EVALUATION OF ROUND FRUITED BRINJAL GENOTYPES FOR YIELD, QUALITY AND TOLERANCE TO FRUIT AND SHOOT BORER

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Thesis submitted in partial fulfillment of the requirement
for the degree of

Master of Science in Horticulture
(Olericulture)

Faculty of Agriculture
Kerala Agricultural University, Thrissur

2011

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DECLARATION

I hereby declare that this thesis entitled **"Evaluation of round fruited brinjal genotypes for yield, quality and tolerance to fruit and shoot borer"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award 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 **"Evaluation of round fruited brinjal genotypes for yield, quality and tolerance to fruit and shoot borer"** is a record of research work done independently by Ms. Kranthi Rekha Gogula (2009-12-119) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associate ship to her.

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I bow my head before God Almighty for all the bountiful blessings he has showered on me at each and every moment without which this study would never have seen light.

Let me place on record of my profound feeling of gratitude and sincere thanks my chair person of the advisory committee. ***Dr. V. A. Celine****, Professor, Department of olericulture for her note worthy guidance, creative suggestions and sustained interest. I am indebted to my major advisor for her constant encouragement, timely advice and friendly approach during the course of study as well as investigation and in the execution of this thesis. This work would not have been possible without her valuable help and support.*

I would express my sincere gratitude to ***Dr. M. Abdul Vahab****, Professor and Head, Department of Olericulture, for his continuous and timely advice, constructive criticisms and guidance at all the stage of research work.*

I am grateful to **Dr. I. Sreelathakumary**, *Professor, Department of Olericulture for her valuable suggestions and critical evaluation during the course of this work.*

I am thankful to **Dr. K. Sudharma,** *Professor of Agricultural Entomology, for her guidance and suggestions rendered to me in formulating the thesis.*

I am indebted to all the staff of the Department of Soil Science and Chemistry who permitted me to use lab facilities for my analysis work.

I wish to express my heartfelt thanks to ***Dean and former Dean*** *College of Agriculture, Vellayani for providing me all the necessary facilities from the university during the whole course of study.*

I accord my sincere thanks to ***Mr. C. E. Ajith Kumar****, Junior Programmer of Department of Agricultural Extension for helping me in getting the data analysed.*

I sincerely thank the facilities rendered by the library of College of Agriculture Vellayani.

I am thankful to non-teaching staff of the Department of Olericulture, farm manager Mohandas sir and skilled assistants Ajith, Ritheesh, Aneesh, Ajitatha chechi, and Jinu for their co-operation during the course of study.

My heartful thanks to my best friend Kasturi Ashwini who has always for me as a friend, loving support, confidance, moral support and so much more. Her care and constant encouragement has gone a long way in helping me to overcome the problems I had to face during the course of my work.

My batchmates Shameena, Kavitha, Anju, Deepa, Vipitha, Siji, Mariya, Agey, Adrika chechi, Athulya, Dhanya, Abhishikth, Lawrence, Darshan, and Siddesh have always provided me a good encouragement during difficulties. My dear friend Divya K. Lekshmanan was with me from beginning to end, lending me a helping hand whenever I most needed it and I take this opportunity to thank her for all the help she did for me.

I find special pleasure in expressing whole hearted thanks to seniors Amala akka, Arpitha akka, Reshmi chechi and Jincy chechi for their valuable advice and guidance during course of my work.

From the depth of my heart I wish to thank my hostel friends Sheethal chechi, Vineetha chechi and Priya Peter for their affection, care, love and unforgettable help.

I wish to express my gratefulness to my juniors Siva Kumar, Lekshmi for their timely help and support.

*I am most indebted to my loving **father** and **mother** for their affection, constant encouragement, moral support and blessings that have enable me to compute this work without which I would not have complete this research.*

Kranthi Rekha Gogula

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LIST OF ABREVIATIONS

%	-	per cent
µg	-	microgram
μm^2	-	micro square metre
CD	-	Critical difference
cm	-	centimeter
DAT	-	Days After Transplanting
et al	-	And others
Fig.	-	Figure
FSB	-	Fruit and Shoot Borer
g	-	gram
GA	-	Genetic Advance
GCV	-	Genotypic Coefficient of Variation
h	-	hour
H^2	-	Heritability
ha	-	hectare
I.U	-	International Unit
IPGRI	-	International Plant Genetic Resources Institute
KAU	-	Kerala Agricultural University
kg	-	Kilogram
m	-	metre
mg	-	milligram
min	-	minutes
ml	-	millilitre
mm	-	millimeter

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mg	-	milligram
min	-	minutes
ml	-	millilitre
mm	-	millimeter

nm	-	nanometer
°C	-	Degree Celcius
PCV	-	Phenotypic Coefficient of Variation
s	-	seconds
SE	-	Standard error
t	-	tons
UPGMA	-	Unweighted Pair Group Method with Arithmetic Mean
Var.	-	variety

Introduction

1. INTRODUCTION

Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine is one of the most important solanaceous vegetable native to India. The unripe fruit is used as vegetable. It is a moderate source of nutrients and rated as poor man's tomato. It contains vitamin A 124 IU, vitamin C 12 mg, calcium 18 mg, phosphorous 47 mg, iron 0.9mg, protein 1.3 mg, carbohydrates 6.4%, water 91.5% per 100g of fresh weight (Aykroyd, 1963). Apart from this, it has some medicinal properties also (Choudhury, 1996). White brinjal is said to be good for diabetic patients.

In India it is cultivated in an area of 5.66 lakh ha with a production of 95.95 lakh tons. But the average productivity of this crop is only 16.9 t/ha (NHB Database, 2008). This low productivity is attributed to non availability of high yielding varieties and incidence of various pests and diseases.

Fruit and shoot borer (*Leucinodes orbonalis* Guen.) is the most serious insect pest of brinjal throughout the country. It attacks the plant in any season and stage of growth, causing dead shoot in vegetative stage and fruit boring later rendering them unmarketable. This pest may cause fruit damage as high as 100 per cent (Panda, 1999). Insecticidal control not only is uneconomical but also invites environmental pollution. Consequently, host plant resistance would be useful either as a complete control measure or as a part of the integrated pest management programme with limited dependence on pesticides.

In Kerala, brinjal is cultivated widely though not on a commercial scale. High variability is noticed in fruit shape, size and colour. However, in southern Kerala, the preference is for round fruited brinjal ("kathiri type"). At present, high yielding round fruited varieties are not available in Kerala despite its high demand.

Collection, characterization and evaluation of the available variability is the basic step *a priori* to any breeding programme. For this, knowledge of the extent of genetic variability available in the population and transmission of these characters from one generation to the next is important. An estimate of inter relation between yield and other traits is of immense importance help to a breeder for selecting the best genotypes.

Investigations into the morphological, anatomical and biochemical basis of resistance/tolerance to fruit and shoot borer would help the breeder to locate resistant types based on these characters.

Under these circumstances, the present study was carried out with the following objectives:

- To assess the genetic variability present in round fruited brinjal genotypes.
- To find out the direct and indirect effects of each component on yield by path coefficient analysis
- To identify superior genotypes with high yield, quality and resistance to fruit and shoot borer
- To elucidate morphological, anatomical and biochemical basis of fruit and shoot borer resistance.

Review of literature

2. REVIEW OF LITERATURE

Brinjal (*Solanum melongena* L.) is an important solanaceous vegetable rich in proteins, minerals, vitamins and dietary fibre. Vavilov (1928) was of the opinion that the centre of origin of this crop was in the Indo-Burma region.

Three main botanical varieties have been reported under the species *melongena*. The round or egg shaped cultivars were grouped under var. *esculentum*, the long slender types were included under var. *serpentinum* and the dwarf brinjal plants were under var. *depressum* (Choudhury, 1996). A wild form with many small fruits sometimes called as var. *insanum* was found in the Bengal plains of India (Martin and Rhodes, 1979).

The available literature on brinjal related to the present study is reviewed under the following heads:

2. 1. Yield and yield components

2.2. Screening brinjal for fruit and shoot borer resistance

2.3. Screening for other pests and diseases

2. 1 Yield and yield components

2.1.1 Germplasm Evaluation

India being the centre of diversity for brinjal provides a large amount of variation for its genetic improvement (Ganabus, 1964). Wide range of variability can be observed in its fruit characters.

Magtang (1936) classified the flowers of eggplant with regard to the position of the stigma in relation to anther tips into long and short styled flowers. Krishnamoorthy and Subramonian (1953) classified the flower types in brinjal into four groups *viz.*, short styled, pseudo short styled, medium styled and long styled.

They showed that under natural conditions, 27 per cent of flowers set fruits and 93 per cent of these came from long styled flowers.

Quagliotti (1967) studied flower production in four eggplant varieties and found that it was maximum at a plant age of 201 to 208 days.

Anserwadekar *et al.* (1979) compared growth and yield of five cultivated varieties of eggplant and found significant difference in plant height between varieties. Cultivated variety "Gondegaon" produced maximum leaves. Mediterranean varieties were more vigorous with more leaves and high total leaf area compared to the varieties from far east.

Nothmann and Rylski (1983) reported that basal fruits were the heaviest and its presence affected the development of other fruits produced further. According to Patil and More (1983), fruit size was linked with fruit shape.

Awasti and Dixit (1986) evaluated 11 round fruited and three long fruited varieties of which marketable yield was highest in NDB 2. In another evaluation, Hussain *et. al.* (1992) reported that the variety Neelum was the highest yielder producing 12.59 t per ha.

Singh *et al.* (1999) evaluated 325 brinjal accessions and divided into groups based on fruit shape: long (105 accessions), round (103 accessions), oblong (97 accessions) and oval (20 accessions). Further grouping was made on the basis of fruit colour: green (54 accessions), white (6 accessions), variegated (20 accessions) and purple (245 accessions).

Thapu *et al.* (2005) studied the performance of 10 aubergine cultivars (Nagarukra local, Sheoraphuli local, Lamba Marka, Soli Marka, Round Marka, Kamdebpur local, Bhangan local, Mirjapur local, Gadamara local and Contai local).

Nagarukra local, Mirjapur local and Kamdebpur local were superior for yield potential, and resistance to pests and diseases

Ramesh Babu and Patil (2008) studied twelve quantitative characters of 90 brinjal genotypes. Among these genotypes top ranking five genotypes for yield in descending order are DBC-75-KA (3280.00g), DBC-38-HA (3615.00g), DBC-13-BA (3032.00g) and DBC -14-KA (3020.00g). The earliest genotypes were DBC-1-TR and DBC-9-KA which came to 50 per cent flowering in 36 days.

Seven open pollinated genotypes of long brinjal were evaluated in three environments under rainy season and irrigated situations for Chhattisgarh plains. Highly significant values were observed for genotypes, genotype x environment interaction and environment (linear). IBWl-2007-1 was the most stable genotype under irrigated condition of Chhattisgarh plains for *kharif* planting situations as it had high mean, regression coefficient not deviated from unity and non significant deviation from regression whereas, a local genotype was suitable for fruit yield under low yielding environment (Mehta *et al.*, 2011).

2.1.2 Genetic parameters:

2.1.2.1 Genetic variability

The efficiency of selection in crop improvement programmes largely depends on the extent of genetic variability present in the population. The variation present in the plant population is of three types *viz.*, phenotypic, genotypic and environmental. Of these the genetic variance can be further partitioned to additive, dominance and epistatic variance components.

Variance component analysis is used to assess the variability present in populations. The phenotypic, genotypic and environmental coefficient of variation

(PCV, GCV and ECV respectively) gives an idea about the magnitude of variability present in the population.

Thirty strains of brinjal were evaluated for 14 characters and genetic variability was observed for total fruit yield and other characters. 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).

In a study by Sinha (1983), fruits per plant and ratio of fruit length to circumference recorded high GCV. Genetic variability and correlation studies by Chadha and Paul (1984) revealed high genetic coefficient of variation for fruits per plant. Genetic variability studies in 27 brinjal varieties revealed that yield had the highest PCV (98.95%) while GCV was highest for single fruit weight (98.2%) (Gopimony *et al.*, 1984).

A wide range of phenotypic variation was observed for days to first flowering, plant height, fruits per plant and fruit yield per plant. The genetic coefficient of variation was high for yield per plant, fruit length, girth and weight of fruits (Vadivel and Bapu, 1989). Vadivel and Bapu (1990a) evaluated 19 brinjal accessions and reported that the genotypic variances were high for fruit length, fruit girth, fruit weight and fruit yield per plant suggesting improvement through pureline selection.

Varma (1995) observed 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 related *Solanum* spp., *viz., S. gilo, S. anomalum, S. incanum and S. indicum* by Behera *et al.* (1999) for yield characters and observed high genotypic and phenotypic coefficients of variation for length and diameter of fruits and yield per plant.

Forty one genotypes of brinjal were evaluated by Patel *et al.* (1999) and observed highest GCV for fruit volume followed by seed to pulp ratio. Rai *et al.* (1999) analyzed variability in long shaped brinjal hybrids and found high coefficient of variation for average fruit weight, total fruits, equatorial fruit length and yield. In an experiment Rajyalakshmi *et al.* (1999) reported lowest genotypic and phenotypic variance for fruit diameter where as highest PCV and GCV were observed for fruits per plant and yield per plant suggesting better scope of selection for these characters.

Seventy eight accessions were studied by Singh and Gopalakrishnan (1999) and reported that PCV was maximum (60.90%) for fruits per plant followed by yield per plant (57.12%). Genotypic variance was also maximum for the above characters (54.8% and 52.67% respectively). For all the characters other than yield per plant, the coefficients of variation were below 50%. 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.

Kalloo *et al.* (2002) reported that additive component was predominant for branches per plant, fruit length and diameter and fruits per plant. The additive and additive x additive components were predominant for fruit size, whereas the dominance and additive x additive components were predominant for plant height, fruit size and yield per plant.

Patel *et al.* (2004) reported existence of considerable amount of genetic variability for all the characters studied except plant spread, plant height and days to 50 per cent flowering. Fruit length, yield per plant and fruit weight exhibited highest values of genotypic and phenotypic coefficients of variation. High estimates of heritability, genotypic coefficients of variation and genetic advance were also observed for fruit length, yield per plant and fruit weight.

Rai *et al.* (2005) observed that non additive gene effect was prominent in expression of fruit and shoot borer resistance. Prohens *et al.* (2005) reported that the round fruited cultivars were more genetically diverse than long fruited ones.

Suneetha *et al.* (2008) studied hybrid vigour and combining ability of 45 brinjal hybrids for yield, yield components and quality characters during late summer season and observed preponderance of non addtitive gene action for all the traits studied. Lohakare *et al.* (2008b) reported high genotypic and phenotypic coefficients of variation for fruits per cluster.

2.1.2.2 Heritability (H^2) and Genetic advance (GA)

Heritability and genetic advance are important selection parameters. The ratio of genetic variance to phenotypic variance is known as heritability. Heritability (%) was categorized into low (0-30%), moderate (30-60%) and high (above 60%) as suggested by Robinson *et al.* (1949). Higher H^2 indicates the least environmental influence on the characters. The difference between the mean phenotypic value of the progeny of selected plants and the base or parental population is called as the genetic advance. The genetic advance was categorized into low (<20%) and high (>20%) as suggested by Robinson *et al.* (1949). High GA indicates that additive genes govern the character and low GA shows that non-additive gene action is involved. Heritability along with GA helps us in predicting the gene action and the method of breeding to be practiced.

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, longitudinal and equatorial fruit lengths, leaf lengths, leaf breadth 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 which suggested that these traits are under the control of additive gene action and would be improved through simple selection (Patel *et al.*, 1999). Rai *et al.* (1999) obtained high value of heritability coupled with GA for fruit weight, yield, equatorial fruit length and total number of fruits, which indicates preponderance of additive genes.

High heritability values were observed for fruit weight, fruit diameter, plant height and fruits per plant. High heritability coupled with high genetic advance for fruits per plant and fruit weight indicating additive gene effect (Rajyalakshmi *et al.*, 1999).

Singh and Gopalakrishnan (1999) evaluated 78 brinjal accessions. They observed high heritability for fruit weight and days to last harvest. Yield per plant both in number and weight of fruits had high values of H^2 and GA indicating scope for improvement through selection. For days to flower and fruit set, the GA was very low and may be due to the involvement of non-additive gene action. Heritability estimates were high for length of fruit, fruits per plant, mean fruit weight and yield per plant (Sharma and Swaroop, 2000).

Singh and Kumar (2005) observed highly significant differences among the 25 diverse brinjal genotypes for different characters. The heritability estimates were high (above 87%) for all the characters. The maximum heritability was observed for average fruit weight closely followed by fruit index and yield per plant. The genetic advance as percentage of mean was high for average fruit weight, fruits per plant and yield per plant. High heritability coupled with high genetic advance was observed for fruits per plant, average fruit weight and yield per plant.

Lohakare *et al.* (2008a) observed highly significant differences among the 23 diverse brinjal genotypes for different characters. Almost all the characters exhibited high heritability except the trait yield per hectare which recorded moderate heritability (46.15% to 98.87%). Highest genetic advance was also observed for the character fruits per cluster.

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. 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*.

2.1.3 Correlation studies and Path coefficient analysis

Yield is a complex character determined by several component characters (Singh, 2005). Improvement in yield is possible only through selection for the desired component characters. Hence knowledge of association between yield and its component characters and between component characters is essential for yield improvement through selection programme.

Certain characters might indirectly influence yield, but their correlation with yield may not be statistically significant. In such cases, path coefficient analysis is an efficient technique, which permits the separation of coefficients into components of direct and indirect effects.

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, girth of main stem, fruit weight, primary branches, flowers and fruits per plant. Positive correlation was observed between fruit length, fruit girth and fruit weight, while fruits per plant was negatively correlated with fruit girth and weight (Mishra and Mishra, 1990).

Vadivel and Bapu (1990b) reported that fruit yield showed higher co-heritability with fruits per plant and branches. Results on path analysis for yield components suggested the importance in order of fruits per plant, branches per plant, plant height and fruit weight on fruit yield.

Nainar *et al.* (1990) reported that in path coefficient analysis, fruit per plant, fruit weight and fruit length showed positive association with yield. 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 as well as high genetic advance (Gautham and Srinivas, 1992). They observed that plant spread and fruits per plant had significant positive correlation with yield. Ushakumari and Subramanian (1993) analysed 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.

Seventeen brinjal genotypes were evaluated by Ponnuswami and Irulappan (1994) and found that yield per plant had significant and positive correlation with plant height, branches per plant, fruit weight, fruit length and fruits per plant. The intercorrelation among fruits per plant, fruit length and branches per plant were all positive and significant and revealed that fruit weight and plant height are the important yield components.

Narendrakumar (1995) evaluated 21 genotypes for correlation analysis. Yield per plant showed 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. Thus the characters, fruit length, primary branches per plant, fruits per plant and early yield could form a sound basis for selection.

Yield showed significant positive correlation with total fruits per plant and average fruit weight, while it showed significant negative correlation with days to first flowering (Varma, 1995).

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 (Vadivel and Bapu, 1998).

Sharma and Swaroop (2000) evaluated 27 brinjal accessions and found 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 and hence direct selection could be made for these characters for improving yield, 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 and hence simultaneous selection for these characters can be made for the improvement of yield.

Kushwah and Bandhyopandhya (2005) reported that genotypic and phenotypic correlation coefficients were estimated to measure the degree of association between yield and its contributing characters. Fruits per plant (0.46), fruit diameter (0.38) and number of pickings (0.38) had significant positive correlation with yield per plant at genotypic level. At phenotypic level, the positive significant correlation was recorded for number of pickings (0.34), fruit diameter (0.36) and fruits per plant (0.45) with fruit yield. A negative significant association of fruit yield per plant (-0.38) was observed with days to first picking at genotypic level.

Senapathi (2006) reported 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. Mesocarp thickness also showed positive association with infested shoot percentage, fruit diameter and ratio of length of peripheral seedless area while it was negatively associated with fruit number, fruit length and ratio of length of peripheral seed ring area. Path analysis indicated that mesocarp thickness had the maximum influence on fruit yield followed by fruit diameter, fruit number and ratio of length of peripheral seed ring.

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, leaves per 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, days to 50 per cent flowering, leaves per plant and per cent fruit set.

Lohakare *et al.* (2008a) studied correlation and path analysis using 23 genotypes of green fruited brinjal indicated that yield per plant was closely associated with fruits per cluster, fruit index, 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, fruit index, days to first harvest, primary branches and plant spread.

Jadhao *et al.* (2009) reported that the phenotypic coefficient of variation was greater than the respective genotypic coefficient variation for all the characters studied. 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. 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.

2.1.4 Genetic divergence

Gunjeet Kumar *et al.* (2008) assessed morphological diversity in a set of 622 accessions, comprising 543 accessions from indigenous sources and 79 accessions of exotic origin. Wide range of variations for 31 characters, 13 quantitative and 18 qualitative, were recorded. Wide regional variations for plant, flower and fruit descriptors revealed enough scope for improvement of yield characters by selection.

Genetic divergence among 19 eggplant genotypes was estimated using Mahalanobis's D^2 statistic by Quamruzzaman *et al.* (2009). Altogether five clusters were formed. Cluster I contained the highest number of genotypes (7) and cluster IV and V contained the lowest (2). The highest intra-cluster distance was observed for cluster V (1.067) and the lowest for cluster III (0.916). The highest inter-cluster distance was observed between cluster IV and V (10.748). Cluster V recorded the highest mean for plant height at last harvest (cm), leaf blade length (cm), leaf blade diameter (cm), leaf pedicel length (cm), fruit pedicel length (cm), prickle on calyx. Whereas, branches per plant, fruit diameter (cm), individual fruit weight (g), fruit yield (t/ha) and prickle on fruit pedicel were in cluster II with the highest means. Therefore, more emphasis should be given on cluster V for selecting genotypes as parents for crossing with the genotypes of cluster II which may produce new recombinants with desired traits.

Polignano *et al.* (2010) studied genetic divergence in 98 accessions of *Solanum melongena* L. and its allied species *S. aethiopicum* L. and *S. macrocarpon* L. for 16 morpho-agronomic and fruit traits revealed the existence of considerable diversity. Plant height, flowering time, flowers per inflorescence, fruit length and fruit acidity contributed mostly towards total divergence. Cluster analysis conducted separately for each species, in relation to the genetic status of accession (sub-species, botanical or variety group, cultivar and population), grouped the accessions into three distinct and significant clusters. No relationship was found between genetic divergence and genetic status of sample.

Muniappan *et al.* (2010) studied the genetic divergence to assess the variability, association, direct and indirect effects of eight morphological characters in thirty four eggplant (*Solanum melongena* L.) genotypes. High PCV and GCV were recorded by the characters *viz.*, branches per plant, fruit length, fruit breadth, fruits per plant, average fruit weight and fruit yield per plant. All the characters were accompanied by high heritability and high genetic advance excepting days to 50 per cent flowering. Branches per plant, fruit breadth, fruits per plant and average fruit weight was exhibited positive and significant association with fruit yield per plant. Path analyses indicated that fruits per plant and average fruit weight had high direct effects and were the major factors that determine fruit yield per plant.

Genetic divergence among 11 eggplant genotypes was estimated using Mahalanobis D^2 statistic. The 11 genotypes were grouped into four distinct clusters. Cluster I comprises 4 genotypes, cluster II had 3, cluster III and IV had 2 genotypes respectively. The highest and the lowest intra cluster distance were observed in cluster II (1.216) and cluster IV (0.047) respectively. The highest inter cluster distance was between clusters I and III (8.757) while it was the lowest between clusters I and II (2.203). Fruit weight, fruit length, flower petiole length, fruit breadth, plant height and yield per plant had the highest contribution towards total divergence. Cluster III recorded the highest means for flowers per inflorescence, north-south plant canopy, leaf petiole length, leaf length, secondary branches per plant and fruits per plant. Whereas, nodes to first flowering, east-west plant canopy, flower pedicel length, leaf petiole diameter, fruit length, plant height and yield per plant were in cluster IV with the highest means. Cluster I had the highest mean values for flower pedicel diameter, leaf blade width, primary branches per plant, fruit weight and fruit breadth (Islam *et al.*, 2011).

Nalini *et al.* (2011) studied heterosis and diversity on 28 F1 hybrids of brinjal derived from germplasm lines *viz.*, IC-112995, IC-111305, IC-90952, IC-99704, IC-99663, IC-136210, IC-126784 and a local cultivar Manjari Gota at botany garden, UAS, Dharwad during summer 2006. Fruit weight (g), fruits per plant and fruit yield (g) exhibited considerably high magnitude of heterosis. High heterosis for fruit yield was attributed to increased fruit weight and fruits per plant. Thirty six entries comprising 28 F1 hybrids and 8 parents were grouped in six clusters. Based on parental divergence, all 28 hybrids were grouped in 4 divergence classes. The combination of heterosis and diversity analysis indicated the high frequency of hybrids classified under DC2 and DC3 suggesting moderate genetic diversity is most desirable to produce highly heterotic hybrids.

2.1.5 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.

