
X21	-0.0677	-0.0008	-0.0085	-0.1388	0.1875*	-0.0804	-0.0141	-0.0261	0.0777	0.1657	0.5705**	0.8782**
X22	-0.0745	-0.0601	-0.0060	0.1131	-0.2022*	0.1488	-0.0286	0.1894*	-0.1458	-0.1083	-0.0571	-0.0119
X23	0.1179	0.1640	0.0912	-0.1504	0.2814**	-0.1865*	-0.0129	-0.1595	0.2714**	0.2570**	0.0008	-0.0175

Table: 15. Continued.

Character	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X13	1.0000										
X14	0.9176**	1.0000									
X15	-0.1549	-0.2152*	1.0000								
X16	0.0299	0.1419	-0.3743**	1.0000							
X17	0.0678	0.1762	-0.4283**	0.6847**	1.0000						
X18	0.2160*	0.2037*	-0.3169**	-0.5156**	0.2452**	1.0000					
X19	-0.0311	-0.1193	0.1113	-0.5144**	0.6434**	-0.0973	1.0000				
X20	-0.0841	-0.0808	-0.2262*	-0.5143**	0.5337**	0.2325*	-0.3521**	1.0000			
X21	-0.0053	-0.0544	0.4084**	-0.0616	-0.1880*	0.0273	0.0053	-0.1953*	1.0000		
X22	0.0318	0.0748	0.0135	0.4512**	0.3930**	0.3002**	-0.4034**	0.3543**	-0.0978	1.0000	
X23	0.0206	-0.0667	0.0879	-0.5658**	-0.4617**	-0.2747**	0.5364**	-0.4700**	0.0657	-0.8643**	1.0000

X1. Plant height (cm) X6.Short styled flowers (%) X11.Girth of fruit (cm) X16. FSB Shoot damage (%) X21. Weight of infested fruits

X2. No.of Primary branches X7. Intra cluster distance (cm) X12.Fruit weight (g) X17. FSB Fruit damage (%) X22. Total sugars (mg/100g)

X3. Days to first flowering X8.Inter cluster distance (cm) X13.Days to first harvest X18. Calyx length (cm) X23. Total phenols (mg/100g)

X4. Medium styled flowers (%) X9. Fruits per plant X14.Days to last harvest X19. RLPS

X5.Long styled flowers (%) X10.Length of fruit (cm) X15. Fruit yield per plant (g) X20. RLSA

distance (-0.2241 and -0.1921), RLSA (-0.1923 and -0.2262), and days to last harvest (-0.1843 and -0.2152) respectively in both seasons.

Plant height showed significant positive correlation with number of primary branches per plant (0.5358 and 0.5531), fruits per plant (0.3842 and 0.4494), fruit yield per plant (0.3298and 0.3877) and length of fruits (0.2205 and 0.2477) respectively in both the season but it was also showed significant positive correlation with RLPS (0.2128) in kharif season only. It also exhibited significant negative correlation with SFB shoot infestation (-0.3754 and -0.3858), SFB fruit infestation (-0.3688 and -0.3869), days to last harvest (-0.3320 and -0.3048), calyx length (-0.2913 and -0.2876), days to first harvest (-0.2607 and -0.2252) and percentage of short styled flowers (-0.2310 and -0.2277) respectively in both seasons. It also showed significant negative correlation with intra cluster distance (-0.1828) and girth of fruit (-0.1817) in the kharif and rabi seasons respectively.

Number of primary branches showed significant positive correlation with fruits per plant (0.4555 and 0.4859), fruit yield per plant (0.3015 and 0.3684) and RLPS (0.2014 and 0.2074) respectively in both the seasons. It also showed significant positive correlation with total sugars (0.2142) in the kharif season only. It showed significant positive correlation with percentage of long styled flowers (0.2319) and length of fruits (0.1923) in rabi season only. It also exhibited significant negative correlation with SFB shoot infestation (-0.2825 and -0.2117), calyx length (-0.2610 and -0.2476), days to last harvest (-0.2503 and -0.2544) and SFB fruit infestation (-0.2293 and -0.2702) respectively in both seasons. It also showed significant negative correlation with percentage of short styled flowers (-0.2039) and intra cluster distance (-0.1980) in rabi season only.

Days to first flower showed significant positive correlation with days to first harvest (0.8425 and 0.8695), days to last harvest (0.7166 and 0.7176) and percentage of short styled flowers (0.3010 and 0.3534) respectively in both seasons. It also showed significant negative correlation with percentage of long styled flowers (-0.2169) in first season only.

Percentage of medium styled flowers showed significant positive correlation with fruit infestation by fruit and shoot borer (0.2400) and intra cluster distance (0.1994) in first season only. It also showed significant negative correlation with percentage of long styled flowers (-0.8040 and -0.7194) and RLPS (-0.2530 and -0.2716) respectively in both seasons. It also exhibited significant negative correlation with percentage of short styled flowers (-0.3906) in rabi season only.

Percentage of long styled flowers showed significant positive correlation with RLPS (0.3662and 0.2515), fruit yield per plant (0.2009 and 0.2297) and total phenols (0.1971 and 0.2814) respectively in both seasons. It also showed significant positive correlation with fruits per plant (0.2473), weight of infested fruits (0.1875) and length of fruits (0.1870) in rabi season only. It also showed significant negative correlation with percentage of short styled flowers (-0.5727 and -0.3189), SFB fruit infestation (-0.4187 and -0.2943), SFB shoot infestation (-0.2946 and -0.2735), days to first harvest (-0.2485 and -0.2558), inter cluster distance (-0.2217 and -0.2404), total sugars (-0.2098 and -0.2022) and days to last harvest (-0.2050 and -0.2111) respectively in both seasons. It also exhibited significant negative correlation with intra cluster distance (-0.2419) and RLSA (-0.2513) respectively in kharif and rabi season.

Percentage of short styled flowers showed significant positive correlation with days to first harvest (0.4070 and 0.2587) and days to last harvest (0.3952 and 2101) respectively in both the seasons. It showed significant positive correlation with SFB shoot infestation (0.4119), SFB fruit infestation (0.4116), total sugars (0.3227), calyx length (0.2189) and inter cluster distance (0.2032) in kharif season only. It also exhibited significant negative correlation with fruits per plant (-0.3406 and -0.2400), fruit yield per plant (-0.2851 and -0.2278) and total phenols (-0.2688 and -0.1865) respectively in both the seasons. It also showed significant negative correlation with RLPS (-0.2369) and length of fruits (-0.2400) respectively in kharif and rabi season.

Intra cluster distance had showed significant positive correlation with fruit infestation by shoot and fruit borer (0.2824 and 0.2759) respectively in kharif and rabi season. It also had significant negative correlation with SFB shoot infestation (-0.1777 and -0.1403), fruits per plant (-0.2682 and -0.2936), RLPS (-0.2617 and -0.2622) and fruit yield per plant (-0.2241 and -0.1921) respectively in both season. Inter cluster distance showed significant positive correlation with calyx length (0.4306 and 0.4179), length of fruits (0.2708 and 0.3131), RLSA (0.2059 and 0.1889) and total sugars (0.2032 and 0.1894) respectively in both seasons. It also exhibited significant negative correlation with SFB shoot infestation (-0.3034 and -0.2881), girth of fruit (-0.2353 and -0.2432) and fruits per plant (-0.2247 and -0.1901) respectively in both seasons.

Fruits per plant had significant positive correlation with fruit yield per plant (0.8217 and 0.7765), total phenols (0.2714 and 0.2453) respectively in both the season. It also showed significant positive correlation with RLPS (0.2450) and length of fruits (0.2023) in rabi season only. Fruits per plant showed significant negative correlation with calyx length (-0.4530 and -0.4801), SFB shoot infestation (-0.4491 and -0.4924), SFB fruit infestation (-0.3846 and -0.4683), RLSA (-0.1987 and -0.2517), days to last harvest (-0.1975 and -0.2744) and days to first harvest (-0.1860 and -0.2160) respectively in both the seasons.

Length of fruits showed significant positive correlation with total phenols (0.2539 and 0.2570), fruit yield per plant (0.2287 and 0.2396) and RLPS (0.1863 and 0.2223) respectively in both the seasons. It also had significant positive correlation with weight of infested fruits (0.1986) in kharif season only. It showed significant negative correlation with girth of fruit (-0.3006 and -0.3072) and SFB fruit infestation (-0.2734 and -0.2675) respectively in both seasons. Girth of fruit showed significant positive correlation with fruit weight (0.6459 and 0.6572), weight of infested fruits (0.5502 and 0.5705) , fruit yield per plant (0.3482 and 0.3053) and it also showed significant negative correlation with RLPS (-0.2315 and -0.2817) and RLSA (-0.1824 and -0.2236) respectively in both seasons. Fruit weight showed significant positive correlation with weight of infested fruits (0.8743 and 0.8782) and fruit yield per plant (0.5367 and 0.4654) respectively in both the seasons.

Days to first harvest showed significant positive correlation with days to last harvest (0.9132 and 0.9176) and calyx length (0.1848 and 0.2160) respectively in both the seasons whereas days to last harvest showed significant positive correlation with calyx length (0.2037) in second season only. It also showed significant negative correlation with fruit yield per plant (-0.1843 and -0.2152) in both seasons.

SFB shoot infestation showed significant positive correlation with SFB fruit infestation (0.7741 and 0.6847) and total sugars (0.4622 and 0.4512) respectively in both seasons. It also showed significant negative correlation with RLPS (-0.5772 and -0.5144), RLSA (-0.5177 and -0.5143), calyx length (-0.5143 and -0.5156) and total phenols (-0.5721 and -0.5658) respectively in Kharif and rabi seasons.

SFB fruit infestation showed significant positive correlation with RLSA (0.5343 and 0.5337), RLPS (-0.5780 and -0.6434), total sugars (0.3399 and 0.3930) and calyx length (0.2916 and 0.2452) respectively in both seasons. It also showed significant negative correlation with, total phenols (-0.4207 and -0.4617) and weight of infested fruits (-0.2218 and -0.1880) respectively in both seasons.

Calyx length had significant positive correlation with total sugars (0.3003 and 0.3002) respectively in both the seasons and it also had significant positive correlation with RLSA (0.2325) in kharif season only. It showed significant negative correlation with total phenols (-0.2788 and -0.2747) in both the seasons respectively.

RLPS had significant positive correlation with total phenols (0.5878 and 0.5364) and significant negative correlation with total sugars (-0.4657 and -0.4034) and RLSA (-0.4000 and -0.3521) in both the seasons respectively. RLSA had significant positive correlation with total sugars (0.3695 and 0.3543) and significant negative correlation with total phenols (-0.4612 and -0.4700) in both seasons respectively. It also showed significant negative correlation with weight of infested fruits (-0.1953) in rabi season only. Total sugars had significant negative correlation with total phenols (-0.8847 and -0.8643) in both the seasons respectively. Total sugars had significantly negative correlation with total phenols (-0.8847 and -0.8643) in both the seasons respectively.

4.1.4.2 Genotypic Correlation Coefficients

Genotypic correlation coefficients were higher than phenotypic correlation for the characters under study. Genotypic correlation coefficients in both kharif and rabi seasons were presented in table 16 and 17 respectively.

Fruit yield per plant showed significant positive correlation with fruits per plant (0.8024 and 0.8491), fruit weight (0.5426 and 0.4693), weight of infested fruit (0.4743 and 0.4107), girth of fruit (0.3543 and 0.3069), plant height (0.3397 and 0.3926), number of primary branches per plant (0.3288 and 0.3903), percentage of medium styled flowers (0.3599 and 0.3849), percentage of long styled flowers (0.2563 and 0.2655), length of fruits (0.2337 and 0.2407) respectively in both the seasons. It exhibited significant negative correlation with SFB fruit infestation (-04436 and -0.4392), SFB shoot infestation (-0.3724 and -0.3782), percentage of short styled flowers (-0.1090 and -0.0215), calyx length (-0.2588 and -0.3219), intra cluster distance (-0.2432 and -0.1935), RLSA (-0.2127 and -0.2349), and days to last harvest (-0.1886 and -0.2161) respectively in kharif and rabi seasons.

Plant height showed significant positive correlation with number of primary branches per plant (0.5582 and 0.5788), fruits per plant (0.3969 and 0.4644), fruit yield per plant (0.3397 and 0.3926) and length of fruits (0.2276 and 0.2540) and RLPS (0.1814 and 0.2189) respectively in both seasons but it was also showed significant positive correlation with percentage of long styled flowers (0.2072) in kharif season only. It also exhibited significant negative correlation with SFB shoot infestation (-0.3860 and -0.4015), SFB fruit infestation (-0.3758 and -0.3967), days to last harvest (-0.3384 and -0.3074), percentage of short styled flowers (-0.3072 and -0.3926), calyx

Table 16. Genotypic correlation coefficients for growth, yield and morphological characters in kharif season

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	1.0000											
X2	0.5582**	1.0000										
X3	-0.1238	-0.0213	1.0000									
X4	-0.0604	-0.0684	-0.0535	1.0000								
X5	0.2072*	0.1222	-0.1979*	-0.974**	1.0000							
X6	-0.307**	-0.0955	0.4198**	-0.461**	-0.329**	1.0000						
X7	-0.1924*	-0.2066*	-0.0893	0.3248**	-0.321**	0.1376	1.0000					
X8	-0.0097	-0.1791	0.0803	0.2388*	-0.336**	0.3071**	0.0994	1.0000				
X9	0.3969**	0.4914**	-0.0565	0.0637	0.2049*	-0.460**	-0.286**	-0.233**	1.0000			
X10	0.2276*	0.1608	0.1628	-0.272**	0.2480**	-0.0797	0.0571	0.2739**	0.1762	1.0000		
X11	-0.1573	-0.0580	-0.1163	0.1945*	-0.0951	-0.1067	0.0622	-0.239**	0.1592	-0.305**	1.0000	
X12	-0.0986	-0.1359	-0.0442	-0.1388	0.1477	-0.0830	-0.0391	-0.0065	0.0621	0.1646	0.6558**	1.0000
X13	-0.274**	-0.1565	0.9029**	-0.0142	-0.270**	0.5104**	0.0774	0.1165	-0.1858*	0.1160	-0.0475	-0.0063
X14	-0.338**	-0.274**	0.7321**	-0.0039	-0.291**	0.5501**	0.1860*	0.1157	-0.2076*	0.1618	-0.0641	-0.0429
X15	0.3397**	0.3288**	-0.0618	-0.1090	0.2563**	-0.359**	-0.243**	-0.1598	0.8024**	0.2337*	0.3543**	0.5426**
X16	-0.386**	-0.305**	-0.1040	0.1868*	-0.437**	0.5775**	0.1945*	0.3083**	-0.459**	-0.1473	0.0087	0.0047
X17	-0.375**	-0.245**	-0.0567	0.3907**	-0.599**	0.5513**	0.2968**	0.1507	-0.399**	-0.281**	0.0489	-0.1795
X18	-0.296**	-0.274**	0.0792	-0.1344	-0.0405	0.2744**	0.0868	0.4420**	-0.480**	0.0224	-0.1119	0.0793
X19	0.1814*	0.2168*	0.1387	-0.503**	0.5345**	-0.353**	-0.269**	-0.0778	0.1447	0.1898*	-0.240**	0.0053
X20	-0.0660	-0.0810	-0.0962	0.2597**	-0.292**	0.2562**	0.1004	0.2065*	-0.2134*	-0.0564	-0.1877*	-0.1152
X21	-0.0350	-0.0611	-0.0055	-0.1921*	0.1648	-0.0585	-0.1212	-0.0145	0.0606	0.2000*	0.5549**	0.8860**
X22	-0.0961	-0.1158	-0.0463	0.1145	-0.326**	0.4656**	-0.0475	0.2065*	-0.1230	-0.1233	-0.0507	0.0076
X23	0.1320	0.2316*	0.1416	-0.1769	0.3126**	-0.383**	-0.0295	-0.1818*	0.2483**	0.2567**	-0.0161	-0.0211

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Table 16. Continued.

Character	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X13	1.0000										
X14	0.9370**	1.0000									
X15	-0.1614	-0.1886*	1.0000								
X16	0.0178	0.0998	-0.3724**	1.0000							
X17	0.0543	0.1090	-0.4436**	0.7921**	1.0000						
X18	0.1932*	0.1691	-0.2588**	-0.5272**	0.3021**	1.0000					
X19	-0.0497	-0.1815*	0.1035	-0.5910**	0.5963**	-0.1071	1.0000				
X20	-0.0800	-0.0753	-0.2127*	-0.5441**	0.5779**	0.2035*	-0.4168**	1.0000			
X21	-0.0205	-0.0378	0.4743**	-0.0527	-0.2249*	0.0320	0.0581	-0.1675	1.0000		
X22	0.0524	0.1039	0.0406	0.4677**	0.3460**	0.3081**	-0.4733**	0.3859**	-0.0872	1.0000	
X23	-0.0028	-0.0932	0.0736	-0.5752**	-0.4295**	-0.286**	0.5986**	-0.4815**	0.0833	-0.889**	1.00

X1. Plant height (cm) X6.Short styled flowers (%) X11.Girth of fruit (cm) X16. FSB Shoot damage (%) X21. Weight of infested fruits

X2. No.of Primary branches X7. Intra cluster distance (cm) X12.Fruit weight (g) X17. FSB Fruit damage (%) X22. Total sugars (mg/100g)

X3. Days to first flowering X8.Inter cluster distance (cm) X13.Days to first harvest X18. Calyx length (cm) X23. Total phenols (mg/100g)

X4. Medium styled flowers (%) X9. Fruits per plant X14.Days to last harvest X19. RLPS

X5.Long styled flowers (%) X10.Length of fruit (cm) X15. Fruit yield per plant (g) X20. RLSA

Table 17. Genotypic correlation coefficients for growth, yield and morphological characters in rabi season

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
X1	1.0000											
X2	0.5788**	1.0000										
X3	-0.1336	-0.0911	1.0000									
X4	0.0914	-0.0858	-0.0627	1.0000								
X5	0.1469	0.2470**	-0.2308*	-0.847**	1.0000							
X6	-0.3926**	-0.242**	0.4597**	-0.506**	-0.0785	1.0000						
X7	-0.1869*	-0.2098*	-0.0915	0.0768	-0.0285	-0.0841	1.0000					
X8	0.0323	-0.1760	0.1522	0.1629	-0.301**	0.1628	0.0900	1.0000				
X9	0.4644**	0.5150**	-0.1505	-0.0674	0.3382**	-0.423**	-0.320**	-0.1996*	1.0000			
X10	0.2540**	0.2026*	0.1670	-0.0236	0.2142*	-0.280**	-0.0030	0.3174**	0.2111*	1.0000		
X11	-0.1840*	0.0227	-0.1251	-0.0023	-0.0157	-0.0019	0.1447	-0.249**	0.0693	-0.308**	1.0000	
X12	-0.1055	-0.0510	-0.0347	-0.1378	0.1681	-0.0438	0.0665	0.0047	0.0744	0.1550	0.6601**	1.0000
X13	-0.2302*	-0.1600	0.8751**	0.0627	-0.306**	0.3806**	0.1200	0.1081	-0.2250*	0.1203	-0.0179	0.0061
X14	-0.3074**	-0.274**	0.7336**	0.0649	-0.250**	0.2865**	0.1671	0.1138	-0.285**	0.1340	-0.0685	-0.0569
X15	0.3926**	0.3903**	-0.1278	-0.0215	0.2655**	-0.384**	-0.1935*	-0.1192	0.8491**	0.2407**	0.3069**	0.4693**
X16	-0.4015**	-0.2202*	-0.0173	0.1550	-0.330**	0.2601**	-0.1411	-0.308**	-0.517**	-0.1173	-0.0114	-0.0359
X17	-0.3967**	-0.273**	-0.0217	0.1754	-0.323**	0.2157*	0.2795**	0.1199	-0.499**	-0.269**	0.0552	-0.1765
X18	-0.2926**	-0.248**	0.1556	0.0458	-0.2019*	0.2287*	0.1182	0.4369**	-0.494**	0.0193	-0.1367	0.0537
X19	0.2189*	0.2217*	0.1656	-0.3216	0.3257**	0.0606	-0.275**	-0.0331	0.2510**	0.2241*	-0.283**	-0.0259
X20	-0.0686	-0.0399	-0.0420	0.1646	-0.304**	0.1831*	0.0597	0.1926*	-0.271**	-0.0514	-0.2322*	-0.1383
X21	-0.0661	0.0014	-0.0046	-0.1462	0.2168*	-0.0903	-0.0149	-0.0238	0.0826	0.1657	0.5721**	0.8833**
X22	-0.0746	-0.0605	-0.0051	0.1239	-0.249**	0.2260*	-0.0210	0.2005*	-0.1551	-0.1099	-0.0578	-0.0112
X23	0.1180	0.1733	0.0928	-0.1683	0.3340**	-0.252**	-0.0140	-0.1651	0.2844**	0.2587**	0.0014	-0.0171

Table 17: Continued.

Character	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X13	1.0000										
X14	0.9273**	1.0000									
X15	-0.1558	-0.2161*	1.0000								
X16	0.0364	0.1500	-0.3782**	1.0000							
X17	0.0747	0.1837*	-0.4392**	0.7073**	1.0000						
X18	0.2210*	0.2078*	-0.3219**	-0.5230**	0.2548**	1.0000					
X19	-0.0279	-0.1196	0.1134	-0.5300**	0.6657**	-0.1026	1.0000				
X20	-0.0874	-0.0852	-0.2349*	-0.5368**	0.5562**	0.2460**	-0.3687**	1.0000			
X21	-0.0082	-0.0551	0.4107**	-0.0636	-0.1943*	0.0259	0.0070	-0.2008*	1.0000		
X22	0.0284	0.0769	0.0115	0.4609**	0.4084**	0.3091**	-0.4089**	0.3753**	-0.1001	1.0000	
X23	0.0223	-0.0670	0.0889	-0.5774**	-0.4738**	-0.2775**	0.5428**	-0.4905**	0.0666	-0.8696**	1.0000

X1. Plant height (cm) X6.Short styled flowers (%) X11.Girth of fruit (cm) X16. FSB Shoot damage (%) X21. Weight of infested fruits

X2. No.of Primary branches X7. Intra cluster distance (cm) X12.Fruit weight (g) X17. FSB Fruit damage (%) X22. Total sugars (mg/100g)

X3. Days to first flowering X8.Inter cluster distance (cm) X13.Days to first harvest X18. Calyx length (cm) X23. Total phenols (mg/100g)

X4. Medium styled flowers (%) X9. Fruits per plant X14.Days to last harvest X19. RLPS

X5.Long styled flowers (%) X10.Length of fruit (cm) X15. Fruit yield per plant (g) X20. RLSA

length (-0.2960 and -0.2926), days to first harvest (-0.2741 and -0.2302) and intra cluster distance (-0.1924 and -0.1869) in kharif and rabi seasons respectively.

Number of primary branches showed significant positive correlation with fruits per plant (0.4914 and 0.5150), fruit yield per plant (0.3288 and 0.3903) and RLPS (0.2168 and 0.2217) respectively in both the seasons. It also showed significant positive correlation with total phenols (0.2316) in the kharif season only. It showed significant positive correlation with percentage of long styled flowers (0.2470) and length of fruits (0.2026) in rabi season only. It also exhibited significant negative correlation with SFB shoot infestation (-0.3057 and -0.2202), days to last harvest (-0.2746 and -0.2747), calyx length (-0.2743 and -0.2484), and SFB fruit infestation (-0.2451 and -0.2736) and intra cluster distance (-0.2066 and -0.2098) respectively in both seasons. It also showed significant negative correlation with percentage of short styled flowers (-0.2423) in rabi season only.

Days to first flower showed significant positive correlation with days to first harvest (0.9029 and 0.8751), days to last harvest (0.7321 and 0.7336) and percentage of short styled flowers (0.4198 and 0.4597) and significant negative correlation with percentage of long styled flowers (-0.1979 and -0.2308) respectively in both seasons.

Percentage of medium styled flowers showed significant positive correlation with SFB fruit infestation (0.3907), intra cluster distance (0.3248), RLSA (0.2597), inter cluster distance (0.2388) and girth of fruit (0.1945) in kharif season only. It also showed significant negative correlation with percentage of long styled flowers (-0.9748 and -0.8477), percentage of short styled flowers (-0.4614 and -0.5065) and RLPS (-0.5037 and -0.3216) respectively in both seasons.

Percentage of long styled flowers showed significant positive correlation with RLPS (0.5345 and 0.3257), fruit yield per plant (0.2563 and 0.2655), total phenols (0.3126 and 0.3340), length of fruits (0.2480 and 0.2142) and fruits per plant (0.2049 and 0.3382) respectively in both the seasons. It also showed significant positive correlation with fruits per plant (0.2473), weight of infested fruits (0.1875) and length of fruits (0.1870) in rabi season only. It also showed significant negative correlation with SFB fruit infestation (-0.5998 and -0.3236), SFB shoot infestation (-0.4375 and -0.3304), inter cluster distance (-0.3367 and -0.3012), total sugars (-0.3268 and -0.2499), days to first harvest (-0.2703 and -0.3063), days to last harvest (-0.2918 and -0.2502) and RLSA (-0.2920 and -0.3048) respectively in both seasons. It also exhibited significant negative correlation with intra cluster distance (-0.3212) and percentage of short styled flowers (-0.3299) in kharif season only.

Percentage of short styled flowers showed significant positive correlation with days to first harvest (0.5104 and 0.3806) and days to last harvest (0.5501 and 0.2865) respectively in both seasons. It also exhibited significant negative correlation with fruits per plant (-0.4605 and -0.4238), fruit yield per plant (-0.3599 and -0.3849) and total phenols (-0.3832 and -0.2520) respectively in both seasons.

Intra cluster distance had showed significant positive correlation with SFB fruit infestation (0.2968 and 0.2759) respectively in kharif and rabi season. It also had negative correlation with SFB shoot infestation (-0. 1945 and -0.1411), fruits per plant (-0.2682 and -0.3205), RLPS (-0.2697 and -0.2758) and fruit yield per plant (-0.2432 and -0.1935) respectively in both season. Inter cluster distance showed significant positive correlation with calyx length (0.4420 and 0.4369), length of fruits (0.2732 and 0.3174), RLSA (0.2065 and 0.1926) and total sugars (0.2065 and 0.2005) respectively in both the seasons. It also exhibited significant negative correlation with SFB shoot infestation (-0.3083 and -0.3087), girth of fruit (-0.2392 and -0.2491) and fruits per plant (-0.2330 and -0.1996) respectively in both the seasons.

Fruits per plant had significant positive correlation with fruit yield per plant (0.8024 and 0.8491), total phenols (0. 2483and 0.2844) respectively in both the season. Fruits per plant showed significant negative correlation with calyx length (-0.4801 and -0.4947), SFB shoot infestation (-0.4598 and -0.5177), SFB fruit infestation (-0.3998 and -0.4991) and RLSA (-0. 2134 and -0.2717) respectively in both the seasons.

Length of fruits showed significant positive correlation with total phenols (0.2567 and 0.2587), fruit yield per plant (0.2337 and 0.2407) and RLPS (0.1898 and 0.2241) respectively in both the seasons. It showed significant negative correlation with girth of fruit (-0.3053 and -0.3087) and SFB fruit infestation (-0.2818 and -0.2697) respectively in both the seasons.

Girth of fruit showed significant positive correlation with fruit weight (0.6558 and 0.6601), weight of infested fruits (0.5549 and 0.5721), fruit yield per plant (0.3543 and 0.3069) and it also showed significant negative correlation with RLPS (-0.2402 and -0.2833) and RLSA (-0.1877 and -0.2322) respectively in kharif and rabi seasons.

Fruit weight showed significant positive correlation with weight of infested fruits (0.8860 and 0.8833) and fruit yield per plant (0.5426 and 0.4693) respectively in both the seasons.

Days to first harvest showed significant positive correlation with days to last harvest (0.9370 and 0.9273) and calyx length (0.1932 and 0.2210) respectively in both the seasons whereas days to last harvest showed significant negative correlation with fruit yield per plant (-0.1886 and -0.2161) in both seasons.

SFB shoot infestation showed significant positive correlation with SFB fruit infestation (0.7921 and 0.7073) and total sugars (0.4677 and 0.4609) respectively in kharif and rabi seasons. It also showed significant negative correlation with RLPS (-0.5910 and -0.5300) and total phenols (-0.5752 and -0.5774) respectively in both the seasons.

SFB fruit infestation showed significant positive correlation with RLSA (0.5779 and 0.5562), total sugars (0.3460 and 0.4084) and calyx length (0.3021 and 0.2548) respectively in both the seasons. It also showed significant negative correlation with RLPS (-0.5963 and -0.6657), RLSA (-0.5441 and -0.5368) and calyx length (-

0.5272 and -0.5230), total phenols (-0.4295 and -0.4738) and weight of infested fruits (-0.2249 and -0.1943) respectively in kharif and rabi seasons.

Calyx length had significant positive correlation with total sugars (0.3081 and 0.3091) respectively in both the seasons respectively. It showed significant negative correlation with total phenols (-0.2867 and -0.2775) in both the seasons respectively.

RLPS had significant positive correlation with total phenols (0.5986 and 0.5428) and significant negative correlation with total sugars (-0.4733 and -0.4089) and RLSA (-0.4168 and -0.3687) in both the seasons respectively. RLSA had significant positive correlation with total sugars (0.3859 and 0.3753) and significant negative correlation with total phenols (-0.4815 and -0.4905) in kharif and rabi seasons respectively. Total sugars had significant negative correlation with total phenols (-0.8894 and -0.8696) in both seasons respectively. Total sugars had significantly negative correlation with total phenols (-0.8894 and -0.8696) in both seasons respectively.

4.1.5 Path Coefficient Analysis

Genotypic correlation between yield and its component characters were portioned into different components to find out the direct and indirect contribution of each character on yield. Plant height, number of primary branches per plant , days to 50 % flowering, percentage of medium styled flowers, percentage of long styled flowers, fruits per plant, length of the fruit, girth of fruit, fruit weight and days to first harvest were selected for path coefficient analysis. Direct and indirect effects of yield components during kharif and rabi seasons are presented in table 18 and 19 respectively.

4.1.5.1 Direct and Indirect Effects of Yield Components of Brinjal in Kharif Season

The plant height showed positive direct effect (0.0462) had strong positive association with fruit yield per plant (0.3397). This is mainly because of its indirect positive effect through number of primary branches (0.0258), fruits per plant (0.0183),

Table 18. Direct and indirect effects of yield components of brinjal in kharif season

Character	Plant height (cm)	No. of primary branches/plant	Days to first flower	Medim styled flowers (%)	Long styled flowers (%)	No.of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Fruit weight (g)	Days to first harvest	Fruit yield per plant (g)
Plant height (cm)	0.0462	0.0258	-0.0057	-0.0028	0.0096	0.0183	0.0105	-0.0073	-0.0046	-0.0127	0.3397
No.of primary branches/plant	0.0432	0.0774	-0.0017	-0.0053	0.0095	0.2138	0.0124	-0.0045	-0.0105	-0.0121	0.3288
Days to first flower	-0.0051	-0.0009	-0.0409	-0.0022	-0.0081	-0.0023	0.0067	-0.0048	-0.0018	0.0369	-0.0618
Medium styled flowers (%)	-0.0344	-0.039	-0.0305	0.5699	-0.5556	0.0363	-0.1555	0.1108	-0.0791	-0.0081	0.109
Long styled flowers (%)	0.1243	0.0733	-0.1187	-0.5847	0.5998	0.1229	0.1488	-0.057	0.0886	-0.1621	0.2563
No.of fruits/ plant	0.2515	0.3113	-0.0358	0.0404	0.1298	0.6335	0.1116	0.1009	0.0393	-0.1177	0.8024
Length of fruit (cm)	-0.0274	-0.0194	-0.0196	0.0329	-0.0299	-0.0212	-0.1206	0.0368	-0.0199	-0.014	0.2337
Girth of fruit (cm)	0.0451	0.0166	0.0333	-0.0557	0.0273	-0.0456	0.0875	-0.2866	0.1882	0.0136	0.3543
Fruit weight (g)	-0.0709	-0.0977	-0.0318	-0.0998	0.1062	0.0447	0.1184	0.4716	0.7192	-0.0046	0.5426
Days to first harvest	-0.0327	-0.0187	0.1077	-0.0017	-0.0323	-0.0222	0.0138	-0.0057	-0.0008	0.1193	-0.1614

RESIDUAL EFFECT = 0.0283

fruit length (0.0105) percentage of long styled flowers (0.0096) and indirect negative effect through days to first harvest (-0.0127), percentage of medium styled flowers (-0.028), fruit weight (-0.0046) and girth of fruit (-0.0073).

Number of primary branches per plant showed positive direct effect (0.0774) on fruit yield per plant (0.3288). However, its strong positive association with fruit yield was mainly of its positive indirect effect through plant height (0.0432), number of fruits per plant (0.2138), fruit length (0.0124), percentage of long styled flowers (0.0095) and negative indirect effect through days to first harvest (-0.0121), fruit weight (-0.0105), percentage of medium styled flowers (-0.0053) and girth of fruit (-0.0045).