2.2. Brinjal fruit and shoot borer resistance evaluation

2.2.1 About fruit and shoot borer, *Leucinodes orbonalis* (Lepidoptera)

Leucinodes orbonalis is the most noxious and ubiquitous pest of brinjal (Naik *et al.*, 2008). The damage symptoms include withered shoots, fruits with bore holes plugged with excreta (Nair, 1999), shedding of flower buds and drying of leaves due to boring of petioles by larvae (Regupathy *et al.*, 1997). It is a regular and most serious pest and single caterpillar may infest 4-6 fruits (Atwal and Dhaliwal, 1999). In severe infestation rotting of fruits may result (Saha, 1995). It is a serious pest of brinjal all over the country causing yield loss up to 100% if no control measures are applied (Rahman, 2007).

Hampson (1896) first reported the occurrence of this pest on egg plant 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). 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).

Brinjal fruit and shoot borer also seen feeding on potato and tomato (Hargreaves, 1937), green pea pods (Atwal and Dhaliwal, 1999) and mango shoots (Hutson, 1930).

This pest infests about 73.33% of top shoots during the end of August, which peaked in the 3rd week of September (86.66%). On initiation of flowering, the pest infestation continuously declined on shoots and reached zero level in the end of

October, but at this critical stage the borer infestation shifted over to flowers and fruits which was 33.33% in the beginning of October and reached at 66.66% within a week and gradually decreased with the advent of winter season. There was a positive role of temperature on the multiplication of pest and the relative humidity responded negatively. The economic injury level of shoots and fruit borer was determined 0.67% on fruits and 0.91% on its shoots (Singh *et al.*, 2000). In July planted brinjal crop the peak infestation levels (59.2 - 75.5%) were mostly recorded at 64-88.3 days after transplanting and seen peaks occurred in the months of September and October (Patnaik, 2000).

Varma *et al.* (2009) reported that this pest incidence showed positive correlation with maximum relative humidity, rainfall and wind speed during first year and with maximum relative humidity and sunshine hours in second year.

2.2.2 Field screening for resistance

Panda *et al.* (1971) evaluated 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.

In another field evaluation of 69 cultivars and six *Solanum* spp. conducted by Lal *et al.* (1976) showed resistance in *S. sisymbrfolium, S. integrifolium, S. integrifolium, S. xanthocarpum, S. incanum, S. khasianum* and in cultivated types like SM – 202, SM – 145, S – 497, S – 519, S – 520, S – 521 and S – 11.

Dhankar *et al.* (1977) screened 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 observed that this pest cause about 63% yield loss.

The yield loss varies with location and season and is greatest when temperature and humidity is high. The role of temperature, relative humidity on life studies is important to assess pest status and its natural enemies and also to develop ecofriendly pest management approach against *L. orbonalis* (Georghia and Taylor, 1978). In a study conducted by Gill and Chadha (1979), the varieties H-4, Punjab Chamkila, PPC, PPL, S-4 ans S-6 are found to be shoot and fruit borer.

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).

Of 13 aubergine cultivars studied by Baksha and Ali (1982), none was resistant to *L. orbonalis*. Moderate tolerance to shoot infestation was noted in Baromashi, Jhumki, Indian and Bogra special and to fruit infestation was noted in Noyankajal, Singnata, Japani, Jhumki, Indian and Baromashi. Tolerance to both shoot and fruit infestation was highest in Jhumki, Indian and Baromashi.

Nair (1983) evaluated 40 accessions and found 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 from the highly susceptible group. Ringan Giant, PPC and SM-62 were found to be tolerant to shoot and fruit borer (Nathani, 1983).

Kabir *et al.* (1984) evaluated 12 brinjal varieties of which the variety Singnath had the lowest infestation whereas, Duodo (1986) reported that fruits of Black Beauty and Florida Market were significantly least infested. The brinjal variety, Manjarigota was found to be fruit and shoot borer resistant (Khaire and Lawande, 1986).

Pawar *et al.* (1987) screened 32 varieties and 22 local accessions of brinjal against jassids and the 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 accessions, Malkapuri, Shirur, Khandala, Khamapur were resistant to fruit borer.

Studies on 150 aubergine 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. Yield performance of the cultivars differed between insecticide treated and untreated plots.

Dharekar *et al.* (1991) screened nine varieties of aubergine against shoot and fruit borer and identified PBR-129-5, Arka Kususmakar and Wild Brinjal as resistant varieties.

Tejarathu *et al.* (1991) found that *S. gilo* was resistant to fruit borer and crossable with *S. melongena*. 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) evaluated 13 varieties and none of them was found tolerance to fruit borer and all were severly infested. The lowest attack of 19.20% was observed in 88066-2, while the highest value of 38.54% in White Egg Round.

Studies conducted on 18 brinjal cultivars by Srinivas and Peter (1995) showed that Arka Kusumakar, Arka Shirish and Neelam were significantly less infested by *L. orbonaslis* than Early Long Fellow and Nagpur Round.

Brinjal varieties *viz.*, Annamalai, Pant Samrat, Bhagyamati, Aushay, PPC, AM 62, *Solanum gilo* and *S. anomalum* were tolerant shoot and furit borer (Ram, 1997). According to Sharma *et al.* (1998) out of eight culitvars of brinjal evaluated for their response to shoot and fruit borer, none of the cultivars were absolutely tolerant.

Eight eggplant genotypes and four related *Solanum* spp, *viz., S. gilo, S. anomalum, S. incanum and S. indicum* were evaluated for characters related to yield and fruit borer infestation. High genotypic and phenotypic coefficients of variation were observed for percentage of infested yield and percentage of infested fruits per plant (Behera *et al.,* 1999)

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%). Sheena (2000) reported resistance in few land races from Kerala.

Daliya (2001) found that CO-2, Pusa Kranthi, Arka Kusumakar and Manjari Gota were high yielders and fruit and shoot borer resistant. Begum *et al.* (2003) observed that Jumki-1 and Jumki-2 were highly resistant to fruit and shoot borer.

Elanchezyan *et al.* (2008b) 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%).

Prabhu *et al.* (2009) reported fruit borer infestation showed high genotypic coefficient of variation and phenotypic coefficient of variation.

2.2.3 Basis of fruit and shoot borer resistance

2.2.3.1 Morphological and Anatomical basis of resistance

Srinivas and Basheer (1961) found that the varieties Coimbatore, H – 128 (Cluster White), H – 129 (IC – 1855) and H – 158 (Gudiatham) were tolerant to shoot and fruit borer and the tolerance is due to toughness of skin and pulp of the fruit.

Panda *et al.* (1971) observed that larval entry is affected by thick cuticle, small pithy stem and pointed unicellular trichomes.

The lower susceptibility shown by the varieties shown by the varieties Ex. Beckwai and Musk Brinjal (IHR 191) may be due to hardiness of fruit skin and flesh, a character which is very distinctly seen in these varieties (Krishnaiah and Vijay, 1975). 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 and closely packed vascular bundles in pulp may probably be the causes of resistance, as explained in some resistant varieties.

Dhankar, 1988 observed two long fruited varieties namely S – 5 and PPL despite thick fruit skin, hard pulp and tightly arranged seeds showed high susceptibility. Similarly, susceptibility increased as the days to first bloom were more.

Singh and Chadha (1991) reported that the resistance in SM -17- 4, PBR-129-5 and Punjab Barsati against *L. orbonalis* could be attributed to a large number of small sized fruits per plant along with late and longer fruiting period.

Shoot thickness, leaf area and pre flowering period have some correlation with the shoot infestation (Grewal and Singh, 1992). Patil and Ajri (1993) reported a negative correlation of seeds per fruit, yield per plant and fruit skin thickness with fruit infestation. Long fruited varieties were less infested than those with spherical fruits (Pradhan, 1994).

Khurana *et al.* (1988) evaluated and found that the percentage of infestation of fruits with *Leucinodes orbonalis* was negatively correlated with fruits and positively correlated with mean weight, fruit diameter, total leaves, branches per plant and plant height.

Path analysis conducted by Kumar and Ram (1998) revealed that diameter, weight and volume of the fruit could be used as the indirect negative selection criteria for improving resistance to shoot and fruit borer. Sheena (2000) noticed shoot and fruit borer resistance in land races S_1, S_{13}, S_{28}, S_{35}, S_{36} and S_{37}. A negative correlation was noticed between fruit borer incidence and fruits per plant.

Hossain *et al.* (2002) reported varieties per lines having thick cuticle, broad and thick collenchymatous area (hypodermis), compact parenchyma cells in the cortical tissue, small area in the cortical tissue, more vascular bundles with narrower spaces in the interfascicular region, and compact arrangement of vascular tissue with lignified cells and small pith were the main characters of resistant per tolerant varieties. On the other hand, thinner cuticle and collenchymatous area (hypodermis), loose parenchyma cells in the cortical region, larger spaces between vascular bundles i.e. interfascicular region and large pith, less number of trichomes, soft parenchymatous cells in the interfascicular region, might be responsible for the susceptibility to brinjal shoot and fruit borer.

Srinivasan *et al.* (2005) observed that resistant accessions EG 058 and Turbo had significantly less trichomes than the susceptible accession, EG 075 while the other two resistant accessions had significantly more trichomes than the susceptible accession, EG 075. Hence, the role of trichomes imparting resistance to fruit and shoot borer is considered to be negligible or nil.

Gupta and Kauntey (2008) observed 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%).

2.2.3.2 Biochemical basis of resistance

Panda and Das (1975) found that higher silica and crude fibre in the shoots of resistant cultivars adversely affected the survival, growth, pupal period, sex ratio and fecundity of eggplant fruit and shoot borer.

Bajaj *et al.* (1989) revealed that low incidence of fruit borer infestation is associated with higher levels of glycoalkaloids, peroxidase and polyphenol in fruits.

Hazra *et al.* (2004) reported 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 (2004) reported that amino acids, crude protein, ash and sugar content (total and reducing sugars) showed a highly positive and silica contents, poly phenol oxidase, phenylalanine ammonialyase, peroxidase, glycoalkaloids and lignin content showed a highly negative correlation with shoot and fruit borer infestation.

Martin (2004) noticed higher phenyl alanine ammonia lyase (PAL) activity in the wild relatives of brinjal, which showed higher resistance against fruit and shoot borer in India and also observed that highest lignin content coupled with lowest shoot and fruit borer infestation in *S. sisymbrifolium*

Elanchezhyan *et al.* (2009) observed hybrid Swetha as highly resistant to borer. Swetha recorded the ash content (12.3%) and total phenols (7.6 mg/g) and lowest moisture content (78.4%), total chlorophyll (1.2 mg/g) and total sugars (5.8 mg/g) while Bejo Sheetal, recorded the lowest ash content (10.1%) and total phenols (1.9 mg per g) and highest moisture (89.2%), total chlorophyll (1.9 mg per g) and total sugars (18.0%). There was significant positive relationship between total sugars, total chlorophyll and moisture content with shoot damage and negative relationship between total phenols and ash contents with shoot damage.

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 in genotypes derived from interspecific crosses and their parents. A higher level of polyphenol oxidase activity was observed in interspecific cross F_6 EP65 x *S. viarum.* There was a clear correlation exists between the levels of biochemical constituents of superior genotypes and resistance to fruit and shoot borer.

Khorsheduzzaman *et al.* (2010) reported that lignin content of all the genotypes was higher in fruits compared to shoots. The genotype containing the highest quantities of lignin showed the lowest shoot and fruit infestation by the borer. Lignin is a phenolic compound, which increases unpalatability of the food materials. This may be the possible reason for receiving lowest infestation in that genotype.

2.3 Screening for other pests and diseases

2.3.1 Bacterial wilt

Bacterial wilt caused by *Ralstonia solanacearum* was first reported from Italy in 1882. Smith (1896) reported first time bacterial wilt in solanaceous crops. Warm humid tropical climate and soil condition in Kerala are conducive for the incidence and severity of bacterial wilt. Symptoms are wilting, stunting, yellowing and finally collapse of entire plant.

Vijayagopal and Sethumadhavan (1973) reported that wilt resistant character of *S. melongena* var. *insanum* was closely associated with the small fruit size. Gowda *et al.* (1974) reported that a local cultivar 'Gulla' and *S. torvum* were resistant to bacterial wilt.

Gopimony and George (1979) reported that percentage of wilt in improved varieties like 'Arka Kusumakar' and 'Banaras Giant' was as high as 100 per cent, where as in local varieties this varied from six to 20 per cent. The prickly line 'SM 6-1' with long purple fruits obtained as a result of pure line and single plant selection was found immune to wilt (Sheela *et al.*, 1984).

Jessykutty and Peter (1986) evaluated four resistant eggplant lines for yield and percentage of wilted plants. They found that yield was highest in 'SM 56'

(1193.07 g) and lowest in 'SM 74' (590.18 g), but percentage of wilted plants was lowest in SM 74 (20 per cent).

Single Seed Descent (SSD) selection was reported as the most effective one in raising the level of resistance to bacterial wilt in eggplant (Sankar *et al.,* 1987). Sadashiva *et al.* (1993) observed those varieties 'IHR 180'and 'IHR 181' survived even after 125 days of planting without any incidence of bacterial wilt.

'Rampur Local', a resistant variety yielded 1.65 kg per plant followed by 'West Coast Green Round' (1.37 kg per plant) in an evaluation trial (Sadashiva *et al.*, 1994).

Pathania *et al.* (1996) reported that 'Arka Neelakanth' and 'Arka keshav' were 100 per cent resistant where as varieties like 'Pant Rituraj', 'Pant Samrat', 'Pusa Purple Long' were 100 per cent susceptible. Screening of 95 accessions of brinjal resulted in eight wilt resistant accessions *viz.,* 'Arka Nidhi', 'Arka Keshav', 'Arka Neelaknth', 'BB- 1', 'BB-49', 'EP-143' and 'Surya' (Ponnuswamy, 1997).

Saraswathi and Shivashankar (1998) studied six brinjal cultivars and their six F_2 hybrids were evaluated for resistance to bacterial wilt. WCGR and SM 6 were the most resistant parents, with 100% survival at 90 days after transplanting. Among the F_2 hybrids, WCGR x Taiwan Naga, WCGR x Ceylon and SM 6 x Taiwan Naga showed 75-80% survival.

Alam *et al.* (2000) conducted an experiment to identify resistant germplasms of brinjal against bacterial wilt. Two cultivars, namely Oli-Begoon and Shingnath showed moderate resistance while Uttara showed moderate susceptibility. These three germplasms gave higher yields.

Swaroop *et al.* (2000) conducted an experiment to evaluate aubergine cultivars resistant to bacterial wilt which are suitable for Andaman and Nicobar

Islands, India. The cultivars were evaluated for bacterial wilt or survival percentage at monthly intervals up to 150 days of transplanting. The highest survival percentage was recorded in cv. Arka Keshav (91.60%) followed by BB-60-C (90.0%), 95-4 Round (88.46%), and CHES-309 (87.50%).

Manna *et al.* (2003) reported eleven genotypes showed resistance to the disease *viz.*, Makra Round, Singhnath, Makra, Kata Makra, Pusa Anupam, Bhayagmati, NDBS-26, BB-40, Sada Lomba, Malwanki Local and CO2.

Sharma *et al.* (2005) conducted an experiment to screen the parental lines (CHBR 3, Swarna Mani, CH 243, CH 309, CH 792, CH 249 and CH 381) and their F1 crosses of aubergine for resistance to wilt. CH 249 and CH 309 were resistant to the pathogen. Among the progenies, CH 249 x CH 792 was resistant while CH 309 x CH 249, CH 309 x CH 381 and CH 381 x Swarna Mani were moderately resistant.

Sharma and Kumar (2007) reported that 'CH 249' ('Swarna Shyamli'), 'CH 309' ('Swarna Pratibha'), 'BB 64', 'JC 8', 'Arka Keshav' and 'Arka Nidhi' showed stability in resistance to bacterial wilt. Hossain *et al.* (2007) reported that brinjal cultivars Jessore, Katabagun, Patabagun, Baromashi and Laboni were moderately resistant.

2.3.2 Leaf hopper

Ninety six eggplant genotypes were screened for field resistance to the cotton leafhopper at vegetative and reproductive stages and resistance to the eggplant fruit borer at harvesting time. The leafhopper population started to build up at 45 DAT, reached its peak at 60 DAT and gradually declined as the plants matured. Accession 495 had the highest leafhopper count, followed by 513, 618, 197, 91-049c and hybrid Long Purple King. The least preferred were *Solanum aethiopicum*, NPGRL accessions 672, 503, 413, 565 and IPB-Vegetable advanced lines 89-002, 610, and 611. Among the farmers' hybrids Ops, Long Violet and Purple Heart had

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the lowest leafhopper counts. Forty percent of the entries, mostly wild relatives of eggplant, were resistant to the leafhopper. The most susceptible entries were 392, Kurumi Onaga, 2550xDLP and 611. Accession 671 was the tallest and 90-049c the shortest. Casino had the largest leaf and Acc. 685, the smallest. Fond Long had the highest infestation of shoot borer. Accessions 537, 554 and 663 were highly susceptible to the fruit borer (Cassi- Lit *et al.*, 2000).

Sonali Deole (2008) reported that cultivars with smooth textured leaves were more preferred by the jassid compared to the cultivars with leaves having leathery texture or leathery texture with spines.

2.3.3 Ash weevils

Brinjal grey or ash weevil, *Myllocerus subfasciatus* (Coleoptera: Curculionidae) is a widely distributed insect. Recently in South India, it has assumed the status of a major pest often resulting in 100 per cent crop loss (Mohandas *et al.,* 2004). The adults are leaf feeders and can cause significant local damage. Larvae feed on roots which results in widespread wilting and can lead to premature death of mature plants. Female *M. subfasciatus* lay up to 500 eggs over a period of three months, however, the eggs are laid in the soil and rarely seen. Elanchezyan *et al.* (2008a) reported infestation of ash weevil in different genotypes of brinjal.

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3. MATERIALS AND METHODS

The experiment entitled "Evaluation of round fruited brinjal genotypes for yield, quality and tolerance to fruit and shoot borer (*Leucinodes orbonalis* Guen.) was conducted at the Department of Olericulture, College of Agriculture, Vellayani, during the period 2010-11. 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 two separate experiments.

Experiment 1: Screening brinjal genotypes for yield and fruit and shoot borer resistance

Experiment 2: Evaluation of genotypes for genetic variability, yield, quality and tolerance to pests and diseases.

3.1 Experiment 1

3.1.1 Materials

The experimental material comprised of 34 accessions of brinjal collected from different parts of the country. The details of genotypes used for the experiment is given in Table 1.

3.1.2 Methods

3.1.2.1 Design and layout

The experiment was laid out in a randomized block design with 34 treatments and three replications. Thirty five days old seedlings having 8-10 cm height were transplanted into the main field at a spacing of 75 x 60 cm. The crop received timely management practices as per package of practices recommendations of Kerala Agricultural University (KAU, 2007). Since main thrust was given for screening of the accessions for shoot and fruit borer under field conditions, pesticide application was avoided to allow natural infestation.

Table 1 Brinjal accessions used for evaluation

Sl. No.	Accession Number	IC No. / accession name	Source
1	SM 1	IC 112727	NBPGR, New Delhi
2	SM 2	IC 89847	NBPGR, New Delhi
3	SM 6	IC 99706	NBPGR, New Delhi
4	SM 7	IC 99672	NBPGR, New Delhi
5	SM 8	IC 99708	NBPGR, New Delhi
6	SM 9	IC 111060	NBPGR, New Delhi
7	SM 10	IC 099664	NBPGR, New Delhi
8	SM 11	IC 310883	NBPGR, New Delhi
9	SM 12	IC 113000	NBPGR, New Delhi
10	SM 14	IC 112346	NBPGR, New Delhi
11	SM 15	IC 99750	NBPGR, New Delhi
12	SM 18	Pusa Upkar	IARI, New Delhi
13	SM 20	Pusa Hybrid 9	IARI, New Delhi
14	SM 22	Pusa Uttam	IARI, New Delhi
15	SM 23	Surya	KAU, Thrissur
16	SM 24	Green Beauty	Guntur, Andhra Pradesh
17	SM 26	Utkarsha	Guntur, Andhra Pradesh
18	SM 28	Co-2	TNAU, Coimbatore
19	SM 29	CoBH-2	TNAU Coimbatore
20	SM 30	Bhagyamathi	APAU, Hyderabad
21	SM 31	Gulabi	APAU, Hyderabad
22	SM 34	Local	Jonnalagadda Andhra Pradesh
23	SM 35	Local	Sowpadu, Andhra Pradesh
24	SM 36	Local	Madavoor, Kerala
25	SM 38	PLR – 2	TNAU, Paloor
26	SM 39	Local	TNAU, Madurai
27	SM 40	Annamalai	Annamalai Univ., Tamil nadu
28	SM 41	Annamalai sel-1	College of Agriculture, Vellayani, Kerala
29	SM 42	Annamalai sel-2	College of Agriculture, Vellayani, Kerala
30	SM 44	Local	Vellayani, Kerala
31	SM 45	Local	Vellayani, Kerala
32	SM 46	Local	Balaramapuram, Kerala
33	SM 48	Green Ball	Green Co. Ltd, Vietnam
34	SM 49	Pusa Purple Cluster	IARI, New Delhi

Out of 34 accessions, 19 showed 100% wilting and hence biometric observations were recorded for 15 accessions which survived the onslaught of bacterial wilt.

3.1.2.2 Biometric observations

Three plants were selected randomly from each plot and tagged for recording the biometric observations.

3.1.2.2.1 Vegetative characters

3.1.2.2.1.1 Plant height (cm)

Plant height was recorded from the ground level to the topmost bud leaf of the plants at the time of flowering and presented in centimeters.

3.1.2.2.1.2 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.

3.1.2.2.1.3 Number of secondary branches

Number of secondary branches produced from each plant was recorded and average was recorded.

3.1.2.2.1.4 Leaf length

The fifth leaf from top of the selected plants was used for making the above observation. The length was measured as the distance from the base of the petiole to the petiole to the top of the leaf and expressed in centimeters.

3.1.2.2.1.5 Leaf width

The width of same leaf, used for recording the length was taken at the region of maximum width.

3.1.2.2.2 Flowering characters

3.1.2.2.2.1 Days to first flowering

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

3.1.2.2.2.2 Days to 50 per cent flowering

Number of days from the date of transplanting to the 50% flowering of observational plants was recorded and the average obtained.

3.1.2.2.2.3 Long styled and medium styled flowers

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

Percentage of long and medium styled flowers =

$$\frac{\text{Number of long and medium styled flowers}}{\text{Total number of flowers}} \times 100$$

3.1.2.2.3 Fruit and yield characters

3.1.2.2.3.1 Fruit length

Five fruits were selected at random 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.

3.1.2.2.3.2 Calyx length

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

3.1.2.2.3.3 Pedicel length

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

3.1.2.2.3.4 Fruit girth

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.

3.1.2.2.3.5 Fruit weight

Weight of fruits used for recording fruit length was measured and average was found out and expressed in grams.

3.1.2.2.3.6 Fruits per plant

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

3.1.2.2.3.7 Yield per plant

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

3.1.2.2.4 Morphological Characters

3.1.2.2.4.1 Pigmentation on stem

Pigmentation on stem of each variety was observed

3.1.2.2.4.2 Leaf hairiness

Based on hairiness on leaf of each variety was divided into pubescent and glabrous.

3.1.2.2.4.3 Leaf spinyness

Number and intensity of spines on leaves of each variety was observed.

3.1.2.2.4.4 Pigmentation on leaf

Pigmentation on leaves of each variety was observed.

3.1.2.2.4.5 Pigmentation on fruit

Dominant pigmentation on fruits of each variety was recorded.

3.1.2.2.4.6 Shape Index (SI)

Shape index was calculated by taking the ratio of fruit length and fruit diameter.

3.1.2.2.4.7 Volume Index (VI)

Volume index was calculated by taking the product of fruit length and fruit diameter.

3.1.2.2.4.8 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

3.1.2.2.4.9 Ratio of seedless area to total length of fruit (RLSP)

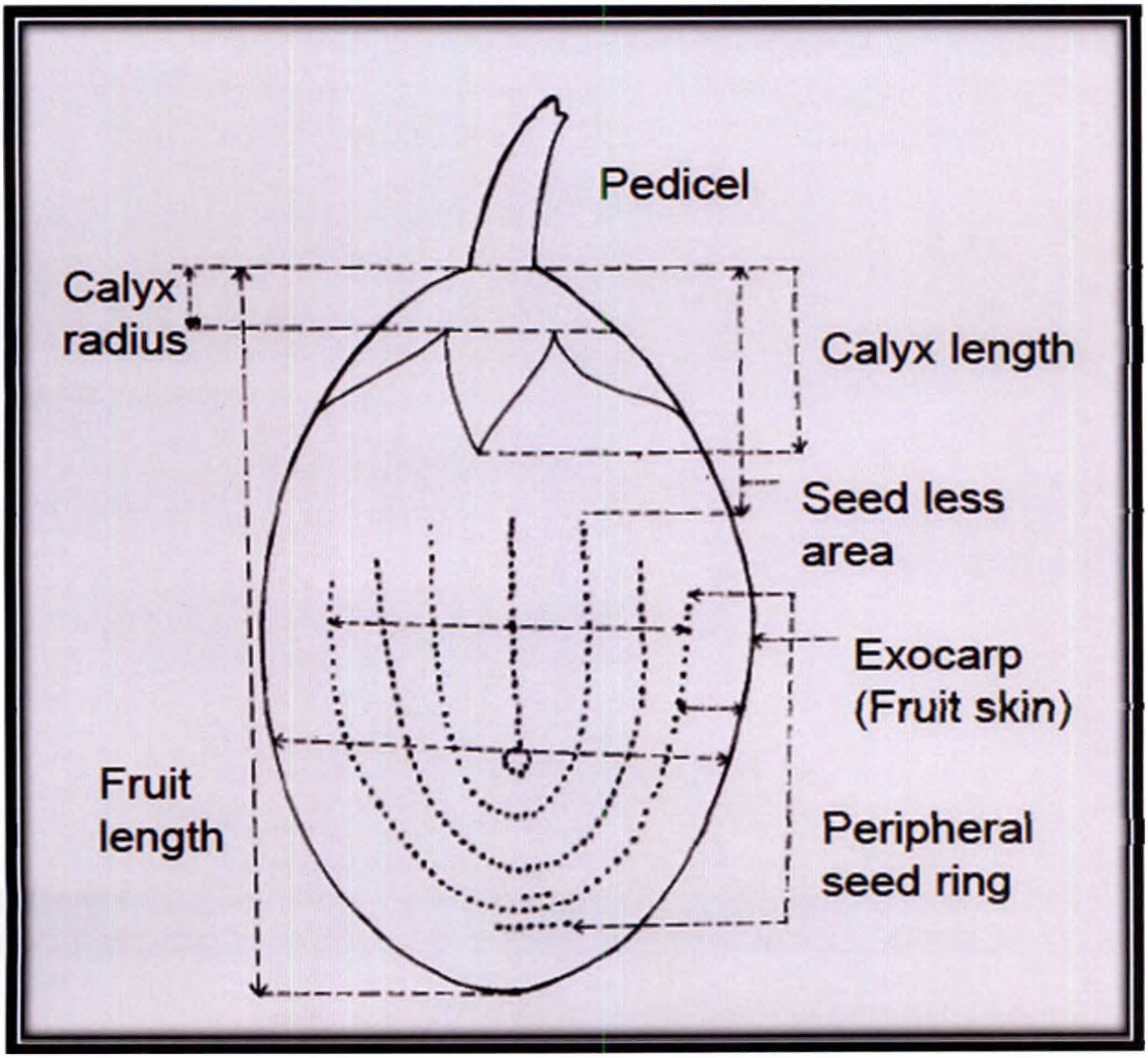
The fruits used for measuring the length of peripheral seed ring were also used to measure the length of seed less area. It was measured both at the lower and upper end from the centre and added up. The total was divided by the total length of fruit to work out the ratio of length of seedless area to total length. (Fig.1)

3.1.2.3 Screening for incidence of pests and diseases

3.1.2.3.1 Fruit and shoot borer (*Leucinodes orbonalis* Guen.)

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

Fig. 1 Diagramatic sketch for various characters of brinjal fruit



3.1.2.3.1.1 Percentage of plants infested

Number of plants showing damage symptoms (on shoots/ on fruits or on both) were recorded and from this percentage of plants infested was calculated. Observations were recorded at ten days interval from 30 DAT (Days After Transplanting) up to 90 days.

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

3.1.2.3.1.2 Percentage of young shoots infested

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

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

3.1.2.3.1.3 Percentage of damaged fruits

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 90 DAT.

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

3.1.2.3.1.4 Severity of fruit damage

For estimating severity of fruit damage the following two parameters were used and observations on these parameters made at peak fruiting period.

3.1.2.3.1.4.1 Number of bore holes per fruit

10 fruits were selected at random and the number of bore holes on the fruits was recorded and the average was worked out.

3.1.2.3.1.4.2 Number of larvae per fruit

Fruits taken for recording the number of bore holes were cut open and the number of larvae present was noted and the average was worked out.

3.1.2.3.1.5 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.* 1998)

3.1.2.3.2 Bacterial Wilt

3.1.2.3.2.1 Percentage of plants infested

Number of plants showing wilting symptoms were recorded and from this percentage of plants infested was calculated. The observations were recorded at ten days interval from 30 DAT (Days After Transplanting) up to 90 days.

$$\text{Percentage of plants infested} = \frac{\text{Number of plants showing wilting}}{\text{Total number of plants}} \times 100$$

3.1.2.3.2.2 Scoring

Reaction to the incidence of bacterial wilt was studied adopting spot planting technique as suggested by Narayankutty (1986). In this technique, a wilt susceptible variety was planted along with the line under test. The wilting of the susceptible line indicated presence of virulent inoculam in the soil.

Wilt incidence was confirmed by bacterial ooze test. The disease rating was done as per the following scale suggested by Mew and Ho (1976).

Percentage of wilted plants	Rating
< 20 %	Resistant (R)
20 – 40 %	Moderately Resistant (MR)
41 – 60 %	Moderately Susceptible (MS)
> 60 %	Susceptible (S)

3.1.2.3.3 Jassids

Number of jassids counted per leaf.

3.1.2.3.4 Ash weevil

Number of adult weevils per plant was counted.

Experiment 2

3.2.1 Materials

The experimental material comprised of the same 34 accessions used for the first experiment.

3.2.2 Methods

3.2.2.1 Design and layout

The experiment was laid out in randomized block design with 34 treatments in two replications. Thirty five old seedlings having 8-10 cm height were transplanted at a spacing of 75 x 60 cm. All cultural practices as per packages of practices recommendations (KAU, 1996) were followed. Out of 34 accessions 7 accessions showed 100 per cent bacterial wilt incidence. Hence, 27 accessions were studied in the second experiment.

3.2.2.2 Biometric observations

Same as experiment 1

3.2.2.3 Quality characters

3.2.2.3.1 Protein

Protein was estimated by Bradford method (Sadasivam and Manickam, 1996).

Reagents:

1. Dye concentrate: 100mg of coomasie brilliant blue G 250 was dissolved in 50 ml of 95 per cent ethanol. 100ml of concentrated orthophosphoric acid

was added and final volume was made up to 200 ml with distilled water. It was stored under refrigerated conditions in amber bottles. One volume of concentrated dye solution was mixed with four volumes distilled water for use. This was filtered with Whatman No. 1 filter paper if any precipitate occurred.

2. Phosphate-buffer saline (PBS)
3. Protein solution (Stock standard): 50 mg of bovine serum albumin was accurately weighed and dissolved in distilled water and made up to 50 ml in a standard flask.
4. Working standard: 10 ml of the stock solution was diluted to 50 ml with distilled water in a standard flask. One ml of this solution contained 200 μg protein.

Procedure:

500 mg of the sample was weighed and ground well with a pestle and mortar in 5-10 ml of the buffer. This was centrifuged and the supernatant was used for protein estimation.

0.2, 0.4, 0.6, 0.8, and 1 ml of the working standard was pipette out into a series of test tubes. 0.1 ml of the sample extract was pipetted out into 2 other test tubes. The volume was made up to 1 ml in all the test tubes. A tube with 1 ml of water is used as blank and 5 ml of diluted dye solution was added to each tube. This was mixed well and the colour was allowed to develop for five minutes, but not longer than 30 minutes. The absorbance was read at 595 nm. A standard curve was plotted using standard absorbance *vs* concentration. The protein in the sample was calculated using the standard curve.

3.2.2.3.2 Ascorbic acid

Ascorbic acid content of fruit was estimated by 2, 6-dichlorophenol indophenols dye method (Sadasivam and Manickam, 1996).

Reagents

1. Oxalic acid (4%)
2. Ascorbic acid standard: Stock solution was prepared by dissolving 100 mg of ascorbic acid in 100 ml of four per cent oxalic acid. 10 ml of this stock solution was diluted to 100 ml with four per cent oxalic acid to get working standard solution.
3. 2, 6-dichlorophenol indophenols dye: 42 mg sodium bicarbonate was dissolved in a small volume of distilled water. 52 mg 2, 6-dichlorophenol indophenols was added into this and made up to 200 ml with distilled water.

Procedure

5 ml of the working standard solution was pipette out into a 100 ml conical flask and 10 ml four per cent oxalic acid was added. It was titrated against the dye (V_1 ml). End point was the appearance of pink colour of which persisted for atleast five seconds. One gram of fresh leaf was extracted in an acid medium (4 % oxalic acid) and made upto a known volume (20 ml) and centrifuged. 5ml of the supernant was taken and titrated against was calculated the dye until pink colour appeared (V_2 ml). Ascorbic acid content was calculated using the formula.

$$\text{Amount of ascorbic acid (mg 100 g}^{-1}\text{ sample)} = \frac{0.5 \times V_2 \times \text{Vol. made up}}{V_1 \times 5 \text{ ml} \times \text{weight of sample}}$$

3.2.2.3.3 Shelf life

The harvested fruits kept under ordinary room conditions to study its shelf life and number of days up to which the fruits remained fresh for consumption without loss of colour and glossiness, were recorded.

3.2.2.4 Anatomical Characters

Secondary shoots were collected on 100 days after transplantation from the observational plants. Transverse sections of stems were made from fresh materials following free hand sectioning, using ordinary razor blades. Sections were made through the region between 3rd and 4th leaf from the top. The uniform sections were selected, stained in acetocarmine and mounted in glycerine temporarily. The slides were observed under microscope to study the variation of anatomical characteristics of different accessions

3.2.2.4.1 Number of vascular bundles

The slides were observed under microscope to count the number of vascular bundles.

3.2.2.4.2 Thickness of epidermal cells

Number of epidermal layers was taken under microscope

3.2.2.4.3 Area of pith

Area of pith of each slide was taken by using micrometer under microscope.

3.2.2.5 Biochemical characters

3.2.2.5.1 Chlorophyll content

The total chlorophyll content was measured by using SPAD meter and it was expressed in spad units.

3.2.2.5.2 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.

3.2.2.5.3. Reducing sugars

Estimation of reducing sugars in a fruit sample by using dinitrosalicylic acid method

Reagents

1. Dinitrosalicylic acid reagent (DNS Reagent): Dissolve by stirring 1g dinitrosalycilic acid, 200mg crystalline phenol and 50mg sodium in 100 ml 1% NaoH. Store at 4^0c. Since the reagent deteriorates due to sodium sulphite may be added at the time of use, if long storage is required, sodium sulphite may be added at the time of use.
2. 40 per cent Rochelle salt solution (Potassium sodium tartrate).

Procedure

Weigh 100 mg of the sample and extract the sugars with hot 80 per cent ethanol twice (5ml each time). Collect the supernant and evaporate it by keeping it on a water bath at 80^0C. Add 10 ml water and dissolve the sugars.

Pipette out 0.5 to 3 ml of the extract in test tubes and equalize the volume to 3mL with water in all the test tubes. Add 3 ml of DNS reagent. Heat the contents in a boiling water bath for 5min. When the contents of the test tubes are still warm, add 1mL of 40 per cent Rochelle salt solution. Cool and read the intensity of dark colour at 510 nm. Run a series of standards using glucose (0 to 500 μg) and plot a graph.

3.2.2.5.4 Non Reducing Sugars

Non reducing sugars were estimated by subtracting the reducing sugars from the total sugars.

3.2.2.5.5 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.

3.2.2.5.6 Proline

Amount of proline in fruit is estimated using aqueous sulphosalicylic acid (Sadasivam and Manickam, 1996).

Reagents:

1. Acid Ninhydrin: Warm 1.25g ninhydrin in 30ml 6M phosphoric acid, with agitation until dissolved. Store at 4^0C and use within 24h.
2. 3% Aqueous Sulphosalicylic Acid
3. Glacial Acetic Acid
4. Toluene
5. Proline

Procedure

Extract 0.5g of plant material by homogenizing in 10ml of 3% aqueous sulphosalicylic acid. Filter the homogenate through Whatman No. 2 filter paper. Take 2 ml of filterate in a test tube and add 2 ml of glacial acetic acid and 2ml acid ninhydrin. Heat it in the boiling water bath for 1h. Terminate the reaction by placing the test tube in ice bath. Add 4 ml toluene to the reaction mixture and stir well for 20-30sec. Separate the toluene layer and warm to room temperature. Measure the red colour intensity at 520 nm. Run a series of standard with pure proline in a similar way and prepare a standard curve. Find out the amount of proline in the test sample from the standard curve.

Calculation

Express the proline content on fresh weight basis as follows:

$$\mu\text{moles per g tissue} = \frac{\mu\text{g proline per ml x ml toluene}}{115.5} \times \frac{5}{\text{g sample}}$$

Where 115.5 is the molecular weight of proline.

3.2.2.6 Screening for incidence of pests and diseases

Same as experiment 1

3.3 Statistical Analysis

Data recorded from experimental plants were statistically analysed. Analysis of variance and covariance were done:

a) to test significant difference among the genotypes and

b) to estimate variance components and other genetic parameters like correlation coefficients, heritability, genetic advance etc.

From the Table 2 other genetic parameters were estimated as follows:

Table 2 Analysis of Variance / Covariance

Source	Dof	Observed mean square XX	Expected mean square XX	Observed mean sum of products XY	Expected mean sum of products XY	Observed mean square YY	Expected mean square YY
Block	(r-1)	B_{xx}		B_{xy}		B_{yy}	
Genotype	(v-1)	G_{xx}	$\sigma^2_{ex} + \sigma^2_{gx}$	G_{xy}	$\sigma^2_{exy} + r\sigma^2_{gxy}$	G_{yy}	$\Sigma^2_{ex} + r\sigma^2_{gx}$
Error	(v-1) (r-1)	E_{xx}	σ^2_{ex}	E_{xy}	$\sigma 2_{exy}$	E_{xy}	σ^2_{xy}
Total	T_{xx}		T_{xx}			T_{yy}	

3.3.1 Variance:

	X	Y
Environmental variance (σ^2_e)	$\sigma^2_{ex} = E_{xx}$	$\sigma^2_{ey} = E_{yy}$
Genotypic variance (σ^2_g)	$\sigma^2_{gx} = \frac{G_{xx} - E_{xx}}{r}$	$\sigma^2_{gy} = \frac{G_{yy} - E_{yy}}{r}$
Phenotypic variance (σ^2_p)	$\sigma^2_{px} = \sigma^2_{gx} + \sigma^2_{ex}$	$\sigma^2_{py} = \sigma^2_{py} + \sigma^2_{ey}$

3.3.2 Coefficient of variation

Phenotypic and genotypic coefficients of variation (PCV and GCV) were estimated as

$$GCV = \frac{\sigma_{gx}}{X} : x \quad 100$$

$$PCV = \frac{\sigma_{px}}{X} \quad x \quad 100$$

Where,

σ_{gx} - genotypic standard deviation

σ_{px} - phenotypic standard deviation

x - Mean of the character under study

3.3.3 Heritability

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

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

3.3.4 Genetic Advance as percentage mean

$$GA = \frac{k H^2 \sigma_p}{\overline{X}} \times 100$$

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

3.3.5 Correlation

Genotypic correlation coefficient (r_{gxy}) $= \dfrac{\sigma_{gxy}}{\sigma_{gx} \times \sigma_{gy}}$

Phenotypic correlation coefficient (r_{pxy}) $= \dfrac{\sigma_{pxy}}{\sigma_{px} \times \sigma_{py}}$

Environmental correlation coefficient (r_{exy}) $= \dfrac{\sigma_{exy}}{\sigma_{ex} \times \sigma_{ey}}$

3.3.6 Path analysis

The direct and indirect effects of yield contributing factors were estimated through path analysis technique (Wright, 1954; Dewey and Lu, 1959)

3.3.7 Mahanolobis D^2 analysis

Genetic divergence was studied based on 9 characters taken together using D^2 statistic. The genotypes were clustered by Tocher's method as described by Rao (1952).

3.3.8 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, $I = b_1 x_1 + b_2 x_2 + \dots\dots\dots + b_k x_k$ and the merit of a plant is described by the function, $H = a_1 G_1 + a_2 G_2 + \dots\dots\dots + b_k G_k$ where $x_1, x_2 \dots\dots\dots\dots x_k$ are the phenotypic values and $G_1, G_2 \dots\dots\dots\dots\dots G_k$ are the genotypic values of the plants with respect to characters, $x_1, x_2 \dots\dots\dots\dots x_k$ 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., $a_1, a_2 \dots\dots\dots\dots a_{k=1}$

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.

3.4 Genetic cataloguing

The accessions were described morphologically using modified descriptor developed from the standard descriptor for brinjal by IPGRI (Appendix 1).

The cataloguing was done on appropriate scales ranging from 0-9.

3.5 Weather parameters

Following weather parameters during the course of investigation were recorded and furnished in Appendix 2.

3.4.1 Maximum temperature (°C)

3.4.2 Rainfall (mm)

3.4.3 Relative humidity (%)

3.4.4 Evaporation (mm)

Results

4. RESULTS

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

4.1 Experiment 1

4.1.1 Mean performance of accessions for biometric characters

Analysis of variance revealed significant difference among the 15 accessions for all the characters studied. The mean performance of the accessions for various vegetative, flowering and yield characters are furnished in Tables 3 and 4

Plant height varied from 94.65 cm in SM 49 to 46.37 cm in SM 6. SM 41 (85.49 cm), SM 18 (83.5 cm) and SM 23 (82.84 cm) were on par with SM 20 (82.4cm). The mean value for canopy spread ranged from 94.44 cm for SM 36 to 47.99 cm for SM 40. SM 46 (61.02 cm) was on par with SM 7, SM 20, SM 6 and SM 42.

Primary branches per plant was highest for SM 49 (9.54) followed by SM 30 (7.83) and lowest mean for SM 18 (3.43). SM 41, SM 23, SM 45, SM 44 and SM 36 were superior for secondary branches per plant (12.93, 12.75, 12.23, 11.61 and 11.20 respectively). SM 20, SM 7, SM 18, SM 40 and SM 6 recorded lower number of secondary branches per plant (5.72, 5.28, 5.01, 4.9 and 4.43 respectively).

SM 36 (25.94 cm) had longest leaves and SM 40 (14.25 cm) the lowest. SM 20 (22.7 cm) was on par with SM 49 and SM 20. Leaf width was maximum in SM 20 (16.90 cm) followed by SM 36 (16.40 cm) and minimum in SM 44 (9.17 cm).

SM 49 had the maximum flowers per cluster (4.36) and SM 20, the lowest (1.37) followed by SM 45 (1.62). SM 36 was the latest whereas SM 7 was the

Table 3 Mean performance of 15 brinjal accessions for vegetative and flowering characters

Accesions	Plant height (cm)	Canopy spread (cm)	Primary branches per plant	Secondary branches per plant	Leaf length (cm)	Leaf width (cm)	Flowers per cluster	Days to first flowering	Days to 50 per cent flowering	Long & med. styled flowers (%)
SM 6	46.37	55.64	3.70	4.43	17.19	13.94	3.03	37.47	45.69	38.73
SM 7	52.29	59.18	3.55	5.28	16.07	10.69	2.95	28.41	36.17	47.68
SM 18	83.50	51.75	3.43	5.01	21.17	13.96	1.95	45.23	58.28	55.70
SM 20	82.40	55.85	4.68	5.72	22.70	16.90	1.37	48.19	55.64	50.38
SM 23	82.84	82.40	6.05	12.75	16.97	14.49	3.68	29.46	37.73	64.30
SM 30	67.48	71.44	7.83	9.59	14.49	10.50	3.36	46.04	54.01	61.93
SM 36	90.45	94.44	5.97	11.20	25.94	16.40	1.78	55.06	68.58	58.70
SM 40	55.34	47.99	6.47	4.90	14.25	11.36	2.52	36.05	45.86	50.03
SM 41	85.49	67.10	6.17	12.93	18.02	10.95	2.30	44.75	53.89	63.38
SM 42	53.91	55.42	6.13	9.16	19.12	12.69	2.52	37.07	49.11	47.53
SM 44	60.10	83.93	6.94	11.61	18.47	9.17	1.81	48.78	59.47	65.31
SM 45	88.09	79.00	7.43	12.23	19.31	13.91	1.62	47.75	60.11	57.70
SM 46	48.39	61.01	5.09	7.27	17.58	13.58	1.96	43.35	56.13	39.42
SM 48	47.50	65.75	5.30	8.51	17.52	13.45	4.34	46.65	58.61	41.43
SM 49	94.65	77.96	9.54	10.10	22.51	13.58	4.36	45.98	61.13	65.59
CD (5%)	3.977	6.055	1.814	1.800	2.823	2.42	0.921	1.901	1.994	1.109
Mean	69.25	67.26	5.88	8.71	18.75	13.04	2.64	42.68	53.36	53.85

Table 4 Mean performance of 15 brinjal accessions for yield and yield attributing characters

Accesions	Fruit length (cm)	Fruit weight (g)	Fruit girth (cm)	Pedicel length (cm)	Calyx length (cm)	Fruits per plant	Yield per plant (g)
SM 6	7.96	81.88	13.73	5.96	3.19	13.85	990.09
SM 7	9.10	63.33	13.69	4.88	2.69	16.14	1160.03
SM 18	10.36	239.91	23.18	4.43	3.02	8.68	1375.06
SM 20	7.18	199.59	23.61	4.08	3.34	7.29	1280.12
SM 23	8.72	90.31	16.49	4.20	3.55	17.92	1938.92
SM 30	9.37	67.10	16.62	4.35	3.24	24.94	1979.12
SM 36	9.38	194.97	24.54	5.65	4.41	10.16	1650.80
SM 40	8.09	54.31	13.25	5.36	2.53	23.00	1280.36
SM 41	10.15	124.92	6.88	6.21	2.47	17.07	2383.98
SM 42	10.78	77.15	14.34	5.45	3.48	13.39	1218.21
SM 44	15.55	378.75	19.06	6.15	4.57	11.29	2980.28
SM 45	8.24	204.83	21.77	4.42	2.67	9.07	1586.10
SM 46	10.08	270.10	23.22	7.26	4.48	8.12	1046.54
SM 48	3.36	20.12	9.13	3.37	1.78	50.70	1072.33
SM 49	11.88	75.55	11.74	6.46	2.42	42.60	3483.35
CD (5%)	0.899	2.956	1.820	0.439	0.285	2.115	94.890
Mean	9.35	142.85	16.75	5.21	3.19	18.28	1695.02

earliest. The days to 50 per cent bloom ranged between 36.17 (SM 7) and 68.58 (SM 36). SM 45 was on par with SM 44, SM 48 and SM 18.

SM 49, SM 44, SM 23, SM 41, SM 30 and SM 36 were superior in production of long and medium styled flowers (65.59, 65.31, 64.30, 63.38, 61.93 and 58.7 respectively). Average fruit length was maximum for SM 44 (15.55 cm) and minimum for SM 48 (3.36 cm). In case of average fruit weight, SM 44 (378.75 g) had the highest value while SM 48 (20.12) had the lowest.

Highest fruit girth was recorded in SM 36 (24.54 cm) followed by SM 20 (23.61 cm) and lowest in SM 41 (6.88 cm). Pedicel length was longest in SM 13 (7.26) and minimum in SM 48 (3.37). For calyx length, maximum value obtained was in SM 44 (4.57 cm) whereas minimum in SM 48 (1.78 cm).

Fruits per plant was maximum in SM 48 (50.70) followed by SM 49 (42.60) and lowest value in SM 20 (7.29). Highest average yield was obtained for SM 49 (3483.35 g) and lowest for SM 6 (990.09 g).

4.1.2 Screening for pest and diseases

The accessions were scored for fruit and shoot borer, bacterial wilt, jassids and ash weevils.

4.1.2.1 Fruit and shoot borer

The percentage of young shoots infested was least in SM 36 (2.80, 3.22, and 3.37) and highest in SM 23 (36.19, 63.89, and 59.79) at 30 DAT, 40 DAT AND 50 DAT respectively. The genotype SM 49 was the least susceptible (9.035, 7.14, 4.05 and 2.13) while SM 23 was the highly susceptible one (42.65, 36.83, 23.31 and 19.24) at 60 DAT, 70 DAT, 80 DAT and 90 DAT respectively. Pooled shoot damage was highest in SM 23(40.29) and lowest in SM 36 (5.85) (Table 5 and Plate 1).