Genotypic correlation of days to first flower with yield was -0.0618. Most of it was contributed by negative direct effect (-0.0409) and by indirect positive effect through days to first harvest (0.0369). It also contributed by negative indirect effect through plant height (-0.0051), percentage of medium styled flowers (-0.0022), percentage of long styled flowers (-0.0081), fruit weight (-0.0018)) and girth of fruit (-0.0048).

Percentage of medium styled flowers showed positive direct effect (0.5699) had strong positive association with fruit yield per plant (0.1090). This is mainly because of its indirect positive effect through number of fruits per plant (0.0363), girth of fruit (0.1108) and indirect negative effect through percentage of long styled flowers (-0.5556), fruit length (-0.1555), days to first harvest (-0.081), fruit weight (-0.0791), number of primary branches per plant (-0.0390) and plant height (-0.0344).

Percentage of long styled flowers showed positive direct effect (0.5998) had strong positive association with fruit yield per plant (0.2563). This is mainly because of its indirect positive effect through plant height (0.1243), number of fruits per plant (0.1229), fruit length (0.1488), fruit weight (0.0886), number of primary branches(0.0733) and indirect negative effect through mainly percentage of medium styled flowers (-0.5847), days to first flower (-0.1187), days to first harvest (-0.1621) and girth of fruit (-0.0570).

Genotypic correlation of number of fruits per plant with yield was 0.8024. Most of it was contributed by positive direct effect (0.6335) and by indirect positive effect through number of primary branches per plant (0.3113), plant height (0.2515), percentage of long styled flowers (0.1298), fruit length (0.1116), girth of fruit (0.1009) and fruit weight (0.0393). It also contributed by negative indirect effect through days to first flower (-0.0358) and days to first harvest (-0.1177).

Fruit length despite its negative direct effect (-0.1206) had strong positive association with fruit yield per plant (0.2337). This is mainly because of its high indirect positive effect through percentage of medium styled flowers (0.0329), girth of fruit (0.0368) and negative indirect effect through plant height (-0.0274), number of branches per plant (-0.0194), days to first flower (-0.0196), percentage of long styled flowers (-0.0299), number of fruits per plant (-0.0212) and fruit weight (-0.0199).

Fruit girth showed negative direct effect (-0.2866) had strong positive association with fruit yield per plant (0.3543). This is mainly because of its indirect positive effect through fruit length (0.0875), plant height (0.0451), days to first flower (0.0333), percentage of long styled flowers (0.0273), number of primary branches (0.0166), days to first harvest (0.0136) and fruit weight (0.1882). Indirect negative effect through percentage of medium styled flowers (-0.0557) and number of fruits per plant (-0.0456).

Fruit weight showed positive direct effect (0.7192) had strong positive association with fruit yield per plant (0.5426). This is mainly because of its indirect positive effect through girth of fruit (0.4716), fruit length (0.1184), percentage of long styled flowers (0.1062), number of fruits per plant (0.0447) and indirect negative effect through number of primary branches (-0.0977), percentage of medium styled flowers (-0.0998), plant height (-0.0709) and days to first flower (-0.0318).

Days to first harvest showed positive direct effect (0.1193) had negative association with fruit yield per plant (-0.1614). This is mainly because of its high indirect positive effect through days to first flower (0.1077), fruit length (0.0138) but its indirect negative contribution to the yield is mainly through number of fruits per plant (-0.0222), plant height (-0.0327) and number of branches per plant (-0.0187).

4.1.5.2 Direct and Indirect Effects of Yield Components of Brinjal in Rabi Season.

The plant height showed positive direct effect (0.0884) had strong positive association with fruit yield per plant (0.3926). This is mainly because of its indirect positive effect through number of primary branches (0.0512), fruits per plant (0.0411), fruit length (0.0225) percentage of long styled flowers (0.0130) and indirect negative effect through days to first harvest (-0.0203), fruit weight (-0.0093) and girth of fruit (-0.0163).

Number of primary branches per plant showed positive direct effect (0.0337) on fruit yield per plant (0.3903). However, its strong positive association with fruit yield was mainly of its positive indirect effect through plant height (0.0195), number of fruits per plant (0.1173) and negative indirect effect through percentage of medium styled flowers (-0.0083) and days to first harvest (-0.0154).

Genotypic correlation of days to first flower with yield was -0.1278. Most of it was contributed by negative direct effect (-0.0663) and by indirect positive effect through days to first harvest (0.0580) and number of fruits per plant (0.0112). It also contributed by negative indirect effect through plant height (-0.0089), percentage of medium styled flowers (-0.0042) and percentage of long styled flowers (-0.0153).

Percentage of medium styled flowers showed positive direct effect (0.4608) had strong positive association with fruit yield per plant (0.0215). This is mainly because of its indirect positive effect through number of fruits per plant (0.0214) and indirect negative effect through percentage of long styled flowers (-0.0177), fruit weight (-0.0029), number of primary branches per plant (-0.0018) and plant height (-0.0019).

Table 19. Direct and indirect effects of yield components of brinjal in rabi season

Character	Plant height (cm)	No. of primary branches/ plant	Days to first flower	Medium styled flowers (%)	Long styled flowers (%)	No. of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Fruit weight (g)	Days to first harvest	Fruit yield per plant (g)
Plant height (cm)	0.0884	0.0512	-0.0118	0.0081	0.0130	0.0411	0.0225	-0.0163	-0.0093	-0.0203	0.3926
No. of primary branches/plant	0.0195	0.0337	0.0031	0.0029	-0.0083	0.1173	-0.0068	-0.0008	0.0017	0.0054	0.3903
Days to first flower	0.0089	0.006	-0.0663	0.0042	0.0153	0.0112	-0.0111	0.0083	0.0023	-0.058	-0.1278
Medium styled flowers (%)	0.0019	-0.0018	-0.0013	0.4608	-0.0177	-0.0014	-0.0005	0.0092	-0.0029	0.0013	-0.0215
Long styled flowers (%)	-0.0123	-0.0168	0.0157	0.0575	0.5113	-0.0229	-0.0145	0.0011	-0.0114	0.0208	0.2655
No.of fruits/ plant	0.3867	0.4289	-0.1254	-0.0561	0.2816	0.8327	0.1758	0.0577	0.062	-0.1873	0.8491
Length of fruit (cm)	-0.0065	-0.0052	-0.0043	0.0006	-0.0055	-0.0054	-0.0256	0.0079	-0.004	-0.0031	0.2407
Girth of fruit (cm)	0.0109	-0.0014	0.0074	0.0001	0.0009	-0.0041	0.0184	-0.0595	0.1393	0.0011	0.3069
Fruit weight (g)	-0.0495	-0.024	-0.0163	-0.0647	0.079	0.035	0.0728	0.3110	0.4696	0.0029	0.4693
Days to first harvest	-0.0188	-0.0131	0.0714	0.0051	-0.025	-0.0184	0.0098	-0.0015	0.0005	0.0816	-0.1558

RESIDUAL EFFECT = 0.0313

Percentage of long styled flowers showed positive direct effect (0.5113) had strong positive association with fruit yield per plant (0.2655). This is mainly because of its indirect positive effect through percentage of medium styled flowers (0.0575), plant height (0.1230), number of fruits per plant (0.0229), number of primary branches (0.0168) and indirect negative effect through mainly days to first flower (-0.0157) and days to first harvest (-0.0208).

Genotypic correlation of number of fruits per plant with yield was 0.8491. Most of it was contributed by positive direct effect (0.8327) and by indirect positive effect through number of primary branches per plant (0.4289), plant height (0.3867), percentage of long styled flowers (0.2816), fruit length (0.1758), girth of fruit (0.0577) and fruit weight (0.0620). It also contributed by negative indirect effect through days to first flower (-0.1254) and days to first harvest (-0.1873).

Fruit length despite its negative direct effect (-0.0256) had strong positive association with fruit yield per plant (0.2407). This is mainly because of its indirect positive effect through percentage of medium styled flowers (0.0026),girth of fruit (0.0079) and negative indirect effect through plant height (-0.0065), number of branches per plant (-0.0052), days to first flower (-0.0043) and girth of fruit (-0.0079).

Fruit girth showed negative direct effect (-0.0595) had strong positive association with fruit yield per plant (0.3069). This is mainly because of its indirect positive effect through fruit girth(0.1393), fruit length (0.0184), plant height (0.0109), days to first flower (0.0074) and indirect negative effect through fruit weight (-0.0393) and number of fruits per plant (-0.0241).

Fruit weight showed positive direct effect (0.4696) had strong positive association with fruit yield per plant (0.4693). This is mainly because of its indirect positive effect through girth of fruit (0.3100), fruit length (0.0728), percentage of long styled flowers (0.0790), number of fruits per plant (0.0350) and indirect negative effect through number of primary branches (-0.0240), percentage of medium styled flowers (-0.0647), plant height (-0.0495) and days to first flower (-0.0163).

Days to first harvest showed positive direct effect (0.0816) had negative association with fruit yield per plant (-0.1558). This is mainly because of its high indirect positive effect through days to first flower (0.0714), fruit length (0.0098) but its indirect negative contribution to the yield is mainly through number of fruits per plant (-0.0184), plant height (-0.0188) and number of branches per plant (-0.0131).

4.1.6 Selection Index

Discriminate function technique was adopted for the construction of selection index for yield using fruit yield per plant and the component characters *viz.*, plant height, number of primary branches, fruits per plant, girth of fruit and fruit weight. These component characters showed relatively stronger association with yield and could form a valuable selection index for yield in this crop.

The index value for each sixty genotypes were determined and they were ranked accordingly (Table 20 and 21). Top index values for five genotypes were recorded. The genotype SM 36 (4714.73 and 4724.25), SM 2 (4554.09 and 4676.91), SM 9 (4417.26 and 4471.43), SM 14 (4330.44 and 4313.06) and SM 21 (4207.61 and 4255.83) respectively in both kharif and rabi season and these best five high yielding genotypes were further selected for hybridization programme.

4.1.7 Screening for Shoot and fruit borer Resistance/Tolerance in Kharif and Rabi Seasons

Screening of accessions based on the extent of damage to shoots and fruits were done under this study. The data of damage parameters collected from field experiment with sixty accessions were subjected to statistical analysis. There is no much seasonal difference among the genotypes for shoot infestation as well as fruit infestation by SFB was observed in Vellayani (Thiruvananthapuram) climatic conditions.

Table 20:Brinjal accessions ranked according to selection index in kharif season (based on discriminante function analysis)

S.N.	Genotype	Index	Rank	S.N.	Genotype	Index	Rank
1	SM 36	4714.73	1	31	SM 28	2305.32	31
2	SM 2	4554.09	2	32	SM 56	2295.84	32
3	SM 9	4417.26	3	33	SM 6	2290.79	33
4	SM 14	4330.44	4	34	SM 58	2284.96	34
5	SM 21	4207.61	5	35	SM 51	2270.18	35
6	SM 60	3859.33	6	36	SM 22	2235.82	36
7	SM 1	3661.80	7	37	SM 52	2225.88	37
8	SM 59	3579.10	8	38	SM 42	2209.02	38
9	SM 30	3431.32	9	39	SM 4	2208.25	39
10	SM 35	3197.99	10	40	SM 5	2147.62	40
11	SM 15	2976.18	11	41	SM 48	2140.68	41
12	SM 19	2966.03	12	42	SM 39	2122.85	42
13	SM 23	2961.37	13	43	SM 38	2115.71	43
14	SM 31	2896.97	14	44	SM 32	2099.37	44
15	SM 13	2814.64	15	45	SM 46	2085.43	45
16	SM 18	2813.60	16	46	SM 8	2072.47	46
17	SM 33	2747.16	17	47	SM 40	2066.38	47
18	SM 7	2707.51	18	48	SM 26	2063.97	48
19	SM 43	2520.65	19	49	SM 24	2057.62	49
20	SM 44	2516.60	20	50	SM 34	2053.17	50
21	SM 20	2504.66	21	51	SM 53	2014.51	51
22	SM 25	2501.75	22	52	SM 10	1980.01	52
23	SM 57	2491.48	23	53	SM 55	1964.36	53
24	SM 50	2475.43	24	54	SM 49	1875.97	54
25	SM 54	2471.05	25	55	SM 27	1819.68	55
26	SM 37	2457.51	26	56	SM 11	1564.33	56
27	SM 45	2389.11	27	57	SM 12	1424.42	57
28	SM 17	2384.04	28	58	SM 29	1400.87	58
29	SM 41	2348.84	29	59	SM 3	1111.67	59
30	SM 47	2312.44	30	60	SM 16	1102.48	60

Table 21:Brinjal accessions ranked according to selection index in rabi season (based on discriminante function analysis)

S.N.	Genotype	Index	Rank	S.N.	Genotype	Index	Rank
1	SM 36	4724.25	1	**31**	SM 58	2113.79	1
2	SM 2	4676.91	2	**32**	SM 52	2111.61	2
3	SM 9	4471.43	3	**33**	SM 20	2110.63	3
4	SM 14	4313.06	4	**34**	SM 28	2084.78	4
5	SM 21	4255.83	5	**35**	SM 51	2070.18	5
6	SM 60	3748.20	6	**36**	SM 6	2065.42	6
7	SM 1	3714.01	7	**37**	SM 56	2027.76	7
8	SM 59	3512.11	8	**38**	SM 42	2026.46	8
9	SM 30	3211.14	9	**39**	SM 4	2003.13	9
10	SM 35	2720.65	10	**40**	SM 26	1979.95	10
11	SM 7	2657.05	11	**41**	SM 5	1977.10	11
12	SM 19	2559.93	12	**42**	SM 8	1959.33	12
13	SM 31	2514.97	13	**43**	SM 48	1942.74	13
14	SM 33	2482.48	14	**44**	SM 53	1914.51	14
15	SM 13	2474.15	15	**45**	SM 38	1890.95	15
16	SM 15	2458.37	16	**46**	SM 39	1861.51	16
17	SM 23	2446.83	17	**47**	SM 24	1831.02	17
18	SM 18	2434.20	18	**48**	SM 55	1822.30	18
19	SM 43	2336.09	19	**49**	SM 32	1773.42	19
20	SM 50	2327.30	20	**50**	SM 46	1771.83	20
21	SM 54	2319.68	21	**51**	SM 49	1748.27	21
22	SM 25	2309.21	22	**52**	SM 27	1651.20	22
23	SM 57	2301.97	23	**53**	SM 10	1636.34	23
24	SM 17	2290.46	24	**54**	SM 34	1600.28	24
25	SM 45	2281.00	25	**55**	SM 40	1592.29	25
26	SM 41	2280.56	26	**56**	SM 11	1373.57	26
27	SM 44	2264.34	27	**57**	SM 29	1290.56	27
28	SM 37	2186.44	28	**58**	SM 12	1263.55	28
29	SM 22	2160.14	29	**59**	SM 3	1051.11	29
30	SM 47	2140.84	30	**60**	SM 16	994.70	30

IC- 345271

Raidurg local

Tiptur Local

IC-433678

Jagaluru Local

Plate: 5. High yielding genotypes

4.1.7.1 Shoot Infestation Percentage by SFB during Kharif and Rabi Season

SFB shoot infestation was screened for all sixty genotypes based on the shoot infestation percentage from 30 to 90 days after transplanting at 10 days interval (Table 22 and 23). A wide variation for shoot infestation by SFB was observed among the genotypes.

The minimum percentage of young shoots infestation was recorded in SM1 (5.65, 5.75, 7.10, 6.83, 6.90, 5.10, and 4.60) followed by SM 60 (7.15, 9.00, 8.25, 7.54, 6.0, 4.65 and 4.10) and SM 59 (11.00, 13.00, 13.00, 12.65, 12.50, 12.40 and 11.65). Infestation of young shoots was highest in SM 47 (51.75, 50.35, 48.95, 48.90, 47.85, 42.75 and 37.60) followed by SM 57 (50.20, 49.90, 51.60, 52.55, 48.75, 37.80 and 34.55), SM 51 (49.00, 50.75, 51.25, 49.00, 48.25, 37.00 and 34.05) and SM 54 (50.70, 48.90, 48.70, 49.85, 50.15, 37.85 and 32.75) at all 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively in kharif season.

In rabi season the minimum percentage of young shoots infestation was recorded in SM1 (6.10, 6.35, 7.50, 6.90, 7.10, 4.90 and 4.50) followed by SM 60 (7.75, 8.75, 7.60, 6.75, 5.25, 5.10 and 3.95) and SM 59 (12.15, 12.75, 12.65, 12.20, 12.45, 11.90 and 11.10). Highest infestation of young shoots was recorded in SM 47 (52.75, 51.05, 52.75, 51.05, 48.00, 37.80 and 30.60) followed by SM 27 (53.75, 51.90, 53.90, 52.60, 46.30, 41.75 and 23.35), SM 51 (51.75, 52.50, 51.70, 48.95, 47.15, 37.50 and 33.65) and SM 54 (53.50, 52.25, 52.50, 48.00, 46.25, 36.85 and 31.75) at 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively.

4.1.7.1.2 Fruit Infestation Percentage by SFB during Kharif and Rabi seasons.

SFB fruit infestation was screened based on the fruit infestation percentage from 60 to 100 days after transplanting at 10 days interval is provided (Table 24 and 25). Differential response to the fruit infestation by SFB was noticed in the germplasm.

Percentage of fruit infestation was least in case of SM 1 (6.15, 7.50, 7.70, 7.35, 7.5 and 7.24), SM 60 (7.00, 7.85, 8.00, 7.15, 7.15 and 7.43) and SM 59 (13.25, 13.00,

Table 22: Percentage of shoots damaged by shoot and fruit borer (*L. orbonalis*) at different intervals in kharif season

Genotype	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled Mean	Rating
SM1	5.65	5.75	7.10	6.84	6.90	5.10	4.60	5.991	HR
SM2	33.75	34.50	35.60	35.75	33.50	33.15	29.50	33.679	S
SM3	46.40	40.30	43.50	35.50	29.90	26.50	24.35	35.207	S
SM4	41.25	40.50	38.20	31.85	29.60	25.00	21.00	32.486	S
SM5	44.65	40.80	44.70	31.95	28.75	25.00	19.75	33.657	S
SM6	50.85	52.60	47.75	48.55	45.90	38.05	35.40	45.586	HS
SM7	42.05	38.00	40.10	29.50	30.00	27.25	24.10	33.000	S
SM8	46.40	38.35	40.75	33.00	29.05	25.00	21.50	33.436	S
SM9	34.72	35.15	34.60	35.50	35.45	32.60	29.25	33.896	S
SM10	47.75	40.55	43.00	31.75	29.25	26.50	23.75	34.650	S
SM11	50.80	47.75	51.65	36.90	30.50	25.80	20.50	37.700	S
SM12	44.75	40.35	43.60	34.00	29.50	25.00	20.10	33.900	S
SM13	42.45	39.80	40.00	29.75	29.50	27.40	24.75	33.379	S
SM14	34.50	34.25	36.50	33.25	31.20	34.70	28.15	33.221	S
SM15	41.35	40.75	42.50	29.30	27.45	25.70	20.50	32.507	S
SM16	48.00	40.50	43.00	32.50	29.75	27.50	24.10	35.050	S
SM17	51.10	44.30	44.80	31.90	29.75	26.10	22.85	35.829	S
SM18	50.10	51.70	51.20	35.50	31.85	25.25	21.50	38.157	S
SM19	50.10	47.50	46.05	39.70	29.50	23.50	17.40	36.250	S
SM20	44.90	45.30	47.50	36.30	33.50	26.90	18.35	36.107	S
SM21	37.50	39.00	41.00	33.50	30.25	31.90	28.00	34.450	S
SM22	35.10	37.60	36.90	35.50	31.75	30.60	21.50	32.707	S
SM23	40.65	42.10	44.00	32.00	29.25	23.40	21.50	33.271	S
SM24	36.40	45.35	41.55	40.50	30.50	25.70	21.50	34.500	S
SM25	56.60	53.50	54.10	37.40	30.50	30.60	28.90	41.657	HS
SM26	38.35	40.00	41.85	32.50	28.00	24.15	22.50	32.479	S
SM27	53.50	53.90	55.30	42.00	35.70	28.50	25.20	42.014	HS
SM28	49.90	50.50	47.80	34.80	32.50	26.20	19.75	37.350	S
SM29	45.80	45.75	46.50	33.50	30.25	25.50	20.00	35.329	S
SM30	50.70	51.60	50.70	33.80	27.90	26.10	20.50	37.329	S
SM31	45.75	47.50	50.00	33.40	27.75	22.60	18.00	35.000	S
SM32	41.90	42.20	41.25	30.70	27.00	24.25	19.00	32.329	S
SM33	39.15	36.70	37.50	24.95	22.00	21.40	17.50	28.457	T
SM34	50.10	50.65	51.40	36.40	27.00	21.25	16.15	36.136	S

SM35	47.45	46.00	45.10	33.90	28.10	22.50	16.25	34.186	S
SM36	34.90	33.85	35.60	34.35	33.50	31.70	30.40	33.471	S
SM37	51.00	50.80	52.10	35.00	31.00	25.65	19.90	37.921	S
SM38	52.90	50.40	50.50	34.00	28.75	24.25	16.30	36.729	S
SM39	48.15	44.50	35.25	30.00	28.00	24.00	19.50	32.771	S
SM40	50.60	51.65	52.60	32.00	29.95	23.90	16.25	36.707	S
SM41	49.15	50.00	52.50	32.25	28.75	23.25	16.65	36.079	S
SM42	37.00	40.60	44.00	29.25	30.25	25.50	20.25	32.407	S
SM43	35.00	34.00	33.75	29.60	27.25	23.86	19.25	28.959	T
SM44	33.00	36.95	36.50	34.00	34.75	34.10	20.35	32.807	S
SM45	36.75	35.80	38.30	35.40	33.65	30.35	18.75	32.714	S
SM46	30.75	32.10	33.75	25.60	23.90	22.85	19.00	26.850	T
SM47	51.75	50.35	48.95	48.90	47.85	42.75	37.60	46.879	HS
SM48	33.60	35.90	36.90	32.60	31.50	32.35	30.25	33.300	S
SM49	31.00	31.70	35.30	26.00	24.50	18.75	15.50	26.107	T
SM50	35.20	33.35	34.10	34.60	32.20	32.05	18.50	31.429	S
SM51	49.00	50.75	51.25	49.00	48.25	37.00	34.05	45.614	HS
SM52	34.00	34.95	35.00	27.90	25.75	19.00	15.80	27.486	T
SM53	34.50	31.90	32.50	27.60	24.25	19.50	14.75	26.429	T
SM54	50.70	48.90	48.70	49.85	50.15	37.85	32.75	45.557	HS
SM55	32.60	31.25	33.60	33.15	31.45	31.55	27.85	31.636	S
SM56	51.50	51.35	50.85	48.15	37.80	33.50	26.70	42.836	HS
SM57	50.20	49.90	51.60	52.55	48.75	37.80	34.55	46.479	HS
SM58	46.40	46.10	51.00	30.90	27.50	20.50	15.10	33.929	S
SM59	11.00	13.00	13.00	12.65	12.50	12.40	11.65	12.314	MR
SM60	7.15	9.00	8.25	7.55	6.00	4.65	4.10	6.671	HR
CD at 5%	4.212	2.363	2.251	3.061	1.862	2.101	1.514	2.902	
Mean	41.64	41.00	41.72	33.45	30.29	26.43	21.72	33.74	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

Table 23: Percentage of shoots damaged by shoot and fruit borer (*L. orbonalis*) at different intervals in rabi season

Genotype	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled Mean	Rating
SM1	6.10	6.35	7.50	6.90	7.10	4.90	4.50	6.193	HR
SM2	33.50	37.65	38.50	31.25	30.50	29.25	27.05	32.529	S
SM3	41.00	38.90	40.05	31.25	30.50	27.90	23.60	33.314	S
SM4	37.25	33.25	37.25	29.40	29.50	26.80	20.75	30.600	S
SM5	40.35	41.70	44.50	32.80	30.50	23.50	20.50	33.407	S
SM6	50.95	49.85	49.10	45.65	42.65	42.30	36.85	45.336	HS
SM7	40.50	35.50	38.60	30.50	29.75	26.90	22.75	32.071	S
SM8	41.80	38.40	40.90	35.00	29.50	25.50	20.50	33.086	S
SM9	33.50	32.95	34.60	31.00	30.25	28.95	27.50	31.250	S
SM10	44.00	37.50	43.80	32.25	29.25	25.25	22.00	33.436	S
SM11	49.10	46.90	47.50	33.50	29.10	24.50	19.75	35.764	S
SM12	44.90	41.15	41.10	31.25	28.70	24.75	21.80	33.379	S
SM13	38.10	35.20	35.50	30.50	29.60	26.50	23.50	31.271	S
SM14	36.75	38.00	38.60	32.00	30.50	29.50	28.50	33.407	S
SM15	32.50	40.10	42.00	30.75	28.40	25.50	22.50	31.679	S
SM16	46.00	40.80	41.60	35.50	27.40	25.40	21.10	33.971	S
SM17	35.25	43.30	44.50	30.60	28.95	25.50	20.50	32.657	S
SM18	38.45	57.50	59.00	40.10	30.60	24.00	20.65	38.614	S
SM19	47.25	43.25	46.00	35.00	29.95	23.30	19.00	34.821	S
SM20	39.20	39.60	43.00	38.75	30.50	26.20	17.50	33.536	S
SM21	40.65	40.70	41.60	32.25	31.25	29.50	27.90	34.836	S
SM22	44.00	51.25	54.00	29.20	30.75	25.00	20.75	36.421	S
SM23	35.50	40.75	42.25	31.10	30.50	25.35	22.50	32.564	S
SM24	38.45	42.30	44.00	36.25	30.15	26.40	20.00	33.936	S
SM25	50.60	52.20	53.10	47.70	42.95	37.85	32.95	45.336	HS
SM26	36.50	41.30	43.00	33.25	27.45	27.25	23.25	33.143	S
SM27	53.75	51.90	53.90	52.60	46.30	41.75	23.35	46.221	HS
SM28	45.25	49.00	50.00	36.40	30.80	26.25	19.25	36.707	S
SM29	39.05	40.25	43.00	35.70	30.25	24.85	19.90	33.286	S
SM30	40.00	41.80	43.00	38.40	31.00	25.75	19.70	34.236	S
SM31	42.50	45.10	47.35	33.50	26.90	23.25	17.95	33.793	S
SM32	45.55	45.95	47.00	33.00	26.40	23.50	18.10	34.214	S
SM33	35.50	35.00	36.50	25.90	26.25	20.70	17.00	28.121	T
SM34	44.50	44.10	44.65	31.80	24.25	21.40	16.30	32.429	S

SM35	47.00	46.00	48.60	33.75	28.50	23.25	18.75	35.121	S
SM36	35.25	32.70	35.50	31.25	31.50	31.70	31.70	32.800	S
SM37	40.00	46.25	48.00	32.75	29.90	25.50	20.25	34.664	S
SM38	38.30	36.90	38.50	31.50	29.95	30.70	23.75	32.800	S
SM39	33.75	44.75	47.00	31.45	27.00	25.00	19.75	32.671	S
SM40	39.75	41.50	45.00	32.70	30.00	25.80	20.60	33.621	S
SM41	45.10	36.90	40.65	31.65	30.70	22.60	21.25	32.693	S
SM42	36.60	41.15	42.75	31.00	29.50	25.50	20.75	32.464	S
SM43	33.00	36.75	40.75	30.50	25.25	20.25	16.20	28.957	T
SM44	36.50	33.40	35.50	32.95	30.90	30.35	27.85	32.493	S
SM45	35.60	32.85	39.00	35.50	33.65	29.60	26.10	33.186	S
SM46	32.00	31.90	30.15	28.60	25.00	19.40	14.40	25.921	T
SM47	52.75	51.05	52.75	51.05	48.00	37.80	30.60	46.286	HS
SM48	35.65	35.90	35.50	33.60	32.75	35.10	31.50	34.286	S
SM49	32.50	32.70	38.00	27.40	25.90	19.00	15.40	27.271	T
SM50	34.10	31.50	30.50	34.60	32.60	30.50	27.65	31.636	S
SM51	51.75	52.50	51.70	48.95	47.15	37.50	33.65	46.171	HS
SM52	33.50	32.30	33.50	26.00	25.00	19.00	14.75	26.293	T
SM53	31.30	35.10	33.75	28.90	24.90	18.10	15.30	26.764	T
SM54	53.50	52.25	52.50	48.00	46.25	36.85	31.75	45.871	HS
SM55	33.35	34.60	36.00	32.70	30.85	29.15	27.10	31.964	S
SM56	52.50	52.90	50.70	49.90	47.15	38.60	28.05	45.686	HS
SM57	48.60	49.90	48.35	47.10	45.60	37.85	34.10	44.500	HS
SM58	40.10	45.75	49.00	30.50	26.90	19.10	15.40	32.393	S
SM59	12.15	12.75	12.65	12.20	12.45	11.90	11.10	12.171	MR
SM60	7.75	8.75	7.60	6.75	5.25	5.10	3.95	6.450	HR
CD at 5 %	5.115	3.937	3.571	2.457	1.682	1.787	1.622	2.124	
Mean	39.01	39.81	41.35	33.37	30.35	26.34	22.02	33.17	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

Table 24: Percentage of fruits damaged by shoot and fruit borer (*L. orbonalis*) at different intervals in kharif season

Genotype	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	Pooled Mean	Rating
SM1	6.15	7.50	7.70	7.35	7.50	7.240	HR
SM2	34.00	34.65	33.95	36.50	32.75	34.370	S
SM3	44.00	44.00	44.50	36.00	30.00	39.700	S
SM4	39.25	41.00	41.25	36.25	36.50	38.850	S
SM5	38.85	42.25	41.75	35.00	32.50	38.070	S
SM6	35.00	39.10	41.00	39.25	39.00	38.670	S
SM7	41.25	42.75	41.75	37.50	35.40	39.730	S
SM8	40.50	40.25	41.00	37.50	37.15	39.280	S
SM9	33.00	34.20	33.50	31.25	30.00	32.390	S
SM10	43.50	43.25	42.00	36.90	33.95	39.920	S
SM11	51.75	52.60	51.90	43.00	39.50	47.750	HS
SM12	47.50	49.40	48.00	44.75	41.50	46.230	HS
SM13	41.25	41.50	40.00	36.50	33.35	38.520	S
SM14	34.75	34.25	33.50	31.25	31.75	33.100	S
SM15	38.00	39.75	39.00	33.75	31.45	36.390	S
SM16	51.00	51.00	49.75	43.00	40.50	47.050	HS
SM17	41.00	41.60	41.65	35.50	33.85	38.720	S
SM18	41.50	40.20	37.20	34.75	33.95	37.520	S
SM19	33.75	35.50	39.45	35.70	32.50	35.380	S
SM20	40.50	42.50	38.60	33.00	30.25	36.970	S
SM21	38.00	37.75	36.50	32.75	31.75	35.350	S
SM22	37.00	36.50	36.75	31.25	31.70	34.640	S
SM23	40.10	41.50	40.25	35.00	33.50	38.070	S
SM24	52.50	52.00	50.50	39.00	37.00	46.200	HS
SM25	52.00	48.90	44.00	40.00	38.45	44.670	HS
SM26	41.50	40.40	39.00	34.50	33.80	37.840	S
SM27	49.00	47.90	44.30	36.40	31.50	41.820	HS
SM28	48.15	48.00	49.00	40.50	40.75	45.280	HS
SM29	44.50	45.75	42.70	32.50	30.50	39.190	S
SM30	41.90	41.90	40.25	33.60	31.50	37.830	S
SM31	42.50	42.80	41.00	32.35	31.50	38.030	S
SM32	45.00	45.00	47.00	40.50	40.50	43.600	HS
SM33	37.00	37.50	39.50	34.50	32.80	36.260	S
SM34	53.10	56.00	50.50	40.50	39.00	47.820	HS

SM35	47.00	51.00	49.00	40.25	36.95	44.840	HS
SM36	34.50	35.30	34.10	32.55	31.50	33.590	S
SM37	53.75	52.50	51.30	42.50	39.50	47.910	HS
SM38	50.70	50.25	49.90	41.25	36.90	45.800	HS
SM39	43.55	44.90	44.50	38.70	35.60	41.450	HS
SM40	52.50	53.00	49.50	39.00	36.25	46.050	HS
SM41	47.25	49.20	48.25	39.50	39.00	44.640	HS
SM42	34.50	35.40	37.00	31.00	30.40	33.660	S
SM43	37.40	38.50	38.75	32.00	31.00	35.530	S
SM44	34.90	34.90	30.40	30.90	30.50	32.320	S
SM45	30.10	29.50	28.75	26.90	25.85	28.220	T
SM46	30.00	28.95	29.65	26.15	23.85	27.720	T
SM47	28.90	27.40	27.95	24.60	23.00	26.370	T
SM48	30.00	29.75	29.50	27.75	26.25	28.650	T
SM49	35.00	36.90	35.25	28.25	27.75	32.630	S
SM50	31.50	29.70	28.50	25.30	23.60	27.720	T
SM51	35.65	35.25	32.75	29.00	29.00	32.330	S
SM52	34.00	35.00	32.70	28.00	28.80	31.700	S
SM53	33.55	34.40	33.00	29.75	28.65	31.870	S
SM54	36.00	37.00	35.70	27.65	26.55	32.580	S
SM55	30.50	30.75	30.50	25.25	23.55	28.110	T
SM56	29.75	29.05	28.75	26.95	22.95	27.490	T
SM57	50.75	49.90	47.75	31.50	30.00	41.980	HS
SM58	51.00	52.25	50.50	35.50	33.65	44.580	HS
SM59	13.25	13.00	13.00	12.50	12.25	12.800	MR
SM60	7.00	7.85	8.00	7.15	7.15	7.430	HR
CD at 5%	5.019	3.776	3.834	3.027	1.918	3.582	
Mean	39.03	39.51	38.56	33.13	31.47	36.34	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

Table 25: Percentage of fruits damaged by shoot and fruit borer (*L. orbonalis*) at different intervals in rabi season.