Table 5 Percentage of shoots damaged by fruit and shoot borer (*L. orbonalis*) at different intervals

Accessions	Percentage of shoots infested							
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled mean
SM 6	35.83(6.06)	36.25(6.10)	51.98(7.27)	35.45(6.03)	31.92(5.73)	20.06(4.59)	15.62(4.07)	32.46(5.69)
SM 7	23.82 4.98)	34.30(5.94)	37.72(6.22)	19.48(4.52)	20.43(4.63)	19.94(4.57)	17.66(4.32)	24.79(4.97)
SM 18	15.85(4.10)	19.57(4.53)	22.21(4.81)	12.78(3.71)	10.64(3.41)	10.04(3.32)	7.22(2.86)	14.06(3.74)
SM 20	19.05(4.47)	26.99(5.29)	32.35(5.77)	15.47(4.05)	11.44(3.52)	13.39(3.79)	4.45(2.33)	17.64(4.20)
SM 23	36.19(6.09)	63.89(8.05)	59.79(7.79)	42.65(6.60)	36.83(6.15)	23.31(4.93)	19.24(4.49)	40.29(6.34)
SM 30	16.33(4.16)	16.16(4.14)	20.77(4.66)	9.76(3.28)	9.54(3.247)	7.17(2.85)	3.01(2.00)	11.84(3.44)
SM 36	2.80(1.95)	3.22(2.05)	3.37(2.09)	12.41(3.66)	10.73(3.42)	6.40 (2.72)	1.90(1.70)	5.85(2.41)
SM 40	22.07(4.80)	32.84(5.81)	36.61(6.13)	18.16(4.37)	18.20(4.38)	14.97(3.99)	14.27(3.90)	22.47(4.74)
SM 41	18.40(4.40)	26.25(5.22)	31.91(5.73)	15.34(4.04)	12.79(3.71)	14.46(3.93)	7.48(2.91)	18.11(4.25)
SM 42	17.92(4.35)	20.30(4.61)	14.23(3.90)	12.16(3.62)	10.58(3.40)	13.22(3.77)	6.15(2.67)	13.52(3.67)
SM 44	16.15(4.14)	17.20(4.26)	11.35(3.51)	10.36(3.37)	10.01(3.31)	8.21(3.03)	5.30(2.51)	11.24(3.35)
SM 45	15.29(4.03)	16.80(4.21)	17.62(4.31)	17.37(4.28)	16.15(4.14)	8.54(3.09)	7.04(2.83)	14.12(3.75)
SM 46	21.79(4.77)	28.06(5.39)	34.39(5.94)	15.88(4.10)	14.01(3.87)	15.66(4.08)	12.88(3.72)	20.40(4.51)
SM 48	23.61(4.96)	32.27(5.76)	36.05(6.08)	20.89(4.67)	16.29(4.15)	14.27(3.90)	15.59(4.07)	22.74(4.76)
SM 49	10.05(3.32)	11.32(3.51)	15.70(4.08)	9.035(3.16)	7.14(2.85)	4.05(2.24)	2.13(1.77)	8.50(2.91)
CD (5%)	0.303	0.280	0.277	0.257	0.354	0.376	0.302	0.089
Mean	19.68	25.69	28.40	17.81	15.78	12.91	9.33	18.53

* DAT – Days After Transplanting (Transformed data given in parenthesis)

The percentage of fruit damage was least in SM 49 (5.44, 8.43 and 7.11) and was highest for SM 23 (64.71, 59.51 and 58.13) at 60 DAT, 80 DAT and 90 DAT respectively. The genotype, SM 36 was the least susceptible one (5.39) and SM 23 was highly susceptible one (52.85) at 70 DAT. The accession SM 23(58.80 and 44.71) had highest pooled fruit damage and plant damage respectively while SM 49 (7.18 and 7.11), the lowest. (Table 6 and Plate 2)

Based on the severity of damage on fruits, the accessions were grouped into six (Table 7). SM 49 was rated as highly resistant and SM 6 as moderately resistant.

Table 7 Rating of accessions against fruit and shoot borer

Immune	Nil
Highly Resistant	SM 49
Moderately Resistant	SM 36
Tolerant	SM 30 and SM 45
Susceptible	SM 18 and SM 44
Highly Susceptible	SM 6, SM 7, SM 20, SM 23 SM 40, SM 41, SM42, SM 46 and SM 48

To find out the severity of fruit damage two parameters *viz.*, number of larvae per fruit and number of bore holes per fruit were estimated. For number of larvae per fruit, the genotype SM 48 had the lowest number (1.31) which was on par with SM 42. The highest number (4.90) was in SM 23 which was on par with SM 30. The number of bore holes per fruit was lowest (5.28) in SM 40 which was on par with SM 45 while the highest was in SM 30 (11.84) which was on par with SM 18. (Table 8)

Table 6 Percentage of fruits damaged by fruit and shoot borer (*L. orbonalis*) at different intervals

Accessions	Percentage of fruits infested				
	60 DAT	70 DAT	80 DAT	90 DAT	Pooled mean
SM 6	63.16(8.01)	50.81(7.19)	51.63(7.25)	40.03(6.40)	51.41(7.17)
SM 7	59. 51(7.77)	49.08(7.07)	49.79(7.12)	39.94(6.39)	49.58(7.04)
SM 18	39.49(6.36)	41.33(6.50)	48.24(7.01)	28.82(5.46)	39.48(6.28)
SM 20	46.60(6.89)	47.06(6.93)	49.75(7.12)	35.54(6.04)	44.75(6.68)
SM 23	64.71(8.10)	52.85(7.33)	59.51(7.77)	58.13(7.69)	58.80(7.66)
SM 30	27.22(5.31)	30.22(5.58)	33.90(5.90)	22.09(4.80)	28.36(5.32)
SM 36	5.96(2.63)	5.39(2.52)	20.25(4.61)	22.10(4.80)	13.45(3.66)
SM 40	52.14(7.29)	47.08(6.93)	50.59(7.18)	37.13(6.17)	46.74(6.83)
SM 41	45.65(6.83)	46.24(6.87)	48.56(7.04)	32.67(5.80)	43.28(6.57)
SM 42	41.95(6.55)	45.69(6.83)	47.70(6.97)	31.99(5.74)	41.84(6.46)
SM 44	36.10(6.09)	34.84(5.98)	39.18(6.33)	24.79(5.07)	33.73(5.80)
SM 45	20.47(4.63)	22.19(4.81)	35.25(6.02)	17.07(4.25)	23.76(4.87)
SM 46	52.43(7.31)	47.02(6.92)	49.32(7.09)	37.25(6.18)	46.51(6.82)
SM 48	59.39(7.77)	49.59(7.11)	37.03(6.16)	28.31(5.41)	43.58(6.60)
SM 49	5.44(2.53)	7.72 (2.95)	8.43(3.07)	7.11(2.84)	7.18(2.68)
CD	0.145	0.235	0.153	0.249	0.107
Mean	41.35	38.47	41.94	30.86	38.16

* DAT – Days After Transplanting (Transformed data given in parenthesis)

Table 8 Severity of fruit damage by fruit and shoot borer (*L. orbonalis*)

Accessions	Bore holes per fruit	Larvae per fruit
SM 6	10.19 (3.34)	4.03 (2.24)
SM 7	9.42(3.22)	4.57 (2.36)
SM 18	11.49(3.53)	4.43 (2.33)
SM 20	11.29(3.50)	4.50(2.34)
SM 23	10.23(3.35)	4.90(2.42)
SM 30	11.84(3.58)	4.58(2.36)
SM 36	8.95(3.15)	2.40(1.84)
SM 40	5.28(2.50)	2.66(1.91)
SM 41	9.03(3.16)	3.80(2.19)
SM 42	A.03 (3.16)	2.18(1.78)
SM 44	9.41(3.22)	3.19(2.04)
SM 45	5.70(2.58)	3.81(2.19)
SM 46	5.92(2.63)	4.52 (2.35)
SM 48	8.01(3.00)	1.31 (1.52)
SM 49	9.97(3.31)	3.27(2.06)
CD (5%)	0.127	0.211
Mean	9.05	3.61

(Transformed data given in parenthesis)

Plate 1. Shoot damage by brinjal fruit and shoot borer (*Leucinodes orbonalis*)

a. Drooping of affected shoot

b. Close up of larva inside shoot

Plate 2. Fruit damage by brinjal fruit and shoot borer (*Leucinodes orbonalis*)

c. Fruits infested by borer showing exit holes plugged with excreta

d. Close up of larva inside fruit

The percentage of plants infested was lowest in SM 36 (5.372, 5.353 and 5.21) at 30, 50 and 70 DAT respectively and the accession SM 49 had lowest infestation (5.38, 5.54, 5.64 and 5.16) at 40, 60, 80 and 90 DAT respectively. Whereas highest was in SM 6 (36.90 and 49.83) at 30 and 60 DAT respectively and the accession SM 23 was highest (49.38, 45.86, 54.55, 52.57 and 41.82) at 40, 50, 70, 80 and 90 DAT respectively. (Table 9)

4.1.2.2 Screening for other pests

The crop was monitored for the incidence of jassids (*Amrasca biguttula biguttula)* and ash weevil (*Myllocerous subfasciatus*) which were the prominent ones exhibiting characteristic damage.

Lowest number of jassids per leaf was recorded in SM 49 (2.81) and highest in SM 36 (20.72), followed by SM 6 (13.48). In case of ash weevils per plant was lowest in SM 18 (1.21) and highest in SM 42 (19.34) followed by SM 41 (17.18). (Table 10 and Plates 3)

4.1.2.3 Screening for bacterial wilt

Out of 34 accessions screened for bacterial wilt nighteen showed hundred per cent bacterial wilt infection. The accessions are SM 1, SM 2, SM 8, SM 9, SM 10, SM 11, SM 12, SM 14, SM 15, SM 22, SM 24, SM 26, SM 28, SM 29, SM 31, SM 34, SM 35, SM 38 and SM 39 showed hundred per cent bacterial wilt infection. (Plate 3)

Table 9 Percentage of plants infested by fruit and shoot borer (*L. orbonalis*) at different intervals

Accessions	Percentage of plants infested by fruit and shoot borer							
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled mean
SM 6	36.90 (6.07)	26.79(5.17)	35.69(5.97)	49.83(7.05)	46.48(6.81)	42.75(6.53)	33.48(5.78)	38.86(6.23)
SM 7	26.23(5.12)	22.83(4.77)	23.72(4.87)	41.98(6.47)	44.40(6.66)	34.60(5.88)	32.84 (5.73)	32.39(5.69)
SM 18	17.91(4.23)	18.48(4.29)	17.95(4.23)	25.73(5.07)	25.79(5.07)	24.60(4.95)	11.91(3.45)	20.38(4.51)
SM 20	13.24(3.63)	18.57(4.31)	18.04(4.24)	33.65(5.80)	33.18(5.76)	25.45(5.04)	26.25(5.12)	24.09(4.90)
SM 23	35.30(5.94)	49.38(7.02)	45.86(6.77)	33.44(5.78)	54.55(7.38)	52.57(7.25)	41.82(6.46)	44.71(6.68)
SM 30	13.55(3.68)	13.22(3.63)	13.38(3.65)	24.26(4.92)	25.68(5.06	26.52(5.14)	24.76(4.97)	20.23(4.49)
SM 36	5.372(2.31)	6.67(2.58)	5.353(2.31)	13.20(3.63)	5.21(2.28)	11.73(3.42)	18.98(4.35)	9.55(3.09)
SM 40	16.30(4.03)	21.83(4.67)	11.83(3.44)	24.14(4.91)	34.03(5.83)	37.90(6.15)	34.98(5.91)	25.90(5.08)
SM 41	10.16(3.18)	17.39(4.17)	11.89(3.44)	26.42(5.14)	23.40(4.83)	25.71(5.07)	21.93(4.68)	19.57(4.42)
SM 42	12.00(3.46)	13.36(3.65)	15.18(3.89)	31.62(5.62)	24.21(4.92)	25.89(5.08)	24.85(4.98)	21.06(4.58)
SM 44	10.28(3.20)	17.98(4.24)	19.76(4.44)	26.21(5.11)	23.47(4.84)	29.45(5.42)	26.40(5.13)	21.97(4.68)
SM 45	15.76(3.97)	11.67(3.41)	12.84(3.58)	26.19(5.11)	30.93(5.56)	32.53(5.70)	26.63(5.16)	22.39(4.73)
SM 46	12.97(3.60)	15.64(3.95)	18.64(4.31)	53.39(7.30)	43.51(6.59)	45.76(6.76)	34.79(5.89)	32.13 (5.66)
SM 48	16.01(4.00)	18.65(4.31)	16.57(4.07)	53.57(7.31)	45.31(6.73)	33.80(5.81)	32.75(5.72)	30.97(5.56)
SM 49	8.66(2.94)	5.38(2.32)	9.012(3.00)	5.54(2.35)	10.16(3.18)	5.64(2.37)	5.16(2.27)	7.11(2.66)
CD	0.444	0.517	0.466	0.354	0.247	0.347	0.393	0.204
Mean	16.71	18.52	18.38	31.28	31.35	30.33	26.50	24.75

* DAT – Days After Transplanting (Transformed data given in parenthesis)

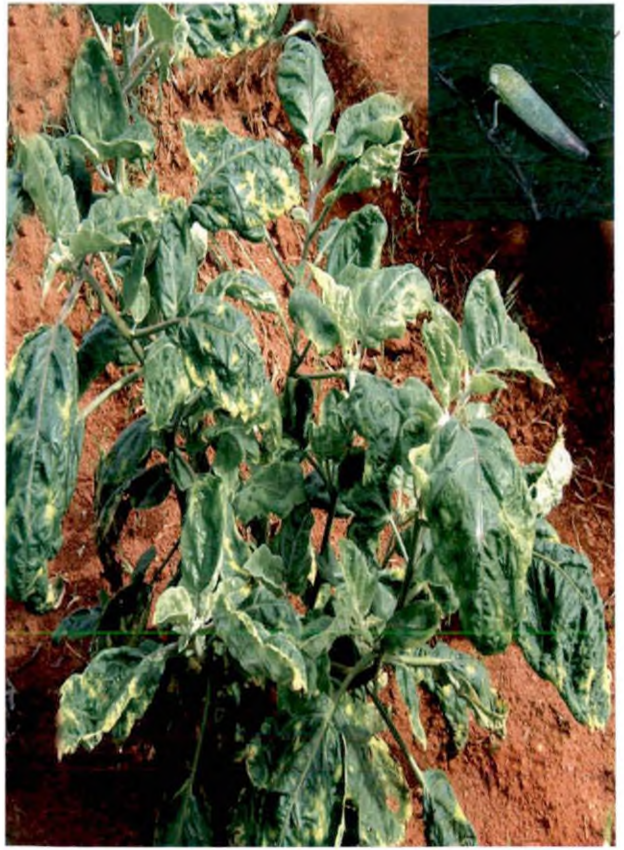
Table 10 Reaction of brinjal accessions to bacterial wilt, Jassids and Ash weevil

Accessions	Percentage of wilted plants							Jassids per leaf	Ash weevils per plant
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT		
SM 6	19.78 (4.55)	40.67(6.45)	62.06(7.94)	80.83 (9.04)	80.83(9.04)	80.83 (9.04)	81.72(9.09)	13.47(3.80)	4.09 (2.25)
SM 7	17.27 (4.27)	34.45(5.95)	51.54(7.24)	66.72(8.22)	66.72(8.22)	66.72(8.22)	67.00(8.24)	13.38(3.79)	4.82(2.41)
SM 18	13.48(3.80)	26.91(5.28)	50.70(7.19)	62.82() 7.98)	62.82(7.98)	63.58(8.03)	63.58(8.03)	5.46(2.54)	1.20(1.48)
SM 20	12.16(3.62)	31.92(5.73)	31.92(5.73)	42.00 (6.55)	41.70(6.53)	51.97(7.27)	52.36(7.30)	5.38(2.52)	6.11(2.66)
SM 23	0(1)	0(1)	0(1)	0(1)	0 (1)	0(1)	0(1)	4.82 (2.41)	8.31(3.05)
SM 30	15.50(4.06)	15.50(4.06)	15.50(4.06)	30.10 (5.57)	57.77(7.66)	58.49 (7.71)	59.26(7.76)	12.23(3.63)	9.33 (3.21)
SM 36	0(1)	0(1)	0(1)	0(1)	0 (1)	0(1)	0 (1)	20.72(4.66)	13.48(3.80)
SM 40	0 (1)	0 (1)	0(1)	0(1)	0(1)	12.48(3.67)	25.25(5.12)	3.59(2.14)	13.19(3.76)
SM 41	0(1)	0 (1)	0(1)	0(1)	17.33(4.28)	17.33(4.28)	32.60(5.79)	4.91(2.43)	17.18(4.26)
SM 42	0(1)	0 (1)	0(1)	0(1)	01()	0(1)	17.76(4.33)	4.57 (2.36)	19.34(4.51)
SM 44	0 (1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	10.40(3.37)	16.16(4.14)
SM 45	0 (1)	0 (1)	0(1)	0(1)	0 (1)	0(1)	18.08(4.36)	12.37(3.65)	10.42(3.38)
SM 46	11.36(3.51)	22.85(4.88)	42.18 (6.57)	51.63(7.25)	62.59(7.97)	62.59(7.97)	62.59(7.97)	6.43(2.72)	9.04(3.16)
SM 48	0(1)	12.66(3.69)	16.53(4.18)	26.62(5.25)	26.62(5.25)	26.62(5.25)	26.68(5.26)	3.55(2.13)	5.55(2.56)
SM 49	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	2.81(1.95)	3.70(2.16)
CD	0.169	0.182	0.122	0.101	0.109	0.111	0.172	0.420	0.214
Mean	5.97	12.33	18.03	24.05	27.82	29.37	33.79	8.28	9.46

* DAT – Days After Transplanting

(Transformed data given in parenthesis)

Plate 3. Incidence of other pests and diseases



a. Jassid infestaiton

b. Ash weevil infestation

c. Bacterial wilt incidence

The remaining fifteen accessions were scored and were classified as follows.

Table 11 Rating of accessions against bacterial wilt

Resistant	SM 23, SM 36, SM 42, SM 44, SM 45 and SM 49
Moderately Resistant	SM 40, SM 41 and SM 48
Moderately Susceptible	SM 20 and SM 30
Susceptible	SM 1, SM 2, SM 6, SM 7, SM 8, SM 9, SM 10, SM 11, SM 12, SM 14, SM 15, SM 18, SM 22, SM 24, SM 26, SM 28, SM 29, SM 31, SM 34, SM 35, SM 38, SM 39 and SM 46

The accession SM 6 showed highest infection of bacterial wilt and lowest infection showed by SM 23, SM 36, SM 42, SM 44, SM 45 and SM 49 (0%). (Table 10)

4.2 Experiment 2

The 27 accessions were subjected to detailed study on variability, heritability, genetic advance, correlation, path analysis, genetic divergence and screening for pests and diseases.

4.2.1 Analysis of variance

The analysis of variance revealed significant variation among the 27 accessions for all the characters studied.

4.2.2 Mean performance of accessions

The mean values of the accessions for growth, yield, quality, biochemical and incidence of pest and diseases are given below.

4.2.2.1 Growth characters

The mean values for growth characters were furnished in the Table 12.

Plant height was maximum in SM 49 (94.65 cm) and minimum in SM 15 (44.9 cm). Maximum canopy spread was observed in SM 30 (95.58 cm) followed by SM 36 (95.13 cm) and minimum in SM 40 (42.79 cm).

The accession SM 16 had the highest number of primary branches (9.05) and SM 7, the lowest (2.85). Number of secondary branches was maximum in SM 23 (13.23) and minimum in SM 34 (4.17).

Leaf blade was longest in SM 36 (25.93 cm) and minimum in SM 40 (14.45 cm). For leaf blade width, highest value was observed in SM 22 (23.97 cm) and SM 44, the lowest (8.43 cm).

The accession SM 49 had the highest number of flowers per cluster (5.41) and SM 18, the lowest. SM 36 took maximum days to first flowering (55.49) where as SM 7 was the earliest (27.29).

Days to 50 per cent flowering was lowest for SM 7 (34.52) and highest for SM 36 (66.49). Percentage of long and medium styled flowers ranged from 37.63 (SM 14) to 68.45 (SM 49).

4.2.2.2 Yield and yield attributes

Mean values of yield and yield attributing characters were furnished in the Table 13.

Table 12 Mean performance of 27 brinjal accessions for vegetative and flowering characters

Accession	Plant height (cm)	Canopy spread (cm)	Primary branches per plant	Secondary branches per plant	Leaf length (cm)	Leaf width (cm)	Flowers per cluster	Days to flowering	Days to 50% flowering	Long and med. styled flowers (%)
SM 2	54.80	49.54	3.31	5.08	19.20	14.35	2.73	45.84	58.10	48.96
SM 6	46.92	53.40	3.70	5.43	19.28	11.05	3.64	35.84	44.94	45.13
SM 7	52.34	62.53	2.85	4.23	19.34	13.27	4.13	27.29	34.52	55.96
SM 8	47.72	79.19	4.11	8.29	19.12	15.21	3.29	45.41	57.32	38.97
SM 9	51.32	66.41	4.65	8.32	23.90	22.37	2.24	48	60.50	47.11
SM 10	63.21	86.58	4.66	5.70	18.89	15.67	1.92	30.64	43.48	47.4
SM 14	61.55	66.58	4.15	6.48	21.88	13.96	3.02	38.12	47.58	37.63
SM 15	44.9	47.06	3.52	4.71	16.1	12.71	2.09	45.77	56.50	39.01
SM 18	82.73	48.49	5.03	4.83	22.19	15.45	1.83	46.58	58.38	45.45
SM 20	83.43	53.79	4.32	5.65	21.21	16.81	1.96	48.99	58.71	47.41
SM 22	65.68	51.33	5.36	7.16	18.88	23.97	3.11	47.69	48.20	44.91
SM 23	84.14	86.26	7.59	13.23	18.92	14.05	4.26	28.4	34.80	58.64
SM 24	82.25	61.08	3.71	4.970	16.54	15.43	3.36	35.7	48.59	46.65
SM 28	64.78	54.36	4.60	6.015	17.16	14.66	2.48	46.17	59.72	47.25
SM 29	81.96	75.44	7.2	9.44	16.71	11.39	4.04	40.36	56.43	48.93
SM 30	63.17	95.58	9.05	5.13	16.04	13.04	3.3	47.56	56.42	55.46
SM 34	75.63	81.21	3.36	4.17	15.22	12.91	2.23	45.37	54.76	41.15
SM 36	88.03	95.13	5.77	12.24	25.93	15.04	2.1	55.49	66.49	54.57
SM 39	82.92	75.11	3.60	7.74	23.56	17.00	3.01	38.33	43.80	52.91
SM 40	57.11	42.79	5.28	6.17	14.14	11.06	3.02	36.84	45.08	42.09
SM 41	87.06	63.21	5.99	6.95	19.37	10.37	2.31	44.98	56.72	58.17
SM 42	53.49	86.29	6.5	6.09	19.88	13.53	2.48	37.62	48.20	54.64
SM 44	57.73	85.58	7.72	6.86	16.03	8.43	3.00	47.76	59.80	66.04
SM 45	91.18	87.5	8.44	6.73	18.91	14.72	2.30	46.87	58.08	53.80
SM 46	54.81	74.14	4.39	5.15	16.94	15.97	2.84	42.91	55.40	46.59
SM 48	46.74	66.52	5.13	7.56	16.96	13.31	4.51	46.37	58.76	44.25
SM 49	94.65	79.91	6.69	9.69	19.9	14.23	5.41	45.26	56.42	68.45
CD (5%)	1.560	3.342	0.894	0.841	1.157	1.216	0.714	1.167	1.268	2.041
Mean	67.42	69.44	5.21	6.81	18.97	14.44	2.98	42.45	52.87	49.53

Table 13 Mean performance of 27 brinjal accessions for yield and yield attributes

Accession	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Fruits per plant	Calyx length (cm)	Pedicel length (cm)	Fruit length (cm)	Yield per plant (g)
SM 2	7.58	16.11	93.15	17.03	3.58	3.26	7.58	1434.31
SM 6	7.5	13.09	78.64	15.60	3.17	6.00	7.5	1286.29
SM 7	8.75	11.37	64.04	23.96	2.45	4.79	8.75	1553.21
SM 8	7.3	13.23	85.29	14.49	3.2	4.3	7.3	997.00
SM 9	9.87	16.17	91.96	15.36	3.5	7.07	9.87	1246.62
SM 10	8.61	27.25	180.23	12.04	3.17	3.23	8.61	1266.66
SM 14	12.34	11.15	41.98	16.67	3.25	5.3	12.34	925.39
SM 15	9.76	9.26	49.25	21.40	3.23	5.75	9.76	987.41
SM 18	10.16	23.03	237.38	10.36	3.21	4.19	10.16	1267.06
SM 20	7.40	24.28	202.82	11.43	3.17	4.22	7.40	1487.75
SM 22	10.35	17.19	183.36	7.21	3.27	5.22	10.35	1162.41
SM 23	8.41	15.85	90.43	22.16	3.5	4.29	8.41	2485.15
SM 24	9.95	18.17	96.05	15.74	2.45	4.06	9.95	1267.91
SM 28	6.94	15.49	61.28	22.41	4.21	4.55	6.94	1277.55
SM 29	7.16	18.18	75.29	17.37	2.45	4.27	7.16	1336.49
SM 30	9.85	17.17	68.49	27.47	3.44	4.05	9.85	2144.9
SM 34	8.63	18.11	94.00	11.03	6.11	5.5	8.63	661.66
SM 36	9.41	23.4	190.41	8.92	4.18	5.5	9.41	1577.28
SM 39	9.16	13.33	87.51	20.02	3.32	2.55	9.16	1538.22
SM 40	7.3	11.53	54.85	20.25	2.42	5.93	7.3	1257.83
SM 41	10.20	7.23	119.92	18.31	2.29	6.29	10.20	2435.39
SM 42	11.38	14.47	75.44	15.03	3.18	6.14	11.38	1900.91
SM 44	15.80	19.22	371.99	12.4	4.55	5.45	15.80	2901.05
SM 45	8.335	21.47	200.26	8.12	2.55	4.33	8.335	1687.09
SM 46	10.14	23.98	258.98	10.07	4.6	7.05	10.14	1244.83
SM 48	3.4	9.43	20.03	48.71	1.8	4.47	3.4	1149.83
SM 49	12.17	10.45	74.64	46.41	2.3	6.07	12.17	3617.15
CD (5%)	0.411	0.482	9.801	1.944	0.219	0.584	0.411	54.884
Mean	9.18	16.28	120.28	18.15	3.28	4.96	9.18	1559.161

For fruit length, highest value of 15.80 cm was recorded by SM 44 and lowest value of 3.4 cm by SM 48.

Fruit girth varied from 7.23 cm (SM 41) to 27.25 cm (SM 10). Highest value for fruit weight was recorded by SM 44 (371.99 g) followed by SM 46 (9258.98 g) and lowest mean was for SM 48 (20.03 g). Plate 4 shows accession with highest fruit weight.

For fruits per plant, highest value was noted in SM 48 (48.71) followed by SM 49 (42.60) and lowest value in SM 22 (7.21). Plate 5 shows accession with highest number of fruits.

Highest average yield was obtained for SM 49 (3617.15 g) followed by SM 44 (2901.05) and lowest for SM 34 (661.66g).

Longest pedicel was in SM 9 (7.07) and shortest in SM 39 (2.55). For calyx length, maximum value obtained was in SM 34 (6.11cm) whereas minimum in SM 48 (1.80 cm).

4.2.2.3 Morphological characters

Morphological characters like pigmentation, spinyness, RLPS, RLSA, shape index and volume index of all accessions were given in the Table 14.

Out of 27, fourteen accessions had green pigmentation on stem where as thirteen have purple pigmentation. All accessions have pubescent leaves except S 10, SM 14 and SM 36 which have glossy leaves.

Regarding leaf spinyness, most of the accessions are spineless except SM 2, SM 7, SM 8, SM 9, SM 10, SM 15, SM 45 and SM 46. Thirteen accessions have green pigmentation on leaf where as fourteen accessions have purple pigmentation (Plate 6).

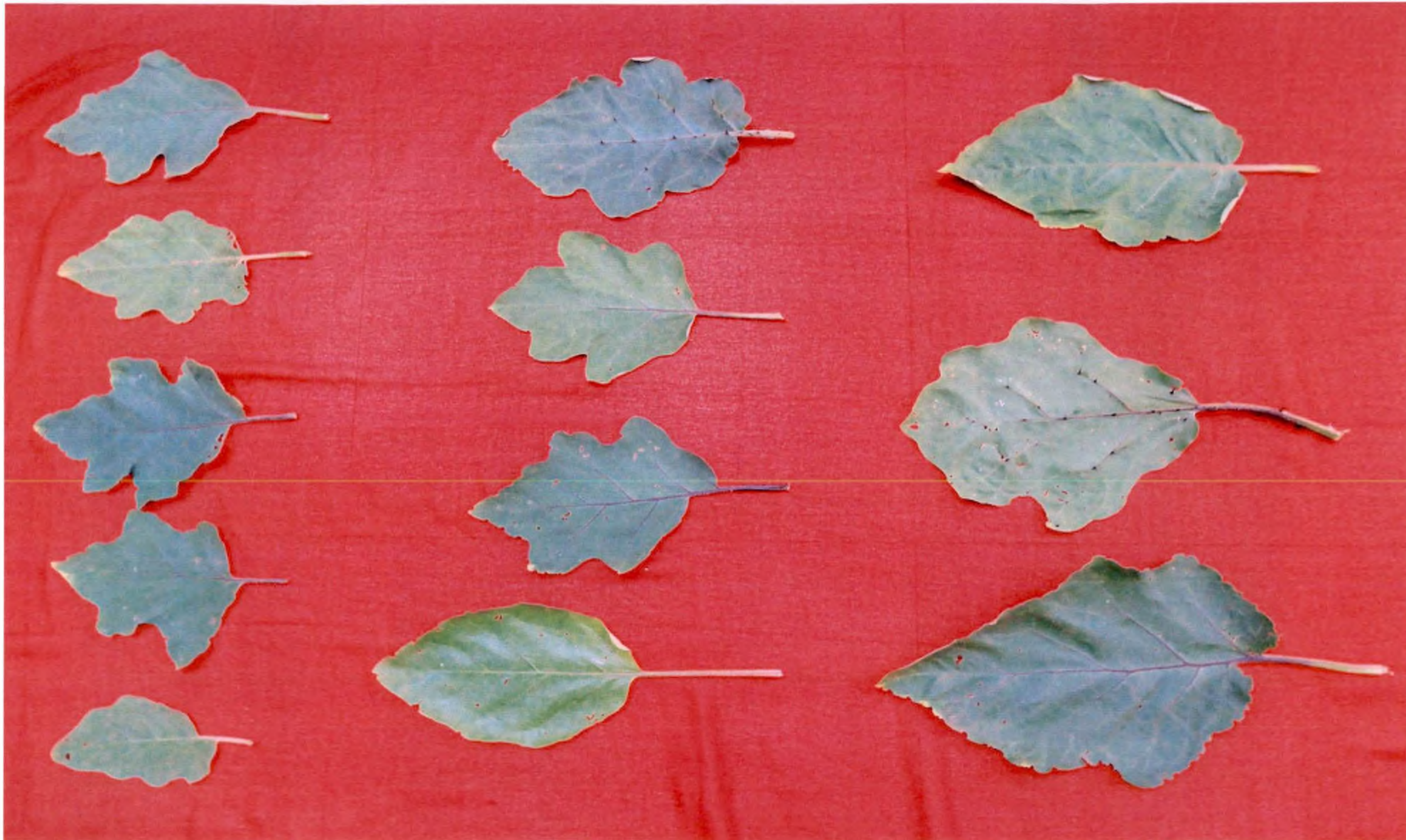
Table 14 Morphological characters of different accessions of brinjal

Accession	Pigmentation on leaf	Pigmentation of stem	Fruit colour	Spinyness on leaf	Hairiness on leaf	RLPS	RLSA	Shape index	Volume index
SM 2	Green	Green	Green With White Bottom	6	Pubescent	0.43	0.24	1.45	38.57
SM 6	Green	Green	Dark Green With Purple Stripes	0	Pubescent	0.53	0.31	1.80	31.08
SM 7	Green	Green	Dark Green With Purple End	6.33	Pubescent	0.58	0.38	2.44	31.32
SM 8	Green	Green	Dark green with purple stripes	0	Pubescent	0.65	0.25	1.76	30.14
SM 9	Green	Green	Purple black	13	Pubescent	0.67	0.29	1.91	50.83
SM 10	Green	Green	Purple black	8	Glossy	0.51	0.30	0.99	74.21
SM 14	Green	Green	Purple black	0	Glossy	0.56	0.39	3.45	42.63
SM 15	Green	Green	Green	3	Light Glossy	0.23	0.31	3.43	29.01
SM 18	Purple	Purple	Purple black	0	Pubescent	0.46	0.33	1.38	74.46
SM 20	Purple	Purple	Purple black	0	Pubescent	0.42	0.32	0.98	57.23
SM 22	Light Purple	Purple	Purple black	0	Pubescent	0.41	0.31	1.92	55.71
SM 23	Purple	Purple	Purple black	0	Pubescent	0.41	0.35	1.66	42.45
SM 24	Green	Green	White Stripes On Green Fruit	0	Light glossy	0.38	0.42	1.73	57.03
SM 28	Green	Green	White Stripes On Purple Fruit	0	Pubescent	0.53	0.43	1.40	34.24
SM 29	Light Purple	Green	Purple black	0	Pubescent	0.46	0.31	1.23	40.81
SM 30	Purple	Purple	Purple black	0	Pubescent	0.58	0.30	1.82	53.07
SM 34	Purple	Purple	Purple black	0	Pubescent	0.51	0.35	1.50	49.49
SM 36	Green	Green	Purple	0	Glossy	0.55	0.23	1.26	70.14
SM 39	Green	Green	Milky White	0	Pubescent	0.60	0.24	2.14	38.14
SM 40	Purple	Purple	Purple	0	Pubescent	0.62	0.24	1.98	26.79
SM 41	Purple	Purple	Purple	0	Pubescent	0.58	0.32	4.50	22.32
SM 42	Purple	Purple	Purple	0	Pubescent	0.63	0.21	2.46	52.40
SM 44	Purple	Purple	Purple black	0	Pubescent	0.61	0.29	2.60	95.85
SM 45	Purple	Purple	Purple black	17.33	Pubescent	0.58	0.30	1.21	57.00
SM 46	Purple	Purple	Purple black	15.6	Pubescent	0.53	0.28	1.30	76.49
SM 48	Green	Green	Green	0	Light Glossy	0.06	0.10	1.13	10.16
SM 49	Purple	Purple	Purple	0	Pubescent	0.85	0.15	3.65	40.46
CD (5%)						0.022	0.011	0.087	2.39
Mean						0.51	0.29	1.96	47.48

Plate 4. SM 44 - Accession with highest fruit weight

Plate 5. SM 48 - Accession with highest number of fruits

Plate 6. Variation in leaf shape, colour and lobing



In case of fruit colour, all accessions have wide variation like milky white, green, striped green, purple and dark purple colours (Plate 7 and Plate 8).

The accession SM 41 had maximum fruit shape index (4.50) while SM 20, the lowest (0.98). For volume index, highest value of 95.85 was recorded by SM 44 and lowest value of 10.16 by SM 48.

RLPS was maximum in SM 49 (0.85) and minimum in SM 48 (0.06). Maximum RLSA was observed in SM 28 (0.43) followed by SM 13 (0.42) and minimum in SM 48 (0.10). (Plate 9)

Based on shape index (SI) varieties were grouped into round (<1.5), oval (1.5-3.0), oblong (3.0-4.5) and long (4.5-7.5) as follows:

Round : SM 2, SM 10, SM 18, SM 20, SM 28, SM 29, SM 36, SM 45, SM 46 and SM 48

Oval : SM 6, SM 7, SM 8, SM 9, SM 22, SM 23, SM 24, SM 30, SM39, SM 40, SM 42 and SM 44

Oblong : SM 14, SM 15 and SM 49

Long : SM 41

Based on volume index (VI) accessions were grouped into very small (<30), small (30-50), medium (50-70) and large (>70) as follows.

Very small : SM 15, SM 40, SM 41and SM 48

Small : SM 2, SM 6, SM 7, SM 8, SM 14, SM 23, SM 28, SM 29, SM 34, SM 39 and SM 49

Medium : SM 9, SM 20, SM 22, SM 24, SM 30, SM 42 and SM 45

Large : SM 10, SM 18, SM 36, SM 46 and SM 44

Plate 7. Variation in fruit colour and shape of the brinjal accessions SM 2 to SM 28

Plate 8. Variation in fruit colour and shape of the brinjal accessions SM 30 to SM 49

Plate 9. Variation in seed arrangement

4.2.2.4 Anatomical characters

Most of the accessions had single layered epidermis except four accessions which were double layered. Number of vascular bundles ranged from 9 to 15 and area of pith varies from 5024 μm^2 to 11304 μm^2 (Table 15 and Plates 10 and 11).

4.2.2.5 Quality characters and biochemical characters

The quality and biochemical characters were showed in Table 16.

The accession SM 48 had maximum shelf life (6.5) and SM 8 had minimum (2.0). The Protein content was maximum in SM 2 (1.55 g/100g) and minimum in SM 49 (1.03). SM 23 had the highest vitamin C content of 5.8 mg/100g and SM 49 had the lowest (4.07 mg/100g).

Highest chlorophyll content was noted in SM 29 (54.85 spad units) and lowest in SM 36 (39.1spad units).

SM 2, SM 23, SM 24, SM 14 and SM 22 were superior in terms of total sugar content (4.22 g, 4.21 g, 3.89 g, 3.56 g and 3.55 g respectively). SM 44, SM 49 and SM 36 recorded lower total sugar content (1.7 g, 1.31 g, 1.25 g respectively).

Maximum reducing sugars obtained for SM 23 (3.52 g/ 100 g) and minimum for SM 49 (0.97 g/100 g). The accession SM 22 had highest non reducing sugars SM 39 had, the lowest (0.06 g/100 g).

SM 49 (21.16 mg/100 g) had the highest phenol content and SM 24 (11.38 mg/100 g) had the lowest. In case of proline content, highest value was noted in SM 49 (25.37 mg/100 g) and lowest value in SM 2 (20.01 mg/100 g).

Table 15 Anatomical characters of different accessions used for study

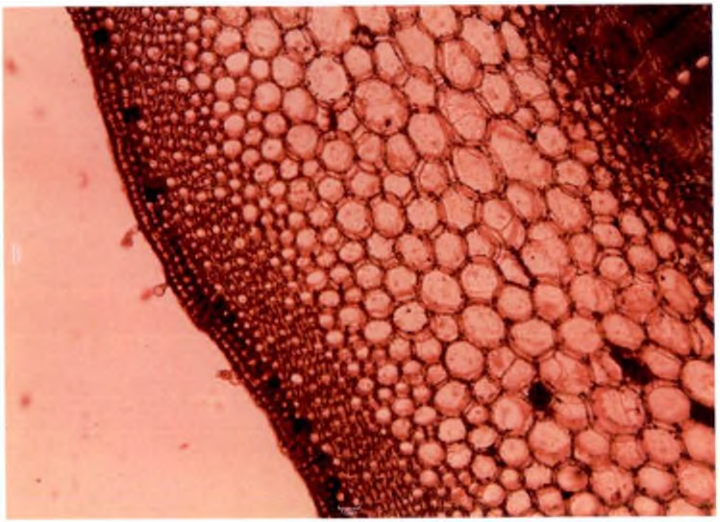
Accession	Number of epidermal layers	Number of vascular bundles	Area of pith (μm^2)
SM 2	Single	10.5	5024
SM 6	Single	9	5672
SM 7	Single	9	5024
SM 8	Single	11	6079
SM 9	Single	13	5672
SM10	Single	13.5	6358
SM 14	Single	11	7085
SM 15	Single	11	6644
SM 18	Double	11	7850
SM 20	Single	13	7084
SM 22	Single	12	9498
SM 23	Single	11.5	6789
SM 24	Double	12.5	7084
SM 28	Single	10.5	5672
SM 29	Single	11	6644
SM30	Single	13	9498
SM 34	Single	11	6358
SM 36	Double	14.5	11304
SM 39	Single	11	7084
SM 40	Single	10.5	6789
SM 41	Double	13.5	7085
SM 42	Single	12.5	6358
SM 44	Single	14.5	11304
SM 45	Single	15.5	9498
SM 46	Single	14.5	6358
SM 48	Single	9	5672
SM 49	Single	15	7850

RLPS – Ratio of peripheral seed ring to total length of fruit

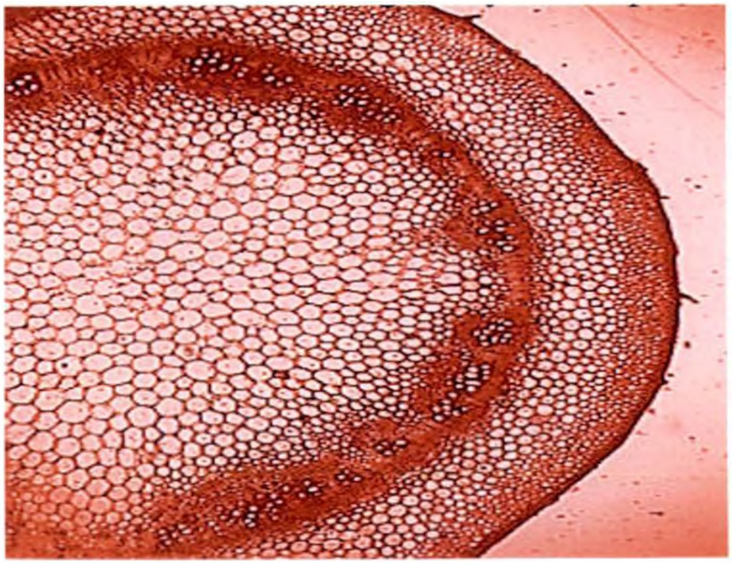
RLSA – Ratio of seedless area to total length of fruit

Plate 10. Anatomical variations in epidermis and trichomes

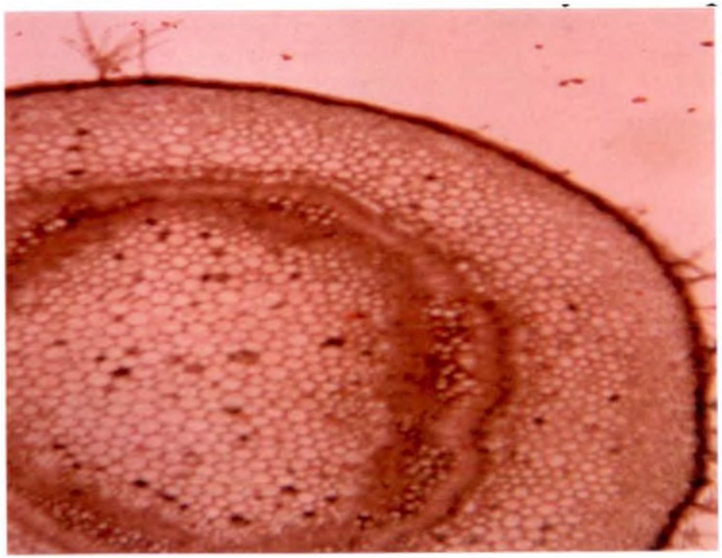
a. SM 28 with single layered epidermis



b. SM 36 with double layered epidermis

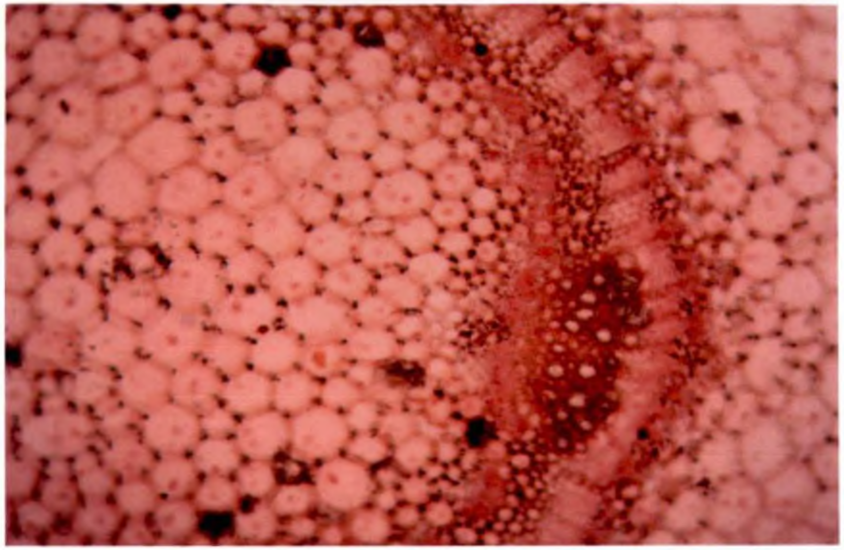


c. SM 23 without trichomes



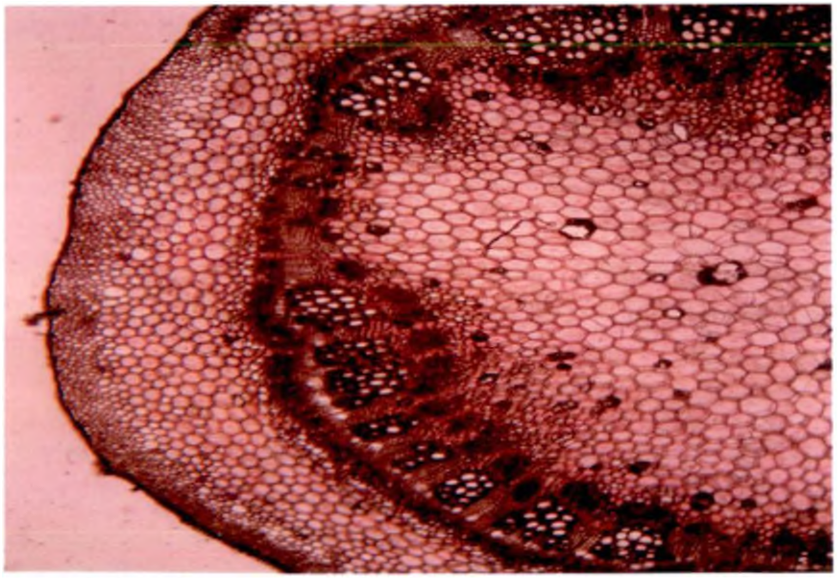
d. SM 7 with branched trichomes

Plate 11. Anatomical variations in vascular bundles and cell wall thickness

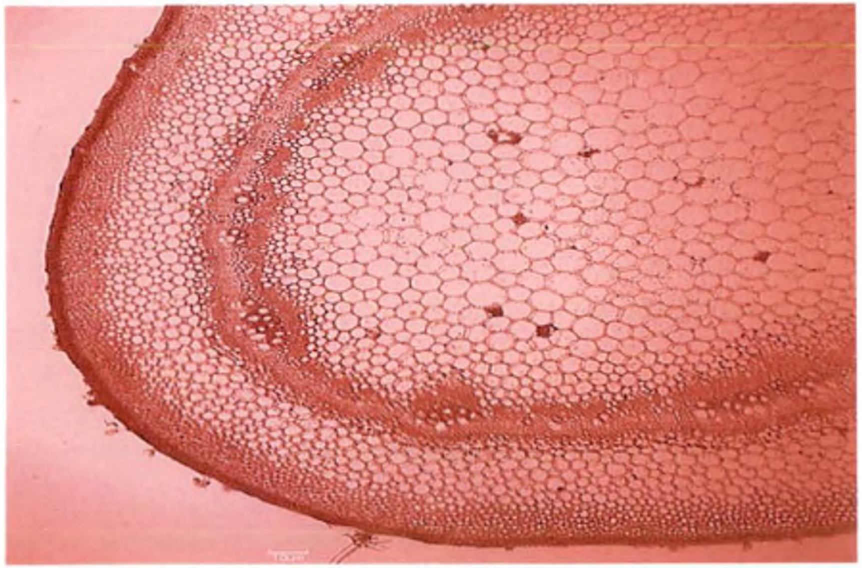


a. SM 36 with high thickening of cell wall

b. SM 23 with less thickening of cell wall



c. SM 44 with well developed vasular bundles



d. SM 23 with poorly developed vascular bundles

Table 16 Quality and Biochemical characters of different accessions used for study

Accession	Shelf life (days)	Chlorophyll (spad units)	Protein (g/100g)	Vitamin C (mg/ 100g)	Total sugars (g/100g)	Reducing (g/100g)	Non reducing sugars (g/100g)	Phenol (mg/ 100g)	Proline (mg/ 100g)
SM 2	3	46.20	1.55	5.69	4.22	3.15	1.06	11.43	20.01
SM 6	3.5	45.10	1.46	5.15	3.37	2.23	1.13	12.62	22.22
SM 7	4	42.30	1.45	5.42	3.09	2.16	0.93	13.69	21.64
SM 8	2	50.25	1.34	4.42	2.56	1.59	0.94	16.24	24.49
SM 9	5	52.38	1.31	4.59	2.06	1.36	0.70	15.61	23.71
SM 10	3	49.00	1.26	4.77	2.66	1.79	0.86	17.83	23.43
SM 14	3.5	39.90	1.41	5.50	3.56	2.46	1.09	13.95	20.39
SM 15	3	52.65	1.45	5.34	3.35	2.25	1.09	14.03	20.60
SM 18	3	49.00	1.36	4.74	2.46	1.54	0.91	14.54	22.98
SM 20	4.5	50.04	1.42	5.31	3.07	2.38	0.69	12.85	22.72
SM 22	3	48.67	1.42	5.39	3.55	2.29	1.26	12.21	22.82
SM 23	3	49.45	1.54	5.80	4.21	3.52	0.68	11.99	20.27
SM 24	3.5	47.50	1.51	5.54	3.89	3.20	0.69	11.38	20.27
SM 28	3	52.55	1.41	5.36	2.74	2.36	0.37	15.60	21.60
SM 29	3	54.85	1.33	5.40	2.90	1.66	1.10	13.21	23.57
SM 30	4	52.95	1.28	4.40	2.12	1.79	0.30	16.65	24.24
SM 34	3.5	48.60	1.42	5.47	3.08	2.70	0.38	12.54	20.87
SM 36	5.5	39.10	1.04	4.12	1.25	1.02	0.23	20.85	25.05
SM 39	6	43.75	1.22	4.40	2.62	1.56	0.06	18.18	23.36
SM 40	5	50.05	1.46	5. 11	3.53	2.14	0.88	12.32	21.53
SM 41	5	54.85	1.44	5.36	3.33	2.40	0.93	13.77	22.23
SM42	6	51.70	1.36	4.83	2.46	1.70	0.75	15.20	23.06
SM 44	4.5	49.75	1.15	4.13	1.70	1.13	0.56	20.20	24.8
SM 45	4	48.40	1.26	4.64	2.98	1.72	1.26	18.14	24.25
SM 46	4	48.50	1.22	4.87	2.59	1.94	0.65	16.09	23.30
SM 48	6.5	47.85	1.33	4.65	2.59	1.65	0.93	18.42	24.92
SM 49	6	41.35	1.03	4.07	1.31	1.97	0.33	21.16	25.37
CD (5%)	0.197	4.669	0.041	0.230	0.485	0.434	0.655	0.439	0.506
Mean	4.07	48.39	1.35	4.97	2.86	2.06	0.77	15.21	22.73

4.2.2.6 Screening for fruit and shoot borer

Screening of accessions based on the extent of damage to shoots and fruits were done in this study. The data of damage parameters collected from field experiment with 27 accessions were subjected to statistical analysis.