Genotype	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	Pooled Mean	Rating
SM1	7.10	7.75	7.55	6.90	7.50	7.360	HR
SM2	34.30	34.00	34.00	31.00	31.00	32.860	S
SM3	43.50	44.50	42.90	34.50	32.50	39.580	S
SM4	36.40	38.80	39.00	35.50	32.25	36.390	S
SM5	40.50	39.90	37.75	34.50	33.25	37.180	S
SM6	39.25	39.75	39.00	37.00	36.50	38.300	S
SM7	38.90	38.50	39.30	33.75	32.50	36.590	S
SM8	46.00	47.50	46.00	36.40	34.50	42.080	HS
SM9	35.00	35.90	36.00	30.25	30.50	33.530	S
SM10	41.50	44.00	43.00	36.50	33.25	39.650	S
SM11	48.50	50.00	48.50	43.50	38.75	45.850	HS
SM12	48.50	51.00	49.00	45.00	43.50	47.400	HS
SM13	37.25	37.90	38.00	35.25	33.80	36.440	S
SM14	35.90	35.50	34.60	31.25	31.25	33.700	S
SM15	37.25	37.25	36.50	33.50	33.50	35.600	S
SM16	45.50	46.70	45.00	39.75	39.50	43.290	HS
SM17	37.75	37.70	34.60	34.85	33.10	35.600	S
SM18	37.50	36.85	37.80	35.00	32.25	35.880	S
SM19	40.50	40.60	37.55	34.50	30.25	36.680	S
SM20	39.00	40.50	41.25	35.50	34.50	38.150	S
SM21	35.50	34.50	34.25	31.00	31.50	33.350	S
SM22	42.00	42.25	41.35	33.40	32.50	38.300	S
SM23	35.00	36.00	34.50	32.50	31.20	33.840	S
SM24	45.85	45.70	43.10	40.50	35.60	42.150	HS
SM25	47.65	48.25	45.95	38.10	33.85	42.760	HS
SM26	39.00	42.00	39.25	35.25	32.90	37.680	S
SM27	50.50	47.85	41.60	36.75	33.55	42.050	HS
SM28	48.25	47.00	46.50	41.00	39.00	44.350	HS
SM29	36.50	38.25	40.50	33.75	32.75	36.350	S
SM30	41.25	41.45	37.00	30.00	30.50	36.040	S
SM31	41.00	42.50	41.50	32.20	32.20	37.880	S
SM32	46.00	46.00	45.50	35.90	33.90	41.460	HS
SM33	36.90	37.50	35.25	31.65	32.00	34.660	S
SM34	44.30	49.00	45.00	38.75	36.85	42.780	HS

SM35	50.00	50.00	51.00	39.50	37.65	45.630	HS
SM36	35.10	34.75	33.60	31.10	31.10	33.130	S
SM37	46.50	47.50	47.50	38.75	39.00	43.850	HS
SM38	51.60	49.75	45.15	36.75	32.50	43.150	HS
SM39	48.15	45.65	41.50	37.25	35.10	41.530	HS
SM40	34.50	37.00	39.50	34.75	33.20	35.790	S
SM41	47.00	49.00	48.40	35.90	36.70	43.400	HS
SM42	37.00	38.00	38.25	30.75	31.20	35.040	S
SM43	35.25	35.40	35.25	30.95	30.60	33.490	S
SM44	29.90	31.00	31.75	29.50	30.50	30.530	S
SM45	28.75	28.90	29.60	28.25	25.95	28.290	T
SM46	29.70	30.10	28.75	27.20	26.50	28.450	T
SM47	30.05	29.10	27.05	26.45	24.15	27.360	T
SM48	30.05	29.15	26.85	26.75	25.95	27.750	T
SM49	31.25	31.50	31.25	29.50	29.20	30.540	S
SM50	29.35	28.70	27.35	26.90	24.85	27.430	T
SM51	31.80	33.95	31.90	29.50	29.75	31.380	S
SM52	31.40	32.75	30.50	29.25	29.20	30.620	S
SM53	32.20	32.25	29.50	27.75	27.60	29.860	T
SM54	33.00	36.00	31.70	29.75	30.00	32.090	S
SM55	29.75	27.60	26.35	26.50	24.15	26.870	T
SM56	30.00	27.75	26.95	26.75	24.30	27.150	T
SM57	47.60	47.90	45.50	37.80	31.60	42.080	HS
SM58	45.50	45.00	43.10	38.95	33.70	41.250	HS
SM59	12.75	12.85	12.25	12.25	12.70	12.560	MR
SM60	6.60	7.60	7.75	7.80	7.80	7.510	HR
CD at 5%	4.577	4.019	3.827	2.320	2.150	3.436	
Mean	37.58	38.03	36.78	32.53	31.12	35.20	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

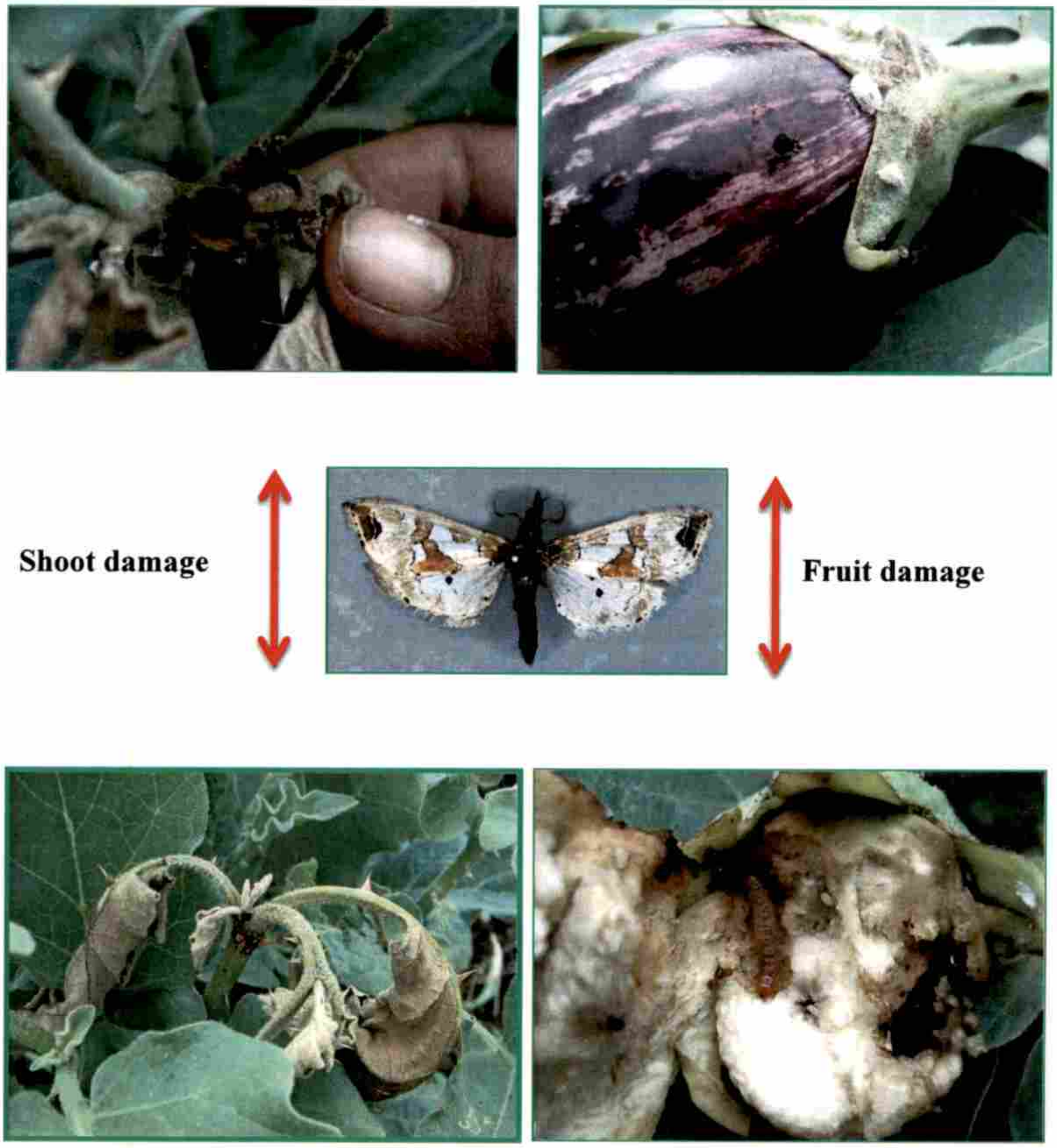

Plate: 6. Shoot and fruit damage caused by brinjal shoot and fruit borer (*leucinodes orbonalis* L.)

Pusa Purple Cluster

Vellayani Local

IC- 89986

Plate: 7. Resistant genotypes to brinjal shoot and fruit borer (*Leucinodes orbonalis* L.)

13.00, 12.50, 12.25 and 12.80). Highest percentage of fruit infestation was found in SM 37 (53.75, 52.50, 51.30, 42.50 and 39.50) followed by SM 34 (53.10, 56.00, 50.50, 40.50 and 39.00), SM 11 (51.75, 52.60, 51.90, 43.00 and 39.50) and SM 16 (51.00, 51.00, 49.75, 43.00 and 40.50) at 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively in kharif season.

In rabi season, minimum percentage of fruit infestation was recorded in SM 1 (7.10, 7.75, 7.55, 6.90 and 7.50), SM 60 (6.60, 7.60, 7.75, 7.80 and 7.8) and SM 59 (12.75, 12.85, 12.25, 12.25 and 12.70). Highest percentage of fruit infestation was found in SM 12 (48.50, 51.00, 49.00, 45.00 and 43.50) followed by SM 11 (48.50, 50.00, 48.50, 43.50 and 38.75), SM 35 (50.00, 50.00, 51.00, 39.50 and 37.65) and SM 18 (48.25, 47.00, 46.50, 41.00 and 39.00) at 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively.

4.2 EXPERIMENT II: LINE X TESTER ANALYSIS

4.2.1 Analysis of Variance for the Experimental Design

The parents showed highly significant difference for all characters studied, that indicates the sufficient variability among them. The variance due to female parents was highly significant for all traits indicating the existence of enormous amount of genetic variability. Similarly, the male parents showed significant difference for all traits except short styled flowers and days to first harvest, thus revealing the presence of sufficient genetic variability among them for majority of the characters studied (Table 26).

The interaction between females x males was significant for all the characters studied except short styled flowers. The mean square due to hybrid showed highly significant difference for all the characters indicating significant difference among hybrids. Parent vs. hybrids showed highly significant differences for all the characters except long styled flowers, which indicates that heterosis was reflected in hybrids (Table 26).

Table 26: Analysis of variance for combining ability (L x T) for yield and yield components in brinjal

Source of Variation	DF	Plant height (cm)	Primary branches/ plant	Days to first flower	Medium styled flower (%)	Long styled flowers (%)	Short styled flowers (%)	No. of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit yield/ plant (kg)
Replicates	2	6.346*	0.12	0.353	2.37	2.7	0.45	1.16	0.001	0.22	3.2	0.12	2.36	0.015
Treatments	22	665.2**	6.63**	64.1**	65.5**	70.6**	16.4**	276**	51.6**	39.5**	2753**	103.6**	161**	3.47**
Parents	7	560.9**	2.70**	46.4**	25.1**	33.3**	3.99*	67.9**	65.3**	59.3**	4709**	24.2**	32.6**	0.59**
Parents (line)	4	291.1**	0.95**	60.8**	28.0**	41.4	4.96*	43.3**	19.7**	26.6**	2489**	35.0**	33.1**	0.04
Parents (Testers)	2	1248**	5.67**	3.87**	24.1**	15.3*	1.08	147**	138**	152**	11241**	1.21	33.9**	0.11**
Parents (L vs T)	1	264.9**	3.78**	73.9**	15.6*	36.8**	5.93	7.02**	102**	4.5**	528**	26.7**	28.1**	3.77**
Parents vs Crosses	1	4939**	37.26**	251**	298.2**	1.3	274.6**	1560**	46.7**	30.6**	5254**	467.0**	1263**	11.11**
Crosses	14	412.0**	6.40**	59.7**	69.1**	94.2**	4.27**	289**	45.0**	30.2**	1597**	117.4**	146**	4.37**
Line effect	4	883.53	8.93	36.1	100.1	160.7	8.17	452.7	97.6**	25.6	3779*	103.6	143.4	3.97
Tester effect	2	72.04	8.79	287**	132.9	157.6	2.36	426.3	75.0*	122**	1271.3	468.6**	485.4*	13.50*
Line X Tester effect	8	261.3**	4.54**	14.5**	37.6**	45.2**	2.8	174**	11.2**	9.5**	587**	36.5**	63.4**	2.28**
Error	44	1.792	0.11	0.39	2.7	3.5	1.58	0.61	0.13	0.1	2.8	0.41	1.13	0.019
Total	68	216.57	2.22	21	23	25.2	6.36	90	16.7	12.9	892.9	33.81	52.9	1.13

4.2.2 Mean Performance of Parents and Hybrids

The mean values of parents and hybrids for different characters are presented in table 27. The performance of hybrids has been compared with check (Haritha) for different characters. The salient features for each character are described in ensuing paragraphs.

4.2.2.1 Plant Height (cm)

Plant height ranged from 74.60 cm (L_3) to 117.87 cm (T_2) for parents. The minimum plant height was recorded for the hybrids L_1 X T_2 (85.33 cm). The tallest hybrid was recorded L_2 X T_2 (126.33 cm) followed by L_2 X T_3 (120.33 cm).

4.2.2.2 Number of Primary Branches per Plant

The primary branches per plant ranged from L_1 (6.20) to T_3 (9.11). Among hybrids this range was 3.77 (L_1 X T_2) to 8.13 (L_5 X T_3).

4.2.2.3 Days to First Flowering

Among parents L_1 (30.00) was the earliest for flowering and L_4 (45.87) the latest for flowering. Among hybrids earliest flowering was observed in L_5 X T_3 (40.33) and delayed flowering was observed in L_1 X T_2 (52.23).

4.2.2.4 Percentage of Medium Styled Flowers

Among the parents percentage of medium styled flowers was ranged from L_2 (42.45) to T_3 (34.00) and among the hybrids it was ranged between L_5 X T_3 (25.87) to L_3 X T_1 (41.40).

4.2.2.5 Percentage of Long Styled Flowers

Among the parents percentage of long styled flowers was ranged from T_3 (60.67) to L_2 (52.26) and among the hybrids it was ranged between L_3 X T_1 (48.70) to L_5 X T_3 (66.43).

Table27. Mean values of eight parents and 15 crosses for yield and yield component Characters

S.No	Parents and crosses	Plant height (cm)	No. of branches/plant	Days to first flower	Medium styled flowers (cm)	Long styled flowers (cm)	short styled flowers (cm)
1	$Line_1$	85.20	6.20	35.00	35.98	60.41	3.61
2	$Line_2$	100.13	6.50	38.47	42.45	52.26	5.28
3	$Line_3$	74.60	7.17	44.80	38.59	54.99	6.09
4	$Line_4$	94.67	6.33	45.87	40.66	52.29	7.05
5	$Line_5$	92.33	7.50	41.87	35.22	58.73	6.05
6	$Tester_1$	77.33	6.50	43.53	39.67	56.16	3.90
7	$Tester_2$	117.87	7.07	45.67	37.07	58.07	4.87
8	$Tester_3$	93.55	9.11	45.28	34.00	60.67	5.00
9	$L_1 XT_1$	108.67	4.60	50.50	39.33	50.60	10.07
10	L_1XT_2	85.33	3.77	52.23	33.00	56.73	10.27
11	L_1XT_3	93.73	5.17	43.20	28.67	62.00	9.33
12	L_2XT_1	118.00	7.60	42.53	26.37	65.73	7.90
13	L_2 X T_2	126.33	5.40	51.33	34.50	55.53	9.97
14	L_2 XT_3	120.33	8.07	40.93	29.83	63.47	6.70
15	L_3XT_1	92.80	3.83	52.03	41.40	48.70	9.90
16	L_3XT_2	115.87	4.93	51.80	36.40	54.13	9.47
17	L_3 X T_3	108.00	5.37	42.77	32.93	56.90	10.17
18	L_4 X T_1	106.33	4.73	45.40	38.60	50.80	10.60
19	L_4 X T_2	118.67	6.77	47.50	37.23	53.03	9.73
20	L_4 X T_3	102.67	5.17	42.70	34.87	53.97	11.17
21	L_5 X T_1	119.33	5.10	44.50	36.03	55.23	8.73
22	L_5 X T_2	114.70	3.93	50.70	28.80	61.60	9.60
23	L_5 X T_3	115.10	8.13	40.33	25.87	66.43	7.70
24	check	116.79	7.73	45.06	40.77	48.43	10.47
	Mean	104.10	6.11	45.17	35.34	56.54	8.07
	SEM	0.78	0.20	0.36	0.96	1.09	0.73
	CD (0.05%)	2.23	0.57	1.02	2.73	3.12	2.07
	CV	1.30	5.70	1.37	4.70	3.35	15.63

Table 27. Continued.

S. No	Parents and crosses	No. of fruits/plant	Length of fruits (cm)	Girth of fruits (cm)	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit yield/plant (kg)
1	$Line_1$	31.00	9.92	18.17	191.70	54.13	139.83	4.06
2	$Line_2$	31.47	10.03	18.73	165.00	60.33	145.60	4.01
3	$Line_3$	32.27	9.17	16.83	154.67	62.33	149.00	3.87
4	$Line_4$	32.30	8.03	15.23	119.67	62.40	146.10	3.87
5	$Line_5$	40.17	14.73	11.30	129.17	58.57	145.33	4.15
6	$Tester_1$	28.83	10.03	23.37	198.00	61.80	144.33	3.08
7	$Tester_2$	27.73	22.43	10.70	152.27	62.33	151.00	3.04
8	$Tester_3$	40.40	11.47	11.39	76.78	61.07	146.90	3.40
9	L_1 XT_1	15.33	9.93	15.67	121.77	70.33	142.67	1.68
10	L_1XT_2	10.00	8.80	12.03	88.17	73.10	144.90	1.01
11	L_1XT_3	18.50	9.17	12.53	92.00	62.50	133.83	3.93
12	L_2XT_1	42.53	15.93	13.73	128.73	56.10	126.33	4.42
13	L_2 X T_2	17.80	21.23	10.27	131.60	71.53	143.83	2.00
14	L_2 XT_3	36.13	17.67	12.07	128.27	55.83	126.97	4.42
15	L_3XT_1	16.63	9.67	16.10	118.03	73.30	145.93	1.03
16	L_3XT_2	19.00	18.73	12.77	128.93	72.50	144.27	2.29
17	L_3 X T_3	22.70	14.27	13.93	126.30	62.90	134.60	3.00
18	L_4 X T_1	18.57	10.23	21.10	148.50	65.90	137.23	1.77
19	L_4 X T_2	22.20	15.70	14.50	141.50	67.93	137.43	3.34
20	L_4 X T_3	21.07	10.73	12.67	128.17	62.50	135.50	3.85
21	L_5 X T_1	21.50	12.93	21.33	186.53	65.03	133.93	2.59
22	L_5 X T_2	19.83	16.23	12.03	134.50	71.27	142.67	2.81
23	L_5 X T_3	43.73	14.33	14.00	148.27	56.77	125.33	4.49
24	check	34.67	14.90	11.79	124.93	68.19	171.33	3.58
	Mean	26.85	13.18	14.68	135.98	64.11	141.45	3.15
	SEM	0.45	0.21	0.24	0.96	0.36	0.64	0.08
	CD (0.05%)	1.27	0.60	0.69	2.72	1.04	1.83	0.23
	CV (%)	2.88	2.78	2.86	1.22	0.98	0.79	4.37

4.2.2.6 Percentage of Short Styled Flowers

Among the parents minimum percentage of short styled flowers was observed in L_1 (3.61) which was on par with T_1 (3.90) and T2 (4.87) whereas maximum was observed in L_4 (7.05). Among the hybrids it was ranged between L_2 X T_3 (6.70) to L_4 X T_3 (11.17).

4.2.2.7 Number of Fruits per Plant

Among parents, fruits per plant ranged between 27.73 (T_2) and 40.33 (T_3). Among hybrids, the maximum fruits per plant was observed for L_5 x T_3 (43.73) followed by L_2 x T_1 (42.53), L_2 x T_3 (36.13) and L_3 x T_3 (22.70). It was minimum for the hybrid L_1 x T_2 (10.00) followed by L_3 x T_1 (16.63) and L_2 x T_2 (17.80).

4.2.2.8 Length of Fruit (cm)

The longest fruits were produced by the parent T_2 (22.43 cm) and shortest fruits were recorded in L_4 (8.03 cm). Fruit length of hybrids ranged from 8.8 cm (L_1 x T_2) to 21.23 cm (L_2 x T_2).

4.2.2.9 Girth of Fruit (cm)

Fruit girth was maximum for the parent T_1 (23.37 cm) and the minimum for T_2 (10.70 cm).The hybrids with maximum and minimum fruit girth were observed in L_5 x T_1 (21.33 cm) and L_2 x T_2 (10.27 cm) respectively.

4.2.2.10 Fruit Weight (g)

The average fruit weight among the parents ranged from 76.78g (T_3) to 198.00g (T_2).The hybrids showed a variation from 88.17g (L_1 x T_2) to 186.53g (L_5 x T_1).

4.2.2.11 Days to First Harvest

Among parents earliest harvest was recorded in L_1 (54.13) and the latest harvest was observed in L_4 (62.40) which was on par with L_3 as well as T_2 (62.33) and T_1

(61.80). Among hybrids $L_2 x T_3$ (55.83) took the minimum days for harvest which was on par with $L_2 x T_1$ (55.83) and $L_5 x T_3$ (56.77).

4.2.2.12 Days to Last Harvest

Among parents maximum and minimum days taken for last harvest was recorded in T_2 (151.00) and L_1 (139.83) respectively. Among hybrids maximum and minimum days taken for last harvest was recorded in $L_3 x T_1$ (145.93) and $L_5 x T_3$ (125.33) respectively.

4.2.2.13 Fruit Yield per Plant (kg)

The parent L_5 recorded the maximum fruit yield of 4.15 kg per plant which was on par with L_1 (4.06) and L_2 (4.01). It was minimum for T_2 (3.04 kg). Maximum yield was observed for the hybrid $L_5 x T_3$ (4.49 kg) which was on par with $L_2 x T_3$ (4.42 kg) and $L_2 x T_1$ (4.42 kg). Minimum fruit yield per plant was recorded for $L_1 x T_2$ (1.01kg) followed by $L_3 x T_1$ (1.03 kg) and $L_4 x T_1$ (1.77kg).

4.2.3 ESTIMATION OF HETEROSIS

The magnitude of heterosis, estimated as per cent increase or decrease of F_1 value over mid-parent (relative heterosis), over better parent (heterobeltiosis) and over standard check Haritha (standard heterosis) for 13 characters were presented in Table 28 to 34. The character wise results were summarized in the following paragraphs.

4.2.3.1 Plant Height (cm)

The pertinent data on heterosis revealed that 14 hybrids over mid-parent, 10 hybrids over better parent and three hybrids over commercial check had significant and positive heterosis for the plant height. The magnitude of heterosis over mid-parent, better parent and commercial check ranged from -15.96 ($L_1 XT_2$) to 40.67 per cent ($L_5 X T_1$), from -27.60 ($L_1 XT_2$) to 29.24 per cent ($L_5 X T_1$), -26.93 ($L_1 XT_2$) to 8.17 per cent ($L_2 XT_2$) respectively. The highest magnitude of heterosis over standard check was observed in the cross $L_2 XT_2$ (8.17 %) and $L_2 XT_3$ (3.03 %).

4.2.3.2 Primary Branches per Plant

Heterosis in F_1 hybrids over their respective mid parent value ranged from -46.00 (L_5 x T_2) to 16.92 per cent (L_2 x T_1). Expression of Heterosis over mid parent was in positive direction in one of the 15 crosses. The extent of heterosis exhibited by the F_1 hybrids over their corresponding better parent ranged from -47.56 per cent (L_5 x T_2) to 16.92 per cent (L_2 X T_1) and one of the 15 crosses exhibited significant positive heterosis. Thirteen crosses exhibited negative heterosis over commercial check. The cross showing significant higher positive heterosis over mid parent and better parent was L_2 X T_1.

4.2.3.3 Days to First Flower

The estimates of relative heterosis revealed that out of 15 hybrids, 14 hybrids exhibited significant relative heterosis, of which 4 hybrids depicted significant and negative relative heterosis, which is desirable for earliness. The extent of relative heterosis ranged from -7.43 per cent (L_5 x T_3) to 29.50 per cent (L_1 x T_2). The hybrid L_5 x T_3 (-7.43 %) showed maximum negative heterosis over mid parent followed by L_4 X T_3 (-6.30 %) and L_3 X T_3 (-5.04 %). Heterobeltiosis for days to first flower ranged from -10.92 (L_5 XT_3) to 16.15 per cent (L_3 X T_1). Five hybrids showed significant and negative heterobeltiosis. The hybrid L_5 X T_3 (-10.92 %) showed maximum negative heterosis over better parent followed by L_2 X T_3 (-9.59 %) and L_4 X T_3 (-6.90%). The estimates of standard heterosis over the check (Haritha) varied from -10.48 (L_5 X T_3) to 15.93% (L_1 X T_2). Among 15 hybrids, 5 hybrids exhibited significant negative standard heterosis over check. Maximum estimates were observed for the hybrid L_5 X T_3 (-10.48 %) followed by L_2 X T_3 (-9.15 %) and L_2 X T_1 (-5.60 %).

4.2.3.4 Medium Styled Flowers

The magnitude of heterosis varied from -35.79% (L_2 x T_1) to -6.59% (L_4 x T_3) over mid-parent, –37.89% (L_2 x T_1) to -8.42% (L_4 x T_2) over better parent and 36.55%

Table 28. Heterosis (%) for Plant height and number of primary branches per plant

Crosses	Plant height (cm)			Primary branches per plant		
	RH	HB	SH	RH	HB	SH
$L_1 XT_1$	33.72**	27.54**	-6.96 **	-27.56 **	-29.23 **	-40.52 **
L_1XT_2	-15.96**	-27.60 **	-26.93**	-43.22 **	-46.70 **	-51.29 **
L_1XT_3	4.88**	0.20	-19.74**	-32.52 **	-43.31 **	-33.19 **
L_2XT_1	32.98**	17.84**	1.04	16.92**	16.92**	-1.72
$L_2 X T_2$	15.90**	7.18**	8.17**	-20.39 **	-23.58 **	-30.17 **
$L_2 XT_3$	24.26**	20.17**	3.03**	3.33	-11.49 **	4.31
L_3XT_1	22.16**	20.00**	-20.54**	-43.90 **	-46.51 **	-50.43 **
L_3XT_2	20.40**	-1.70	-0.79	-30.68 **	-31.16 **	-36.21 **
$L_3 X T_3$	28.46**	15.45**	-7.53**	-34.07 **	-41.11 **	-30.60 **
$L_4 X T_1$	23.64**	12.32**	-8.95**	-26.23 **	-27.18 **	-38.79 **
$L_4 X T_2$	11.67**	0.68	1.61	1.00	-4.25	-12.50 **
$L_4 X T_3$	9.09**	8.45**	-12.09**	-33.10 **	-43.31 **	-33.19 **
$L_5 X T_1$	40.67**	29.24**	2.18*	-27.14 **	-32.00 **	-34.05 **
$L_5 X T_2$	9.13**	-2.69 **	-1.79	-46.00 **	-47.56 **	-49.14 **
$L_5 X T_3$	23.84**	23.04**	-1.45	-2.09	-10.75**	5.17

Table 29. Heterosis (%) for Days to first flower and Medium styled flowers

Crosses	Days to first flower			Medium styled flowers (%)		
	RH	HB	SH	RH	HB	SH
$L_1 XT_1$	28.61**	16.00**	12.08**	4.00	-0.84	-3.52
L_1XT_2	29.50**	14.38**	15.93**	-9.64**	-10.97**	-19.05**
L_1XT_3	7.63**	-4.59 **	-4.12 **	-18.07**	-20.32**	-29.68**
L_2XT_1	3.74**	-2.30	-5.60 **	-35.79**	-37.89**	-35.32**
$L_2 X T_2$	22.03**	12.41**	13.93**	-13.23**	-18.73**	-15.37**
$L_2 XT_3$	-2.24**	-9.59 **	-9.15 **	-21.96**	-29.73**	-26.82**
L_3XT_1	17.81**	16.15**	15.48**	5.81	4.37	1.55
L_3XT_2	14.52**	13.43**	14.97**	-3.78	-5.68	-10.71**
$L_3 X T_3$	-5.04**	-5.54 **	-5.08 **	-9.26**	-14.66**	-19.22**
$L_4 X T_1$	1.57**	-1.02	0.76	-3.89	-5.06	-5.31
$L_4 X T_2$	3.79**	3.56**	5.42**	-4.19	-8.42*	-8.67*
$L_4 X T_3$	-6.30**	-6.90 **	-5.23 **	-6.59*	-14.24**	-14.47**
$L_5 X T_1$	4.22**	2.22	-1.24	-3.77	-9.16*	-11.61**
$L_5 X T_2$	15.84**	11.02**	12.52**	-20.32**	-22.30**	-29.35**
$L_5 X T_3$	-7.43**	-10.92 **	-10.48 **	-25.27**	-26.56**	-36.55**

RH-Relative Heterosis HB- Heterobeltiosis SH- Standard heterosis

*Significant at 5 per cent level **Significant at 1 per cent level

Table 30. Heterosis (%) for long styled flowers and Short styled flowers

Crosses	Long styled flowers (%)			Short styled flowers (%)		
	RH	HB	SH	RH	HB	SH
$L_1 XT_1$	-13.19**	-16.24**	4.47	168.21**	158.12**	-3.82
L_1XT_2	-4.23	-6.09*	17.14**	142.33**	110.96**	-1.91
L_1XT_3	2.41	2.20	28.01**	116.89**	86.67**	-10.83
L_2XT_1	21.25**	17.05**	35.72**	72.05**	49.53*	-24.52*
$L_2 X T_2$	0.67	-4.36	14.66**	96.39**	88.64**	-4.78
$L_2 XT_3$	12.40**	4.62	31.04**	30.31	26.81	-35.99**
L_3XT_1	-12.37**	-13.28**	0.55	98.20**	62.56**	-5.41
L_3XT_2	-4.24	-6.77*	11.77**	72.80**	55.45**	-9.55
$L_3 X T_3$	-1.61	-6.21*	17.48**	83.35**	66.94**	-2.87
$L_4 X T_1$	-6.32*	-9.54**	4.89	93.61**	50.35**	1.27
$L_4 X T_2$	-3.89	-8.67**	9.50**	63.36**	38.06*	-7.01
$L_4 X T_3$	-4.45	-11.04**	11.42**	85.34**	58.39**	6.69
$L_5 X T_1$	-3.85	-5.95*	14.04**	75.54**	44.35*	-16.56
$L_5 X T_2$	5.49*	4.89	27.19**	75.88**	58.68**	-8.28
$L_5 X T_3$	11.28**	9.51**	37.16**	39.37*	27.27	-26.43*

Table 31. Heterosis (%) for Number of fruits per plant and Length of fruits

Crosses	Number of fruits per plant			Length of fruits (cm)		
	RH	HB	SH	RH	HB	SH
$L_1 XT_1$	-48.75 **	-50.54 **	-55.78**	-0.42	-1.00	-33.33**
L_1XT_2	-65.95 **	-67.74 **	-71.16**	-45.60**	-60.77**	-40.94**
L_1XT_3	-48.18 **	-54.21 **	-46.64**	-14.26**	-20.06**	-38.48**
L_2XT_1	41.07 **	35.17**	22.67**	58.83**	58.80**	6.94**
$L_2 X T_2$	-39.86 **	-43.43 **	-48.66**	30.81**	-5.35**	42.51**
$L_2 XT_3$	0.56	-10.56 **	4.21*	64.37**	54.07**	18.57**
L_3XT_1	-45.55 **	-48.45 **	-52.03**	0.69	-3.65	-35.12**
L_3XT_2	-36.67 **	-41.12 **	-45.20**	18.57**	-16.49**	25.73**
$L_3 X T_3$	-37.52 **	-43.81 **	-34.53**	38.29**	24.42**	-4.25*
$L_4 X T_1$	-39.26 **	-42.52 **	-46.45**	13.33**	1.99	-31.32**
$L_4 X T_2$	-26.04 **	-31.27 **	-35.97**	3.09	-30.01**	5.37*
$L_4 X T_3$	-42.04 **	-47.85 **	-39.24**	10.12**	-6.40*	-27.96**
$L_5 X T_1$	-37.68 **	-46.47 **	-37.99**	4.44*	-12.22**	-13.20**
$L_5 X T_2$	-41.58**	-50.62**	-42.80**	-12.65**	-27.64**	8.95**
$L_5 X T_3$	8.56**	8.25**	26.13**	9.41**	-2.71	-3.80

RH-Relative Heterosis HB- Heterobeltiosis SH- Standard heterosis

*Significant at 5 per cent level **Significant at 1 per cent level

Table 32. Heterosis (%) for Girth of fruit and Fruit weight

Crosses	Girth of fruit (cm)			Fruit weight (cm)		
	RH	HB	SH	RH	HB	SH
L_1 XT_1	-24.56**	-32.95**	32.92**	-37.51 **	-38.50 **	-2.53*
L_1XT_2	-16.63**	-33.76**	2.09	-48.74 **	-54.01 **	-29.43**
L_1XT_3	-15.19**	-31.01	6.33*	-31.47 **	-52.01 **	-26.36**
L_2XT_1	-34.76**	-41.23**	16.52**	-29.07 **	-34.98 **	3.05*
L_2 X T_2	-30.24**	-45.20**	-12.90**	-17.04 **	-20.24 **	5.34**
L_2 XT_3	-19.88**	-35.59**	2.38	6.10**	-22.26 **	2.67*
L_3XT_1	-19.90**	-31.10**	36.60**	-33.06 **	-40.39 **	-5.52**
L_3XT_2	-7.26	-24.16**	8.31**	-15.99 **	-16.64 **	3.21**
L_3 X T_3	-1.26	-17.23**	18.21**	9.14**	-18.34 **	1.10
L_4 X T_1	9.33**	-9.70**	79.02**	-6.51 **	-25.00 **	18.87**
L_4 X T_2	11.83**	-4.81*	23.02**	4.07**	-7.07 **	13.27**
L_4 X T_3	-4.85*	-16.85**	7.47*	30.48**	7.10**	2.59*
L_5 X T_1	23.08**	-8.70**	81.00**	14.03**	-5.79 **	49.31**
L_5 X T_2	9.39**	6.49*	2.09	-4.42 **	-11.67**	7.66**
L_5 X T_3	23.40**	22.91**	18.78**	43.98**	14.79**	18.68**

Table 33. Heterosis (%) for Days to first harvest and Days to last harvest

Crosses	Days to first harvest			Days to last harvest		
	RH	HB	SH	RH	HB	SH
L_1 XT_1	21.33**	13.81**	3.14**	0.41	-1.15	-16.73 **
L_1XT_2	25.53	17.27**	7.20**	-0.36	-4.04 **	-15.43 **
L_1XT_3	8.51**	2.35*	-8.34 **	-6.65 **	-8.89 **	-21.89 **
L_2XT_1	-8.13**	-9.22**	-17.73 **	-12.85 *	-12.47 **	-26.26 **
L_2 X T_2	16.63**	14.76**	4.90**	-3.01 **	-4.75 **	-16.05 **
L_2 XT_3	-8.02**	-8.57**	-18.12 **	-13.19 *	-13.57 **	-25.89 **
L_3XT_1	18.10**	17.59**	7.49**	-0.50	1.11	-14.82 **
L_3XT_2	16.31**	16.31**	6.32**	-3.82 **	-4.46 **	-15.80 **
L_3 X T_3	1.94**	0.91	-7.76 **	-9.02 **	-8.37 **	-21.44 **
L_4 X T_1	6.12**	5.61**	-3.36 **	-5.50 **	-4.92 **	-19.90 **
L_4 X T_2	8.93**	8.87**	-0.38	-7.48 **	-8.98 **	-19.79 **
L_4 X T_3	1.24	0.16	-8.34 **	-7.51 **	-7.76 **	-20.91 **
L_5 X T_1	8.06**	5.23**	-4.63 **	-7.53 **	-7.21 **	-21.83**
L_5 X T_2	17.89**	14.33**	4.51**	-3.71 **	-5.52 **	-16.73**
L_5 X T_3	-5.10**	-7.04**	-16.75 **	-14.22 *	-14.68 **	-26.85**

RH-Relative Heterosis HB- Heterobeltiosis SH- Standard heterosis

*Significant at 5 per cent level **Significant at 1 per cent level

Table 34. Heterosis (%) for Fruit yield per plant

Crosses	Fruit yield per plant (kg)		
	RH	HB	SH
$L_1 XT_1$	-52.83**	-58.54 **	-53.02**
L_1XT_2	-71.64**	-75.21 **	-71.91**
L_1XT_3	5.45*	-3.12	9.77**
L_2XT_1	24.74**	10.22**	23.35**
$L_2 X T_2$	-43.26**	-50.12 **	-44.19**
$L_2 XT_3$	19.21**	10.14**	23.26**
L_3XT_1	-70.44**	-73.47 **	-71.35**
L_3XT_2	-33.72**	-40.83 **	-36.09**
$L_3 X T_3$	-17.56**	-22.57 **	-16.37**
$L_4 X T_1$	-49.14**	-54.35 **	-50.70**
$L_4 X T_2$	-3.33	-13.70 **	-6.79*
$L_4 X T_3$	5.91*	-0.52	7.44*
$L_5 X T_1$	-28.29**	-37.54 **	-27.72**
$L_5 X T_2$	-21.71**	-32.15 **	-21.49**
$L_5 X T_3$	18.99**	8.28**	25.30**

RH-Relative Heterosis HB- Heterobeltiosis SH- Standard heterosis

*Significant at 5 per cent level **Significant at 1 per cent level

(L_5 x T_3) to -8.67% (L_4 X T_2) over check. None of the hybrids exhibited positive heterosis for this trait.

4.2.3.5 Long Styled Flowers

The mid parental heterosis ranged from –13.19 per cent (L_1 x T_1) to 21.25 per cent (L_2 x T_1). Four crosses L_2 x T_1 (21.25 per cent), L_2 x T_3 (12.40 per cent), L_5 x T_3 (11.28 per cent) and L_5 x T_2 (5.49 per cent) exhibited significantly positive heterosis. Heterobeltiosis ranged from -16.24 per cent (L_1 x T_1) to 17.05 per cent (L_2 x T_1). Two of the crosses recoded significantly positive heterobeltiosis. The range of standard heterosis was from 9.50 per cent (L_4 X T_2) to 37.16 per cent (L_5 x T_3). Twelve crosses recoded significantly positive standard heterosis. The hybrids L_5 x T_3 (37.16 %) showed maximum positive standard heterosis followed by L_2 x T_1 (35.72 %) and L_2 x T_3 (31.04 %).

4.2.3.6 Short Styled Flowers:

The range of heterosis for short styled flowers was from 39.37per cent (L_5 x T_3) to 168.21 per cent (L_1 x T_1). Significantly negative heterosis was exhibited by none of crosses. Heterobeltiosis values ranged from 44.35 per cent (L_5 x T_1) to 158.12 per cent (L_1 x T_1). Heterobeltiosis values were significantly negative in none of the crosses. The standard heterosis ranged from -35.99 per cent (L_2 x T_3) to -24.52 per cent (L_2 x T_1). Standard heterosis was significantly negative in three crosses.

4.2.3.7 Number of Fruits per Plant

The range of heterosis (mid parent) was from -65.95 per cent (L_1 x T_2) to 41.07 per cent (L_2 x T_1). Out of 15 crosses, 2 crosses recorded a significant positive heterosis for number of fruits per plant. Heterobeltiosis was significant and positive in 2 crosses with a range of 67.74 per cent (L_1 x T_2) to 35.17 per cent (L_2 x T_1). The standard heterosis for number of fruits per plant ranged from -71.16 per cent (L_1 x T_2) to 26.13 per cent (L_5 x T_3), only three crosses L_5 x T_3, L_2 x T_1 and L_2 x T_3 recorded significant positive standard heterosis.

4.2.3.8 Length of Fruit (cm)

Estimates of relative heterosis revealed that out of 15 hybrids, 9 hybrids showed significant positive heterosis over mid parent. The extent of relative heterosis ranged from -45.60 (L_1 x T_2) to 64.37% (L_2 x T_3). For heterobeltiosis, three hybrids showed significant and positive heterosis over better parent. The magnitude of heterobeltiosis varied from -60.77 (L_1 x T_2) to 58.80% (L_2 x T_1). For standard heterosis, six hybrids showed significant and positive heterosis over check Haritha. The magnitude of standard heterosis varied from -40.94 (L_1 x T_2) to 42.51 per cent (L_2 x T_2). Maximum standard heterosis for this trait was depicted by hybrid L_2 x T_2 (42.51%) followed by L_3 x T_2 (25.73%), L_2 x T_3 (18.57%), L_5 x T_2 (8.95%), L_2 x T_1 (6.94%) and L_4 x T_2 (5.37%).

4.2.3.9 Girth of Fruit (cm)

The heterosis over mid parent ranged between -34.76 (L_2 x T_1) to 23.40 per cent (L_5 x T_3). Top two crosses for heterosis over mid parent were L_5 x T_3 (23.40%) and L_5 x T_1 (23.08%). Two crosses exhibited significant positive heterosis over better parent and thirteen of the crosses exhibited significant negative heterosis over better parent. The heterosis over better parent ranged from -45.20 (L_2 x T_2) to 22.90 per cent (L_5 x T_3). The magnitude of standard heterosis varied from -12.90 (L_2 x T_2) to 81.00 per cent (L_5 x T_1). Out of 15 crosses, 11 hybrids exhibited significant positive heterosis while, one hybrids exhibited significant negative heterosis over commercial check.

4.2.3.10 Fruit Weight (g)

The expression of significant heterosis over mid parent in desired positive direction was revealed in 6 crosses. Per cent heterosis over mid parent ranged from -48.74 per cent (L_1 x T_2) to 43.98 per cent (L_5 x T_3). Maximum heterosis over the mid parent was observed in crosses L_5 x T_3 (43.98%), L_4 x T_3 (30.48%) and L_5 x T_1 (14.03%). Heterosis in F_1 hybids over their respective better parent value ranged from -54.01 per cent (L_1 x T_2) to 14.79 per cent (L_5 x T_3). Expression of heterosis over better parent was in positive direction in two crosses. Ten crosses manifested significant positive heterosis over commercial check. The cross L_5 x T_1 (49.31%) exhibited significantly higher positive heterosis over commercial check.

4.2.3.11 Days to First Harvest

A total of 3 hybrids expressed significant negative heterosis over mid parent, which ranged from -8.13 (L_2 X T_1) to 25.53 per cent (L_1 X T_2). The three hybrids that showed significant negative heterosis for days to first picking in order of merit were L_2 X T_1 (-8.13%), L_2 X T_3 (- 8.02 %) and L_5 X T_3 (-5.10%) over mid parent. The extent of heterosis exhibited by the F_1 hybrids over their corresponding better parent ranged from -9.22 per cent (L_2 x T_1) to 17.59 per cent (L_3 X T_1). Eight hybrids exhibited desired negative heterosis for days to first picking over commercial check. The estimates of standard heterosis over the check Haritha varied from -18.12% (L_2 X T_3) to 7.49% (L_3 X T_1).

4.2.3.12 Days to Last Harvest

For the trait under consideration negative heterosis is desirable. Heterosis over mid parent value ranged from -14.22 per cent (L_5 X T_3) to -3.01 per cent (L_2 x T_2), twelve exhibited significantly negative heterosis over mid parent. The extent of heterosis exhibited by the F1s over their corresponding better parent ranged from 1.11 (L_3 X T_1) to -14.68 per cent (L_5 x T_3). Thirteen crosses exhibited significant negative heterosis over better parent for days to last harvest. Similarly, high magnitude of economic heterosis was observed in crosses L_5 x T_3 (-26.85%), L_2 x T_3 (-25.89%) and L_2 x T_1 (-26.26%). All crosses exhibited significant negative heterosis over commercial check.

4.2.3.13 Fruit Yield per Plant (kg)

The data on per cent heterosis revealed that the hybrids ranged from –71.64 (L_1 x T_2) to 24.74 per cent (L_2 x T_1), -75.21(L_1 x T_2) to 10.22 per cent (L_2 x T_1) and -71.91 (L_1x T_2) to 25.30 per cent (L_5 x T_3) respectively over mid parent, better parent and commercial check. Out of 15 hybrids, five, three and five hybrids exhibited significant positive average heterosis, heterobeltosis and standard heterosis respectively. Among the 15 hybrids, the cross L_5 x T_3 had highest significant positive heterosis of 25.30 per cent over standard check followed by L_2 x T_1 (23.35%), L_2 x T_3 (23.26 %) and L_1 x T_3 (9.77%). The cross L_5 x T_3 also showed significant positive heterosis over mid-parent, better parent and commercial check with 18.99, 8.28 and 25.30 per cent respectively. Similarly, remaining two hybrids L_2 x T_1 (24.72, 10.22 and 23.35 per cent) and L_2 x T_3 (19.21, 1.14 and 23.26 per cent) showed significant positive heterosis over mid-parent, better parent and commercial check respectively.

4.2.4 Combining Ability Analysis

4.2.4.1 Combining Ability Variances

In the present study (Table 35) variance due to *gca* was higher than *sca* as evidenced by the ratio being greater than one, for days to first flower, fruit length, fruit girth, days to first harvest, days to last harvest suggesting major role of additive gene action in expression of these characters. When additive gene action form the principal factor for genetic variance use of pedigree method could be desirable.

For other characters variance due to *sca* was higher than *gca* as evidenced by the ratio being less than one, suggesting significant role of non-additive gene action like dominance, epistasis and other interaction effects in expression of these characters. When non-additive genes govern the characters this suggest that there is scope of improvement of these characters by using selection methods as well as go for hybrid breeding programme for exploitation of heterosis.

4.2.4.2 Estimation of Combining Ability (gca and sca) Effects.

The general combining ability effects estimated for both the lines (female parents) and testers (male parents) and the specific combining ability effects of hybrids for different characters studied are presented in Tables 36 and 37. The salient features of the results on combining ability effects for different characters are presented as under

Table 35. Combining ability variances for different characters in brinjal

Sources of variation	Plant height (cm)	Primary branches/ plant	Days to first flower	Medium styled flower (%)	Long styled flowers (%)	Short styled flowers (%)	No. of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit yield/ plant (kg)
σ^2gca	39.67	0.73	13.46	9.48	12.97	0.31	36.58	7.19	6.15	161.40	23.81	26.11	0.73
σ^2sca	86.52	1.48	4.71	11.64	13.88	0.41	57.80	3.71	3.11	194.97	12.05	20.78	0.76
σ^2gca/σ^2sca	0.46	0.49	2.85	0.82	0.93	0.76	0.63	1.94	1.98	0.83	1.98	1.26	0.96

Table 36. Estimates of general combining ability effects of parents

Parents	Plant height (cm)	Primary branches/ plant	Days to first flower	Medium styled flower (%)	Long styled flowers (%)	Short styled flowers (%)	No. of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit yield/ plant (kg)
$Line_1$	-13.81**	-0.993**	2.080**	0.078	-0.547	0.469	-8.42**	-4.40**	-0.90**	-29.44**	2.811**	3.438**	-0.63**
$Line_2$	11.83**	1.518**	-1.631**	-3.356**	4.587**	-1.23**	9.120**	4.573**	-2.29**	-0.551	-4.67**	-4.65**	0.771**
$Line_3$	-4.169**	-0.793**	2.302**	3.322	-3.74**	0.424	-3.59**	0.518**	-0.049	-5.662**	3.733**	4.571**	-0.73**
$Line_4$	-0.502	0.051	-1.364**	3.311**	-4.39**	1.080*	-2.42**	-1.48**	1.773**	9.304**	-0.389	-0.307	0.144**
$Line_5$	6.653**	0.218	-1.387**	-3.356**	4.098**	-0.742	5.320**	0.796**	1.473**	26.349**	-1.47**	-3.05**	0.456**
$Tester_1$	-0.698	-0.331**	0.429*	2.758**	-2.77**	0.020	-0.122	-1.96**	3.271**	10.629**	0.300	0.191	-0.54**
$Tester_2$	2.456**	-0.544**	4.149**	0.398	-0.784	0.387	-5.26**	2.436**	-1.99**	-5.144**	5.433**	5.591**	-0.55**
$Tester_3$	-1.758**	0.876**	-4.578**	-3.156**	3.562**	-0.407	5.391**	-0.47**	-1.27**	-5.484**	-5.73**	-5.78**	1.096**

Table 37. Estimates of Specific combining ability effects of hybrids.

Hybrids	Plant height (cm)	Primary branches/ plant	Days to first flower	Medium styled flower (%)	Long styled flowers (%)	Short styled flowers (%)	No. of fruits/ plant	Length of fruit (cm)	Girth of fruit (cm)	Fruit weight (g)	Days to first harvest	Days to last harvest	Fruit yield/ plant (kg)
$L_1 XT_1$	13.453**	0.420*	1.427**	2.909**	-3.06**	0.158	0.844	2.598**	-1.01**	10.493**	1.389**	2.009**	0.020
L_1XT_2	-13.03**	-0.200	-0.560	-1.064	1.073	-0.009	0.658	-2.93**	0.618**	-7.333**	-0.978*	-1.158	-0.65**
L_1XT_3	-0.420	-0.220	-0.867*	-1.844	1.993	-0.149	-1.502**	0.338	0.398	-3.160**	-0.411	-0.851	0.630**
L_2XT_1	-2.858**	0.909**	-2.829**	-6.624**	6.933**	-0.309	10.500**	-0.380	-1.56**	-11.42**	-5.35**	-6.23**	1.352**
$L_2 X T_2$	2.322**	-1.078**	2.251**	3.869**	-5.26**	1.391	-9.087**	0.520*	0.240	7.211**	4.944**	5.864**	-1.06**
$L_2 XT_3$	0.536	0.169	0.578	2.756**	-1.673	-1.082	-1.413**	-0.140	1.320**	4.218**	0.411	0.371	-0.29**
L_3XT_1	-12.05**	-0.547	2.738**	1.731	-1.767	0.036	-2.689**	-2.59**	-1.43**	-17.01**	3.433**	4.142**	-0.53**
L_3XT_2	7.856**	0.767**	-1.216**	-0.909	1.673	-0.764	4.824**	2.076**	0.496	9.656**	-2.50**	-2.92**	0.737**
$L_3 X T_3$	4.202**	-0.220	-1.522**	-0.822	0.093	0.729	-2.136**	0.516*	0.942**	7.362**	-0.933*	-1.218	-0.204*
$L_4 X T_1$	-2.191**	-0.491*	-0.229	-1.058	0.978	0.080	-1.922**	-0.024	1.740**	-1.518	0.156	0.320	-0.67**
$L_4 X T_2$	6.989**	1.756**	-1.849**	-0.064	1.218	-1.153	6.858**	1.042**	0.407	7.256**	-2.94**	-4.88**	0.906**
$L_4 X T_3$	-4.798**	-1.264**	2.078**	1.122	-2.196	1.073	-4.936**	-1.01**	-2.14**	-5.738**	2.789**	4.560**	-0.23**
$L_5 X T_1$	3.653**	-0.291	-1.107**	3.042**	-3.07**	0.036	-6.733**	0.398	2.273**	19.471**	0.378	-0.236	-0.164
$L_5 X T_2$	-4.133**	-1.244**	1.373**	-1.831	1.296	0.536	-3.253**	-0.70**	-1.76**	-16.78**	1.478**	3.098**	0.067
$L_5 X T_3$	0.480	1.536**	-0.267	-1.211	1.782	-0.571	9.987**	0.304	-0.513*	-2.682*	-1.85**	-2.86**	0.096

4.2.4.2.1 Plant Height (cm)

Out of 5 female parents, L_1 (-13.81) and L_3 (-4.16) had significant negative *gca* effect, while parent, L_2 (11.83) and L_5 (6.65) had significant positive *gca* effect. In the remaining parent (L_4) exhibited negative *gca* effects. Among the males T_2 (2.45) showed significant positive *gca* effects, while T_3 (-1.75) had significant negative *gca* effect.

In all 15 crosses, six each had significant positive and negative *sca* effects, respectively. In three crosses *sca* effects were non-significant and in six crosses it is in desirable negative direction. The *sca* effect ranges from -13.03 (L_1 x T_2) to 13.45 (L_1 x T_1).

4.2.4.2.2 Number of Branches per Plant

Positive *gca* effects L_2 (1.51) and negative *gca* effects L_1 (-0.99) and L_3 (-0.79) were noticed in female parents. In males, T_3 (0.87) and T_1 (-0.33), T_2 (-0.54) exhibited significant positive and negative *gca* effect, respectively.

Nine crosses displayed significant *sca* effects of four and five crosses with positive and negative effects respectively. The estimates of specific combining ability effects ranged from -1.26 (L_4 x T_3) to 1.75 (L_4 x T_2).

4.2.4.2.3 Days to First Flowering

The parents with negative *gca* effects are desirable. With respect to the character under consideration, all the females had significant *gca* effects of which, parent L_1 (2.08) and L_3 (2.30) had significant positive *gca* effect, while other L_2 (-1.63), L_4 (-1.36) and L_5 (-1.38) had significant *gca* effects in negative direction. Among the male, T_3 (-4.57) had significant negative *gca* effect.

The *sca* effect was significant for eleven crosses out of fifteen. The *sca* effect ranges from -2.82 (L_2 x T_1) to 2.73 (L_3 x T_1) in which 6 crosses showed desirable negative direction.

4.2.4.2.4 Medium Styled Flowers

Among the females chosen for the study three exhibited significant *gca* effects in which two parents L_2 and L_5 were in negative direction and other L_4 was in positive direction. Female parent L_4 showed highest (3.31) positive *gca* effect, while L_2 showed lowest *gca* effect (-3.35). Out of three males under investigation, T_1 (2.57) had significant positive *gca* effects, while T_3 (-3.15) had significant negative *gca* effects.

Out of 15 F_1 cross combinations, four crosses were significant positive *sca* effects and one cross significant negative *sca* effects for this trait. The *sca* effect ranges from -6.62 (L_2 x T_1) to 3.86 (L_2 x T_2). High significant positive *sca* effectswas noticed in L_2 x T_2 (3.86) followed by L_5 x T_1 (3.04), L_1 x T_1 (2.90) and L_2 x T_3 (2.75).

4.2.4.2.5 Long Styled Flowers

Four out of five females exhibited significant *gca* effects, two each of them exhibited significant negative and positive *gca* effect. Among males, two parents exhibited significant *gca* effects, of these T_3 (3.56) registered significant positive *gca* effects and T_1 (-2.77) exhibited significant negative *gca* effects.

In all crosses, three had negative and one with positive significant *sca* effect, respectively. The maximum and minimum *sca* effect was noticed in crosses L_2 x T_1 (6.93) and L_5 x T_1 (-3.07) respectively. Remaining 12 crosses had non-significant *sca* effects.

4.2.4.2.6 Short Styled Flowers

Two females had shown highly significant *gca* effect. Among them, L_2 had negative and L_4 had positive *gca* effect. None of the male parents exhibited significant *gca* effects.

The number of crosses none have registered significant positive and negative *sca* effects. Among the all crosses *sca* effects varied from -1.15 (L_4 x T_2) to 1.39 (L_2 x T_2).

4.2.4.2.7 Number of Fruits per Plant

All the females chosen for the study exhibited significant *gca* effects, out of which L_2 and L_5 gave positive *gca* effect and others L_1, L_3 and L_4 gave negative *gca* effect. Females L_2 (9.12) and L_1 (-8.42) exhibited highest and lowest *gca* effect, respectively. Out of three males under investigation, T_3 (5.39) had significant positive *gca* effects, while T_2 had significant negative *gca* effects.

In crosses, four had positive significant *sca* effects and nine of the crosses exhibited negative significant *sca* effects. The maximum and minimum *sca* effect was noticed in crosses L_2 x T_1 (10.50) and L_2 x T_2 (-9.08) respectively. Remaining two crosses had non-significant *sca* effects of which were in positive direction.

4.2.4.2.8 Length of Fruit (cm)

For fruit length, two out of five females had desirable significant negative *gca* effects *viz.,* L_1 (-4.40) and L_4 (-1.48). Female L_2 (4.57), L_3 (0.51) and L_5 (0.79) expressed significant positive *gca* effects. Among the males, T_1 (-1.96) and T_3 (-0.47) exhibited significant negative and T_2 (2.43) exhibited significant positive *gca* effects, respectively.

Nine of the crosses were significant for *sca* effects. For this trait *viz.,* three each of crosses showed negative and positive *sca* effects, respectively. The estimates of specific combining ability effects ranged from -2.93 (L_1 x T_2) to 2.59 (L_1 x T_1).

4.2.4.2.9 Girth of Fruit (cm)

In respect to fruit diameter out of four female parents and three males were significant. The *gca* effects were positive significant for females L_4 (1.77) and L_5 (1.47) and *gca* effects were negative significant for L_1 (-0.94) and L_2 (-2.29). Parent L_3 had exhibited negative *gca* effect (-0.049) but non-significant. The male T_1 had highly significant positive *gca* effect of 3.27 whereas T_2 and T_3 with negative significant *gca* effects of -1.99 and -1.27.

It was observed that five crosses showed significant positive *sca* effect and six crosses had shown significant *sca* effects in negative direction for fruit diameter. For this trait, specific combining ability effects ranges from -2.14 (L_4 x T_3) to 2.27 (L_5 x T_1).

4.2.4.2.10 Fruit Weight (g)

The data on general combining ability effects revealed that two female parents registered significant positive *gca* effects. Among these L_5 (26.34) recorded maximum significant positive *gca* effect, followed by L_4 (9.30). Female L_1 (-29.44) and L_3 (-5.66) exhibited significant negative *gca* effects. Among the male parents T_2 and T_3 exhibited significant negative *gca* effects while T_1 exhibited significant positive *gca* effects.

The estimates of *sca* effects varied from -17.01 (L_3 x T_1) to 19.47 (L_5 x T_1). Among the fifteen crosses 14 showed significant *sca* effect of which seven each of crosses had significant positive and negative *sca* effect.

4.2.4.2.11 Days to First Harvest

All the females chosen for the study exhibited significant *gca* effects except L_4 out of which L_1 and L_3 gave positive *gca* effect and others (L_2 and L_5) gave negative *gca* effect in desirable direction. Females L_3 (3.73) and L_2 (-4.67) exhibited highest and lowest *gca* effect, respectively. Out of three males under investigation, T_2 (5.43) had significant positive *gca* effects while T_3 (-5.73) had negative *gca* effects.

The estimates of specific combining ability effects ranged from -5.35 (L_2 x T_1) to 3.43 (L_3 x T_1). Out of fifteen crosses, the *sca* effects were significant for 10 crosses. Among these, five crosses each had significant positive and negative *sca* effects, respectively. The cross L_2 x T_1 (-5.35) depicted highest negative *sca* effects followed by L_3 x T_2 (-2.50).

4.2.4.2.12 Days to Last Harvest

Out of five female parents, four have shown highly significant gca effect. However among these, two each had positive and negative *gca* effect. Among three males 2 exhibited significant *gca* effects in which T_2 (5.59) depicted positive *gca* effect and T_3 (-5.78) expressed significant negative *gca* effect.

The estimates of *sca* effect varied from -6.23 (L_2 x T_1) to 5.86 (L_2 x T_2). Out of 15 crosses, 9 had significant *sca* effects. The *sca* effects were positively significant for 5 crosses with maximum value of 5.86 (L_2 x T_2) followed by 4.56 (L_4 xT_3) while other 4 crosses had significant negative *sca* effects.

4.2.4.2.13 Fruit Yield per Plant (kg)

For a complex character under address, all the females exhibited significant *gca* effects in which, L_2, L_4 and L_5 was positive and L_1 and L_3 were negative general combiners. Female L_2 (0.77) was highly significant general combiner in desirable direction. The two negative general combiners in the order of merit were L_1 (-0.63) and L_3 (-0.73). In male parents, two males *viz.,* T1 (-0.54) and T_2 (-0.55) registered significant negative *gca* effects and while T_3 (1.09) had significant positive *gca* effects respectively.

An examination of *sca* effects for fruit yield per plant revealed that 11 crosses out of fifteen had significant *sca* effects in which 4 and 7 crosses had positive and negative significant *sca* effect respectively. The cross L_2 x T_1 (1.35) had maximum positive significant *sca* effect followed by L_4 x T_2 (0.90), L_3 x T_2 (0.73) and L_1 x T_3 (0.63). The estimates of *sca* effects varied from -1.06 (L_2 x T_2) to 1.35 (L_2 x T_1).

4.2.5 Screening for Shoot and fruit borer Resistance/Tolerance

Screening of 15 F_1 Hybrids for shoot and fruit borer resistance/tolerance was done based on the extent of damage to shoots and fruits. The data of damage parameters collected from field experiment with 15 F_1 Hybrids were subjected to statistical analysis. The shoot infestation and fruit infestation by SFB was given separately under fallowing headings.

4.2.5.1 Shoot Infestation Percentage by SFB

SFB shoot infestation was screened for all 15 F_1 hybrids based on the shoot infestation percentage from 30 to 90 days after transplanting at 10 days interval is furnished in Table (38). A wide variation for shoot infestation by SFB was observed among the hybrids.

The minimum percentage of young shoots infestation was recorded in the hybrids IC-433678 X IC-89986 (8.47, 9.50, 10.10, 8.57, 8.63, 6.29, and 5.30) followed by Raidurg Local X Pusa Purple Cluster (8.73, 9.77, 9.75, 8.42, 7.92,6.93 and 6.84), IC-433678 X Pusa Purple Cluster (18.41, 23.20, 20.48, 18.20, 15.70, 14.70 and 13.98), Raidurg Local X IC-89986 (27.83, 30.37, 29.33, 25.67, 24.63, 23.00 and 23.45), Tiptur Local X Vellayani Local (28.13, 30.73, 26.97, 25.87, 24.50, 24.65 and 23.67), Tiptur Local X Pusa Purple Cluster (28.81,30.40, 29.03, 26.21, 24.87, 22.69 and 23.29) and Jagaluru Local X Pusa Purple Cluster (27.30, 30.73, 28.57, 27.14, 25.27, 23.74 and 23.15) at all 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively. The maximum percentage of young shoots infestation was recorded in the hybrids IC-433678 X Vellayani Local (40.73, 52.94, 50.34, 48.50, 48.83, 45.18 and 43.62) followed by IC-345271 X Vellayani Local (34.79, 38.14, 36.07, 35.07, 32.97, 30.37 and 28.37), IC-345271 X Pusa Purple Cluster (33.90, 38.50, 37.00, 34.50, 33.84, 29.60 and 27.77), Jagaluru Local X Vellayani Local (32.70, 38.37, 37.24, 33.77, 34.07, 29.12 and 28.23), Jagaluru Local X IC-89986 (32.77, 37.24,37.10, 31.97, 28.97, 29.10 and 28.23), IC-345271 X IC-89986 (33.57, 36.37, 37.17, 32.57, 32.97, 29.07 and 28.57), Raidurg Local X Vellayani Local (34.14, 37.88, 36.51, 34.27, 31.62, 28.50 and 28.67) and Tiptur Local X IC-89986 (33.57, 37.37, 36.37, 30.93, 29.23, 28.90 and 29.12) at all 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively.

Table 38. Shoot infestation by shoot and fruit borer in 15 hybrids at 10 days interval

Hybrid	30DAT	40DAT	50DAT	60DAT	70DAT	80DAT	90DAT	Pooled mean	Rating
$L_1 XT_1$	33.57	36.37	37.17	32.57	32.97	29.07	28.57	32.90	S
L_1XT_2	34.79	38.14	36.07	35.07	32.97	30.37	28.37	33.68	S
L_1XT_3	33.90	38.50	37.00	34.50	33.84	29.60	27.77	33.68	S
L_2XT_1	8.47	9.50	10.10	8.57	8.63	6.29	5.30	8.12	HR
$L_2 X T_2$	40.73	52.94	50.34	48.50	48.83	45.18	43.62	47.16	HS
$L_2 XT_3$	18.41	23.20	20.48	18.20	15.70	14.70	13.98	17.81	MR
L_3XT_1	32.77	37.24	37.10	31.97	28.97	29.10	28.23	32.20	S
L_3XT_2	32.70	38.37	37.24	33.77	34.07	29.12	28.28	33.36	S
$L_3 X T_3$	27.30	30.73	28.57	27.14	25.27	23.74	23.15	26.55	T
$L_4 X T_1$	33.57	37.37	36.37	30.93	29.23	28.90	29.12	32.21	S
$L_4 X T_2$	28.13	30.73	26.97	25.87	24.50	24.65	23.67	26.36	T
$L_4 X T_3$	28.81	30.40	29.03	26.21	24.87	22.69	23.29	26.47	T
$L_5 X T_1$	27.83	30.37	29.33	25.67	24.63	23.00	23.45	26.33	T
$L_5 X T_2$	34.14	37.88	36.51	34.27	31.62	28.50	28.67	33.08	S
$L_5 X T_3$	8.73	9.77	9.75	8.42	7.92	6.93	6.84	8.34	HR
Mean	28.26	32.10	30.80	28.11	26.93	24.79	24.15	27.88	
CD at 5 %	1.908	1.787	1.612	1.694	1.998	1.674	1.266	1.49	

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly susceptible

4.2.5.2 Fruit Infestation Percentage by SFB

SFB fruit infestation was screened based on the fruit infestation percentage at 10 days interval from 60, 70, 80, 90 and 100 days after transplanting (Table 39). Differential response to the fruit infestation by SFB was noticed all the hybrids studied.