The mean values of each of the 27 accessions for the damage parameters studied are presented in tables 17, 18, 19. The percentage of young shoots infestation worked out at 10 days interval. (Fig. 2)

The percentage of young shoots infested was lowest in SM36 (7.748, 7.29, 8.83 and 3.04) and was highest in SM 24, SM 2, SM 22 and SM23 (50.29, 54.31, 51.20 and 30.37) at 30 DAT, 40 DAT, 50 DAT AND 60 DAT respectively.

The accession SM 46 (2.67) showed least susceptibility while the accession SM 23 (24.00) showed highest susceptibility at 70 DAT. The genotype SM 49 was the least susceptible (2.03 and 1.49) while SM 2 and SM 24 was the highly susceptible ones (21.55 and 17.67) at 80 DAT and 90 DAT respectively.

The percentage of damaged fruits was least in case of SM 49 (13.08, 9.39and 6.55) and was highest for SM 23 (68.03, 64.29 and 47.55) at 60 DAT, 80 DAT and 90 DAT respectively. The genotype, SM 49 was the least susceptible one (14.22) and SM 22 was highly susceptible (75.99) at 70 DAT. (Fig. 3)

To find out the severity of fruit damage two parameters *viz.*, number of larvae per fruit and number of bore holes per fruit were estimated. For number of larvae per fruit SM 28 had the lowest number (1.68) which was on par with SM 36. The highest number (5.12) recorded in SM 20 which was on par with SM 23. The number of bore holes per fruit was lowest (5.66) in case of SM 10 which was on par with SM 45 while the highest number recorded in accession SM 23 (13.80) which was on par with SM 41.

Table 17 Percentage of shoots infested by fruit and shoot borer (*L. orbonalis*) at 10 days interval

Accession	Percentage of shoots infested						
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT
SM 2	49.14(7.08)	54.31(7.43)	34.97(5.99)	24.58(5.05)	23. 32 (4.93)	21.55(4.74)	15.89 (4.10)
SM 6	33.40(5.86)	38.91(6.31)	32.91(5.82)	18.02(4.36)	18.13(4.37)	16.69(4.20)	8.80(3.13)
SM 7	31.82(5.72)	37.53 (6.20)	39.29(6.34)	18.56(4.42)	17.25(4.27)	17.97(4.35)	11.07(3.47)
SM 8	8.80 (3.13)	9.02(3.16)	10.98(3.46)	9.944(3.30)	3.64(2.15)	3.55(2.13)	2.59(1.89)
SM 9	14.64 (3.95)	17.28(4.27)	17.18(4.26)	10.85(3.44)	8.88(3.14)	7.83(2.97)	4.63(2.37)
SM 10	13.61(3.82)	16.25(4.15	15.99(4.12)	10.69(3.41)	9.54(3.24)	7.24 (2.87)	3.35(2.08)
SM 14	31.56(5.70)	35.93(6.07)	37. 37(6.19)	21.43(4.73)	14.73(3.96)	14.65(3.95)	9.52(3.24)
SM 15	30.79(5.63)	39.61(6.37)	38.95(6.32)	17.29(4.27)	17.41(4.29)	14.41(3.92)	14.38(3.92)
SM 18	20.88(4.67)	23.44(4.94)	22.5 (4.84)	18.41(4.40)	18.60(4.42)	15.63(4.07)	9.28 (3.20)
SM 20	21.36(4.72)	26.52(5.24)	25.63(5.16)	19.07(4.48)	17.25(4.27)	14.11(3.88)	8.24(3.04)
SM 22	49.07(7.07)	52.07(7.28)	51.20(7.22)	14.51(3.93)	19.97(4.58)	18.17(4.37)	15.66(4.08)
SM 23	45.28(6.80)	49.78(7.12)	34.00(5.91)	30.37(5.60)	24.00(5.00)	17.02(4.24)	14.72(3.96)
SM 24	50.29(7.16)	53.03(7.35)	38.02(6.24)	22.12(4.80)	21.31(4.72)	19.22(4.49)	17.67(4.32)
SM 28	18.62(4.42)	22.04(4.80)	22.83(4.88)	16.06(4.13)	14.45(3.93)	10.91(3.45)	7.92(2.98)
SM 29	16.45(4.17)	18.51(4.41)	18.49(4.41)	12.48(3.67)	11.65(3.55)	10.16(3.34)	5.44(2.53)
SM 30	11.53(3.54)	12.26(3.64)	13.91(3.86)	9.238(3.19)	9.50 (3.24)	8.64(3.10)	3.32(2.08)
SM 34	25.93(5.19)	30.62(5.62)	29.14(5.49)	16.07(4.13)	13.80(3.84)	12.88(3.72)	11.46(3.53)
SM 36	7.748 (2.95)	7.29(2.88)	8.83(3.13)	3.040(2.01)	2.91(1.97)	2.03(1.74)	1.49(1.58)
SM 39	11.95(3.59)	11.58(3.54)	16.57 (4.19)	9.63(3.26)	8.15(3.02)	7.32 (2.88)	3.49(2.11)
SM 40	27.04(5.29)	26.42(5.23)	26.11(5.20)	13.83(3.85)	13.77(3.84)	10.74(3.42)	9.67(3.26)
SM 41	25.60(5.15)	28.22(5.40)	28.65(5.44)	16.07(4.13)	15.28(4.03)	15.02(4.00)	10.45(3.38)
SM 42	17.45(4.29)	22.16(4.81)	22.37(4.83)	16.49(4.18)	15.75(4.09)	11.73(3.56)	8.29(3.04)
SM 44	12.83(3.71)	10.25(3.35)	12.93(3.73)	7.99(2.99)	6.08(2.66)	3.58(2.14)	1.35(1.53)
SM 45	12.93(3.73)	16.00(4.12)	17.84(4.34)	9.25(3.20)	3.88(2.21)	3.37(2.09)	2.70(1.92)
SM 46	13.40(3.79)	13.49(3.80)	16.32(4.16)	10.33(3.36)	2.67(1.91)	1.71(1.64)	1.39(1.54)
SM 48	15.05(4.00)	15.82(4.10)	15.12(4.01)	11.58(3.54)	10.87(3.44)	8.42(3.070)	5.35(2.52)
SM 49	8.77(3.12)	8.59(3.098)	9.58(3.253)	3.80(2.19)	3.18(2.04)	1.27(1.50)	0.94(1.39)
CD (5%)	0.214	0.164	0.109	0.143	0.186	0.205	0.167
Mean	23.18	25.81	24.35	14.50	12.67	10.96	7.68

*DAT- Days After Transplanting (Transformed values given in parenthesis)

Table 18 Percentage and severity of fruits infested by fruit and shoot borer (*L. orbonalis*)

Accession	Percent of fruits infested				Severity	
	60 DAT	70 DAT	80 DAT	90 DAT	Bore holes per fruit	Larvae per fruit
SM 2	66.69(8.22)	71.52(8.51)	61.58(7.91)	43.63(6.68)	7.12	2.51
SM 6	54.04(7.41)	66.93(8.24)	45. 93(6.85)	32.61(5.79)	9.82	3.46
SM 7	52.07(7.28)	65.87(8.17)	44.72(6.76)	30.22(5.58)	11.13	4.24
SM 8	30.00 (5.56)	33.56(5.87)	22.34(4.83)	18.85(4.45)	12.47	2.93
SM 9	32.23(5.76)	39.61(6.37)	29.52(5.52)	17.72(4.32)	11.93	2.95
SM 10	29.89(5.55)	39.04(6.32)	28.31(5.41)	21.78(4.77)	5.66	4.19
SM 14	56.00(7.55)	62.07(7.94)	42.76(6.61)	31.83(5.73)	8.29	4.03
SM 15	52.33(7.30)	61.35(7.89)	45.49(6.81)	30.21(5.58)	5.92	2.87
SM 18	41.65(6.53)	54.59(7.45)	35.75(6.06)	24.79(5.07)	11.34	4.39
SM 20	41.87(6.54)	53.83(7.40)	41.87(6.54)	23.77(4.97)	12.68	5.12
SM 22	65.83(8.17)	75.99(8.77)	52.99(7.34)	25.95(5.19)	10.58	4.20
SM 23	68.03(8.30)	72.14(8.55)	64.29(8.08)	47.55(6.96)	13.80	4.64
SM 24	67.82(8.29)	75.51(8.74)	63.39(8.02)	40.95(6.47)	10.01	3.19
SM 28	40.65(6.45)	54.45(7.44)	40.09(6.41)	27.02(5.29)	12.28	1.68
SM 29	36.91(6.15)	43.58(6.67)	32.66(5.80)	23.52(4.95)	13.03	3.29
SM 30	29.15(5.49)	34.50(5.95)	22.89(4.88)	17.92(4.35)	13.00	3.32
SM 34	49.46(7.10)	56.73(7.59)	42.83(6.62)	33.21(5.84)	9.20	2.04
SM 36	15.55(4.06)	18.78(4.44)	14.04 (3.87)	8.33(3.05)	8.80	1.69
SM 39	28.51(5.43)	34.21(5.93)	23.32(4.93)	19.14 (4.48)	6.98	2.75
SM 40	46.97(6.92)	59.96(7.80)	42.78(6.61)	29.57(5.52)	10.00	3.00
SM 41	47.92(6.99)	59.06(7.75)	43.14(6.64)	30.46(5.60)	13.16	3.33
SM 42	43.15(6.64)	50.87(7.20)	38.11(6.25)	27.68(5.35)	8.49	2.78
SM 44	22.55(4.85)	27.64(5.35)	16.59(4.19)	12.94(3.73)	6.21	4.44
SM 45	23.93(4.99)	31.48(5.69)	20.51(4.63)	16.10(4.13)	6.13	4.29
SM 46	24.23(5.02)	28.53(5.43)	18.94(4.46)	17.37(4.28)	7.03	4.13
SM 48	30.99(5.65)	39.84(6.39)	27.30(5.32)	21.69(4.76)	7.86	1.98
SM 49	13.08(3.75)	14.22(3.90)	9.39(3.22)	6.55(2.74)	8.60	2.17
CD (5%)	0.243	0.220	0.268	0.223	1.549	1.135
Mean	41.17	48.24	35.6	25.23	9.68	3.31

*DAT- Days After Transplanting

(Transformed values given in parenthesis)

Table 19 Percentage of plants infested by fruit and shoot borer (*Leucinodes orbonalis*) at 10 days interval

Accession	Percentage of plants infested							
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	Pooled data
SM 2	54.88(7.40)	75.00(8.66)	49.58(7.04)	48.00(6.92)	35.24(5.93)	60.46(7.77)	66.11 (8.13)	55.62(7.45)
SM 6	31.92(5.65)	32.78(5.72)	32.53 (5.70)	55.58(7.45)	40.73(6.38)	44.57(6.67)	68.24 (8.26)	43.78(6.61)
SM 7	26.67 (5.16)	23.01(4.79)	24.74(4.97)	45.08(6.71)	34.22(5.84)	34.61(5.88)	37.06(6.08)	32.21(5.67)
SM 8	6.193(2.48)	5.27(2.29)	10.24(3.20)	25.02 (5.00)	20.32(4.50)	20.32(4.50)	26.83(5.18)	16.32 (4.04)
SM 9	13.30(3.64)	15.24(3.90)	12.64(3.55)	21.63(4.65)	35.08 (5.92)	36.34(6.02)	31.64 (5.62)	23.72(4.87)
SM 10	16.80(4.09)	17.49(4.18)	10.33(3.21)	16.85 (4.10)	24.49(4.94)	20.22(4.49)	25.37(5.03)	18.81(4.33)
SM 14	21.41(4.62)	21.89(4.67)	15.55(3.94)	27.65(5.25)	34.66(5.88)	28.32(5.32)	27.95(5.28)	25.36(5.03)
SM 15	12.88(3.59)	23.27(4.82)	20.20(4.49)	35.33(5.94)	30.24(5.49)	42.23 (6.49)	41.85(6.46)	29.46(5.42)
SM 18	16.63(4.07)	12.262 (3.50)	10.39(3.22)	36.55(6.04)	32.23(5.67)	41.74 (6.46)	36.16(6.01)	26.59(5.15)
SM 20	22. 60(4.75)	12.87(3.58)	15.67 (3.95)	25.97(5.09)	27. 69(5.26)	32.62(5.71)	26.68(5.16)	23.48(4.84)
SM 22	47.71(6.90)	54.92(7.41)	37.81(6.14)	46.67(6.83)	37.63(6.13)	57.46(7.58)	42.78(6.54)	46.43(6.81)
SM 23	39.11 (6.25)	34.32(5.85)	20.41(4.51)	47.79(6.91)	55.24(7.43)	56.96(7.54)	51.96(7.20)	43.69(6.61)
SM 24	39.50 (6.28)	33.25(5.76)	24.77(4.97)	50.83(7.13)	45.72(6.76)	47.01(6.85)	53.55(7.31)	42.10(6.48)
SM 28	17.50(4.18)	27.01(5.19)	22.11(4.70)	34.99(5.91)	28.50(5.33)	37.19(6.09)	35.30(5.94)	28.97(5.38)
SM 29	12.64(3.55)	12.68(3.56)	5.276(2.29)	23.28(4.82)	30.24(5.49)	34.72(5.89)	28.53 (5.34)	21.09(4.59)
SM 30	7.583(2.75)	17.98(4.24)	15.95(3.99)	27.89(5.28)	25.70(5.07)	30.62(5.53)	34.49 (5.87)	22.92(4.78)
SM 34	24.95(4.99)	17.99(4.24)	21.86(4.67)	24.22(4.92)	28.55(5.34)	34.96(5.91)	27.06(5.20)	25.68(5.06)
SM 36	5.574(2.36)	7. 726(2.77)	10.22(3.19)	9.908(3.14)	15.42 (3.92)	10.47(3.23)	5.24(2.290)	9.253(3.04)
SM 39	12.52(3.53)	12.75(3.57)	10.11(3.18)	14.72(3.83)	59.62 (7.72)	23.47 (4.84)	12.69(3.56)	21.75(4.66)
SM 40	16.32(4.04)	22.85(4.78)	22.67(4.76)	25.16(5.01)	37.21 (6.10)	23.07(4.80)	23.34(4.83)	24.39(4.93)
SM 41	24.91 (4.99)	22.77(4.77)	15.58(3.94)	36.07(6.00)	44.43 (6.66)	44.85 (6.69)	35.76(5.98)	32.07(5.66)
SM 42	15.52(3.94)	45.11(6.71)	28.00(5.29)	37.44 (6.11)	40.78(6.38)	47.04(6.85)	44.12(6.64)	36.87(6.07)
SM 44	11.31(3.36)	11.87(3.44)	15.35(3.91)	25.24(5.02)	24.17(4.91)	37.06(6.08)	36.07(6.00)	23.02(4.79)
SM 45	10.34(3.21)	15.10(3.88)	12.51(3.53)	28.24(5.31)	32.27(5.68)	25.35(5.03)	24.40(4.93)	21.194(4.60)
SM 46	17.71(4.20)	12.64(3.55)	15.24(3.90)	44.27(6.65)	45.68(6.75)	37.85(6.15)	35.24(5.93)	29.83(5.46)
SM 48	19.48(4.41)	11.60(3.40)	10.16 (3.18)	25.57(5.05)	26.88(5.18)	23.89(4.88)	16.97(4.11)	19.24(4.38)
SM 49	5.27(2.29)	10.62(3.25)	10.24(3.20)	15.24(3.90)	10.24(3.20)	10.37(3.22)	10.24(3.20)	10.32(3.21)
CD (5%)	0.442	0.686	0.386	0.276	1.823	0.273	0.327	0.459
Mean	20.41	23.17	18.52	31.67	33.45	34.95	33.54	27.93

*DAT- Days After Transplanting

(Transformed values given in parenthesis)

Fig. 2

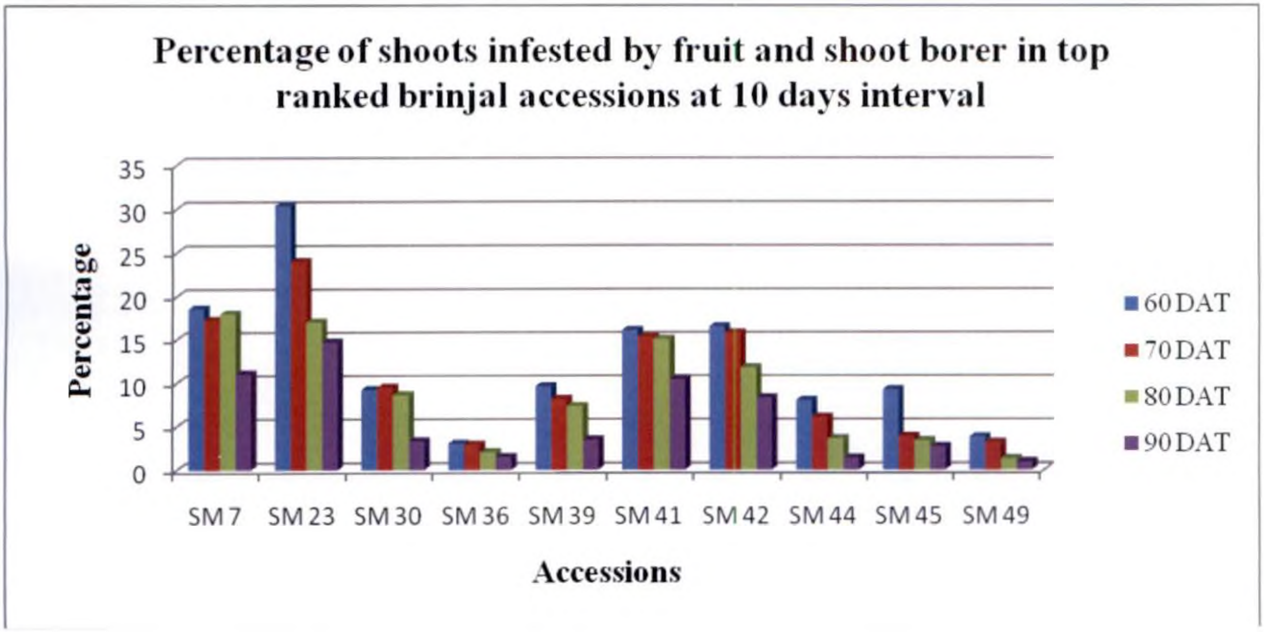
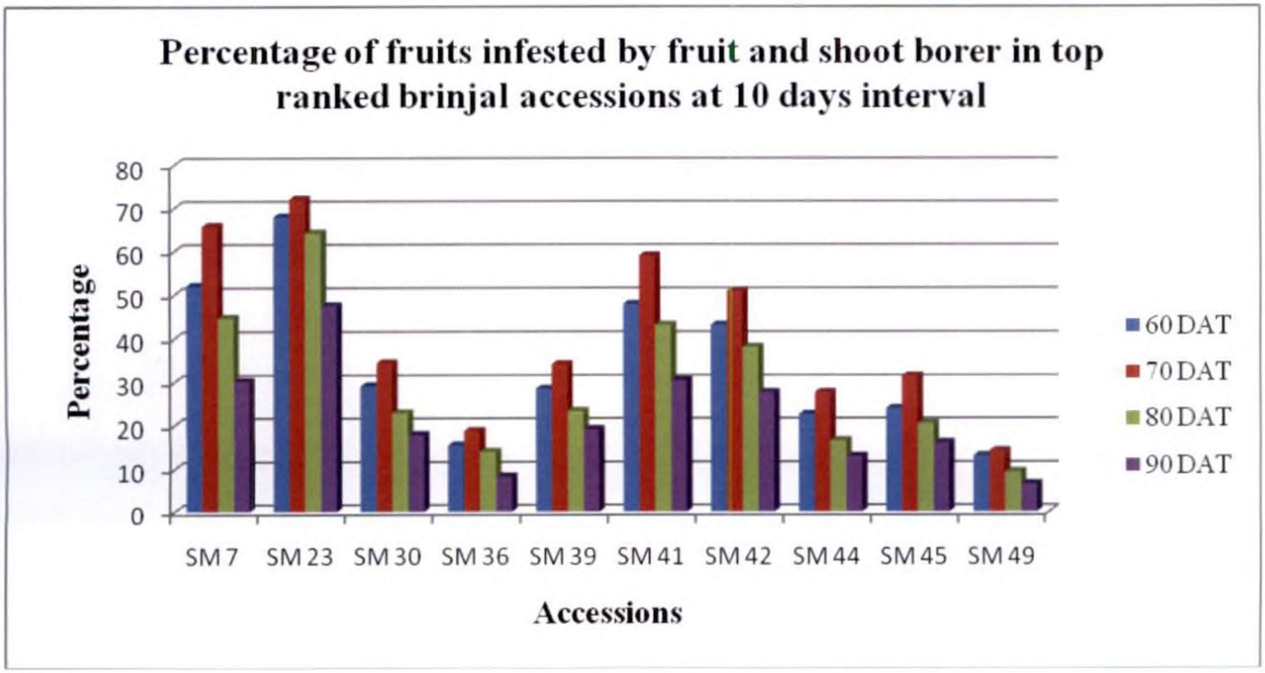

Percentage of shoots infested by fruit and shoot borer in top ranked brinjal accessions at 10 days interval
35
30
25
20
15
10
5
0
Percentage
SM 7
SM 23
SM 30
SM 36
SM 39
SM 41
SM 42
SM 44
SM 45
SM 49
Accessions
60 DAT
70 DAT
80 DAT
90 DAT

Fig.3


Percentage of fruits infested by fruit and shoot borer in top ranked brinjal accessions at 10 days interval
80
70
60
50
40
30
20
10
0
Percentage
SM 7
SM 23
SM 30
SM 36
SM 39
SM 41
SM 42
SM 44
SM 45
SM 49
Accessions
60 DAT
70 DAT
80 DAT
90 DAT

The percentage of plants infested was lowest in SM 36 (9.25) while highest in SM 2 (55.62) (Table 19). Based on percentage of shoots and fruits infested, the current accessions were categorized as Moderately Resistant (MR), Tolerant (T), Susceptible (S), and Highly Susceptible (HS) and furnished in the Table 21.

4.2.2.7 Screening for bacterial wilt

Among 34 accessions studied, SM 1, SM 11, SM 12, SM 26, SM 31, SM 35 and SM 38 showed hundred per cent bacterial wilt infection. Among other accessions lowest infection showed by SM 23, SM 36 and SM 44 (0%) while SM 24 showed highest bacterial wilt infection (64.53%) (Table 20).

Based on percentage of wilted plants accessions were classified as resistant (R), Moderately Resistant (MR), Tolerant (T), Susceptible (S), and Highly Susceptible (HS) and were furnished in the Table 21.

4.2.3 Genetic variability, heritability and genetic advance

The population means, range, genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV), heritability and genetic advance for the 31 characters were studied and are presented in Table 22. (Fig. 4 and 5)

4.2.3.1 Growth characters

Plant height ranged from 44.9 to 94.65 cm with a mean of 67.41 cm. The GCV was 23.71 and PCV was 23.73. Heritability was as high as 99.77 per cent while genetic advance was only 32.89. Canopy spread ranged from 42.79 to 95.58 cm and had mean value of 69.45 cm. The GCV and PCV values were 22.72 and 22.84 respectively. Heritability was 98.95 per cent. Genetic advance was calculated to be 32.34.