Least percentage of fruit infestation was recorded in the hybrids IC-433678 X IC-89986 (8.93, 9.67, 9.35, 8.17 and 7.17), Raidurg Local X Pusa Purple Cluster (9.06, 9.71, 8.81, 8.53 and 6.57), IC-433678 X Pusa Purple Cluster (16.34, 21.39, 17.41, 15.53 and 13.13), Raidurg Local X IC-89986 (28.20, 31.27, 28.41, 26.37 and 24.23), Tiptur Local X Vellayani Local (28.16, 31.00, 29.37, 24.39 and 22.99), Tiptur Local X Pusa Purple Cluster (23.71, 30.72, 27.01, 24.03 and 23.71) and Jagaluru Local X Pusa Purple Cluster (25.68, 30.86, 27.51, 26.12 and 24.68) at all 60 DAT, 70DAT, 80DAT, 90DAT and 100DAT respectively. Highest percentage of fruit infestation was found in the hybrids IC-433678 X Vellayani Local (36.80, 40.67, 36.46, 33.47 and 33.53) followed by IC-345271 X Vellayani Local (38.36,40.54, 37.75, 31.33 and 30.27), IC-345271 X Pusa Purple Cluster (36.28, 40.93, 34.95, 33.62 and 30.71), Jagaluru Local X Vellayani Local (36.22, 39.28, 35.89, 33.26 and 30.44), Jagaluru Local X IC-89986 (35.30, 38.36, 34.92, 33.55 and 29.80), IC-345271 X IC-89986 (36.60, 38.00, 36.81, 33.40 and 32.25), Raidurg Local X Vellayani Local (36.77, 41.03, 38.90, 34.55 and 31.87) and Tiptur Local X IC-89986 (36.00, 39.16, 38.34, 36.50 and 33.68) at all 60 DAT, 70DAT, 80DAT, 90DAT and 100DAT respectively.

4.3 EXPERIMENT III

4.3.1 Field Screening of F_2 Segregants for Resistance to Shoot and fruit borer.

The two highly resistant as well as high yielding hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were further selected to raise the F_2 population. The F_1 plants from selected two crosses was selfed and produced the F_2 population. Among the two hybrids sixty segregants from each cross was raised in the

Table 39. Fruit infestation by shoot and fruit borer in 15 hybrids at 10 days interval

Hybrid	60 DAT	70DAT	80DAT	90DAT	100DAT	Pooled mean	**Rating**
$L_1 XT_1$	36.60	38.00	36.81	33.40	32.25	35.41	S
L_1XT_2	38.36	40.54	37.75	31.33	30.27	35.65	S
L_1XT_3	36.28	40.93	34.95	33.62	30.71	35.30	S
L_2XT_1	8.93	9.67	9.35	8.17	7.17	8.66	HR
$L_2 X T_2$	36.80	40.67	36.46	33.47	33.53	36.19	S
$L_2 XT_3$	16.34	21.39	17.41	15.53	13.13	16.76	MR
L_3XT_1	35.30	38.36	34.92	33.55	29.80	34.38	S
L_3XT_2	36.22	39.28	35.89	33.26	30.44	35.02	S
$L_3 X T_3$	25.68	30.86	27.51	26.12	24.68	26.97	T
$L_4 X T_1$	36.00	39.16	38.34	36.50	33.68	36.74	S
$L_4 X T_2$	28.16	31.00	29.37	24.39	22.99	27.18	T
$L_4 X T_3$	23.71	30.72	27.01	24.03	23.71	25.84	T
$L_5 X T_1$	28.20	31.27	28.41	26.37	24.23	27.70	T
$L_5 X T_2$	36.77	41.03	38.90	34.55	31.87	36.62	S
$L_5 X T_3$	9.06	9.71	8.81	8.53	6.57	8.54	HR
Mean	28.83	32.17	29.46	26.85	25.00	28.46	
CD at 5 %	1.656	1.776	1.841	1.217	2.143	1.607	

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly susceptible

main field and screened for shoot and fruit borer resistance/tolerance under field conditions.

Screening of 60 segregants for shoot and fruit borer resistance/tolerance was done based on the extent of damage to shoots and fruits. The data of damage parameters collected from field experiment with 60 segregants in two cross combinations were subjected to statistical analysis. The shoot infestation and fruit infestation by SFB was given separately under fallowing headings.

4.3.1.1 Shoot Infestation Percentage by SFB

SFB shoot infestation was screened individually for all 60 segregants based on the shoot infestation percentage from 30, 40, 50, 60, 70, 80 and 90 days after transplanting at 10 days interval in two cross combinations (Tables 40 and 42). A wide variation for shoot infestation by SFB was observed among the segregants.

The minimum percentage of young shoots infestation was recorded in thirteen segregants of cross combination IC-433678 X IC-89986 viz., plant5 (10.00,12.00, 8.50, 8.00, 9.50, 7.50 and 6.50), plant8 (5.50, 9.50, 12.00, 10.00, 6.00, 6.00 and 5.00), plant13 (5.50, 8.90, 9.50, 7.00, 6.50, 4.90 and 5.00), plant15 (5.50, 8.00, 12.50, 10.80, 8.00, 7.80 and 5.50), plant20 (6.00, 10.00, 12.00, 6.50, 6.00, 5.00 and 5.00), plant23 (6.80, 12.40, 10.90, 8.50, 10.00, 5.50 and 5.00), plant34 (5.00, 6.80, 10.50, 9.50, 6.50, 6.00 and 5.00), plant38 (6.50, 7.20, 8.50, 6.50, 5.50, 5.00 and 4.80), plant42 (6.50, 10.20, 9.50, 9.00, 7.00, 6.50 and 6.00), plant43 (7.50, 11.60, 10.50, 9.50, 9.00, 7.00 and 5.50), plant49 (5.50, 5.00, 8.50, 9.00, 6.00, 5.50 and 4.50), plant53 (8.00, 12.00, 7.50, 7.00, 6.00, 6.00 and 5.00), plant59 (8.00, 9.50, 12.00, 8.50, 10.50, 6.50 and 6.00) at all 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively. Infestation of young shoots was highest in twelve segregants viz., plant7 (50.00, 52.40, 53.00, 53.40, 45.50, 46.30 and 40.20), plant10 (44.20, 45.50, 48.50, 43.50, 38.20, 36.40 and 33.00), plant12 (53.00, 56.00, 50.00, 47.00, 46.20, 32.50 and 30.00), plant18 (53.00, 54.50, 53.80, 48.60, 46.00, 43.50 and 38.00), plant27 (52.20, 55.00, 50.80,

Table 40: Percentage of shoots damaged by shoot and fruit borer at different intervals in F_2 cross IC-433678 X IC-89986

F_2 segregant	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled Mean	Rating
Plant 1	34.20	42.20	40.60	31.90	30.90	32.00	29.90	34.53	S
Plant 2	40.20	41.00	44.00	43.00	37.00	30.70	30.00	37.99	S
Plant 3	25.00	28.00	33.00	30.00	27.00	22.00	18.00	26.14	T
Plant 4	15.20	20.70	25.60	19.40	16.50	13.40	12.50	17.61	MR
Plant 5	10.00	12.00	8.50	8.00	9.50	7.50	6.50	8.86	HR
Plant 6	45.00	47.20	44.30	35.70	33.50	35.00	30.50	38.74	S
Plant 7	50.00	52.40	53.00	53.40	45.50	46.30	40.20	48.69	HS
Plant 8	5.50	9.50	12.00	10.00	6.00	6.00	5.00	7.71	HR
Plant 9	35.00	36.40	40.00	40.50	34.00	30.80	29.50	35.17	S
Plant 10	44.20	45.50	48.50	43.50	38.20	36.40	33.00	41.33	HS
Plant 11	25.60	30.50	34.50	26.50	24.00	22.00	20.30	26.20	T
Plant 12	53.00	56.00	50.00	47.00	46.20	32.50	30.00	44.96	HS
Plant 13	5.50	8.90	9.50	7.00	6.50	4.90	5.00	6.76	HR
Plant 14	44.90	46.80	43.50	40.50	34.00	30.00	29.50	38.46	S
Plant 15	5.50	8.00	12.50	10.80	8.00	7.80	5.50	8.30	HR
Plant 16	48.40	40.00	44.00	32.00	29.50	28.00	25.00	35.27	S
Plant 17	18.80	22.00	22.00	18.50	18.00	13.00	13.50	17.97	T
Plant 18	53.00	54.50	53.80	48.60	46.00	43.50	38.00	48.20	HS
Plant 19	13.80	19.50	22.00	16.70	13.00	13.50	14.00	16.07	MR
Plant 20	6.00	10.00	12.00	6.50	6.00	5.00	5.00	7.21	HR
Plant 21	34.00	41.00	40.00	35.00	33.00	31.50	27.00	34.50	S
Plant 22	35.00	40.50	44.00	40.00	38.00	36.00	30.40	37.70	S
Plant 23	6.80	12.40	10.90	8.50	10.00	5.50	5.00	8.44	HR
Plant 24	38.00	46.50	44.00	40.00	30.70	30.00	28.00	36.74	S
Plant 25	28.20	30.50	29.40	22.00	23.00	25.00	19.80	25.41	T
Plant 26	34.30	45.00	45.50	38.50	35.00	30.20	26.50	36.43	S
Plant 27	52.20	55.00	50.80	52.00	42.40	30.50	28.00	44.41	HS
Plant 28	22.00	25.80	32.50	30.40	20.00	18.50	20.00	24.17	T
Plant 29	20.50	18.50	32.00	30.50	20.20	24.00	20.00	23.67	T
Plant 30	48.00	51.00	46.00	44.00	44.00	37.00	35.00	43.57	HS
Plant 31	15.00	20.50	25.00	16.50	16.00	14.00	10.90	16.84	MR
Plant 32	40.00	44.00	43.00	39.00	40.00	32.00	30.50	38.36	S
Plant 33	50.20	55.00	54.50	46.00	47.00	48.30	38.00	48.43	HS
Plant 34	5.00	6.80	10.50	9.50	6.50	6.00	5.00	7.04	HR

Plant 35	15.60	20.00	21.50	16.50	13.00	12.50	12.50	15.94	MR
Plant 36	36.00	37.20	35.20	35.60	32.40	32.00	30.00	34.06	S
Plant 37	42.50	42.00	41.50	38.50	33.20	35.00	30.60	37.61	S
Plant 38	6.50	7.20	8.50	6.50	5.50	5.00	4.80	6.29	HR
Plant 39	18.00	20.50	18.00	16.50	16.00	14.00	14.00	16.71	MR
Plant 40	34.00	36.60	38.00	35.50	30.60	29.00	27.40	33.01	S
Plant 41	32.00	30.80	32.00	29.50	24.80	20.80	19.50	27.06	T
Plant 42	6.50	10.20	9.50	9.00	7.00	6.50	6.00	7.81	HR
Plant 43	7.50	11.60	10.50	9.50	9.00	7.00	5.50	8.66	HR
Plant 44	15.32	11.23	14.23	15.62	17.62	16.32	11.32	14.52	MR
Plant 45	37.00	36.00	38.90	34.60	34.80	30.60	20.00	33.13	S
Plant 46	16.50	19.50	28.00	20.50	18.00	15.40	12.50	18.63	MR
Plant 47	45.50	42.40	46.50	41.60	32.50	30.50	28.00	38.14	S
Plant 48	33.00	36.00	37.00	33.20	30.50	33.20	30.70	33.37	S
Plant 49	5.50	5.00	8.50	9.00	6.00	5.50	4.50	6.29	HR
Plant 50	48.50	50.00	50.50	48.80	48.70	36.80	33.50	45.26	HS
Plant 51	50.20	54.00	53.50	48.50	44.50	40.70	38.60	47.14	HS
Plant 52	28.50	32.00	31.20	25.20	25.00	18.00	14.80	24.96	T
Plant 53	8.00	12.00	7.50	7.00	6.00	6.00	5.00	7.36	HR
Plant 54	33.50	32.60	30.50	25.60	25.00	20.50	18.00	26.53	T
Plant 55	26.00	32.00	30.00	25.50	23.50	23.50	20.00	25.79	T
Plant 56	55.00	53.00	50.70	48.00	38.50	35.00	33.00	44.74	HS
Plant 57	15.60	20.00	18.50	15.00	18.00	12.00	10.80	15.70	MR
Plant 58	50.70	52.00	55.00	49.50	50.00	36.50	36.00	47.10	HS
Plant 59	8.00	9.50	12.00	8.50	10.50	6.50	6.00	8.71	HR
Plant 60	52.00	47.50	48.00	50.00	43.50	38.00	33.00	44.57	HS
Mean	28.92	31.41	32.28	28.74	25.99	23.26	20.85	27.35	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

Table 42: Percentage of shoots damaged by shoot and fruit borer at different intervals in F_2cross Raidurg local X Pusa Purple Cluster

F_2segregant	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled Mean	Rating
Plant 1	34.00	38.00	40.00	38.00	34.00	32.00	32.00	35.43	S
Plant 2	5.00	5.00	12.00	12.00	6.00	5.00	5.00	7.14	HR
Plant 3	45.00	46.50	48.00	46.80	36.40	35.40	36.80	42.13	HS
Plant 4	50.20	48.50	48.00	44.60	40.50	38.00	38.00	43.97	HS
Plant 5	18.00	16.50	19.00	17.80	16.30	18.45	20.00	18.01	MR
Plant 6	5.50	10.00	10.00	8.00	6.50	5.00	5.00	7.14	HR
Plant 7	41.50	38.60	40.20	30.00	30.00	25.00	24.20	32.79	S
Plant 8	15.32	15.20	19.20	17.32	20.00	19.00	16.95	17.57	MR
Plant 9	34.44	34.80	34.00	36.00	36.20	33.00	29.00	33.92	S
Plant 10	5.50	5.00	5.50	7.50	8.20	8.00	5.80	6.50	HR
Plant 11	48.00	48.00	46.00	34.00	30.00	26.00	20.00	36.00	S
Plant 12	4.50	4.00	5.80	7.20	7.80	5.50	4.80	5.66	HR
Plant 13	22.12	23.40	20.48	22.32	21.10	26.80	24.50	22.96	T
Plant 14	52.00	56.20	48.00	46.50	50.00	43.50	34.00	47.17	HS
Plant 15	9.50	8.50	6.50	9.62	8.92	8.94	9.00	8.71	HR
Plant 16	48.40	40.00	44.00	32.00	29.50	28.00	25.00	35.27	S
Plant 17	25.60	27.42	28.00	25.68	24.20	22.00	18.20	24.44	T
Plant 18	46.00	52.00	52.00	48.60	44.40	40.00	38.50	45.93	HS
Plant 19	8.00	8.00	10.00	6.00	7.00	5.00	5.00	7.00	HR
Plant 20	44.00	45.00	46.00	40.00	34.00	28.00	20.00	36.71	S
Plant 21	35.00	38.00	40.00	34.00	30.00	32.20	27.00	33.74	S
Plant 22	5.50	6.00	7.20	6.50	5.80	6.20	5.50	6.10	HR
Plant 23	43.20	44.00	45.00	34.00	29.00	22.80	21.00	34.14	S
Plant 24	36.00	46.50	42.00	40.00	30.00	25.00	21.00	34.36	S
Plant 25	14.78	16.00	13.86	17.23	14.75	16.21	15.23	15.44	MR
Plant 26	40.00	45.00	50.00	48.00	50.00	45.00	38.00	45.14	HS
Plant 27	53.00	53.80	54.60	43.00	36.00	29.00	25.00	42.06	HS
Plant 28	6.00	6.00	10.00	10.00	6.00	5.00	5.00	6.86	HR
Plant 29	44.40	45.00	46.00	34.00	31.00	26.00	20.50	35.27	S
Plant 30	22.00	26.00	27.00	24.60	27.00	26.20	18.50	24.47	T
Plant 31	48.10	50.00	52.00	36.00	40.50	32.00	30.80	41.34	HS
Plant 32	5.00	5.00	10.00	11.00	6.00	5.00	5.00	6.71	HR
Plant 33	38.70	38.00	39.00	25.00	22.00	20.80	18.00	28.79	T
Plant 34	36.50	35.00	36.00	25.70	24.50	21.00	17.00	27.96	T

Plant 35	7.50	11.50	10.00	10.00	6.00	6.00	5.00	8.00	HR
Plant 36	35.00	33.20	35.20	35.60	32.40	32.00	30.00	33.34	S
Plant 37	52.00	51.60	56.50	48.50	45.60	38.50	32.40	46.44	HS
Plant 38	52.10	50.40	51.00	32.00	29.00	24.00	15.80	36.33	S
Plant 39	40.20	38.50	36.00	26.80	22.80	18.00	16.50	28.40	T
Plant 40	6.00	12.00	10.00	10.00	6.00	5.00	5.00	7.71	HR
Plant 41	33.00	33.80	30.20	32.50	26.00	20.70	16.50	27.53	T
Plant 42	39.00	40.00	44.00	29.50	30.50	26.00	20.00	32.71	S
Plant 43	36.00	34.20	33.50	35.00	30.60	30.00	28.50	32.54	S
Plant 44	15.32	11.23	14.23	15.62	17.62	16.32	11.32	14.52	MR
Plant 45	4.00	7.00	12.00	10.00	6.00	5.00	5.00	7.00	HR
Plant 46	29.50	30.20	34.00	24.80	23.80	22.50	18.50	26.19	T
Plant 47	51.30	50.40	48.70	48.70	48.50	42.30	38.00	46.84	HS
Plant 48	33.00	36.00	37.00	33.20	30.50	33.20	30.70	33.37	S
Plant 49	32.00	33.00	38.00	26.00	24.00	19.00	16.00	26.86	T
Plant 50	5.00	6.00	10.00	10.00	6.50	6.50	6.00	7.14	HR
Plant 51	48.50	50.00	50.50	48.80	48.70	36.80	33.50	45.26	HS
Plant 52	32.00	33.50	34.00	26.80	25.50	19.00	15.60	26.63	T
Plant 53	24.00	26.40	22.00	18.00	14.00	12.50	10.00	18.13	MR
Plant 54	51.20	48.80	47.80	49.20	50.50	38.50	32.00	45.43	HS
Plant 55	16.00	14.50	16.00	15.80	15.00	12.50	9.00	14.11	MR
Plant 56	8.00	9.50	10.50	12.00	5.00	5.00	5.00	7.86	HR
Plant 57	10.52	11.32	15.65	17.32	16.54	10.98	10.52	13.26	MR
Plant 58	44.80	45.00	50.00	32.00	29.00	20.00	15.20	33.71	S
Plant 59	20.00	28.00	35.00	32.00	26.00	22.60	16.40	25.71	T
Plant 60	45.00	45.00	38.00	34.00	30.00	28.00	28.00	35.43	S
Mean	29.36	30.27	31.25	27.22	24.83	21.93	19.16	26.29	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

52.00, 42.40, 30.50 and 28.00), plant30 (48.00, 51.00, 46.00, 44.00, 44.00, 37.00 and 35.00), plant33 (50.20, 55.00, 54.50, 46.00, 47.00, 48.30 and 38.00), plant50 (48.50, 50.00, 50.50, 48.80, 48.70, 36.80 and 33.50), plant51 (50.20, 54.00, 53.50, 48.50, 44.50, 40.70 and 38.60), plant56 (55.00, 53.00, 50.70, 48.00, 38.50, 35.00 and 33.00), plant58 (50.70, 52.00, 55.00, 49.50, 50.00, 36.50 and 36.00), plant60 (52.00, 47.50, 48.00, 50.00, 43.50, 38.00 and 33.00) at all 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively.

In another cross combination Raidurg Local X Pusa Purple Cluster the minimum percentage of young shoots damage was recorded in fourteen segregants viz., plant2 (5.00, 5.00, 12.00, 12.00, 6.00, 5.00 and 5.00), plant6 (5.50, 10.00, 10.00, 8.00, 6.50, 5.00 and 5.00), plant10 (5.50, 5.00, 5.50, 7.50, 8.20, 8.00 and 5.8), plant12 (4.50, 4.00, 5.80, 7.20, 7.80, 5.50 and 4.80), plant15 (9.50, 8.50, 6.50, 9.62, 8.92, 8.94 and 9.00), plant19 (8.00, 8.00, 10.00, 6.00, 7.00, 5.00 and 5.00), plant22 (5.50, 6.00, 7.20, 6.50, 5.80, 6.20 and 5.50), plant28 (6.00, 6.00, 10.00, 10.00, 6.50, 5.00 and 5.00), plant32 (5.00, 5.00, 10.00, 11.00, 6.00, 5.00 and 5.00), plant35 (7.50, 11.50, 10.00, 10.00, 6.00, 6.00 and 5.00), plant40 (6.00, 12.00, 10.00, 10.00, 6.00, 5.50 and 5.00), plant45 (4.00, 7.00, 12.00, 10.00, 6.00, 5.00 and 5.00), plant50 (5.00, 6.00, 10.00, 10.00, 6.50, 6.50 and 6.00) and plant56 (8.00, 9.50, 10.50, 12.00, 5.00, 5.00 and 5.00) at all 30 DAT, 40 DAT, 50 DAT, 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively. Infestation of young shoots was highest in eleven segregants viz., plant3 (45.00, 46.50, 48.00, 46.80, 36.40, 35.40 and 36.80), plant4 (50.20, 48.50, 48.00, 44.60, 40.50, 38.00 and 38.00), plant14 (52.00, 56.20, 48.00, 46.50, 50.00, 43.50 and 34.00), plant18 (46.00, 52.00, 52.00, 48.60, 44.40, 40.00 and 38.50), plant26 (40.00, 45.00, 50.00, 48.00, 50.00, 45.00 and 38.00), plant27 (53.00, 53.80, 54.60, 43.00, 36.00, 29.00 and 25.00), plant31 (48.10,50.00, 52.00, 36.00, 40.50, 32.00 and 30.80), plant37 (52.00, 51.60, 56.50, 48.50, 45.60, 38.50 and 32.40), plant47 (51.30, 50.40, 48.70, 48.70, 48.50, 42.30 and 38.00), plant51 (48.50, 50.00, 50.50, 48.80, 48.70, 36.80 and 33.50) and plant54 (51.20, 48.80, 47.80, 49.20, 50.50, 38.50 and 32.00) at all 30 DAT, 60 DAT, 70DAT, 80DAT and 90DAT respectively.

4.3.1.2 Fruit Infestation Percentage by SFB

SFB fruit infestation was screened based on the fruit infestation percentage at 10 days interval from 60, 70, 80, 90 and 100 days after transplanting in two cross combinations (Table 41 and 43). Differential response to the fruit infestation by SFB was noticed all the hybrids studied.

The minimum percentage of young fruits infestation was recorded in thirteen segregants of cross combination IC-433678 X IC-89986 viz., plant5 (10.00,12.50, 7.50, 7.00 and 6.50), plant8 (12.00, 10.00, 8.00, 6.00 and 6.00), plant13 (8.50, 12.50, 9.00, 7.50 and 6.00), plant15 (7.00, 8.50, 8.00, 6.50 and 5.00), plant20 (6.50, 12.00, 11.00, 7.00 and 5.00), plant23 (6.50, 10.20, 12.00, 6.00 and 5.50), plant34 (5.50, 7.50, 7.00, 6.00 and 6.00), plant38 (10.00, 10.00, 9.00, 9.00 and 6.50), plant42 (9.50, 10.00, 9.00, 7.00 and 7.00), plant43 (10.00, 10.00, 8.00, 6.00 and 6.00), plant49 (9.50, 12.00, 8.00, 8.00 and 6.50), plant53 (12.00, 9.50, 7.00, 5.00 and 5.00), plant59 (8.00, 12.00, 10.00, 6.00 and 6.00) at all 30 DAT, 60 DAT, 70DAT, 80DAT and 90DAT respectively. Maximum infestation of young fruits was observed in thirteen segregants of the same cross combination viz., plant7 (48.00, 48.50, 46.50, 38.00 and 40.00), plant10 (52.00, 49.50, 44.80, 39.50 and 34.00), plant12 (50.50, 54.00, 48.50, 38.00 and 35.50), plant18 (52.20, 53.50, 45.00, 38.00 and 35.00), plant27 (46.50, 51.00, 48.60, 44.50 and 39.70), plant33 (51.00, 50.00, 48.00, 45.00 and 45.50), plant37 (52.50, 53.00, 52.00, 42.00 and 40.00), plant45 (48.00, 50.00, 50.00, 45.00 and 30.00), plant50 (48.00, 50.00, 52.00, 43.00 and 37.00), plant51 (45.50, 52.00, 45.00, 39.00 and 34.00), plant56 (46.00, 48.00, 46.00, 39.00 and 37.00), plant58 (49.00, 52.00, 44.00, 35.00 and 35.00), plant60 (45.00, 48.00, 51.00, 38.00 and 38.00) at all 60 DAT, 70DAT, 80DAT, 90DAT and 100DAT respectively.

Table 41: Percentage of fruits damaged by shoot and fruit borer at different intervals in F_2 cross IC-433678 X IC-89986

F_2 segregant	60DAT	70DAT	80DAT	90DAT	100DAT	Pooled Mean	Rating
Plant 1	43.00	46.20	38.50	35.00	32.00	38.94	S
Plant 2	36.50	44.00	45.00	32.50	33.00	38.20	S
Plant 3	28.50	32.00	30.50	28.50	25.00	28.90	T
Plant 4	16.50	20.00	15.50	12.00	10.50	14.90	MR
Plant 5	10.00	12.50	7.50	7.00	6.50	8.70	HR
Plant 6	35.00	42.00	44.00	34.50	30.80	37.26	S
Plant 7	48.00	48.50	46.50	38.00	40.00	44.20	HS
Plant 8	12.00	10.00	8.00	6.00	6.00	8.40	HR
Plant 9	35.00	34.80	37.50	29.50	30.00	33.36	S
Plant 10	52.00	49.50	44.80	39.50	34.00	43.96	HS
Plant 11	30.50	32.00	28.00	24.00	22.50	27.40	T
Plant 12	50.50	54.00	48.50	38.00	35.50	45.30	HS
Plant 13	8.50	12.50	9.00	7.50	6.00	8.70	HR
Plant 14	35.50	43.00	40.00	38.50	34.00	38.20	S
Plant 15	7.00	8.50	8.00	6.50	5.00	7.00	HR
Plant 16	38.00	43.00	36.50	32.00	29.80	35.86	S
Plant 17	20.50	29.00	26.00	22.50	22.00	24.00	T
Plant 18	52.20	53.50	45.00	38.00	35.00	44.74	HS
Plant 19	16.00	20.00	18.00	15.00	12.50	16.30	MR
Plant 20	6.50	12.00	11.00	7.00	5.00	8.30	HR
Plant 21	40.00	42.00	38.00	34.00	30.50	36.90	S
Plant 22	41.00	42.00	36.00	32.00	30.80	36.36	S
Plant 23	6.50	10.20	12.00	6.00	5.50	8.04	HR
Plant 24	40.00	43.00	40.00	36.50	32.00	38.30	S
Plant 25	17.60	20.50	15.00	14.80	12.70	16.12	T
Plant 26	42.50	44.30	38.60	36.40	30.75	38.51	S
Plant 27	46.50	51.00	48.60	44.50	39.70	46.06	HS
Plant 28	25.00	30.00	31.70	22.50	20.80	26.00	T
Plant 29	28.00	32.00	28.50	28.00	25.00	28.30	T
Plant 30	35.60	39.00	36.00	33.60	30.50	34.94	S
Plant 31	16.00	20.00	21.00	14.00	14.00	17.00	MR
Plant 32	35.50	38.00	40.00	32.00	30.50	35.20	S

Plant 33	51.00	50.00	48.00	45.00	45.50	47.90	HS
Plant 34	5.50	7.50	7.00	6.00	6.00	6.40	HR
Plant 35	18.00	20.00	16.00	16.00	12.00	16.40	MR
Plant 36	34.00	36.00	36.00	30.00	30.00	33.20	S
Plant 37	52.50	53.00	52.00	42.00	40.00	47.90	HS
Plant 38	10.00	10.00	9.00	9.00	6.50	8.90	HR
Plant 39	21.00	20.50	20.00	14.00	12.50	17.60	MR
Plant 40	33.00	38.00	40.00	32.00	32.00	35.00	S
Plant 41	25.00	28.00	25.00	20.00	18.00	23.20	T
Plant 42	9.50	10.00	9.00	7.00	7.00	8.50	HR
Plant 43	10.00	10.00	8.00	6.00	6.00	8.00	HR
Plant 44	15.00	18.00	20.00	18.00	15.50	17.30	MR
Plant 45	48.00	50.00	50.00	45.00	30.00	44.60	HS
Plant 46	20.00	22.00	18.00	15.00	15.00	18.00	MR
Plant 47	40.00	44.00	35.00	32.00	30.00	36.20	S
Plant 48	32.00	37.00	35.00	30.00	31.00	33.00	S
Plant 49	9.50	12.00	8.00	8.00	6.50	8.80	HR
Plant 50	48.00	50.00	52.00	43.00	37.00	46.00	HS
Plant 51	45.50	52.00	45.00	39.00	34.00	43.10	HS
Plant 52	22.00	22.00	20.00	16.00	12.00	18.40	T
Plant 53	12.00	9.50	7.00	5.00	5.00	7.70	HR
Plant 54	30.00	30.00	25.00	25.00	22.00	26.40	T
Plant 55	28.00	28.00	30.00	22.00	20.50	25.70	T
Plant 56	46.00	48.00	46.00	39.00	37.00	43.20	HS
Plant 57	20.00	23.00	16.70	15.00	12.00	17.34	MR
Plant 58	49.00	52.00	44.00	35.00	35.00	43.00	HS
Plant 59	8.00	12.00	10.00	6.00	6.00	8.40	HR
Plant 60	45.00	48.00	51.00	38.00	38.00	44.00	HS
Mean	29.06	31.66	29.27	24.73	22.66	27.47	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

Table 43: Percentage of fruits damaged by shoot and fruit borer at different intervals in F_2cross Raidurg local X Pusa Purple Cluster

F_2 segregant	60DAT	70DAT	80DAT	90DAT	100DAT	Pooled Mean	Rating
Plant 1	42.00	45.00	38.50	34.00	32.40	38.38	S
Plant 2	5.00	13.00	10.00	6.00	5.00	7.80	HR
Plant 3	44.50	47.00	45.80	38.40	35.50	42.24	HS
Plant 4	42.50	44.00	45.00	40.00	38.00	41.90	HS
Plant 5	15.50	16.00	17.80	14.60	12.40	15.26	MR
Plant 6	10.00	10.50	8.00	6.00	6.00	8.10	HR
Plant 7	42.00	47.00	48.50	43.60	37.00	43.62	HS
Plant 8	18.50	26.30	28.00	20.50	18.00	22.26	T
Plant 9	34.00	36.50	38.00	30.80	30.00	33.86	S
Plant 10	6.50	9.70	6.50	5.80	5.00	6.70	HR
Plant 11	42.00	45.00	36.00	30.00	30.00	36.60	S
Plant 12	7.50	8.80	9.50	7.20	6.80	7.96	HR
Plant 13	36.20	28.20	20.60	19.25	18.50	24.55	T
Plant 14	50.20	49.80	54.30	45.50	38.70	47.70	HS
Plant 15	6.70	8.65	8.90	6.32	5.60	7.23	HR
Plant 16	38.00	55.20	36.50	32.60	30.40	38.54	S
Plant 17	42.00	43.00	38.50	35.00	34.50	38.60	T
Plant 18	48.60	50.20	48.50	37.25	35.00	43.91	HS
Plant 19	8.00	12.00	6.00	6.00	6.00	7.60	HR
Plant 20	37.64	40.60	34.70	33.50	30.35	35.36	S
Plant 21	36.20	39.40	38.00	33.00	30.26	35.37	S
Plant 22	7.80	9.20	9.00	8.90	5.60	8.10	HR
Plant 23	42.30	48.80	47.60	37.40	34.50	42.12	HS
Plant 24	55.00	52.00	51.00	40.00	38.00	47.20	HS
Plant 25	17.60	20.50	15.00	14.80	12.70	16.12	MR
Plant 26	42.50	44.30	38.60	36.40	30.75	38.51	S
Plant 27	48.00	52.50	48.60	44.50	39.70	46.66	HS
Plant 28	7.00	12.00	12.00	6.00	6.00	8.60	HR
Plant 29	40.00	40.00	38.00	30.00	30.00	35.60	S
Plant 30	28.00	30.00	24.00	19.00	15.00	23.20	T
Plant 31	42.00	52.40	53.00	46.00	36.50	45.98	HS
Plant 32	4.80	6.20	12.00	4.50	4.50	6.40	HR
Plant 33	29.50	32.20	33.00	22.60	18.20	27.10	T
Plant 34	28.00	36.40	22.70	19.80	16.40	24.66	T

Plant 35	10.00	12.00	8.00	8.00	5.00	8.60	HR
Plant 36	35.00	35.20	34.20	32.10	31.00	33.50	S
Plant 37	52.50	53.00	52.00	42.00	40.00	47.90	HS
Plant 38	38.00	40.00	40.00	35.00	30.00	36.60	S
Plant 39	28.70	30.12	34.20	24.50	23.92	28.29	T
Plant 40	10.00	12.00	8.00	6.00	6.00	8.40	HR
Plant 41	34.00	31.90	30.70	24.20	20.54	28.27	T
Plant 42	35.00	36.00	36.00	32.00	31.00	34.00	S
Plant 43	38.00	40.00	39.00	31.00	30.00	35.60	S
Plant 44	16.00	19.00	19.00	16.00	16.00	17.20	MR
Plant 45	6.00	11.00	8.00	5.00	4.00	6.80	HR
Plant 46	28.00	29.20	30.00	26.90	23.50	27.52	T
Plant 47	48.20	50.30	47.30	40.10	34.10	44.00	HS
Plant 48	31.60	34.30	31.70	30.00	30.00	31.52	S
Plant 49	29.00	30.00	30.00	27.00	20.00	27.20	T
Plant 50	5.00	6.50	10.00	5.00	5.00	6.30	HR
Plant 51	49.20	48.50	50.00	44.00	41.50	46.64	HS
Plant 52	20.00	28.20	26.40	21.00	20.50	23.22	T
Plant 53	12.54	18.60	20.30	15.40	13.70	16.11	MR
Plant 54	52.00	48.10	44.00	40.00	35.40	43.90	HS
Plant 55	13.50	14.80	20.10	19.40	15.40	16.64	MR
Plant 56	5.00	9.50	10.50	6.00	6.00	7.40	HR
Plant 57	23.60	27.00	25.40	25.00	20.10	24.22	T
Plant 58	50.00	52.00	50.00	36.00	34.10	44.42	HS
Plant 59	28.20	32.00	28.60	25.00	22.00	27.16	T
Plant 60	42.50	45.00	46.00	42.50	38.00	42.80	HS
Mean	29.13	31.78	30.03	25.24	22.83	27.80	

DAT- Days After Transplanting

HR- Highly Resistant MR- Moderately Resistant T- Tolerant

S- Susceptible HS- Highly Susceptible

In another cross combination Raidurg Local X Pusa Purple Cluster the minimum percentage of young fruits damage was recorded in fourteen segregants viz., plant2 (5.00, 13.00, 10.00, 6.00 and 5.00), plant6 (10.00, 10.50, 8.00, 6.00 and 6.00), plant10 (6.50, 9.70, 6.50, 5.80 and 5.00), plant12 (7.50, 8.80, 9.50, 7.20 and 6.80), plant15 (6.70, 8.65, 8.90, 6.32, and 5.60), plant19 (8.00, 12.00, 6.00, 6.00 and 6.00), plant22 (7.80, 9.20, 9.00, 8.90 and 5.60), plant28 (7.00, 12.00, 12.00, 6.00 and 6.00), plant32 (4.80, 6.20, 12.00, 4.50 and 4.50), plant35 (10.00, 12.00, 8.00, 8.00 and 5.00), plant40 (10.00, 12.00, 8.00, 6.00 and 6.00), plant45 (6.00, 11.00, 08.00, 5.00 and 4.00), plant50 (5.00, 6.50, 10.00, 5.00 and 5.00) and plant56 (5.00, 9.50, 10.50, 6.00 and 6.00) at all 60 DAT, 70DAT, 80DAT, 90DAT and 100DAT respectively. Maximum infestation of young fruits was observed in fifteen segregants of the same cross combination viz., plant3 (44.50, 47.00, 45.80, 38.40 and 35.50), plant4 (42.50, 44.00, 45.00, 40.00 and 38.00), plant7 (42.00, 47.00, 48.50, 43.60 and 37.00), plant14 (50.20, 49.80, 54.30, 45.50 and 38.70), plant18 (48.60, 52.20, 48.50, 37.25 and 35.00), plant23 (42.30, 48.80, 47.60, 37.40 and 34.50), plant24 (55.00, 52.00, 51.00, 40.00 and 38.00), plant27 (48.00, 52.50, 48.60, 44.50 and 39.70), plant31 (42.00,52.40, 53.00, 46.00 and 36.50), plant37 (52.00, 53.00, 52.00, 42.00 and 40.00), plant47 (48.20, 50.30, 47.30, 40.10 and 34.10), plant51 (49.20, 48.50, 50.00, 44.00 and 41.50) and plant54 (52.00, 48.10, 44.00, 40.00 and 35.40), plant58 (50.00, 52.00, 50.00, 36.00 and 34.10) and plant60 (42.50, 45.00, 46.00, 42.50 and 38.00) at all 30 DAT, 60 DAT, 70DAT, 80DAT and 90DAT respectively.

4.3.2 Molecular Analysis of F_2 Segregants

The two highly resistant as well as high yielding hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were further selected to raise the F_2 population. The F_1 plants from selected two crosses was selfed and produced the F_2 population. Among the two F_2 populations sixty segregants from each cross was raised along with their eight parents which include three resistance and five susceptible to SFB in the main field and screened for shoot and fruit borer resistance/tolerance under field conditions. The same phenotypical data (Table 40, 41, 42 and 43) was subjected to molecular analysis to compare the susceptible and resistance segregants in two F_2 population. Among the two F_2 populations, randomly ten each resistant and highly susceptible segregants (F_2 plants) were taken along with their eight parents. DNA from all the resistant and susceptible segregants along with their respective parents was isolated. After that, DNA was pooled separately and made the resistant bulk and susceptible bulk. Using 22 RAPD markers, pooled DNA from resistant and susceptible segregants was compared along with the DNA of respective parents though bulk segregant analysis. The step wise results were given as under.

4.3.2.1 Polymorphic Survey between Resistant and Susceptible Parents

In the present study, 22 RAPD primers (table) were subjected to amplify the genomic DNA of the parents, out of them eight primers (OPO-20, OPW-4, OPO-17, OPL-6, OPC-4, OPL-9, OPC-5 and OPA-3) showed the banding pattern. Further these eight primers were used to study the polymorphism between resistant and susceptible parents. Only three primers namely OPO-20, OPC-4 and OPL-9 showed polymorphism between resistant and susceptible parents (plate 18 and 19), rest of the primers were monomorphic. Out of three primers, two primers OPC-4 and OPL-9 amplified the DNA product in the cross IC-433678 × IC-89986 at 550 and 500 base pairs respectively (plate 19). One primer OPO-20 amplified the DNA product in the cross Raidurg Local × Pusa Purple Cluster at 400 base pairs (plate 18).

4.3.2.2 Bulk Segregant Analysis

Bulk segregant analysis was performed using three primers *viz*., OPO-20, OPC-4 and OPL-9 for discriminating the parents. The primer OPO-20 amplified at 400 base pair in cross Raidurg Local × Pusa Purple Cluster and two primers OPL-9 and OPC-4 amplified at 500 and 550 base pair respectively in cross IC-433678 × IC-89986. These resistant bands were also present in resistant bulk. The primers which was present in the resistant parent and resistant bulk showed co-segregation of the marker with

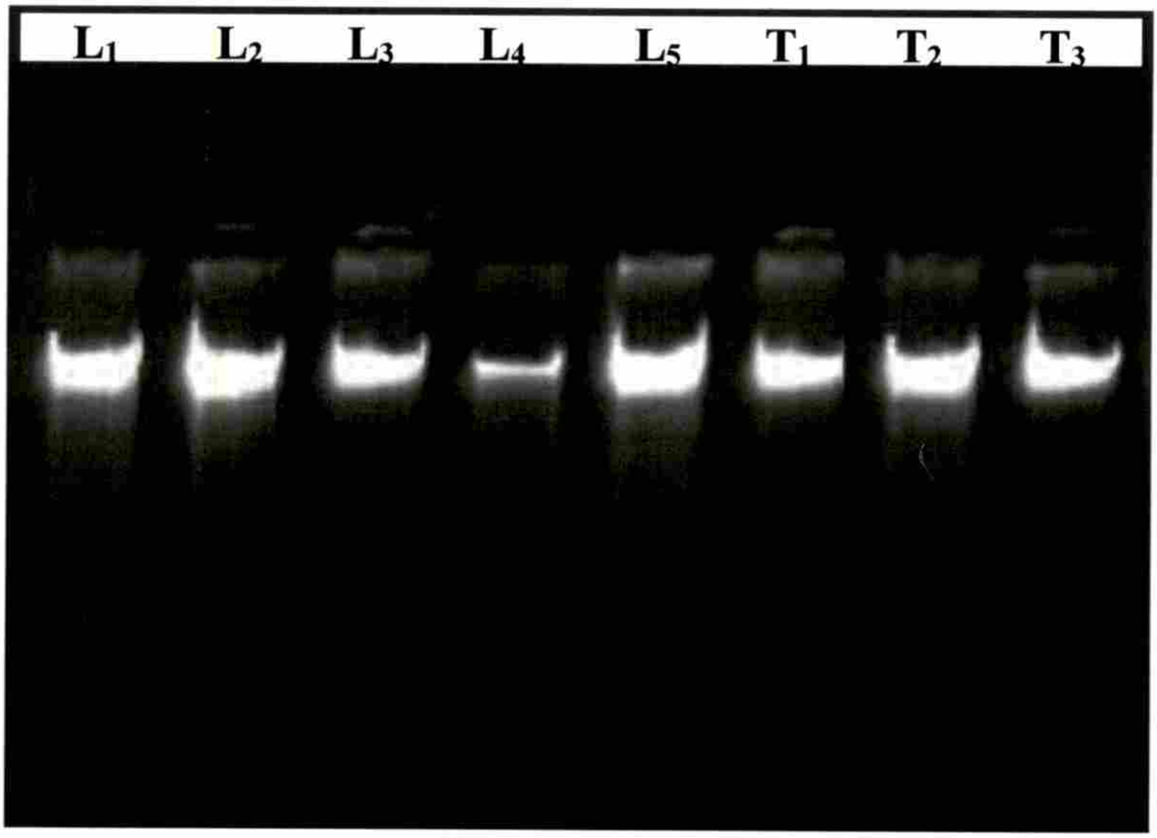

Plate 15. Isolation of parental DNA of brinjal

L_1	-	IC-345271
L_2	-	IC-433678
L_3	-	Jagaluru Local
L_4	-	Tiptur Local
L_5	-	Raidurg Local
T_1	-	IC-89986
T_2	-	Vellayani Local
T_3	-	Pusa Purple Cluster

resistant gene where the band was absent in susceptible parent and susceptible bulk in F_2 generation.

4.3.2.2.1 Single Plant Analysis for BSA

4.3.2.2.1.1 F_2 Population of the Cross Raidurg Local × Pusa Purple Cluster

The primer OPO-20 (ACACACGCTG) amplified a fragment of approximately 400 base pair in the resistant parent, resistant bulk which consisted of 10 randomly selected resistant individuals (plate 21).

4.3.2.2.1.2 F_2 Population of the Cross IC-433678 × IC-89986

The primer OPC-4 (CCGCATCTAC) amplified a fragment of approximately 550 base pair (plate 20) in the resistant parent, resistant bulk and primer and primer OPL-9 (TGCGAGAGTC) amplified a fragment of approximately 500 base pair (plate 22) in the resistant parent, resistant bulk which consisted of 10 randomly selected resistant individuals.

Table 44. List of RAPD primers used for polymorphic survey between resistant and susceptible parents

SN	Primer	Primer sequence	Base pair (bp)	Genotype
1	OPA-01	caggcccttc	450	IC-345271
2	OPA-02	tgccgagctg	450	Jagaluru Local
3	OPA-03	agtcagccac	450	IC-433678
4	OPA-04	aatcgggctg	450	Raidurg Local
5	OPB-12	ccttgacgca	450	Tiptur Local
6	OPB-14	tccgctctgg	450	Jagaluru Local
7	OPC-02	gtgaggcgtc	450	IC-433678
8	OPC-04	ccgcatctac	550	'IC-89986'

9	OPC-05	gatgaccgcc	450	Raidurg Local
10	OPE-19	acggcgtatg	450	IC-345271
11	OPE-20	aacgctgacc	450	Jagaluru Local
12	OPL-05	acgcaggcac	450	IC-345271
13	OPL-06	gagggaagag	450	Tiptur Local
14	OPL-07	aggcgggaac	450	Raidurg Local
15	OPL-08	agcaggtgga	450	IC-433678
16	OPL-09	tgcgagagtc	500	'IC-89986'
17	OPO-17	ggcttatgtc	450	Tiptur Local
18	OPO-18	ctcgcacgtt	450	Tiptur Local
19	OPO-19	ggtgcacgtt	450	IC-345271
20	OPO-20	acacacgctg	400	'Pusa Purple Cluster'
21	OPW-04	cagaagcgga	450	Jagaluru Local
22	OPW-05	ggtgactgtg	450	IC-345271

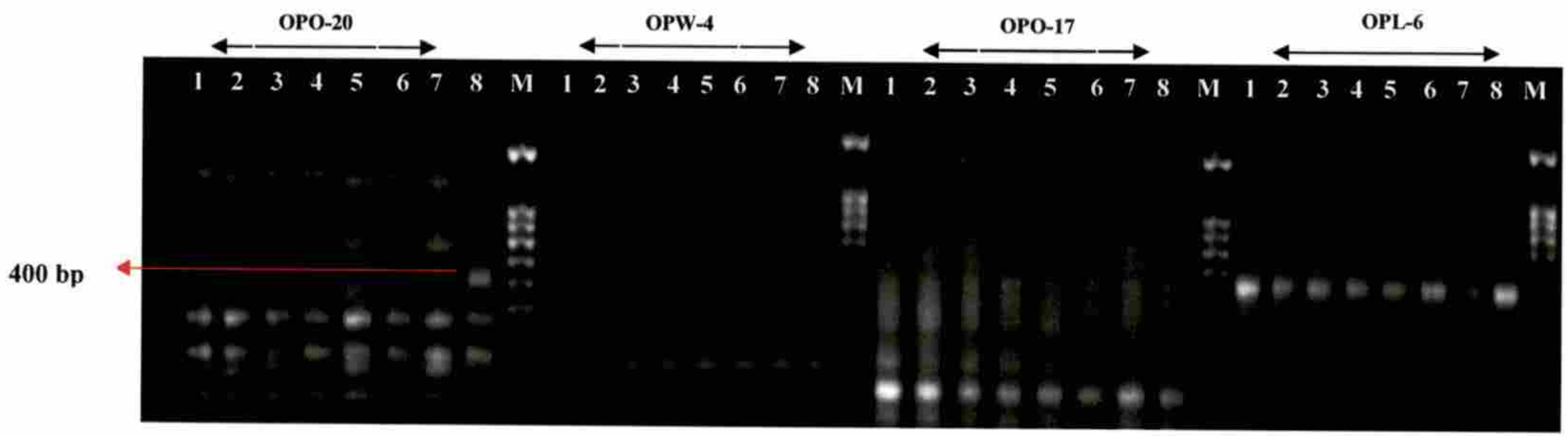

Plate 18. Polymorphic survey of resistant and susceptible parents using 10-mer primers

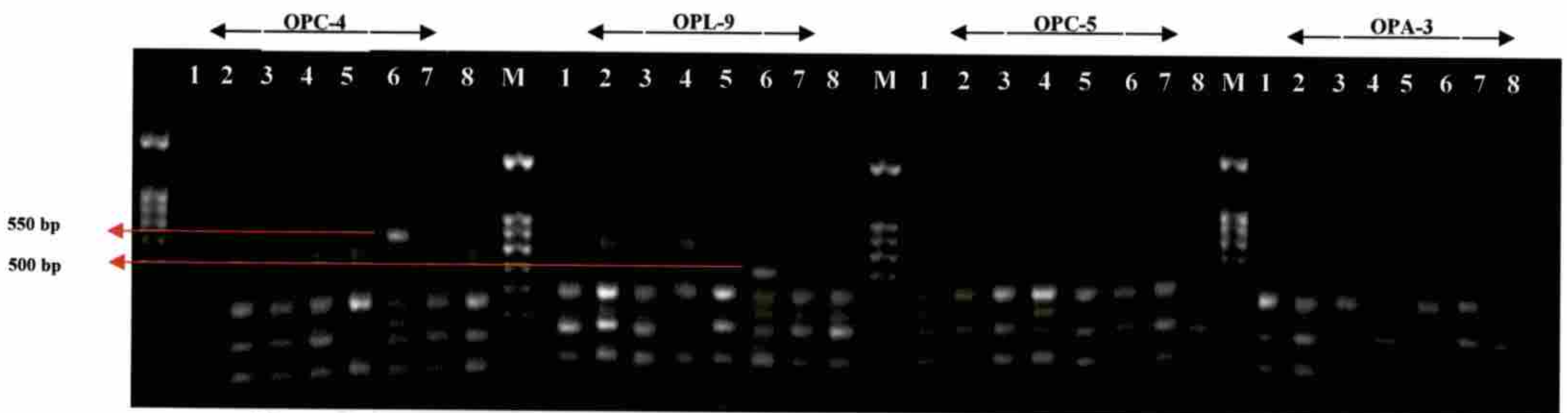

Plate 19. Polymorphic survey of resistant and susceptible parents using 10-mer primers

M	-	**Marker**
1	-	IC-345271
2	-	IC-433678
3	-	Jagaluru Local
4	-	Tiptur Local
5	-	Raidurg Local
6	-	IC-89986
7	-	Vellayani Local

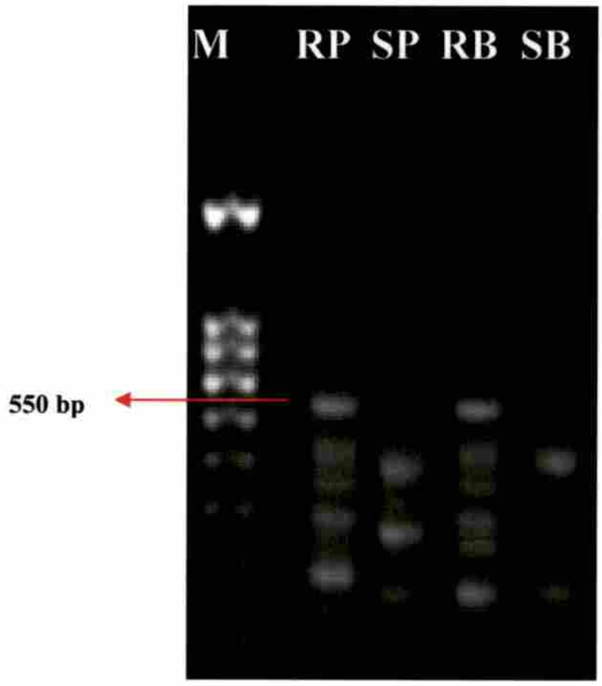

Plate 20. Bulked Segregant analysis (BSA) of F_2 in cross 'IC-433678 × IC-89986' using OPC-4 primer

M - Marker
RP - IC-89986
SP - IC-433678
RB - Resistant Bulk
SB - Susceptible Bulk

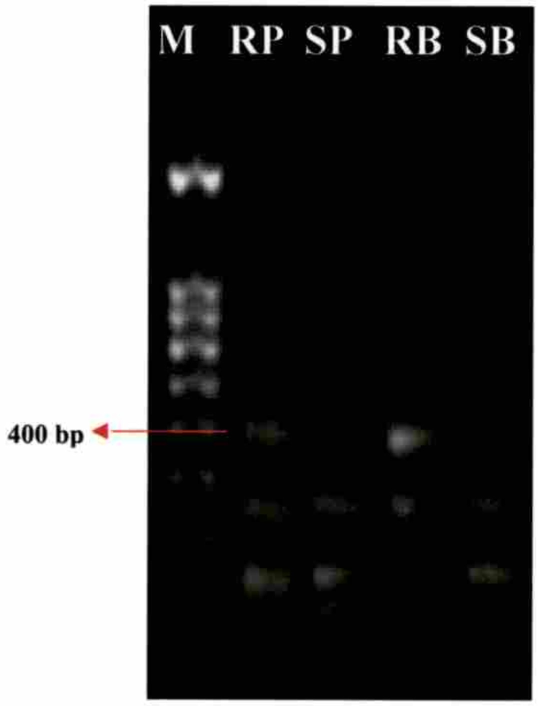

Plate 21. Bulked segregant analysis (BSA) of F_2 in cross 'Raidurg Local × Pusa Purple Cluster.' using OPO-20 primer

M - Marker
RP - Pusa Purple Cluster
SP - Raidurg Local
RB - Resistant Bulk
SB - Susceptible Bulk

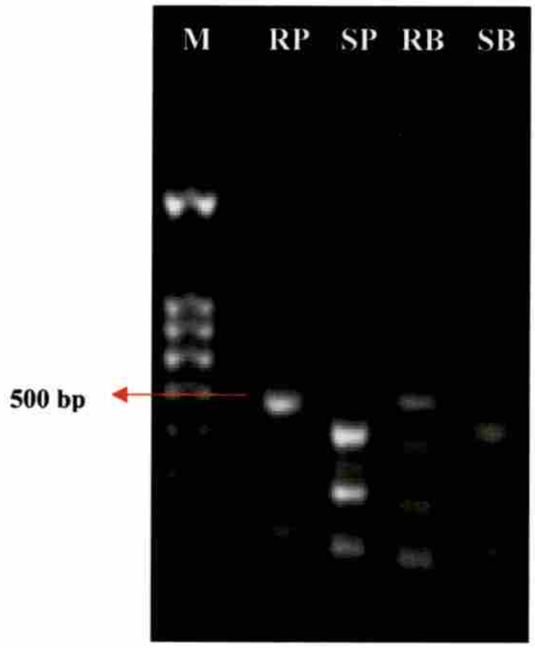

Plate 22. Bulked segregant analysis (BSA) of F_2 in cross 'IC-433678 × IC-89986' using OPL-9 primer

M - Marker

RP - IC-89986

SP - IC-433678

RB - Resistant Bulk

SB - Susceptible Bulk

Discussion

5. DISCUSSION

The experimental data collected on growth, morphological, yield and yield attributing characters of brinjal were statistically analyzed and the experimental results are discussed under following headings.

5.1 EXPERIMENT I. COLLECTION AND EVALUATION OF GERMPLASM

The sixty brinjal accessions were subjected to detailed study on variability, heritability, genetic advance, correlation, path analysis and screening for shoot and fruit borer resistance/tolerance.

5.1.1 Mean Performance of Accessions during Kharif and Rabi Season.

In any statistical analysis of data *per se* performance is the true realized mean of the recorded data and this is a direct estimate based on the observation and not on assumption. Selection of superior genotypes based on *per se* performance is more reliable data than any other parameter. The success of crop improvement lies in the selection of suitable parents. While evaluating the genotypes, the high mean value is considered as the acceptable procedure for a long time among the breeders.

In the present study, significant differences were recorded among the sixty genotypes in kharif and rabi seasons for all twenty three characters studied. The growth, yield and yield attributing characters like plant height, number of primary branches plant^{-1}, days to first flower, percentage of medium styled flowers, percentage of long styled flowers, percentage of short styled flowers, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, days to first harvest, days to last harvest and fruit yield plant^{-1} have shown remarkable variation among the genotypes. Such variances for these characters were in accordance with the earlier reports in brinjal by Rajput *et al*. (1996), Patel *et al*. (2004), Singh and Kumar (2005), Rameshbabu and Patil (2008), Islam and Uddin (2009), Prabhu *et al*. (2009), Ansari *et al*. (2011), Roychowdhury *et al.* (2011), Kumar *et al*. (2011), Kranthirekha (2011), Shekar *et al.*(2012), Arunkumar *et al.* (2013), Kumar and Arumugam (2013),Yadav *et al*. (2014), Gavade and Ghadage

(2015), Solaimana *et al.* (2015) and Gangadhara and Abraham (2016a).

Morphological characters like SFB shoot damage, SFB fruit damage, intra cluster distance, inter cluster distance, calyx length, RLPS, RLSA, weight of infested fruits as well as quality parameters like total sugars and total phenols showed considerable variation among the genotypes. Similar differential variation for morphological and quality parameters in different genotypes of brinjal was reported by Panda *et al.* (1971), Mishra *et al.* (1988), Hossain *et al.* (2002), Hazra *et al.* (2004), Senapathi and Senapathi (2006), Gupta and Kauntey. (2008). Kranthirekha (2011), Arunkumar *et al.* (2013), Kumar and Arumugam (2013), Yadav *et al.* (2014), Gavade and Ghadage (2015), Solaimana *et al.* (2015) and Gangadhara and Abraham (2016b).

5.1.2 Genetic Variability, Heritability and Genetic Advance during Kharif and Rabi season.

For a successful crop improvement programme, information on the nature and magnitude of genetic variability and degree of transmission of the traits is of immense importance. The variability available in the population can be partitioned into heritable and non-heritable component *viz.,* phenotypic and genotypic coefficients of variation, heritability and genetic advance on which selection can be effectively carried out. The relative values of these types of co-efficient give an idea about magnitude of variability present in the genetic population (Singh and Singh, 1975). High phenotypic and genotypic co-efficient of variation values indicate the presence of ample variation among the germplasm under study and facilitate the selection of desirable genotypes for improving that particular character. However, presence of sufficient variation is not enough unless the character is additively inherent. High heritability accompanied with high genetic advance confirms the additively inherent nature of a particular character. Heritability and genetic advance are important selection parameters. High heritability alone is not enough for a rewarding selection, unless accompanied by substantial amount of genetic advance (Johnson *et al*., 1955).

Various genetic parameters like phenotypic and genotypic co- efficient of variability (PCV, GCV), heritability, genetic advance (GA) and genetic advance as per cent of mean (GAM) for the twenty three quantitative characters were measured for kharif and rabi seasons have been discussed as below.

5.1.2.1 Genetic Variability

One of the ways by which variability in the characters assessed is through a simple approach of examining the range of variations. Range of variation is observed for all the traits in the present study at kharif and rabi seasons indicates, sufficient amount of variation among the genotypes for characters under study.

In general, higher phenotypic co efficient of variability values than that of genotypic co-efficient of variability values indicates the influence of environment on traits. But, closer PCV and GCV values were observed for majority of the characters in the present study and possibly they were less influenced by environment indicating reliability of selection based on these traits. The higher PCV and GCV values in the kharif and rabi seasons were observed for the characters like plant height, number of primary branches plant^{-1}, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, intra cluster distance, fruit yield plant$^{-1,}$ SFB shoot damage, SFB fruit damage, RLPS, RLSA and weight of infested fruits indicating that a greater amount of genetic variability was present for these characters which provide greater scope for selection. These results are similar with earlier reports by Singh and Kumar (2005), Nayak *et al.* (2009), Sherly and Shanthi (2009), Kranthirekha (2011), Arunkumar *et al.* (2013), Kumar and Arumugam (2013),Yadav *et al.* (2014), Gavade and Ghadage (2015), Solaimana *et al.* (2015) and Gangadhara and Abraham (2016a) in brinjal.

Moderate PCV and GCV values were also obtained both kharif and rabi seasons for the characters like percentage of short styled flowers, inter cluster distance, calyx length, total sugars and total phenols. These findings were in accordance with the reports of and Ansari *et al.* (2011), Kumar *et al.* (2011), Kranthirekha (2011), Danquah and Orfori (2012), Karak *et al.* (2012), Kumar *et al.* (2012) and Danquah and Orfori (2012), Kumar *et al.* (2011) and Gangadhara and Abraham (2016a) in brinjal.

5.1.2.2 Heritability and Genetic Advance

High heritability was noticed for almost all the characters under study both in kharif and rabi seasons *viz*., plant height, number of primary branches plant^{-1}, days to first flower, percentage of medium styled flowers, percentage of long styled flowers, intra cluster distance, inter cluster distance, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, days to first harvest, days to last harvest, fruit yield plant^{-1}, SFB shoot damage, SFB fruit damage, calyx length, RLPS, RLSA, weight of infested fruits, total sugars and total phenols suggesting that the selection based on phenotypic performance of these traits would be more effective. Moderate heritability was observed for short styled flowers suggesting less inheritance of these traits.

High genetic advance as percentage of mean (GAM) was observed for the characters like plant height, number of primary branches plant^{-1}, intra cluster distance, inter cluster distance, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, fruit yield plant^{-1}, SFB shoot damage, SFB fruit damage, calyx length, RLPS, RLSA, weight of infested fruits, total sugars and total phenols in both the seasons revealed that, greater improvement in the population mean could be observed if selection was carried out for next generation for these characters. The characters like days to first flower, percentage of short styled flowers, days to first harvest, days to last harvest showed moderate level of genetic advance as percentage of mean. Low genetic advance as percentage of mean was observed for percentage of medium styled flowers and percentage of long styled flowers.

High heritability coupled with high genetic advance as per cent of mean was observed in kharif and rabi seasons for the characters like plant height, number of primary branches plant^{-1}, intra cluster distance, inter cluster distance, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, fruit yield plant^{-1}, SFB shoot damage, SFB fruit damage, calyx length, RLPS, RLSA, weight of infested fruits, total sugars and total phenols. It indicated that, these traits were under the strong influence of additive gene action and hence simple selection based on phenotypic performance of these traits would be more effective. Similar line of work was observed previously by Dhankar *et al*. (1977), Doshi *et al.* (1999), Singh and Gopalakrishnan (1999), Sharma and Swaroop, (2000), Patel *et al*. (2004), Kushwah and Bandhyopadhya (2005), Singh and Kumar, (2005), Kamani and Monpara (2007), Mishra *et al*., (2008), Sherly and Shanthi, (2009), Prabhu *et al*. (2009), Ansari *et al*. (2011), Chattopadhyay *et al*. (2011), Kafytullah *et al*. (2011), Kranthirekha (2011), Kumar *et al*. (2012), Karak *et al*. (2012), Kumar and Arumugam (2013), Solaimana *et al*., (2015) and Gangadhara and Abraham (2016a).

Moderate heritability and moderate GAM values were observed for percentage of short styled flowers in both the seasons, recognizing considerable influence of environment on the expression of these traits. High heritability with moderate genetic advance was found for the characters days to first flower, days to first harvest, days to last harvest while percentage of medium styled flowers and percentage of long styled flowers had high heritability with low genetic advance in both kharif and rabi seasons. Characters with high heritability with low genetic advance were controlled by non additive gene action i.e. either dominant or epistatic gene action indicating that these characters in brinjal could be exploited through development of hybrids. Similar results were reported by Sharma and Swaroop, (2000), Prabhu *et al*. (2009), Tripathi *et al*. (2009), Kumar *et al*. (2011), Karak *et al*. (2012) and Yadav *et al*. (2014) and Gangadhara and Abraham (2016a).

5.1.3 Correlation Studies during Kharif and Rabi Season

Correlation between characters could be due to linkage or pleiotropy. Correlation due to linkage can be manipulated or changed through recombination but it could be impossible to overcome the correlation due to pleiotropy. In the latter case, genetic improvement in one trait is not eventually possible without bringing a change in the associated component characters. Yield being a complex character, is governed by a large number of genes. The influence of each character on yield could be known through correlation studies with a view to determine the extent and nature of relationships prevailing among yield and yield attributing characters. The present investigation was carried out to study the association of different characters on yield and yield attributing traits as well as shoot and fruit infestation by SFB in kharif and rabi seasons both at phenotypic and genotypic levels.

5.1.3.1 The Phenotypic and Genotypic Correlation Coefficients in Kharif and Rabi seasons

Fruit yield per plant showed significant positive correlation with fruits per plant, fruit weight, girth of fruit, plant height, number of primary branches plant, percentage of medium styled flowers, length of fruits and percentage of long styled flowers respectively in both seasons. It exhibited significant negative correlation with weight of infested fruit, SFB fruit infestation, SFB shoot infestation, percentage of short styled flowers, calyx length, intra cluster distance and days to last harvest at phenotypic and genotypic level in both seasons. The positive associations between characters imply the possibility of correlated response to selection and it follows that with the increase in one, will entail an increase in another and the negative correlation preclude the simultaneous improvement of those traits along with each other. The same line of work was reported in brinjal by Mishra and Mishra (1990), Vadivel and Bapu (1990), Gautham and Srinivas (1992), Ushakumari and Subramanian (1993), Ponnuswami and Irulappan (1994), Narendrakumar (1995), Varma (1995), Sharma and Swaroop (2000), Patel and Sarnaik (2004), Pathania *et al*. (2005), Singh *et al*. (2005), Senapati and Senapati, (2006), Kushwah and Bandhyopadhya (2005), Bansal and Mehta (2008), Lohakare *et al*. (2008), Prabhu and Natarajan (2008), Dharwad *et al.* (2009), Jadhao *et al*.(2009). Chattopadhyay *et al*. (2011), Singh *et al*. (2011), Kranthirekha (2011), Karak *et al*. (2012), Thangamani and Jansirani (2012), Kranthirekha and Celine (2013), Arunkumar *et al.* (2013) and Gangadhara and Abraham (2016b).