Table 20 Response of brinjal accessions for bacterial wilt caused by *Ralstonia solanacearum* at 10 days interval

Accession	Percentage of wilted plants						
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT
SM 2	0(1)	9.41(3.22)	27.60 (5.34)	34.40(5.95)	42.55 (6.59)	52.42(7.30)	52.42 (7.30)
SM 6	0(1)	0 (1)	0 (1)	7.39(2.89)	21.41 (4.73)	33.72 (5.89)	42.14 (6.56)
SM 7	0(1)	0(1)	0 (1)	6.49 (2.73)	13.48 (3.80)	27.54 (5.34)	31.69(5.71)
SM 8	9.38(3.22)	13.48(3.80)	32.91(5.82)	42.49(6.59)	42.49 (6.59)	52.37(7.30)	58.66(7.72)
SM 9	6.91(2.81)	14.47(3.93)	25.99(5.19)	34.74(5.97)	42.10(6.56)	47.56(6.96)	52.56(7.31)
SM 10	0(1)	0 (1)	0(1)	0(1)	21.43 (4.73)	21.43(4.73)	34.82(5.98)
SM 14	0(1)	0 (1)	13.48(3.80)	25.74(5.17)	38.56 (6.29)	52.01(7.28)	52.01(7.28)
SM 15	7.55(2.92)	13.77(3.84)	41.74(6.53)	53.53(7.38)	61.47 (7.90)	61.90(7.93)	61.90(7.93)
SM 18	0 (1)	0(1)	12.91 (3.72)	13.47 (3.80)	24.31 (5.03)	23.87(4.98)	52.69(7.32)
SM 20	0(1)	11.39(3.52)	12.29(3.64)	21.30 (4.72)	29.80 (5.55)	41.42 (6.51)	49.46(7.10)
SM 22	0(1)	14.41(3.92)	21.87(4.78)	36.44(6.11)	50.89 (7.20)	50.89 (7.20)	51.99(7.27)
SM 23	0 (1)	0(1)	0(1)	0(1)	0(1)	0(1)	0 (1)
SM 24	0(1)	0 (1)	14.39(3.92)	14.39 (3.92)	34.49 (5.95)	45.08(6.78)	64.53(8.09)
SM 28	0 (1)	0(1)	12.45(3.66)	12.45 (3.66)	42.51 (6.59)	54.35 (7.43)	54.35 (7.43)
SM 29	14.39 (3.92)	27.05(5.29)	34.40(5.95)	34.40(5.95)	60.94 (7.87)	61.88(7.93)	62.32 (7.95)
SM 30	5.88(2.62)	7.07(2.84)	7.40(2.89)	14.32(3.91	32.27 (5.76)	46.06(6.86)	52.27(7.29)
SM 34	0 (1)	0 (1)	0 (1)	21.79(4.77)	29.61 (5.53)	41.41(6.51)	51.86(7.27)
SM 36	0(1)	0(1)	0 (1)	0(1)	0(1)	0(1)	0(1)
SM 39	0(1)	14.42(3.92)	34.40(5.95)	53.94(7.41)	61.24(7.88)	61.24(7.88)	61.24(7.88)
SM 40	0(1)	0 (1)	0 (1)	0 (1)	0 (1)	5.66(2.58)	11.78(3.57)
SM 41	0(1)	0(1)	0(1)	0(1)	0 (1)	11.87(3.58)	9.73(3.27)
SM 42	0(1)	0(1)	0(1)	0(1)	0 (1)	0 (1)	9.43(3.22)
SM 44	0(1)	0 (1)	0 (1)	0(1)	0(1)	0(1)	0(1)
SM 45	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	11.90(3.59)
SM 46	12.72(3.70)	22.03(4.79)	22.03(4.79)	22.03(4.79)	29.41(5.51)	32.32(5.77)	43.06(6.63)
SM 48	0 (1)	0 (1)	0 (1)	0(1)	12.19 (3.63)	18.67 (4.43)	20.73 (4.66)
SM 49	0(1)	0(1)	0(1)	0 (1)	0(1)	5.50(2.55)	6.00(2.64)
CD (5%)	0.248	0.173	0.237	0.159	0.207	1.322	0.107
Mean	2.10	5.36	11.62	16.64	25.59	31.45	37.02

*DAT- Days After Transplanting

(Transformed values given in parenthesis)

Accession	Percentage of borer incidence		Rating of borer incidence (Fruits)	Bacterial wilt (Per cent of plants infested)	Rating of bacterial wilt incidence
	On shoots	On fruits			
SM 2	31.97 (5.65)	60.87 (7.80)	HS	52.42 (7.30)	MS
SM 6	23.85 (4.88)	49.88 (7.06)	HS	42.14 (6.56)	MS
SM 7	24.79 (4.97)	48.23 (6.94)	HS	31.69 (5.71)	MR
SM 8	6.94 (2.63)	26.20 (5.11)	T	58.66 (7.72)	MS
SM 9	11.62 (3.40)	29.78 (5.45)	T	52.56 (7.31)	MS
SM 10	10.96 (3.31)	29.77 (5.45)	T	34.82 (5.98)	MR
SM 14	23.61 (4.85)	48.17 (6.94)	HS	52.01 (7.28)	MS
SM 15	24.71 (4.97)	47.35 (6.88)	HS	61.90 (7.93)	S
SM 18	18.40 (4.28)	39.22 (6.26)	S	52.69 (7.32)	MS
SM 20	18.89 (4.34)	40.34 (6.35)	HS	49.46 (7.10)	MS
SM 22	31.53 (5.61)	55.19 (7.42)	HS	51.99 (7.27)	MS
SM 23	30.74 (5.54)	63.01 (7.93)	HS	0 (1)	R
SM 24	31.68 (5.62)	61.92 (7.86)	HS	64.53 (8.09)	S
SM 28	16.12 (4.01)	40.56 (6.36)	HS	54.35 (7.43)	MS
SM 29	13.32 (3.64)	34.18 (5.84)	S	62.32 (7.95)	S
SM 30	9.79 (3.12)	26.13 (5.11)	T	52.27 (7.29)	MS
SM 34	20.00 (4.47)	45.56 (6.75)	HS	51.86 (7.27)	MS
SM 36	4.77 (2.18)	14.18 (3.76)	MR	0 (1)	R
SM 39	9.82 (3.13)	26.31 (5.12)	T	61.24 (7.88)	S
SM 40	18.23 (4.27)	44.83 (6.69)	HS	11.78 (3.57)	R
SM 41	19.91 (4.46)	45.15 (6.71)	HS	9.73 (3.27)	R
SM 42	16.33 (4.04)	39.98 (6.32)	S	9.43 (3.22)	R
SM 44	7.87 (2.80)	19.95 (4.46)	MR	0 (1)	R
SM 45	9.43 (3.07)	23.01 (4.79)	T	11.90 (3.59)	R
SM 46	8.48 (2.91)	22.28 (4.72)	T	43.06 (6.63)	MS
SM 48	11.75 (3.42)	29.96 (5.47)	T	20.73 (4.66)	MR
SM 49	5.17 (2.27)	10.83 (3.28)	MR	6.00 (2.64)	R
Mean	17.06	37.88		37.02	
CD (5%)	0.694	0.141		0.107	

HR – Highly Resistant; R – Resistant; T – Tolerant; S – Susceptible; HS – Highly Susceptible (Transformed values given in parenthesis)

Primary branches showed a range of 2.85 – 9.05 and the mean was 5.21. GCV was found to be 31.67 and PCV was 32.76. Heritability was 93.51 per cent while genetic advance was only 3.29. Number of secondary branches ranged from 4.17 - 13.23 cm and showed a mean value of 6.81. The GCV and PCV were 32.78 and 33.32 respectively. Heritability was 96.75 per cent and genetic advance was only 4.53.

Days to anthesis ranged from 27.29 - 55.49 days and showed a mean value of 42.45. The GCV and PCV were 15.95 and 16.00 respectively. Heritability was 99.30 per cent and genetic advance was only 13.90. Days to 50 per cent flowering ranged from 34.52 - 66.49 days with an overall mean of 52.87. GCV was 14.90 and PCV was 14.95. Heritability was found to be 99.40 per cent. Genetic advance was 16.30.

Percentage of long and medium styled flowers varied from 37.63 to 68.45 per cent and the mean was 49.83 per cent. GCV was 15.56 and PCV was 15.69. Heritability was 98.37 and genetic advance was 15.75.

Mean of fruit length was 9.18 and the range 3.40 - 12.34. GCV and PCV values were 24.68 and 24.78 respectively. Heritability was 99.22 per cent and genetic advance was very low, only 4.66. Fruit weight ranged from 20.03 - 371.99 g with a mean of 120.28. The GCV was 67.30 and PCV was 67.42. Heritability was 99.65and genetic advance was 166.48.

4.2.3.2 Yield characters

Fruit girth ranged from 7.23 - 27.25 cm with an overall mean of 16.28. GCV was 31.96 and PCV was 31.99. Heritability was 99.80 per cent. Genetic advance was 10.71.

Calyx length ranged from 1.80 - 3.58 cm with a mean of 3.28 cm. The GCV was 27.16 and PCV was 27.36. Heritability was 98.58 and genetic advance was very low, only 1.82. Pedicel length showed a range of 2.55 - 7.07 cm and the mean was 4.96. GCV was found to be 22.54 and PCV was 23.26. Heritability was 93.91and genetic advance was 2.23.

Fruits per plant ranged from 7.21 to 48.71 cm with a mean of 18.15 cm. The GCV was 54.45 and PCV was 54.70. Heritability was 99.09 and genetic advance was 20.27. Yield per plant showed a range of 661.66 -3617.15 g and the mean was 1559.16 g. GCV was found to be 41.85 and PCV was 41.89. Heritability was 99.83 and genetic advance was 1343.11.

4.2.3.3 Morphological characters

Mean of RLPS was 0.51and the range 0.06 - 0.85. GCV and PCV values were 28.29 and 28.37 respectively. Heritability noted was 99.45 per cent and genetic advance was very low, only 0.30. The range and overall mean of RLSA was 0.10 - 0.43 and 0.29 respectively. GCV was 24.51and PCV was 24.58. Heritability noted was 99.44 per cent and genetic advance was very low, only 0.15.

Shape index varied from 0.98 - 3.65 per cent and the mean was 1.96 per cent. GCV was 45.17 and PCV was 45.22. Heritability was 99.77 and genetic advance was very low, only 1.83. Mean of volume index was 47.48 and the range 10.16 - 95.85. GCV and PCV values were 40.56 and 40.63respectively. Heritability noted was 99.63 per cent and genetic advance 39.60.

4.2.3.4 Biochemical characters

Chlorophyll content varied from 39.10 - 54.85 spad units and the mean was 48.39. GCV was 8.06 and PCV was 9.33. Heritability was 74.68 and genetic advance was 6.94. In case of protein content, range was 1.03 - 1.55 g/100 g and mean value was 1.35. GCV was 9.89 and PCV was 10.01. Heritability showed a value of 97.79 per cent. Genetic advance was 0.27. Vitamin C ranged from 4.07 - 5.80 mg/100 g with a mean of 4.97. The GCV was 10.22 and PCV was 10.46. Heritability was 95.38 and genetic advance was very low, only 1.02.

Total sugar content ranged from 1.31 to 4.22 g per 100 g with 2.86 as the general mean. PCV and GCV were 26.06 and 27.33 respectively. Heritability was 90.90 per cent and genetic advance was 1.46. Reducing sugars ranged from 1.02 - 3.52 g per 100 g with an overall mean of 2.06. GCV was 30.77 and PCV was 32.48. Heritability was found to be 89.72 per cent. Genetic advance was 1.21. Mean of non reducing sugars was 0.77g per 100 g and the range 0.06 - 1.26. GCV and PCV values were 30.45 and 51.30 respectively. Heritability noted was 35.24 per cent and genetic advance was very low, only 0.28.

Phenol content varied from 11.38 - 21.16 mg/100 g and the mean was 15.21. GCV was 18.85 and PCV was 19.28. Heritability was 95.52 and genetic advance was 5.77. Proline content showed a range of 20.01 - 25.37 mg/100 g and the mean was 22.73. GCV was found to be 7.16 and PCV was 7.25. Heritability was 97.77 and genetic advance was 3.32.

4.2.3.5 Incidence of pest and diseases

Percentage of fruit and shoot borer shoot damage at 40 DAT ranged from 7.29 (SM 36) - 54.31(SM 2) per cent with a mean of 25.81. The GCV was 56.77and PCV was 56.86. Heritability was 99.70 and genetic advance was 30.15.

Percentage of fruit and shoot borer fruit damage at 70 DAT ranged from 14.22 (SM 49) - 75.99 (SM 22) days with a mean value of 49.10. The GCV and PCV were 35.74 and 35.88 respectively. Heritability was 99.26 per cent and genetic advance was only 36.03. In case of number of bore holes per fruit, range was 5.66 - 13.16 and mean value was 9.68. GCV was 25.85 and PCV was 26.99. Heritability

Table 22 Estimates of genetic parameters for various characters in brinjal

Characters	Range	Mean	GCV	PCV	Heritability	Genetic advance at 5%	Genetic advance as percentage of mean
Plant height (cm)	44.9- 94.65	67.41	23.71	23.73	99.77	32.89	48.78
Canopy spread (cm)	42.79 - 95.58	69.45	22.72	22.84	98.95	32.34	46.56
Primary branches	2.85 - 9.05	5.21	31.67	32.76	93.51	3.29	63.14
Secondary branches	4.17 - 13.23	6.81	32.78	33.32	96.75	4.53	66.42
Days to 50 per cent flowering	34.52 - 66.49	52.87	14.90	14.95	99.40	16.30	30.59
Long and medium styled flowers (%)	37.63 -68.45	49.53	15.56	15.69	98.37	15.75	31.79
Fruit length (cm)	3.40 - 12.34	9.18	24.68	24.78	99.22	4.66	50.75
Fruits per plant	7.21 - 48.71	18.15	54.45	54.70	99.09	20.27	111.68
Yield per plant (gm)	661.66 -3617.15	1559.16	41.85	41.89	99.83	1343.11	86.14
Fruit weight (gm)	20.03 - 371.99	120.28	67.30	67.42	99.65	166.48	138.41
Days to first flowering	27.29 - 55.49	42.45	15.95	16.00	99.30	13.90	32.74
Fruit girth (cm)	7.23 - 27.25	16.28	31.96	31.99	99.80	10.71	65.77
Shape index	0.98 - 3.65	1.96	45.17	45.22	99.77	1.83	92.98
Volume index	10.16 - 95.85	47.48	40.56	40.63	99.63	39.60	83.34
Calyx length (cm)	1.80 - 3.58	3.28	27.16	27.36	98.58	1.82	55.47
Pedicel length (cm)	2.55 - 7.07	4.96	22.54	23.26	93.91	2.23	44.98
FSB shoot damage	7.29 - 54.31	25.81	56.77	56.86	99.70	30.15	116.76
FSB fruit damage	14.22 - 75.99	49.10	35.74	35.88	99.26	36.03	73.35
Bacterial wilt infection	0.00 - 64.53	37.02	61.11	61.28	99.42	46.49	125.51
Bore holes per fruit	5.66 - 13.16	9.68	25.85	26.99	91.69	4.94	50.98
Larvae per fruit	1.68 - 5.12	3.31	26.35	31.16	71.51	1.52	45.78
RLPS	0.06 - 0.85	0.51	28.29	28.37	99.45	0.30	57.8
RLSA	0.10 - 0.43	0.29	24.51	24.58	99.44	0.15	50.33
Chlorophyll content (spad units)	39.10 - 54.85	48.39	8.06	9.33	74.68	6.94	14.34
Total sugars (g)	1.31 - 4.22	2.86	26.06	27.33	90.90	1.46	51.01
Reducing sugars (g)	1.02 - 3.52	2.06	30.77	32.48	89.72	1.21	59.66
Non reducing sugars(g)	0.06 - 1.26	0.77	30.45	51.30	35.24	0.28	36.26
Protien (g)	1.03 - 1.55	1.35	9.89	10.01	97.79	0.27	19.97
Phenol (mg)	11.38 - 21.16	15.21	18.85	19.28	95.52	5.77	37.92
Proline (mg)	20.01 - 25.37	22.73	7.16	7.25	97.77	3.32	14.60
Vitamin C (mg)	4.07 - 5.80	4.97	10.22	10.46	95.38	1.02	20.47

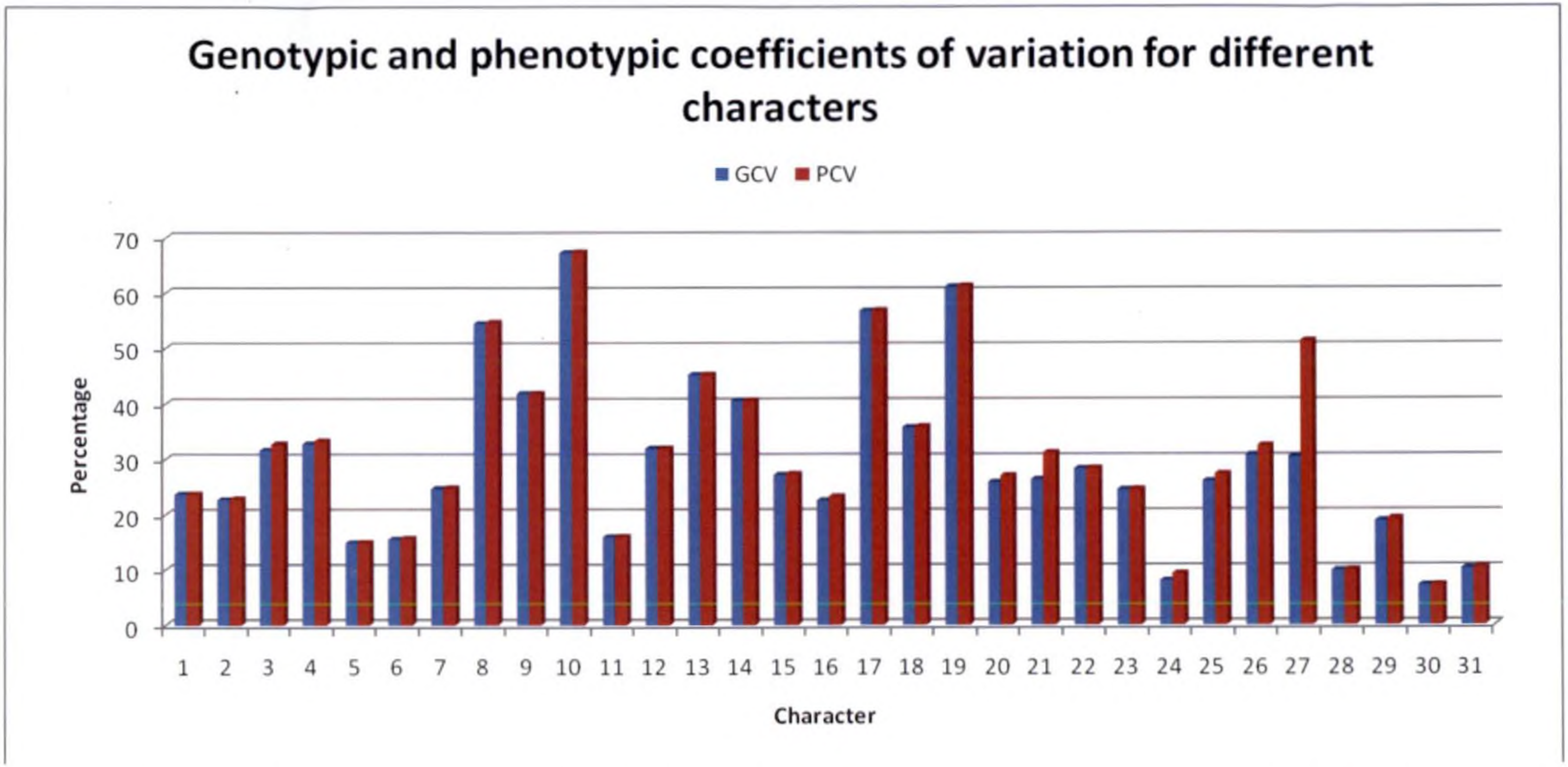
GCV – Genotypic coefficient of variation

PCV – Phenotypic coefficient of variation

RLPS – Ratio of peripheral seed ring to total length of fruit

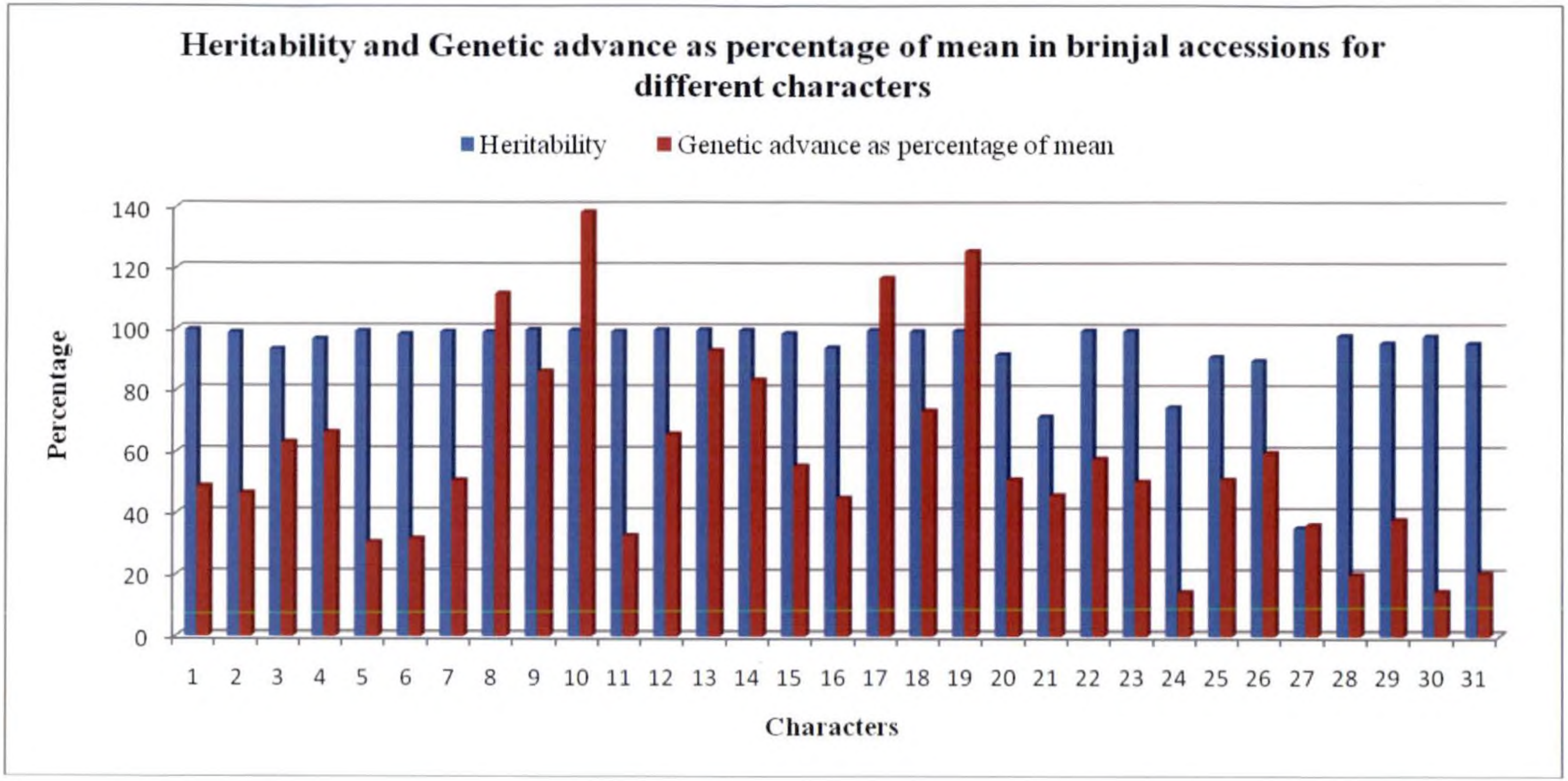
RLSA – Ratio of seed less area to the total length of fruit

Fig. 4



1. Plant height (cm)
2. Canopy spread (cm)
3. Primary branches
4. Secondary branches
5. Days to 50 per cent flowering (%)
6. Long and medium styled flowers (%)
7. Fruit length (cm)
8. Fruits per plant
9. Yield per plant (g)
10. Fruit weight (g)
11. Days to first flowering
12. Fruit girth (cm)
13. Shape index
14. Volume index
15. Calyx length (cm)
16. Pedicel length
17. FSB shoot damage
18. FSB fruit damage
19. Bore holes per fruit
20. Larvae per fruit
21. RLPS
22. RLSA
23. Chlorophyll content (spad units)
24. Total sugars (g)
25. Reducing sugars (g)
26. Non reducing sugars (g)
27. Protein (g)
28. Phenol (mg)
29. Proline (mg)
30. Proline (mg)
31. Vitamin C (mg)

Fig. 5



11. Plant height (cm)
12. Canopy spread (cm)
13. Primary branches
14. Secondary branches
15. Days to 50 per cent flowering (%)
16. Long and medium styled flowers (%)
17. Fruit length (cm)
18. Fruits per plant
19. Yield per plant (g)
20. Fruit weight (g)

11. Days to first flowering
12. Fruit girth (cm)
13. Shape index
14. Volume index
15. Calyx length (cm)
16. Pedicel length
17. FSB shoot damage
18. FSB fruit damage
19. Bore holes per fruit
20. Larvae per fruit

21. RLPS
22. RLSA
23. Chlorophyll content (spad units)
24. Total sugars (g)
25. Reducing sugars (g)
26. Non reducing sugars (g)
27. Protein (g)
28. Phenol (mg)
29. Proline (mg)
30. Proline (mg)

31. Vitamin C (mg)

showed a value of 91.69 per cent. Genetic advance was 4.94. The range and general mean for number of larvae per fruit were 1.68 to 5.12 and 3.31 respectively. GCV was 26.35 and PCV was 31.16. Heritability was 71.51 and genetic gain noted to be 1.52.