Plant height showed significant positive correlation with number of primary branches per plant, fruits per plant, fruit yield per plant and length of fruit whereas number of primary branches showed significant positive correlation with fruits per plant and fruit yield per plant at phenotypic and genotypic level in both the season. It was quite evident that plant height increases the number of primary branches per plant which leads to increase in the number of fruits and total yield per plant in brinjal. These findings were in accordance with reports of Mishra and Mishra (1990), Ponnuswami and Irulappan (1994), Vadivel and Bapu (1998), Singh *et al.* (2005), Senapati and Senapati, (2006), Bansal and Mehta (2008), Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Dharwad *et al.* (2009), Jadhao *et al.* (2009), Nalini *et al.* (2009), Kafytullah *et al.* (2011), Arunkumar *et al.* (2013), Kranthirekha and Celine (2013) and Gangadhara and Abraham (2016b) in brinjal.

Days to first flower showed significant positive correlation with days to first harvest, days to last harvest and negative correlation with fruit yield per plant at phenotypic and genotypic level in both kharif and rabi seasons. Negative correlation for days to first flower with yield is preferable as it indicates earliness of the flowers and fruit set in brinjal. However, any selection aimed at earliness would be useful for improving yield or yield associated characters. Percentage of medium styled flowers and percentage of long styled flowers showed significant positive correlation whereas percentage of short styled flowers shown negative correlation with fruit yield per plant. In brinjal only medium and long styled flowers are productive and short styled flowers are unproductive. Hence the positive correlation of medium and long styled flowers as well as negative correlation of short styled flowers with yield per plant were preferable in brinjal. These findings were similar with earlier works in brinjal by Vadivel and Bapu (1990), Gautham and Srinivas (1992), Ponnuswami and Irulappan (1994), Narendrakumar (1995), Varma (1995), Sharma and Swaroop (2000), Patel and Sarnaik

(2004), Pathania *et al.* (2005), Singh *et al.* (2005), Senapati and Senapati, (2006), Kushwah and Bandhyopadhya (2005), Bansal and Mehta (2008), Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Jadhao *et al.*(2009). Chattopadhyay *et al.* (2011), Singh *et al.* (2011), Kranthirekha (2011), Karak *et al.* (2012), Thangamani and Jansirani (2012), Kranthirekha and Celine (2013), Arunkumar *et al.* (2013) and Gangadhara and Abraham (2016b).

Fruits per plant, fruit weight, girth of fruit and length of fruit had shown positive correlation towards yield per plant in both the seasoni at phenotypic and genotypic level. Mishra and Mishra (1990), Nainar *et al.* (1990), Ponnuswami and Irulappan (1994), Varma (1995), Naliyadhara *et al.* (2007), Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Jadhao *et al.* (2009), Nalini *et al.* (2009), Islam and Uddin (2009), Dahatonde *et al.* (2010), Muniappan *et al.* (2010), Kafytullah *et al.* (2011), Praneetha *et al.* (2011), and Danquah and Orofi (2012), Karak *et al.* (2012), Thangamani and Jansirani (2012), Kranthirekha and Celine (2013), Arunkumar *et al.* (2013) and Gangadhara and Abraham (2016b) in brinjal have reported the same.

Days to first harvest and days to last harvest showed negative correlation with fruit yield per plant at phenotypic and genotypic level in both the season. The same results were reported by Lohakare *et al.* (2008), Nalini *et al.* (2009), Jadhao *et al.* (2009), Thangamni and Jansirani (2012). Pathania *et al.* 2005, (Solaimana *et al.*, 2015). Karak *et al.* (2012), Thangamani and Jansirani (2012), Arunkumar *et al.* (2013), Kranthirekha and Celine (2013), and Gangadhara and Abraham (2016b) in brinjal.

SFB shoot infestation showed significant positive correlation with SFB fruit infestation and total sugars in both seasons. It also showed significant negative correlation with RLPS, RLSA, calyx length and total phenols in kharif and rabi seasons. SFB fruit infestation showed significant positive correlation with RLSA, RLPS, total sugars, calyx length, intra cluster distance and inter cluster distance in both seasons. It also showed significant negative correlation with total phenols and weight of infested fruits in both kharif and rabi seasons. In general varieties with high shoot infestation were showing high fruit infestation also. These results are highly supported by Darekar *et al*. (1991), Patil and Ajri (1993), Hazra *et al.* (2004), Prabhu *et al*. (2008), Khorsheduzzaman *et al.* (2010), Kranthirekha (2011), Wagh *et al.* (2012), Payal *et al*.(2015) and Imtiaz *et al* (2015) in brinjal.

Calyx is the most important morphological component which has strong positive association with shoot and fruit borer in both seasons. The genotypes which had more distance within the fruit clusters and between the two fruit clusters shows positive correlation towards fruit infestation. The long and loose calyx with lobed shape were highly prone to fruit borer attack. Long calyx in the highly susceptible genotypes might help the young borer to hide and get easily into the fruit through the soft tissue below the calyx. The present findings were in the conformity with studies in brinjal by Patil and Ajri (1993), Hazra *et al.* (2004), Prabhu *et al* (2008), Kranthirekha (2011), Wagh *et al* (2012), Payal *et al* (2015), Imtiaz *et al* (2015), Niranjana *et al.* (2015) and Nirmala and Irene (2016).

RLSA and RLPS showed positive correlation with fruit borer infestation in both kahrif and rabi seasons. Compact arrangement of seeds in closely placed rings, imparts resistance in brinjal against the borer. Long peripheral seed ring forms a sort of mechanical barrier against easy entry of the borer, *L. orbonalis*. Similar observations in brinjal have also been made by Panda *et al*. (1971), Gupta and Kauntey (2008) and Kranthirekha (2011).

The biochemical defense mechanism would certainly be helpful in selection of plants as source of resistance. Many biochemical factors are known to be associated with insect resistance in crop plants. The scientific results clearly showed that the presence of biochemical constituents acted as stimulants of resistance mechanism towards shoot and fruit borer. It is obvious in many cases the biochemical factors are more important than morphological and physiological factors in conferring non preference and antibiosis (Prabhu *et al*, 2008).

Total phenol content had negative correlation with shoot and fruit borer in both seasons. Higher phenol content present in the plant shoot as well as fruits indicates the tolerance to the pest. The phenols are oxidized by polyphenol oxidases to produce the toxic quinines, protective melanin pigments and other oxidation products (Hung and Rohde, 1973) which might have imparted tolerance through discouraging feeding of the insects. Negative association between fruit infestation and total phenols was observed in the present study and was previously studied by Doshi *et al.* (1998), Doshi (2004), Hazra *et al*. (2004), Asati *et al*. (2004), Chandrasekhar *et al.* (2008), Prabhu *et al*, 2008) and Shinde *et al.* (2009), Kranthirekha (2011), Prasad *et al*. (2014), Imtiaz *et al* (2015) and Nirmala and Irene (2016) in brinjal.

Total sugar content showed strong association with shoot and fruit borer infestation in kharif and rabi seasons. Sugar is considered one of the vital nutrients in plants might act as phago stimulants to SFB feeding on eggplant. Earlier works by Panda and Das, (1975), Praneetha (2002), Hazra *et al*. (2004), Asati *et al*. (2004), Chandrasekhar *et al.* (2008), Prabhu *et al*. (2008), Elanchezhyan *et al.* (2009), Kranthirekha (2011), Prasad *et al.* (2014), Imtiaz *et al.* (2015) and Nirmala and Irene (2016) had also reported that concentration of feeding stimulants like sugars and protein in the fruits will lead to susceptibility to fruit infestation by the shoot and fruit borer.

It is suggested that the eggplant genotypes with seediness with low amount of sugars and high amounts of phenols may be used in hybridization program to develop cultivars with resistance to shoot and fruit borer (*Leucinodes orbonalis)*. Both bitterness and discolouration in the fruits increase with increasing total phenols, which however, impose restriction in increasing maximum phenol content as the approach of resistance breeding. So it is essential to strike proper balance to breed a genotype with fruit quality coupled with resistance attribute. Similar studies was reported in eggplant by Hazra *et al*. (2004), Elanchezhyan *et al.* (2009) and Kranthirekha. (2011) and Nirmala and Irene (2016)

5.1.4 Direct and Indirect Effects in Kharif and Rabi Season

The path analysis unravels whether the association of the component characters with yield is due to their direct effect on yield, or is a consequence of their indirect effect via some other trait(s). Thus path analysis helps in partitioning the genotypic correlation coefficient into direct and indirect effects of the component characters on the yield on the basis of which improvement programme can be devised effectively. If the correlation between yield and any of its components is due to the direct effect, it reflects a true relation between them and selection can be practiced for such a character in order to improve yield. But if the correlation is mainly due to indirect effect of the character through another component trait, the breeder has to select the latter trait through which the indirect effect is exerted.

Path coefficient analysis was based on correlation coefficients using fruit yield plant^{-1}as the dependent factor (effect) to fix other quantitative characters *viz.,* plant height, number of primary branches plant^{-1}, days to first flower, percentage of medium styled flowers, percentage of long styled flowers, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, days to first harvest. In the present study, genotypic path coefficient were worked out during kharif and rabi seasons is discussed below.

Characters like number of fruits plant^{-1}, fruit weight, percentage of long styled flowers, percentage of medium styled flowers and plant height showed positive direct effect as well as significant positive correlation with fruit yield per plant in both seasons. Selection based on these characters would be highly effective. These findings were agree with earlier reports in brinjal by Gautham and Srinivas (1992), Ushakumari and Subramanian (1993), Ponnuswami and Irulappan (1994), Narendrakumar (1995), Varma (1995), Sharma and Swaroop (2000), Patel and Sarnaik (2004), Pathania *et al.* (2005), Singh *et al.* (2005), Kushwah and Bandhyopadhya (2005), Senapati and Senapati, (2006), Bansal and Mehta (2008), Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Dharwad *et al.* (2009), Jadhao *et al.*(2009), Mohanty (2009), Muniappan *et al.* (2010), Dahatonde *et al.* (2010), Chattopadhyay *et al.* (2011), Singh *et al.* (2011), Kranthirekha (2011), Karak *et al.* (2012), Thangamani and Jansirani (2012), Kranthirekha and Celine (2013), Arunkumar *et al.* (2013) and Gangadhara and Abraham (2016b).

Though days to days to first harvest and fruit weight imparted positive direct effect on fruit yield per plant in both seasons, negative correlation coefficient with fruit yield per plant indicated that the negative indirect effects are the cause of manifestation of the correlation. The same line of findings was given in brinjal by Senapati and Senapati, (2006), Bansal and Mehta (2008), Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Jadhao *et al.*(2009), Mohanty (2009), Nalini *et al.* (2009), Muniappan *et al.* (2010), Dahatonde *et al.* (2010), Chattopadhyay *et al.* (2011), Karak *et al.* (2012), Thangamani and Jansirani (2012), Kranthirekha and Celine (2013), Arunkumar *et al.* (2013) and Gangadhara and Abraham (2016b).

Length of fruit, girth of fruit and number of primary branches plant^{-1} had significantly positive correlation with fruit yield per plant in kharif and rabi seasons but had negative direct effect on fruit yield per plant and fruit weight respectively. It indicates the high indirect effect through number of fruits per plant and fruit weight respectively as the main cause for such a correlation coefficient. This was in line with the findings of Bansal and Mehta (2008), Lohakare *et al.* (2008), Prabhu and Natarajan (2008), Dharwad *et al.* (2009), Jadhao *et al.*(2009), Mohanty (2009), Muniappan *et al.* (2010), Dahatonde *et al.* (2010), Chattopadhyay *et al.* (2011), Singh *et al.* (2011), Kranthirekha (2011), Karak *et al.* (2012), Thangamani and Jansirani (2012), Kranthirekha and Celine (2013), Arunkumar *et al.* (2013) and Gangadhara and Abraham (2016b) in brinjal.

Therefore, number of fruits plant^{-1}, fruit weight, percentage of long styled flowers, percentage of medium styled flowers and plant height, length of fruit, girth of fruit number of primary branches plant^{-1} was identified as major characters contributing towards yield directly and indirectly. Hence selection based on these characters would be effective in developing high yielding brinjal varieties.

5.1.5 Selection Index

Discriminant function analysis developed by Fisher (1936) gives information on the proportionate weightage to be given to a yield component. Thus, selection index was formulated to increase the efficiency of selection by taking into account the important characters contributing to yield. Further Hazel (1943) suggested that selection based on suitable index was more efficient than individual selection for the characters.

Plant height, number of primary branches, number of fruits plant^{-1}, girth of fruit and fruit weight together with fruit yield plant^{-1} were used for constructing selection index.

Based on the selection index values, out of sixty genotypes studied, top five ranks were given to the genotypes namely SM 36 (4714.73 and 4724.25), SM 2 (4554.09 and 4676.91), SM 9 (4417.26 and 4471.43), SM 14 (4330.44 and 4313.06) and SM 21 (4207.61 and 4255.83) respectively in both kharif and rabi seasons and were identified as superior ones in terms of fruit yield. The similar results were reported in brinjal by Vadivel and Bapu (1991), Chattopadyay *et al.* (2011), Kranthirekha (2011) and Bashar *et al.* (2015). The genotypes namely SM 36 (IC-433678), SM 2 (IC-345271), SM 9 (Raidurga Local), SM 14 (Jagalur Local) and SM 21 (Tiptur local) have shown high yield in both kharif and rabi seasons. These five high yielding genotypes were selected as a female parents for hybridization programme in the second experiment.

5.1.6 Screening for Shoot and fruit borer Resistance/Tolerance in Kharif and Rabi seasons

Brinjal shoot and fruit borer (*Lucinodes orbonalis* Guenee) reduces the yield and inflicts colossal loss in brinjal production. The losses caused by pest vary from season to season because moderate temperature and high humidity favour the population build-up of brinjal shoot and fruit borer (Shukla and Khatri, 2010), (Bhushan *et al.*, 2011). The yield loss caused by this pest has been estimated up to 60-70% (Singh and Nath, 2010) and up to 100% if no control measures are applied (Rahman, 2007).

In the present study, sixty genotypes of brinjal were screened for shoot and fruit borer based on percentage of shoot and fruit infestation by SFB at 10days intervals from 30days after transplanting to final harvest. The rating of each genotypes was also given based on the percentage of shoot and fruit infestation scale given by Tewari and Krishnamoorthy (1985).

5.1.6 .1 Screening of Shoot Infestation Percentage by SFB during Kharif and Rabi Seasons

SFB shoot infestation was screened based on the shoot infestation percentage from 30 to 90 days after transplanting at 10 days interval and rating was also given for sixty individual genotypes. Genotype SM1 (IC-89986) and SM 60 (Pusa Purple Cluster) were highly resistant, SM 59 (Vellayani Local) was moderately resistant to SFB. Genotype SM 33, SM 43, SM 46, SM 49, SM 52 and SM 53 showed tolerance to SFB. The following genotypes namely SM 2, SM 3, SM 4, SM 5, SM 7, SM 8,SM 9, SM 10,SM 11, SM 12,SM 13,SM 14, SM 15,SM 16,SM 17, SM 18, SM 19, SM 20, SM 21, SM 22, SM 23, SM 24, SM 26, SM 28, SM 29, SM 30, SM 31, SM 32, SM 34, SM 35, SM 36,SM 37, SM 38, SM 39, SM 40, SM 41, SM 42, SM 44, SM 45, SM 48, SM 50, SM 55 and SM 58 exhibited susceptibility while SM 6, SM 25, SM 27, SM 47, SM 51, SM 54, SM 56 and SM 57 showed highly susceptible to shoot and fruit borer in both kharif and rabi seasons. Similar kind of results were reported in the same crop by Panda *et al.* (1971), Dhankar *et al.* (1977), Kumar and Shukla (2002), Jat *et al.* (2003), Senapati (2003), Hazra *et al.* (2004), Yadav and Sharma (2005), Elanchezyan *et al.* (2008), Patial *et al.* (2008), Javed *et al.* (2011), Kranthirekha (2011), Shinde *et al.*(2012), Wagh *et al.* (2012), Kumar *et al.*(2013), Kumar and Arumugam (2013, Bhumitra *et al.* (2014), Kumar and Raghuraman (2014) and Nirmala and Irene. (2016).

5.1.6 .2 Screening of Fruit Infestation Percentage by SFB during Kharif and Rabi seasons

SFB fruit infestation was screened based on the fruit infestation percentage from 60 to 100 days after transplanting at 10 days interval and rating was also given for sixty individual genotypes. Genotype SM1 (IC-89986) and SM 60 (Pusa Purple Cluster) were highly resistant while genotype SM 59 (Vellayani Local) shown moderately resistant to SFB. Genotypes SM 45, SM 46, SM 47, SM 48, SM 50, SM 53, SM 55 and SM 56 were showed tolerance to SFB. The following genotypes namely SM 2, SM 3, SM 4, SM 5, SM 6, SM 7, SM 9, SM 10, SM 13,SM 14, SM 15, SM 17, SM 18, SM 19, SM 20, SM 21, SM 22, SM 23, SM 26, SM 29, SM 30, SM 31, SM 33, SM 36, SM 42, SM 43, SM 44, SM 49, SM 51, SM 52 and SM 54 showed susceptible while SM 8, SM 11, SM 12, SM 16, SM 24, SM 25, SM 27, SM 28, SM 32, SM 34, SM 35, SM 37, SM 38, SM 39, SM 57 and SM 58 exhibited highly susceptible to shoot and fruit borer in both the seasons. The similar results were reported by Panda *et al*. (1971), Dhankar *et al*. (1977), Kumar and Shukla (2002). Jat *et al*. (2003), Senapati (2003), Hazra *et al*. (2004), Yadav and Sharma (2005), Elanchezyan *et al*. (2008), Patial *et al*. (2008), Javed *et al*. (2011), Kranthirekha (2011), Shinde *et al*. (2012), Wagh *et al*. (2012), Kumar *et al*.(2013), Kumar and Arumugam (2013, Bhumita *et al*. (2014), Kumar and Raghuraman (2014) and Nirmala and Irene (2016) in brinjal.

Out of the sixty genotypes screened against shoot and fruit borer, none emerged as immune to the pest. The genotypes namely SM1 (IC-89986), SM 60 (Pusa Purple Cluster) were shown highly resistant and genotype SM 59 (Vellayani Local) showed moderately resistance to both shoot as well as fruit infestation by SFB in kharif and rabi seasons. These three tolerant genotypes were selected as male parents for hybridization programme in the second experiment.

5.2 EXPERIMENT II: LINE X TESTER ANALYSIS

5.2.1 Analysis of Variance for the Experimental Design

The analysis of variance for experimental design revealed highly significant differences among genotypes for all the characters. This indicated that considerable amount of genetic variation is present in the materials for all the traits. The significant mean squares due to parents as well as hybrids depicted presence of adequate variability in them for all the characters. The higher magnitude of mean squares of parents as compared to hybrids indicated that the parents are more variable as compared to hybrids. Comparison of mean squares due to parents vs. hybrids was found to be significant for most of the characters except for long styled flowers. This indicated that average performance of hybrids may significantly differ for these traits depending upon the genetic makeup of the constituent parents.

5.2.2 Heterosis

Plant breeding can be divided into three stages; creation of a gene pool of variable germplasm, selection of superior individuals from the gene pool and utilization of the selected individuals directly for commercial cultivation or in hybridization to create a superior variety. The improvement in yield, which is considered as a final product in almost all the crop plants is usually obtained by screening and selecting the suitable genes from a huge collection of germplasm and accumulating them in a productive genotype for commercial cultivation. Hence, the chief aim in any plant breeding programme is to develop high yielding varieties. To fulfill this, the breeding programme can efficiently be planned with prior knowledge of the genetic makeup of complex quantitative characters like yield and its attributes. It is, therefore, necessary to examine the nature of the crop and the genetic architecture of various quantitative characters in relation to breeding behaviour of the crop.

The genetic yield potential of varieties and hybrids can be improved by using suitable parents in hybridization. The information regarding extent of heterosis and combining ability for various characters is of great value in handling the breeding materials. Development of hybrids necessitates the incorporation of good parents in their genetic makeup. Sometimes high yielding parents may not produce superior hybrids. Thus, the identification of specific parental combination capable to produce the desired level of heterotic effect by their F_1 is also important in improvement of yield potential. The knowledge of combining ability provides a useful clue for selection of desirable parents for the development of better hybrids. Information regarding gene action is also very essential for developing superior genotype.

In the present investigation heterosis and combining ability effects were studied for thirteen traits to identify and develop high yielding hybrids.

5.2.2.1 Growth Parameters

Heterosis for growth parameters is an indication of heterosis for yield because growth and yield parameters are strongly associated. The ideal plant type should be tall with high number of branches. These are the major parameter which acts as source trait to support yield and its component traits. For this trait hybrids (126.33cm) showed high mean value over standard check (116.79 cm). The data on heterosis also showed that the hybrids in general were taller. Out of fifteen crosses, three showed significantly positive standard heterosis for plant height. This suggested the importance of dominant gene action. The cross L_2 XT_2 showed highest standard heterosis for this character. Similar findings have also been reported by earlier workers, Singh *et al.* (1978b), Rajput *et al.* (1984), Kaur (1998), Bulgundi (2000), Indiresh and Kulkarni (2002), Suneetha *et al.* (2008), Shanmugapriya *et al*. (2009), Sao and Mehta (2010), Makani (2013), Ajjappalavara *et al*. (2013), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015) in brinjal.

Number of primary branches per plant is one of the major parameter contributing for total fruit yield per plant. The mean value of hybrids (8.13) was lesser than parents (9.11) but higher than the standard check Haritha (7.73). But out of the fifteen crosses, none showed significant positive standard heterosis for the trait but positive non significant heterosis was observed in two crosses indicating predominance of non-additivity. The cross L_5 x T_3 (5.17%) showed highest standard heterosis for this character followed by L_2 x T_3 (4.31%). These results were in conformation with the results of earlier workers in brinjal *viz.* Patil (1998), Bulgundi (2000), Mallikarjun (2002), Prabhu *et al.* (2005), Shafeeq (2005), Ajjappalavara (2006), Shafeeq *et al.* (2007), Murthy *et al.* (2011), Nalini *et al*. (2011), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015).

5.2.2.2 Yield and its Components

Yield components greatly influence the yield and expression of heterosis for number of long, medium and short styled flowers, days to fist flower, number of fruits per plant, fruit length, fruit girth, fruit weight, days to first harvest and days to last harvest can greatly contribute for total fruit yield per plant. For all these traits, positive heterosis is desirable except short styled flowers.

The mean value of number of long styled flowers of parents (60.67%) and of crosses (66.43%) was higher than standard check (40.77%) involved in the study. It was revealed that crosses had high number of long styled flowers than parents and standard check. Majority of crosses exhibited positive significant standard heterosis suggesting the importance of dominant gene action. More number of long styled flowers among crosses was evident from the recorded positive significant heterosis in all crosses. The cross L_5 x T_3 showed maximum positive and significant heterosis of 37.16 per cent over the standard check. In case of medium styled flowers none of the crosses recorded higher values than standard check. Similar findings in brinjal was reported by Suneetha and Kathiria (2006), Chowdhury *et al.* (2010), Nalini *et al.* (2011), Makani (2013), Reddy and Patel (2014) and Rajasekhar (2014) and Sivakumar (2015).

With respect to number short styled flowers lower values were preferred as these are unproductive. The mean value of parents (3.61%) was lower than that recorded for the crosses (6.70%). The data showed that the mean values of parents and crosses for number of short styled flowers were lower than the standard check (10.47). Out of fifteen crosses, three exhibited negative and significant heterosis over the standard check. The data suggests that dominant gene action had its influence on number of short styled flowers. The cross L_2 x T_3 (-35.99 %) showed maximum negative and significant heterosis over the standard check. Similar findings have also been reported in brinjal by Suneetha and Kathiria (2006), Chowdhury *et al.* (2010), Nalini *et al.* (2011), Makani (2013), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015).

Early flowering is generally an indication of early yield and also early hybrids fit well in multiple cropping systems. For these traits, negative heterosis is considered to be desirable. The mean value of parents (35) and crosses (40.33) were very less than the mean value over standard check (45.06). All the crosses exhibited significant negative (desirable) heterosis over the standard check. This indicates the predominant non -additive gene action. Similar results were also reported by Patil (1998), Bulgundi (2000), Kaur *et al.* (2001), Singh and Maurya (2005), Chowdhury *et al.* (2010), Nalini *et al.* (2011), Reddy and Patel (2014) and Rajasekhar (2014) in brinjal.

Similarly, the mean value of parents (54.13) and hybrids (55.83) for days to first harvest showed less mean value over standard check (68.19), as many as twelve crosses exhibited significant negative standard heterosis for days to first harvest. Maximum negative heterosis over the commercial check (-18.12 %) was exhibited by the cross L_2 x T_3 which indicate the early fruiting habit in brinjal. The character days to last harvest indirectly measures the duration of the crop. The mean value of crosses (125.33) was less than parents (139.83) and standard check (171.33). All the crosses exhibited significant negative heterosis over the standard check which indicates earliness of the hybrids. The results were in conformation with those of earlier workers *viz.,* Chadha *et al*. (1990), Patil (1998), Kaur (1998), Bulgundi (2000), Kaur *et al.* (2001), Patel (2003), Suneetha and Kathiria (2006), Chowdhury *et al.* (2010), Nalini *et al.* (2011), Makani (2013), Reddy and Patel (2014) and Rajasekhar (2014) and Sivakumar (2015) in eggplant.

Fruit length in brinjal is an important parameter of fruit deciding consumer preference. The hybrid (L_2 x T_2) mean for fruit length (21.23 cm) was higher to both parents (14.73 cm) and standard check (14.90 cm) but lower than one parent (T_2) with mean of 22.43cm. Based on consumer preference positive heterosis of long fruit length and negative for shorter ones are preferred. Therefore, the crosses showing high negative heterosis were L_1 x T_2 and L_1 x T_3. The crosses showing high positive heterosis were L_2 x T_2, L_2 x T_3 and L_5 x T_2. For fruit length nine hybrids exhibited negative and six hybrids exhibited positive heterosis over the standard check. These were in conformity with the studies of Bhutani *et al.* (1980), Ram *et al.* (1981), Patel (1984), Rajput *et al.* (1984), Dixit and Gautam (1987), Prakash *et al.* (1993), Mankar *et al.* (1995), Indiresh and Kulkarni (2002), Mallikarjun (2002), Shafeeq (2005), Singh and Maurya (2005), Rameshkumar *et al.* (2012), Bhushan *et al.* (2013), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015) in brinjal.

Girth of fruit in brinjal is another important character as that of fruit length. The mean fruit diameter of crosses (21.33 cm) had higher mean performance than the standard check (11.79 cm) but lower than parental mean (23.37cm). Cross L_5 x T_1 showed positive and significant heterosis of 81.00 per cent over the standard check. Majority of the crosses showed positive heterosis over standard check. The same results were suggested in brinjal by earlier workers, Chadha and Sidhu (1982), Ingale and Patil (1996), Kaur (1998), Bulgundi (2000), Mallikarjun (2002), Indiresh and Kulkarni (2002), Singh and Maurya (2005), Nalini *et al*. (2011), Rameshkumar *et al*. (2012), Ajjappalavara *et al*. (2013), Bhushan *et al.* (2013), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015).

Total yield per plant is dependent mainly on the number of fruits per plant and average fruit weight. Number of fruits per plant was influenced by the size of the fruit that is fruit length and fruit girth. Fruit weight is one of the component characters directly influencing the fruit yield. In the present study, average fruit weight of crosses (186.53 g) was superior to the standard check (124.93) g but lower than parents (198.0 g). The cross L_5 x T_1 showed positive and significant heterosis of 49.31 per cent over the standard check. Out of 15 crosses, ten exhibited significant standard heterosis in positive direction. Similar views in eggplant were put forth by Peter and Singh (1974), Patel (1984), Sawant *et al.* (1991), Kaur (1998), Kumar *et al.,* (1999), Indiresh and Kulkarni (2002), Shafeeq (2005), Prabhu *et al.* (2005), Kamal *et al.* (2006), Sao and Mehta (2010), Nalini *et al.* (2011), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015).

Increased number of fruits per plant is commercially important trait to gain high market value through high productivity. The average *per se* value of crosses (43.73) was higher than the standard check (34.67) and parents (40.17).Out of 15 crosses, three exhibited positive and significant heterosis over the standard check. The cross L_5 x T_3 showed maximum positive heterosis of 26.13 per cent over the commercial check followed by L_2 x T_1 (22.67%). Similar findings for number of fruits per plant over standard heterosis were also reported in brinjal by Singh *et al.* (1978b), Vijay *et al.,* Dharmegowda *et al.* (1979), Bhutani *et al.* (1980), Rajput *et al.* (1984), Kaur (1998), Kumar *et al.* (1999), Mallikarjun (2002), Indiresh and Kulkarni (2002), Shafeeq (2005), Singh and Maurya (2005), Abhinav and Nandan (2010), Kamal *et al.* (2006), Shanmugapriya *et al.* (2009), Abhinav and Nandan (2010), Nalini *et al.* (2011), Makani (2013), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015).

Fruit yield per plant is the ultimate and most important trait. However, yield of a crop cannot be taken as a single entry since it is associated with many yield attributing characters. In brinjal, heterosis in yield per plant was positively associated with the heterosis in number of marketable fruits per plant (Singh and Nandpuri, 1974). In some

IC-345271 X IC-89986

IC-345271 X Vellayani Local

IC-345271 X Pusa Purple Cluster

Plate: 10. Variations of fruit colour in three F_1 hybrids involving IC-345271 as female parent

IC-433678 X IC-89986

IC-433678 X Vellayani Local

IC-433678 X Pusa Purple Cluster

Plate: 11. Variations of fruit colour in three F_1 hybrids involving IC-433678 as female parent

Jagaluru Local X IC-89986

Jagalur Local X Vellayani Local

Jagaluru Local X Pusa Purple Cluster

Plate: 12. Variations of fruit colour in three F_1 hybrids involving Jagaluru Local as female parent

Tiptur Local X IC-89986

Tiptur Local X Vellayani Local

Tiptur Local X Pusa Purple Cluster

Plate: 13. Variations of fruit colour in three F_1 hybrids involving Tiptur Local as female parent

Raidurg Local X IC-89986

Raidurg Local X Pusa Purple Cluster

Raidurg Local X Vellayani Local

Plate: 14. Variations of fruit colour in three F_1 hybrids involving Raidurg Local as female parent

cases it associated with number of branches per plant, plant height and fruit weight (Chadha and Sidhu, 1982).

For fruit yield per plant the overall mean of crosses was higher than the parental mean. However, the highest mean value which was shown by the hybrid L_5 x T_3 (4.49 kg / plant) followed by L_2 x T_1 (4.42 kg / plant) and L_2 x T_3 (4.42 kg / plant). Among fifteen crosses, L_5 x T_3 (25.30%), L_2 x T_3 (23.26%), L_2 x T_1 (23.35%), L_1 x T_3 (9.77%) and L_4 x T_3 (7.44%) exhibited significant and positive heterosis over the standard check for fruit yield per plant. These results were in conformation of the results of earlier workers in brinjal by Singh *et al.* (1978b), Rajput *et al.* (1984), Chadha *et al.* (1990), Bulgundi (2000), Kaur *et al.* (2001), Bavage (2002), Indiresh and Kulkarni (2002), Prabhu *et al.* (2005), Shafeeq (2005), Prakash *et al.* (2008), Suneetha *et al.* (2008), Timmapur *et al.* (2008), Chowdhury *et al.* (2010), Nalini *et al .* (2011), Murthy *et al.* (2011), Abhinav and Mehta (2011), Rameshkumar *et al.* (2012), Bhushan and Singh (2013), Reddy and Patel (2014), Rajasekhar (2014) and Sivakumar (2015).

5.2.3 Combining Ability

The combining ability concept was proposed by Sprague and Tatum (1942) in corn. According to them, the general combining ability (*gca*) is the mean performance of all the crosses involving a parent from over all mean. Specific combining ability (*sca*) was defined as the deviation in the performance of specific cross from the performance of expected on the basis of the general combining ability effects of parents involved in the crosses.

The combining ability analysis gives an indication of the variance due to *sca* and *gca*, which represents a relative measure of non -additive and additive gene act ions, respectively. It is an established fact that the dominance is a component of non -additive genetic variance. Breeders use these variance components to infer the gene action and assess the genetic potentialities of the parents in hybrid combination.

5.2.3.1 Analysis of Variance for Combining Ability and Gene Action

The analysis of variance for combining ability indicated that the mean squares due to general combining ability and specific combining ability were significant.

Nature of gene action as measured by *GCA* and *SCA* variances is particularly useful in deciding the inheritance of character and thereby selection of a suitable breeding programme. Greater *GCA* variance for a character indicates the predominance of additive gene action and if *SCA* variance is greater, non-additive gene action plays an important role in controlling that trait. Simple selection is enough for a character controlled by additive gene action as it as fixable, but if non-additive gene action is predominant for a character, which is non-fixable, heterosis breeding may be rewarding or selection has to be postponed to later generations.

The variance due to SCA was higher in magnitude than GCA for all the traits except for days to first flower, fruit length, fruit girth, days to first harvest and days to last harvest supports the predominance of non-additive gene effects in governing the expression of all these characters. The preponderance of non-additive gene action, suggested that there is scope of heterosis breeding for the improvement of these characters. The similar results were reported in brinjal by Chowdhury *et al.* (2010), Nalini *et al.* (2011), Sane *et al.* (2011), Pachiyappan *et al.* (2012), Makani (2013), Rajasekhar (2014), Sivakumar (2015).

5.2.3.2 General and Specific Combining Ability Effects (gca and sca Effects)

For exploitation of heterosis, the information on gca should be supplemented with sca and hybrid performance. Heterosis in F_1 indicates operation of non-additive gene effects, but it cannot give any idea about the relative magnitude of non-additive (dominance + epistasis) and additive gene action. Hence, analysis of combining ability is one of the potential tools for identifying prospective parents to develop commercial F_1hybrids (Griffing, 1956).

General and specific combining ability effects and variances obtained from a set of F_1's would enable a breeder to select desirable parents and crosses for each of the quantitative components. General combining ability effects of parents and sca effects of crosses were highly significant for the characters studied. From the present investigation, it was evident that gca or sca effects in parents or crosses were in desirable direction for some characters and in undesirable direction for some other traits. Therefore it is important to ascertain the status of parent or hybrid with respect to combining ability effects over a number of component characters (Arunachalam and Bandopadhay, 1979).

Among the female parental lines L_5 (Raidurg Local) and L_2 (IC- 433678) were good general combiners for all character studied *viz.,* length of fruit, number of fruits per plant, long styled flowers, days to first flower and plant height, days to first harvest and days to last harvest. The female parental line L_4 (Tiptur Local) was an average combiner for days to first flower, girth of fruit, fruit weight and fruit yield per plant but L_1 (IC- 345271) was poor combiner for all characters. Among the testers, T_3 (Pusa Purple Cluster) was good general combiner for number of fruits per plant, long styled flowers, days to first flower and number of primary branches per plant, days to first harvest and last harvest whereas T_1 (IC-89986) and T_2 (Vellayani Local) were poor combiners. Therefore, the above parents could be considered as a good source of favourable genes for increasing fruit yield along with other yield attributes. Similar results were reported in brinjal by Varshney *et al.* (1999), Bulgundi (2000), Singh and Singh (2004), Vadodaria *et al*. Shafeeq (2005), Kamalakkannan *et al.* (2007), (2009), Abhinav and Nandan (2010), Sao and Mehta (2010), Rai and Asati (2011), Nalini *et al*. (2011), Pachiyappan *et al.* (2012), Al-Hubaity and Teli (2013), Rajasekhar (2014), Sivakumar (2015).

It was evident from these results that high gca effects for fruit yield per plant in the genotypes L_5 (Raidurg Local), L_2 (IC- 433678), L_4 (Tiptur Local) and T_3 (Pusa Purple Cluster) were mainly due to important yield contributing characters mentioned above. Therefore, it would be worthwhile to use the above parental lines in the hybridization programme for improvement of brinjal. The potentiality of a parent in hybridization may be assessed by its *per se* performance and gca effects. The results revealed that most of the characters had relatively high degree of correspondence between *per se* performance and gca effects. This could be ascribed to the predominant role of additive and additive x additive type of gene action for the inheritance of these traits.

The estimates of specific combining ability effects revealed that cross combinations L_1 x T_3 (IC-345271 X Pusa Purple Cluster), L_2 x T_1 (IC-433678 X IC-89986), L_3 x T_2 (Jagaluru Local X Vellayani Local) and L_4 x T_2 (Tiptur Local X Vellayani Local) exhibited significant and positive sca effects for fruit yield per plant. The cross combination L_2 x T_1 (IC-433678 X IC-89986) had highest sca effects for fruit yield (1.35), which also recorded significant sca effects in desired direction for number of fruits per plant, long styled flowers and number of primary branches per plant. In another hybrid L_4 x T_2 (Tiptur Local X Vellayani Local) also manifested significant sca effects for plant height, number of fruits per plant, days to first flower, length of fruit and fruit yield per plant in desired direction. The cross L_5 x T_3 (Raidurg Local X Pusa Purple Cluster) exhibited high significant sca effects for number of fruits per plant, number of primary branches per plant and days to first harvest. Similar finding have also been reported in brinjal by Shinde and Patil (1984), Mishra and Mishra (1990b), Varshney *et al.* (1999), Bulgundi (2000), Mallikarjun (2002), Aswani and Khandelwal (2005), Singh and Singh (2004), Vadodaria *et al.* (2004), Shafeeq (2005), Bisht *et al.* (2006), Kamalakkannan *et al.* (2007), Suneetha *et al.* (2008, Abhinav and Nandan (2010), Sao and Mehta (2010), Rai and Asati (2011), Nalini *et al.* (2011), Sane *et al.* (2011), Pachiyappan *et al.* (2012), Al-Hubaity and Teli (2013), Rajasekhar (2014), Sivakumar (2015).

Earliness is an important trait in vegetables like brinjal. Earliness is required in such crops for realizing the potential economic yield in as less time as possible to catch early market. The crosses that exhibited significant sca effects for earliness like days to first flower and days to first harvest were L_1 x T_3 (IC-345271 X Pusa Purple Cluster), L_2 x T_1 (IC-433678 X IC-89986), L_3 x T_2 (Jagaluru Local X Vellayani Local) and L_4 x T_2 (Tiptur Local X Vellayani Local) L_3 x T_3 (Jagaluru Local X Pusa Purple Cluster) and L_5 x T_3 (Raidurg Local X Pusa Purple Cluster). In earlier studies, Sawant *et al.* (1991), Bulgundi (2000), Chaudhary and Pathania (2000), Singh and Singh (2004), Vadodaria *et al.* (2004), Suneetha (2008), Shanmugapriya *et al.* (2009), Chowdhury *et al.* (2010), Nalini *et al.* (2011), Sane *et al.* (2011), Pachiyappan *et al.* (2012), Al-Hubaity and Teli (2013), Makani (2013), Rajasekhar (2014), Sivakumar (2015) also found similar results in brinjal.

If a cross combination exhibited high sca effects as well as *per se* performance having at least one parent as good general combiner for a particular trait, it is expected that such cross combinations would throw desirable transgressive segregants in later generations. Significant sca effects of those combinations involving good x good combiners showed the major role of additive type of gene effects, which is fixable. However, two good general combiners may not necessarily throw good segregants. Similarly, in the case of superior crosses involving both the poor x poor general combiners, very little gain is expected from such crosses because high sca effects may dissipate with the progress towards homozygosity.

In the present study, top three crosses L_2 x T_1 (IC-433678 X IC-89986), L_4 x T_2 (Tiptur Local X Vellayani Local) and L_5 x T_3 (Raidurg Local X Pusa Purple Cluster) which exhibited high sca effects for yield per plant involved at least one good general combiners. The two crosses L_3 x T_2 (Jagaluru Local X Vellayani Local) and L_1 x T_3 (IC-345271 X Pusa Purple Cluster) had high sca effects for yield per plant in which poor x poor (L_3 x T_2) and poor x good (L_1 x T_3) general combiners was involved which clearly indicated that, the parental contribution to the heterosis is mainly through non-additive gene effects. Hence, exploitation of heterosis appeared to be an appropriate strategy for improvement in brinjal. These crosses could also be improved through recurrent selection schemes. These results were in accordance with the findings of Bulgundi (2000), Chaudhary and Pathania (2000), Singh and Singh (2004), Shanmugapriya *et al*. (2009), Chowdhury *et al.* (2010), Nalini *et al*. (2011), Sane *et al.* (2011), Pachiyappan *et al.* (2012), Makani (2013), Rajasekhar (2014), Sivakumar (2015) in brinjal.

Thus, the ideal crosses would be the one, which have good *per se* performance, high heterosis or heterobeltiosis, at least one good general combiner parent and high sca effects. On the basis of combining ability, the parents L_5 (Raidurg Local), L_2 (IC-433678), L_4 (Tiptur Local) and T_3 (Pusa Purple Cluster) was good general combiner for yield and yield contributing characters. Considering mean performance, heterosis and combining ability, the hybrid L_2 x T_1 (IC-433678 X IC-89986) and L_4 x T_2 (Tiptur Local X Vellayani Local) followed by L_5 x T_3 (Raidurg Local X Pusa Purple Cluster) was found promising for commercial exploitation. It is evident that both additive and non additive gene effects are involved in the genetic control of the traits. So both gene effects should be considered when developing superior lines. The identified hybrids could be effectively used for heterosis breeding to exploit maximum hybrid vigour.

5.2.4 Screening for Shoot and fruit borer Resistance/Tolerance

Screening of 15 F_1 Hybrids for shoot and fruit borer resistance/tolerance was done based on the extent of damage to shoots and fruits. The data of damage parameters collected from field experiment with 15 F_1 Hybrids were subjected to statistical analysis. The shoot infestation and fruit infestation by SFB was discussed separately under following headings.

5.2.4.1 Shoot Infestation Percentage by SFB

SFB shoot infestation was screened for all 15 F_1 hybrids based on the shoot infestation percentage from 30 to 90 days after transplanting at 10 days interval. A wide variation for shoot infestation by SFB was observed among the hybrids.

Among the 15 F_1 hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were highly resistant, IC-433678 X Pusa Purple Cluster was moderately resistant to shoot damage by SFB. Four hybrids namely Raidurg Local X IC-89986, Tiptur Local X Vellayani Local, Tiptur Local X Pusa Purple Cluster and Jagaluru Local X Pusa Purple Cluster were showed tolerance to shoot damage by SFB. The following hybrids namely IC-345271 X Vellayani Local , IC-345271 X Pusa Purple Cluster, Jagaluru Local X Vellayani Local), Jagaluru Local X IC-89986, IC-345271 X IC-89986, Raidurg Local X Vellayani Local and Tiptur Local X IC-89986 have shown susceptibility while IC-433678 X Vellayani Local was highly susceptible to shoot damage by shoot and fruit borer. Similar results were reported in brinjal by Panda *et al.* (1971), Dhankar *et al.* (1977), Kumar and Shukla, (2002). Jat *et al.* (2003), Senapati (2003), Hazra *et al.* (2004), Yadav and Sharma, (2005), Elanchezyan *et al.* (2008), Patial *et al.* (2008), Javed *et al.* (2011), Kranthirekha (2011), Shinde *et al.*(2012), Wagh *et al.* (2012), Kumar *et al.*(2013), Kumar and Arumugam, (2013, Bhumitra *et al.* (2014), Kumar and Raghuraman. (2014) and Nirmala and Irene. (2016).

5.2.4.2 Fruit Infestation Percentage by SFB

SFB fruit infestation was screened for 15 F_1 hybrids based on the fruit infestation percentage at 10 days interval from 60, 70, 80, 90 and 100 days after transplanting. Differential response to the fruit infestation by SFB was noticed all the hybrids studied.

Among the 15F_1 hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were highly resistant, IC-433678 X Pusa Purple Cluster was moderately resistant to fruit damage by SFB. Four hybrids namely Raidurg Local X IC-89986, Tiptur Local X Vellayani Local, Tiptur Local X Pusa Purple Cluster and Jagaluru Local X Pusa Purple Cluster were showed tolerance to fruit damage by SFB. The following hybrids namely IC-345271 X Vellayani Local , IC-345271 X Pusa Purple Cluster, Jagaluru Local X Vellayani Local), Jagaluru Local X IC-89986 , IC-345271 X IC-89986 , Raidurg Local X Vellayani Local, Tiptur Local X IC-89986 and IC-433678 X

IC-43368 × IC-89986

Raidurg Local × Pusa Purple Cluster

Plate 15. Superior Hybrids for yield and resistance to shoot and fruit borer

Vellayani Local were shown susceptible to shoot damage by shoot and fruit borer. These results agree with earlier reports by Panda *et al*. (1971), Dhankar *et al*. (1977) Kumar and Shukla, (2002). Jat *et al*. (2003), Senapati (2003), Hazra *et al*. (2004), Yadav and Sharma, (2005), Elanchezyan *et al*. (2008), Patial *et al*. (2008), Javed *et al*. (2011), Kranthirekha (2011), Shinde *et al*.(2012), Wagh *et al*. (2012), Kumar *et al*.(2013), Kumar and Arumugam, (2013), Bhumita *et al*. (2014), Kumar and Raghuraman. (2014) and Nirmala and Irene. (2016).

Out of the fifteen hybrids screened against shoot and fruit borer, none emerged as immune to the pest. The hybrids namely IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were highly resistant with high yield while the hybrid IC-433678 X Pusa Purple Cluster shown moderately resistant to both shoot as well as fruit infestation by SFB. The two hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were further selected to raise the F_2 population for molecular analysis of segregants in the third experiment.

5.3 EXPERIMENT III

5.3.1 Field Screening of F_2 Segregants for Resistance to Shoot and fruit borer

Screening of 60 F_2 segregants each of two cross combination for shoot and fruit borer resistance/tolerance was done based on the extent of damage to shoots and fruits.

5.3.1.1 Shoot Infestation Percentage by SFB

SFB shoot infestation was screened based on the shoot infestation percentage from 30 to 90 days after transplanting at 10 days interval and individually rating was also given for sixty F_2 segregants of two cross combinations viz., IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster.

Among the sixty F_2 segregants of the cross combination IC-433678 X IC-89986, thirteen plants exhibited highly resistant to SFB (plant5, plant8, plant13, plant15, plant20, plant23, plant34, plant38, plant42, plant43, plant49, plant53 and plant59), eight plants were moderately resistant (plant4, plant19, plant31, plant35, plant39, plant44, plant46 and plant57) and ten plants showed tolerance to SFB (plant3, plant11, plant17, plant25, plant28, plant29, plant41, plant52, plant54, and plant55). The following seventeen F_2 segregants namely plant1, plant2, plant6, plant9, plant14, plant16, plant21, plant23, plant24, plant26, plant32, plant36, plant37, plant40, plant45, plant47 and plant48 were susceptible while twelve segregants namely plant7, plant10, plant12, plant18, plant27, plant30, plant33, plant50, plant51, plant56, plant58 and plant60 were highly susceptible reaction to shoot damage by shoot and fruit borer.

In another cross combination Raidurg Local X Pusa Purple Cluster, fourteen plants were highly resistant to SFB (plant2, plant6, plant10, plant12, plant15, plant19, plant22, plant28, plant32, plant35, plant40, plant45, plant50 and plant56), seven plants were moderately resistant (plant5, plant8, plant25, plant44, plant53, plant55 and plant57), eleven plants showed tolerance to SFB (plant13, plant17, plant30, plant33, plant34, plant39, plant41, plant46, plant49, plant52 and plant59). The following seventeen F_2 segregants namely plant1, plant7, plant9, plant11, plant16, plant20, plant21, plant23, plant24, plant29, plant36, plant38, plant42, plant43, plant48, plant58 and plant60 were susceptible while eleven segregants namely plant3, plant4, plant14, plant18, plant26 plant27, plant31, plant37, plant47, plant51 and plant54 exhibited highly susceptibility to shoot damage by shoot and fruit borer. These results are similar with earlier reports in brinjal by Panda *et al.* (1971), Dhankar *et al.* (1977), Kumar and Shukla (2002). Jat *et al.* (2003), Senapati (2003), Hazra *et al.* (2004), Yadav and Sharma, (2005), Elanchezyan *et al.* (2008), Patial *et al.* (2008), Javed *et al.* (2011), Kranthirekha (2011), Shinde *et al.*(2012), Wagh *et al.* (2012), Kumar *et al.* (2013), Kumar and Arumugam (2013, Bhumitra *et al.* (2014), Kumar and Raghuraman (2014) and Nirmala and Irene (2016).

5.3.1.2 Fruit Infestation Percentage by SFB

SFB fruit infestation was screened based on the fruit infestation percentage at 10 days interval from 60, 70, 80, 90 and 100 days after transplanting along with individual rating was also given for sixty F_2 segregants of two cross combinations viz., IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster.

In the cross combination IC-433678 X IC-89986, sixty F_2 segregants were studied. Among them thirteen plants were highly resistant to SFB (plant5, plant8, plant13, plant15, plant20, plant23, plant34, plant38, plant42, plant43, plant49, plant53 and plant59), eight plants were moderately resistant (plant4, plant19, plant31, plant35, plant39, plant44, plant46 and plant57) and ten plants showed tolerance to SFB (plant3, plant11, plant17, plant25, plant28, plant29, plant41, plant52, plant54, and plant55).The following sixteen F_2 segregants namely plant1, plant2, plant6, plant9, plant14, plant16, plant21, plant22, plant24, plant26, plant30, plant32, plant36, plant40, plant45, plant47 and plant48 exhibited susceptiblity while twelve segregants namely plant7, plant10, plant12, plant18, plant27, plant30, plant33, plant50, plant51, plant56, plant58 and plant60 were highly susceptible to shoot damage by shoot and fruit borer.

In another cross combination Raidurg Local X Pusa Purple Cluster, out of sixty F_2 segregants fourteen plants exhibited high resistance to SFB (plant2, plant6, plant10, plant12, plant15, plant19, plant22, plant28, plant32, plant35, plant40, plant45, plant50 and plant56), five plants were moderately resistant (plant5, plant25, plant44, plant53 and plant55) and thirteen plants showed tolerance to SFB (plant8, plant13, plant17, plant30, plant33, plant34, plant39, plant41, plant46, plant49, plant52, plant57 and plant59). The following thirteen F_2 segregants namely plant1, plant9, plant11, plant16, plant20, plant21, plant26, plant29, plant36, plant38, plant42, plant43, plant48 were susceptible while fifteen segregants namely plant3, plant4, plant7, plant14, plant18, plant23, plant24, plant27, plant31, plant37, plant47, plant51, plant54, plant58 and plant59 exhibited high susceptibility to shoot damage by shoot and fruit borer. These findings agree with the earlier reports by Panda *et al.* (1971), Kumar and Shukla (2002). Jat *et al.* (2003), Senapati (2003), Hazra *et al.* (2004), Yadav and Sharma, (2005), Elanchezyan *et al.* (2008), Patial *et al.* (2008), Javed *et al.*, (2011), Kranthirekha (2011), Shinde *et al.*(2012), Wagh *et al.* (2012), Kumar *et al.*(2013), Kumar and

Plate 16. General field view of F_2 population block

Arumugam (2013, Bhumitra *et al.* (2014), Kumar and Raghuraman (2014) and Nirmala and Irene (2016) in brinjal.

5.3.2 Molecular Analysis of F_2 Segregants

In the current investigations, 22 RAPD primers were tested and only eight primers produced polymorphism between susceptible and resistant parents. BSA (Michelmore *et al.*, 1991) was also attempted to narrow down the number of polymorphic primers. Out of eight polymorphic primers, only three primers *viz.*, OPO-20, OPC-4 and OPL-9 could clearly distinguish the resistant and susceptible bulks in the cross IC-433678 × IC-89986 (OPC-4 and OPL-9) and one primer OPO-20 in cross Raidurg Local × Pusa Purple Cluster. These results were in accordance with Fondevilla *et al.* (2007) and Tiwari *et al.* (1998). Many studies have demonstrated the fact that RAPD analysis in combination with BSA of F_2 population provides an efficient approach to identify the target gene in crop plants (Tragoonrung *et al.*, 1997; Yang *et al.*, 2004).

The primers OPO-20, OPL-9 and OPC-4 amplified at 400, 500 and 550 base pair was present in resistant parent and resistant bulk (pooled DNA of 10 randomly selected resistant F_2 plants). Thus, showing co-segregation of the marker with resistant gene but these bands were absent in susceptible parents and susceptible bulk (pooled DNA of 10 randomly selected susceptible F_2 plants) in cross IC-433678 × IC-89986 and Raidurg Local × Pusa Purple respectively. The markers OPO-20, OPC-4 and OPL-9 being coupled with the allele causing resistance may substantially increase the efficiency of marker assisted selection in brinjal breeding for shoot and fruit borer. The specific primers OPO-20, OPC-4 and OPL-9 will be useful in identifying homozygous resistant individuals in F_2 and subsequent segregating generations in crosses IC-433678 × IC-89986 and Raidurg Local × Pusa Purple, respectively and will form a strong base for designing ideal genotypes with higher levels of shoot and fruit borer resistance in brinjal.

Summary

6. SUMMARY

The experiment entitled "Inheritance of yield and resistance to shoot and fruit borer (*Leucinodes orbonalis* Guen.) in brinjal (*Solanum melongena* L.)" was conducted at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during the period 2012-2015. In the first experiment, sixty accessions of brinjal were collected from different parts of country and grown in the field in RBD with two replications in in two parallel experiments in two seasons. Highly significant differences among the genotypes were observed for all the characters under study in two seasons, indicating the presence of sufficient amount of variability to carry out further analyses.

In general, higher phenotypic co efficient of variability values than that of genotypic co-efficient of variability values indicates the influence of environment on traits. But, closer PCV and GCV values were observed for majority of the characters in the present study and possibly they were less influenced by environment indicating reliability of selection based on these traits. The higher PCV and GCV values in the kharif and rabi seasons were observed for the characters like plant height, number of primary branches plant^{-1}, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, intra cluster distance, fruit yield plant$^{-1,}$ SFB shoot damage, SFB fruit damage, RLPS, RLSA and weight of infested fruits indicating that a greater amount of genetic variability was present for these characters which provide greater scope for selection.

High heritability coupled with high genetic advance as per cent of mean was observed in kharif and rabi seasons for the characters like plant height, number of primary branches plant^{-1}, intra cluster distance, inter cluster distance, number of fruits plant^{-1}, length of fruit, girth of fruit, fruit weight, fruit yield plant^{-1}, SFB shoot damage, SFB fruit damage, calyx length, RLPS, RLSA, weight of infested fruits, total sugars and total phenols. It indicated that, these traits were under the strong influence of

additive gene action and hence simple selection based on phenotypic performance of these traits would be more effective.

Fruit yield per plant showed significant positive correlation with fruits per plant, fruit weight, girth of fruit, plant height, number of primary branches plant, percentage of medium styled flowers, length of fruits and percentage of long styled flowers respectively in both seasons. It exhibited significant negative correlation with weight of infested fruit, SFB fruit infestation, SFB shoot infestation, percentage of short styled flowers, calyx length, intra cluster distance and days to last harvest at phenotypic and genotypic level in both seasons. The positive associations between characters imply the possibility of correlated response to selection and it follows that with the increase in one, will entail an increase in another and the negative correlation preclude the simultaneous improvement of those traits along with each other.

SFB shoot infestation showed significant positive correlation with SFB fruit infestation and total sugars in both seasons. It also showed significant negative correlation with RLPS, RLSA, calyx length and total phenols in kharif and rabi seasons. SFB fruit infestation showed significant positive correlation with RLSA, RLPS, total sugars, calyx length, intra cluster distance and inter cluster distance whereas significant negative correlation with total phenols and weight of infested fruits in both kharif and rabi seasons.

Characters like number of fruits plant^{-1}, fruit weight, percentage of long styled flowers, percentage of medium styled flowers and plant height showed positive direct as well as significant positive correlation with fruit yield per plant in both seasons. Selection based on these characters would be highly effective.

Selection index was worked out and based on the discriminant function analysis and out of sixty genotypes studied, top five ranks were given to the genotypes namely SM 36 (IC-433678), SM 2 (IC-345271), SM 9 (Raidurga Local), SM 14

(Jagalur Local) and SM 21 (Tiptur Local) were shown high yield in both kharif and rabi seasons.

Out of the sixty genotypes screened against shoot and fruit borer in kharif and rabi seasons, none emerged as immune to the pest. The genotypes namely SM1 (IC-89986), SM 60 (Pusa Purple Cluster) have shown highly resistant, SM 59 (Vellayani Local) shown moderately resistant and remaining genotypes showed susceptibility to both shoot as well as fruit infestation by SFB in kharif and rabi seasons.

In the second experiment, line x tester analysis was carried out and developed fifteen hybrid combinations by utilising the five highly susceptible as well as three highly resistant lines to brinjal shoot and fruit borer. Materials for the study consists of eight parents, 15 hybrids and one standard check (Haritha) from KAU were evaluated for following traits *viz.,* plant height (cm), number of primary branches plant per plant, days to first flower, percentage of medium styled flowers, percentage of long styled flowers, percentage of short styled flowers, number of fruits per plant, colour of fruit, length of fruit (cm), girth of fruit (cm), fruit weight (cm), days to first harvest, days to last harvest and fruit yield plant (kg). The analysis of variance indicated significant differences among the genotypes for all the traits studied.

The data on heterosis calculated over mid parent, better parent and standard check Haritha revealed superiority of some outstanding cross combinations. For fruit yield per plant the overall mean of crosses was higher than the parental mean. The maximum standard heterosis for yield per plant was observed in the cross L5 X T3 Raidurg Local X Pusa Purple Cluster, followed by L_2XT_1 (IC-433678 X IC-89986), L_2XT_3 (IC-433678 X Pusa Purple Cluster), L_1XT_3 (IC-345271 X Pusa Purple Cluster) and L_4XT_3 (Tiptur Local X Pusa Purple Cluster). The hybrid L_5XT_3 (Raidurg Local X Pusa Purple Cluster) also exhibited high significant standard heterosis for long styled flowers, number of fruits per plant, fruit weight, days to first harvest and days to last harvest. The hybrid L_2XT_3 (IC-433678 X Pusa Purple Cluster) showed significant standard heterosis for days to first flower long styled flowers, number of fruits per plant and length of fruit.

The *gca* values revealed that two lines and one tester viz., L_2 (IC- 433678), L_5 (Raidurg Local) and T_3 (Pusa Purple Cluster) were identified as good general combiners for fruit yield per plant. These lines and testers were also best combiner for yield component characters like number of primary branches per plant, days to first flower, medium styled flower, long styled flowers, number of fruits per plant and length of fruit. The estimates of specific combining ability effects indicated that cross combinations *viz.,* IC-433678 X IC-89986, Tiptur Local X Vellayani Local, Jagaluru Local X Vellayani Local, IC-345271 X Pusa Purple Cluster and Raidurg Local X Pusa Purple Cluster were most promising for fruit yield per plant and its component attributes. The 15 hybrids were also screened for shoot and fruit borer resistance based on the percentage of infested shoots and fruits at 10 days interval from 30 to 100 DAT. The hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were found highly resistant to brinjal shoot and fruit borer.

In the third experiment, high yielding hybrids (IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster) along with shoot and fruit borer resistance were further advanced to F_2 generation in order to carry out the bulk segregant analysis. The genomic DNA of the parents and individual F_2 plants was isolated using CTAB method. Polymorphism survey of the resistant and susceptible parents was done by amplifying their DNA using 22 decamer random primers. Of these, eight primers produced amplification and only three of these produced polymorphism between the parents and bulks. The primers OPO-20, OPL-9 and OPC-4 produced polymorphic bands at 400, 500 and 550 base pair in resistant parent and resistant bulk indicating the co-segregation with the resistance gene in cross IC-433678 × IC-89986 and Raidurg Local × Pusa Purple, respectively. However, more closely linked marker(s) needed to be identified for undertaking Marker Assisted Selection (MAS) in developing shoot and fruit borer resistance in brinjal.

In the present study attempts were made to identify crosses which were resistant or tolerant to shoot and fruit borer incidence. Two Superior crosses (IC-433678 × IC-89986 and Raidurg Local × Pusa Purple) were identified which could be further carry forward to develop a resistant varieties of brinjal in future.

6.1 FUTURE LINE OF WORK

1. The stability of the superior hybrids need to be assessed and the superior hybrids could be released for cultivation.
2. Pedigree method of selection can be followed to select superior recombinants from the segregating generations which on attaining uniformity could be released as varieties for cultivation.
3. More closely linked marker(s) needed to be identified through Marker Assisted Selection (MAS) in developing shoot and fruit borer resistance in brinjal.
4. The three primers namely OPC-4, OPL-9 and OPO-20 can be used to develop a scar marker and which could be used further resistance breeding.

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INHERITANCE OF YIELD AND RESISTANCE TO SHOOT AND FRUIT BORER (*Leucinodes orbonalis* GUEN.) IN BRINJAL (*Solanum melongena* L.)

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ABSTRACT

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ABSTRACT

The present study entitled "Inheritance of yield and resistance to shoot and fruit borer (*Leucinodes orbonalis* Guen.) in brinjal (*Solanum melongena* L.)" was conducted at College of Agriculture, Vellayani during 2012-15 with the major objective to study the genetic basis of yield, yield attributes and developing high yielding shoot and fruit borer resistant varieties of brinjal. Molecular comparison of resistant and susceptible segregants will also be done

In the first experiment, 60 genotypes were evaluated using RBD with two replications. Evaluation was carried out in both *kharif* and *rabi* seasons for yield as well as for shoot and fruit borer resistance in two parallel experiments. Analysis of variance revealed significant difference among the accessions for all the characters under study. High PCV and GCV were recorded for plant height, number of primary branches plant^{-1}, intra cluster distance, number of fruits plant^{-1}, length of fruits, girth of fruits, fruit weight, fruit yield plant^{-1} and shoot and fruit infestation. High heritability coupled with high genetic advance as per cent mean was observed for plant height, number of primary branches plant^{-1}, intra cluster distance, inter cluster distance, number of fruits plant^{-1}, length of fruits, girth of fruits, fruit weight, fruit yield plant^{-1} and shoot and fruit infestation in both seasons.

Fruit yield plant^{-1} showed significant positive correlation with fruits plant^{-1}, fruit weight, fruit girth, plant height, number of primary branches plant^{-1}, fruit length and percent of long styled flowers in both the seasons at phenotypic and genotypic level. Path coefficient analysis revealed that fruits plant^{-1} showed high positive direct effect on yield followed by fruit weight, per cent long styled flowers, per cent medium styled flowers and days to first harvest in both the seasons. SM 36 followed by SM 2, SM 9, SM 14 and SM 21 was having the highest selection index values based on discriminant function analysis in both the seasons. Screening of 60 accessions based on the per cent of infested shoots and fruits were recorded at 10 days interval from 30

to 100 DAT. The minimum per cent of shoots and fruits infestations was recorded in SM1 followed by SM 60 and SM 59 in both *kharif* and *rabi* season.

The second experiment was laid out in RBD with three replications with five high yielding susceptible genotypes namely SM 36, SM 2, SM 9, SM 14 and SM 21 along with three resistant genotypes *viz.,* SM 1, SM 60 and SM 59. These were crossed to produce fifteen hybrids in a line x tester pattern with Haritha as check. Heterosis and combining ability were estimated for plant height, primary branches plant^{-1}, days to first flowering, per cent long styled flowers, per cent medium styled flowers, per cent short styled flowers, fruit length, fruit girth, fruit weight, fruits plant^{-1}, days to first harvest, days to last harvest and fruit yield plant^{-1}. Analysis of variance revealed significant differences among the genotypes for all the traits studied.

The maximum standard heterosis for yield per plant was observed in the cross Raidurg Local X Pusa Purple Cluster followed by IC-433678 X IC-89986, Jagaluru Local X Vellayani Local, IC-345271 X Pusa Purple Cluster and Tiptur Local X Pusa Purple Cluster. The hybrid IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster showed high significant standard heterosis for number of fruits plant^{-1}, long styled flowers, fruit weight, days to first harvest and days to last harvest.

The *gca* values revealed that two lines (IC- 433678 and Raidurg local) and one tester (Pusa Purple Cluster) as good general combiners for fruit yield plant^{-1}. These lines and testers were also best combiner for yield component characters like number primary branches plant^{-1}, days to first flowering, per cent medium styled flower, per cent long styled flowers, number of fruits plant^{-1} and length of fruit. The estimates of specific combining ability effects indicated that IC-433678 X IC-89986, Tiptur Local X Vellayani Local, Raidurg Local X Pusa Purple Cluster, Jagaluru Local X Vellayani Local and IC-345271 X Pusa Purple Cluster were most promising for fruit yield plant^{-1}. Out of fifteen hybrids screened for shoot and fruit borer resistance at 10days interval from 30 to 100 DA, the hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were found highly resistant.

In the third experiment, high yielding hybrids IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster with shoot and fruit borer resistance were further advanced to F_2 generation to carry out the bulk segregant analysis. The pools contrasting for shoot and fruit borer resistance were analyzed with 22 RAPD primers along with their respective parents and three primers namely OPC-4, OPL-9 and OPO-20 has shown polymorphic band between the bulks. In the present study two superior crosses IC-433678 X IC-89986 and Raidurg Local X Pusa Purple Cluster were identified which could be further carried forward carry forward to develop a resistant varieties to shoot and fruit borer. The three primers namely OPC-4, OPL-9 and OPO-20 can be used to develop a scar marker which could be used further resistance breeding.