Percentage of bacterial wilt infected plants at 90 DAT ranged from 0.00 - 64.53 per cent with an overall mean of 37.02. GCV was 61.11 and PCV was 61.28. Heritability was found to be 99.42 per cent. Genetic advance was 46.49.

4.2.4 Correlation studies

The phenotypic, genetic and error correlation among 14 morphological, yield characters were worked out and are presented in Tables 23, 24 and 25 respectively. Fruit and shoot borer infestation with anatomical and biochemical characters were computed and presented in Tables 26, 27 and 28 respectively.

4.2.4.1 Phenotypic Correlation Coefficients

Yield per plant showed significant positive correlation with per cent of long and medium styled flowers (0.9279), number of primary branches (0.6170), fruit length (0.4901), plant height (0.4019), number of secondary branches (0.4007), canopy spread (0.3933) and number of fruits per plant (0.3816). It exhibited significant negative correlation with fruit infestation by fruit and shoot borer (-0.3665) (Table 22).

Shoot damage by fruit and shoot borer showed significant positive correlation with fruit infestation (0.9334), total sugars (0.8437), vitamin C content (0.8403), reducing sugars (0.8368), protein content (0.8264), RLSA (0.4659) and non reducing sugars (0.3761). It exhibited negative correlation with proline content (-0.8382), phenol content (-0.8198) and R LPS (-0.4145). Fruit infestation also showed the same (Table 25).

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Calyx length, pedicel length and chlorophyll content showed negative correlation with fruit and shoot borer infestation and boreholes and larvae per fruit showed positive correlation but it is not significant.

4.2.4.2 Genotypic Correlation Coefficients

Genotypic correlation coefficients were in general higher than phenotypic correlation for the characters under study.

High positive correlation was obtained between yield and % of long and medium styled flowers (0.9387), number of primary branches (0.6368), fruit length (0.4936), number of secondary branches (0.4056), plant height (0.4027), canopy spread (0.3959) and fruits per plant (0.3839). It exhibited negative correlation with fruit infestation by fruit and shoot borer (-0.3683) (Table 23).

Shoot infestation by fruit and shoot borer exhibited negative correlation with canopy spread (-0. 6455), days to anthesis (-0.4329), days to 50 per cent flowering (-0.4255) and number of primary branches (-0.4180).

Fruit infestation by fruit and shoot borer showed significant positive correlation with protein content (0.9424), fruit and shoot borer shoot damage (0.9385), total sugars (0.9019), vitamin C content (0.9016), RLSA (0.5456), Number of larvae per fruit (0.2839). It exhibited negative correlation with phenol content (-0.9248) and proline content (-0.8718). Shoot damage by fruit and shoot borer showed significant positive correlation with protein content (0.9424), fruit infestation (0.9385), total sugars (0.9019), vitamin C content (0.9016) and it showed negative correlation with phenol content (-0.8386) and proline content (-0.8486) (Table 26)

Calyx length, pedicel length and chlorophyll content showed negative correlation with fruit and shoot borer infestation and bore holes and larvae per fruit showed positive correlation but it was not significant.

Table 23 Phenotypic correlation coefficients among yield and yield components

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1													
X2	0.2742	1												
X3	0.3585	0.5653	1											
X4	0.3948	0.4351	0.4331	1										
X5	0.1046	0.0121	0.1929	0.0527	1									
X6	0.4404	0.4876	0.5759	0.3786	-0.0406	1								
X7	0.1358	0.2551	0.2497	-0.0158	0.0513	0.4498	1							
X8	-0.0775	0.0064	0.1072	0.1705	-0.0933	0.2627	-0.2456	1						
X9	0.4019	0.3933	0.6171	0.4007	-0.0207	0.9279	0.4901	0.3816	1					
X10	0.2202	0.1946	0.2464	-0.0227	0.3288	0.3057	0.4854	-0.5544	0.2237	1				
X11	0.1352	0.0263	0.1927	0.0768	0.9605	-0.0091	0.0759	-0.0833	0.0146	0.3148	1			
X12	0.284	0.2958	0.1417	-0.0271	0.2184	0.0054	0.0708	-0.5996	-0.1397	0.6911	0.1654	1		
X13	-0.1037	-0.5497	-0.3626	-0.2236	-0.3709	-0.2714	-0.0819	-0.1537	-0.2435	-0.2467	-0.3754	-0.1992	1	
X14	-0.1825	-0.6404	0.3978	-0.3304	-0.4208	-0.3973	-0.1835	-0.1846	-0.3665	-0.3134	-0.4272	0.2493	0.9334	1

X1. Plant height (cm)

X2. Canopy spread (cm)

X3. Primary branches

X4. Secondary branches

X6. Long and medium styled flowers (%)

X7. Fruit length (cm)

X8. Fruits per plant

X9. Yield per plant (g)

X11. Days to first flowering

X12. Fruit girth (cm)

X13. FSB Shoot damage

X14. FSB Fruit damage

*FSB – Fruit and shoot borer

Table 24 Genotypic correlation coefficients among yield and yield components

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1													
X2	0.2771	1												
X3	0.3725	0.5913	1											
X4	0.4013	0.4513	0.446	1										
X5	0.1063	0.0093	0.1958	0.0573	1									
X6	0.4433	0.4947	0.6071	0.3861	-0.0386	1								
X7	0.1356	0.2591	0.2639	-0.0151	0.0511	0.4538	1							
X8	-0.0777	0.0064	0.1167	0.1719	-0.0946	0.2646	-0.2484	1						
X9	0.4027	0.3959	0.6368	0.4056	-0.0212	0.9387	0.4936	0.3839	1					
X10	0.2203	0.1973	0.2589	-0.0237	0.3301	0.3086	0.4873	-0.5599	0.2242	1				
X11	0.1362	0.0286	0.1954	0.0776	0.9663	-0.0051	0.0768	-0.0829	0.0144	0.3158	1			
X12	0.2843	0.2977	0.1439	-0.0281	0.2195	0.0073	0.0707	-0.6019	-0.1407	0.6928	0.1658	1		
X13	-0.1033	-0.5534	-0.3744	-0.2278	-0.3731	-0.2745	-0.0833	-0.1556	-0.2436	-0.2476	-0.3772	-0.1991	1	
X14	-0.1837	-0.6455	-0.4181	-0.3352	-0.4255	-0.3984	-0.1844	-0.1872	-0.3683	-0.3158	-0.4329	-0.2511	0.9385	1

X1. Plant height (cm)
X2. Canopy spread (cm)
X3. Primary branches
X4. Secondary branches
X6. Long and medium styled flowers (%)
X7. Fruit length (cm)
X8. Fruits per plant
X9. Yield per plant (g)
X11. Days to first flowering
X12. Fruit girth (cm)
X13. FSB Shoot damage
X14. FSB Fruit damage

*FSB – Fruit and shoot borer

Table 25 Error correlation coefficients among yield and yield components

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1													
X2	-0.2426	1												
X3	-0.1081	-0.1352	1											
X4	0.0489	0.3571	0.1921	1										
X5	-0.3262	0.3548	0.2079	-0.2531	1									
X6	0.2129	-0.0316	-0.1938	0.0878	-0.2502	1								
X7	0.2091	-0.1761	-0.1985	-0.0621	0.0877	0.1249	1							
X8	-0.0611	0.0004	-0.2133	0.1261	0.0841	0.1151	0.0814	1						
X9	-0.0522	-0.0518	0.1658	0.2891	0.1168	-0.4298	-0.3464	-0.0512	1					
X10	0.1987	-0.2157	-0.2351	0.0496	0.0541	0.0642	0.1569	0.3517	0.0375	1				
X11	-0.0907	-0.2382	0.2059	0.0495	0.0746	-0.3693	-0.0563	-0.1402	0.0672	0.1376	1			
X12	0.1165	-0.0095	0.2325	0.0705	-0.0499	-0.3148	0.1214	-0.2352	0.3902	0.0531	0.0914	1		
X13	-0.2599	-0.0186	-0.0751	0.0131	0.1248	0.0703	0.1845	0.1775	-0.2413	0.0362	-0.0253	-0.2871	1	
X14	0.0744	-0.0792	0.2251	-0.1214	0.2738	-0.331	-0.0629	0.1289	0.0498	0.1429	0.3528	-0.1042	-0.0417	1

X1. Plant height (cm)

X2. Canopy spread (cm)

X3. Primary branches

X4. Secondary branches

X6. Long and medium styled flowers (%)

X7. Fruit length (cm)

X8. Fruits per plant

X9. Yield per plant (g)

X11. Days to first flowering

X12. Fruit girth (cm)

X13. FSB Shoot damage

X14. FSB Fruit damage

*FSB – Fruit and shoot borer

Table 26 Phenotypic correlation coefficients among FSB damage and morphological and biochemical characters

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	1																
X2	0.9334	1															
X3	0.1262	0.2701	1														
X4	0.2006	0.2178	0.0908	1													
X5	-0.0681	-0.0963	-0.1336	-0.1015	1												
X6	-0.0943	-0.0949	0.0325	-0.0771	0.1476	1											
X7	0.0882	0.0708	-0.0223	-0.0517	-0.2232	0.4152	1										
X8	-0.4145	-0.4176	0.0984	-0.0714	0.1203	0.2692	0.3153	1									
X9	0.4659	0.5418	0.3196	0.3546	0.2669	-0.0931	0.0027	-0.0166	1								
X10	-0.0243	0.1193	0.3398	0.0943	-0.0077	0.0721	-0.0571	-0.1688	0.1344	1							
X11	0.8437	0.8634	0.1342	0.2551	-0.1388	-0.2241	-0.0085	-0.4295	0.4397	0.1064	1						
X12	0.8368	0.8233	0.2072	0.1568	0.0712	-0.1978	-0.0354	-0.3948	0.5307	0.0774	0.8773	1					
X13	0.3761	0.3979	-0.0038	0.3326	-0.3373	0.0534	0.0349	-0.2783	0.0966	0.1492	0.5211	0.1511	1				
X14	0.8264	0.9307	0.3426	0.1786	-0.1184	-0.1324	-0.0064	-0.4311	0.4837	0.2937	0.8759	0.8325	0.4029	1			
X15	-0.8198	-0.8961	-0.3984	-0.2046	0.2001	0.0297	0.0409	0.3157	-0.5241	-0.2479	-0.8419	-0.8032	-0.3756	0.9095	1		
X16	-0.8382	-0.8553	-0.1008	-0.0848	-0.1271	0.0836	-0.1314	0.2927	-0.6108	-0.0551	-0.8215	-0.8593	-0.2017	-0.8383	0.8106	1	
X17	0.8402	0.8785	0.2767	0.1627	0.0011	-0.0813	0.0106	-0.4192	0.5846	0.1794	0.8764	0.8623	0.3772	0.8634	0.8801	-0.8784	1

X1. FSB shoot infestation (%)

X2. FSB fruit infestation (%)

X3. Bore holes per fruit

X4. Larvae per fruit

X5. Calyx length (cm)

X6. Pedicel length (cm)

X7. Shape index

X8. Volume index

X9. RLPS

X10. RLSA

X11. Total sugars (g)

X12. Reducing sugars(g)

X13. Non reducing sugars (g)

X14. Protein content (g)

X15. Phenol content(mg)

X16. Proline content (mg)

X17. Vitamin C content (mg)

*RLPS – Ratio of peripheral seed ring to total length of fruit

*RLSA – Ratio of seed less area to the total length of fruit

Table 27 Genotypic correlation coefficients among FSB damage and morphological and biochemical characters

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	1																
X2	0.9385	1															
X3	0.1323	0.2839	1														
X4	0.2346	0.2401	0.1011	1													
X5	-0.0685	-0.0976	-0.1397	-0.1213	1												
X6	-0.0956	-0.1071	0.0189	-0.1339	0.1604	1											
X7	0.0881	0.0701	-0.0283	-0.0731	-0.2264	0.4256	1										
X8	-0.4155	-0.4213	0.0929	-0.0327	0.1214	0.2741	0.3148	1									
X9	0.4693	0.5456	0.3351	0.4111	0.2693	-0.0986	0.0026	-0.0174	1								
X10	-0.0305	0.1521	0.4139	0.1009	-0.0141	0.0874	-0.0558	-0.1914	0.1567	1							
X11	0.8871	0.9019	0.1388	0.3134	-0.1597	-0.2451	-0.0126	-0.4474	0.4592	0.1837	1						
X12	0.8842	0.8653	0.2553	0.2029	0.0813	-0.2148	-0.0401	-0.4098	0.5581	0.1658	0.9465	1					
X13	0.6449	0.6633	-0.1145	0.5547	-0.6356	-0.1015	0.0499	-0.4776	0.1383	0.2471	0.6185	0.4495	1				
X14	0.8362	0.9424	0.3439	0.1888	-0.1201	-0.1496	-0.0072	-0.4415	0.4879	0.3183	0.9394	0.8966	0.6872	1			
X15	-0.8386	-0.9248	-0.4276	-0.3002	0.0265	0.0256	0.0445	0.3245	-0.5344	-0.3297	-0.8925	-0.8471	-0.6502	-0.9398	1		
X16	-0.8486	-0.8718	-0.1064	-0.1163	-0.1288	0.0871	-0.1356	0.2957	-0.6201	-0.0062	-0.8851	-0.9323	-0.3619	-0.8514	0.8437	1	
X17	0.8627	0.9016	0.2951	0.2495	-0.0128	-0.0891	0.0113	-0.4281	0.6009	0.1957	0.9165	0.9372	0.5942	0.9004	-0.9191	-0.9042	1

X1. FSB shoot infestation (%)

X2. FSB fruit infestation (%)

X3. Bore holes per fruit

X4. Larvae per fruit

X5. Calyx length (cm)

X6. Pedicel length (cm)

X7. Shape index

X8. Volume index

X9. RLPS

X10. RLSA

X11. Total sugars (g)

X12. Reducing sugars(g)

X13. Non reducing sugars (g)

X14. Protein content (g)

X15. Phenol content(mg)

X16. Proline content (mg)

X17. Vitamin C content (mg)

*RLPS – Ratio of peripheral seed ring to total length of fruit

*RLSA – Ratio of seed less area to the total length of fruit

Table 28 Error correlation coefficients among FSB damage and morphological and biochemical characters

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	1																
X2	-0.0417	1															
X3	-0.0169	-0.0334	1														
X4	0.0868	0.3403	0.0583	1													
X5	-0.0229	0.0202	-0.0218	0.0054	1												
X6	-0.1345	0.4014	0.2107	0.2485	-0.2297	1											
X7	0.1591	0.2414	0.3433	0.3935	0.2293	0.2746	1										
X8	-0.1834	0.1588	0.4577	0.2587	0.0128	0.2413	0.4749	1									
X9	-0.3384	-0.052	-0.0171	0.2021	0.0249	-0.1558	0.0281	0.1271	1								
X10	0.0721	-0.2681	-0.0187	0.0764	0.0728	-0.0091	-0.3671	-0.1042	-0.0176	1							
X11	-0.0507	0.2595	0.0856	0.0145	0.3438	0.0323	0.2415	-0.1784	0.1411	-0.2959	1						
X12	0.0306	0.2454	-0.2643	-0.0337	-0.1378	-0.0078	0.1636	-0.3234	0.1461	-0.3612	0.2324	1					
X13	-0.1402	0.0805	0.2644	0.1262	0.3893	-0.0251	0.1394	0.0742	0.2461	0.0554	0.7042	-0.3946	1				
X14	0.0879	0.1751	0.3958	0.2618	-0.0267	0.2973	0.1007	0.4015	0.2309	0.2897	-0.2174	-0.1544	-0.0047	1			
X15	-0.1185	0.2512	0.0294	0.3856	-0.2303	0.1044	-0.2571	-0.0342	-0.2041	0.2873	-0.1603	-0.2812	0.0094	-0.0353	1		
X16	0.0683	0.2784	-0.0022	0.1551	-0.0378	0.0024	0.3421	0.1029	0.0602	-0.6621	0.2854	0.2901	0.0893	-0.2596	-0.1489	1	
X17	-0.0992	0.0632	0.0123	-0.3784	0.5282	0.0556	-0.0399	-0.1462	-0.0403	0.1317	0.3553	-0.0674	0.1891	-0.1938	-0.0612	-0.1628	1

X1. FSB shoot infestation (%)

X2. FSB fruit infestation (%)

X3. Bore holes per fruit

X4. Larvae per fruit

X5. Calyx length (cm)

X6. Pedicel length (cm)

X7. Shape index

X8. Volume index

X9. RLPS

X10. RLSA

X11. Total sugars (g)

X12. Reducing sugars(g)

X13. Non reducing sugars (g)

X14. Protein content (g)

X15. Phenol content(mg)

X16. Proline content (mg)

X17. Vitamin C content (mg)

*RLPS – Ratio of peripheral seed ring to total length of fruit

*RLSA – Ratio of seed less area to the total length of fruit

4.2.4.3 Error correlation coefficients

Most of the error correlation coefficients were very low.

4.2.5 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, canopy spread, number of primary branches, number of secondary branches, days to 50 % flowering, % of long and medium styled flowers, fruit length and fruits per plant were selected were selected for path coefficient analysis (Table 29).

Direct effects and correlation of these yield components are presented in Fig. 6

Plant height had genotypic correlation of 0.4027 with yield. In this, the direct effect was only 0.0219. Major portion of indirect effects was through per cent of long and medium styled flowers (0.3159). Indirect effect of plant height on yield through days to 50% flowering (-0.0026), fruits per plant (-0.0167), fruit length (0.0297), number of secondary branches (0.0338), canopy spread (-0.0452) and number of primary branches (0.0660).

Genotypic correlation of canopy spread with yield was 0.3959. Its direct effect is only -0.1632. But its indirect effect on yield through days to 50 per cent flowering, fruits per plant, plant height, secondary branches, fruit length, primary branches, percentage of long and medium styled flowers were -0.0062, 0.0014, 0.0061, 0.0380, 0.0566 and 0.1047 respectively.

The direct effect of number of primary branches on yield was 0.1771 but genotypic correlation with yield was 0.6368. This is mainly by the indirect effect of number of primary branches on yield through % of long and medium styled flowers

(0.4326) followed by fruit length (0.0577), number of secondary branches (0.0375), fruits per plant (0.0251) and plant height (0.0082). Indirect effect through canopy spread (-0.0965) and days to 50 % flowering (-0.0049).

Number of secondary branches had a genotypic correlation of 0.4056 with yield of which the direct effect was only 0.0842. Indirect effects through % of long and medium styled flowers, number of primary branches, canopy spread, fruits per plant, plant height, fruit length and days to 50 % flowering were 0.2751, 0.0790, -0.0737, 0.0369, 0.0088, -0.0033 and -0.0014 respectively.

Days to 50 % flowering had a genotypic correlation of -0.0212 with yield. In this, the direct was only -0.0248. Indirect effect on yield through canopy spread (-0.0015), plant height (0.0023), number of secondary branches (0.0048), number of primary branches (0.0347), per cent of long and medium styled flowers (-0.0275), fruits per plant (-0.0203) and fruit length (0.0112).

Per cent of long and medium styled flowers had the highest genotypic correlation with yield (0.9387). Its direct effect on yield was as high as 0.7127. Indirect effects through number of primary branches, fruit length, canopy spread, fruits per plant, number of secondary branches plant height and days to 50 % flowering were 0.1075, 0.0992, -0.0807, 0.0569, 0.0325, 0.0097 and 0.0010 respectively.

Fruit length had a genotypic correlation of 0.4936 with yield of which the direct effect was 0.2187. This is mainly by the indirect effect of per cent of long and medium styled flowers (0.3234), fruits per plant (-0.0534), number of primary branches (0.0467), canopy spread (-0.0423), plant height (0.0030), number of secondary branches (-0.0013) and days to 50 % flowering (-0.0013).

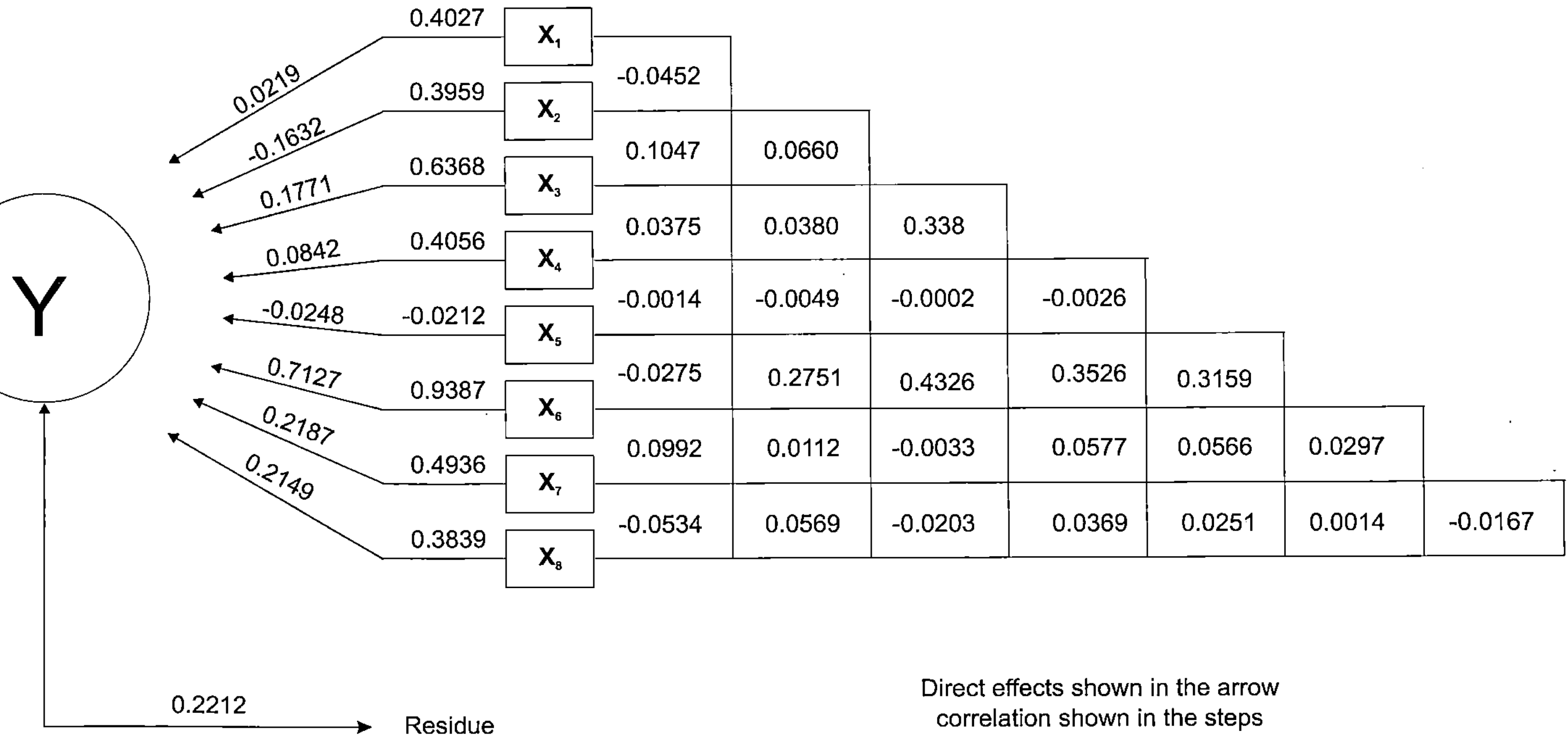
Table 29 Direct and indirect effects of yield components of brinjal

Characters	Plant height	Canopy spread	Number of primary branches	Number of secondary branches	Days to 50 per cent flowering	Long and medium styled flowers (%)	Fruit length	Fruits per plant	Total correlation
Plant height	0.0219	-0.0452	0.0660	0.0338	-0.0026	0.3159	0.0297	-0.0167	0.4027
Canopy spread	0.0061	-0.1632	0.1047	0.0380	-0.0002	0.3526	0.0566	0.0014	0.3959
Primary branches	0.0082	-0.0965	0.1771	0.0375	-0.0049	0.4326	0.0577	0.0251	0.6368
Secondary branches	0.0088	-0.0737	0.0790	0.0842	-0.0014	0.2751	-0.0033	0.0369	0.4056
Days to 50 per cent flowering	0.0023	-0.0015	0.0347	0.0048	-0.0248	-0.0275	0.0112	-0.0203	-0.0212
Long and medium styled flowers(%)	0.0097	-0.0807	0.1075	0.0325	0.0010	0.7127	0.0992	0.0569	0.9387
Fruit length	0.0030	-0.0423	0.0467	-0.0013	-0.0013	0.3234	0.2187	-0.0534	0.4936
Fruits per plant	-0.0017	-0.0010	0.0207	0.0145	0.0024	0.1886	-0.0543	0.2149	0.3839

Residue (R) = 0.2212

(Underlined figures are Direct effects)

Fig.6 Path diagram showing direct effects and correlation of yield components on total yield of brinjal accessions



The direct effect of fruits per plant on yield was 0.2149 but genotypic correlation with yield was 0.3839. Indirect effects on yield through per cent of long and medium styled flowers (0.1886), fruit length (-0.05430, number of primary branches (0.0207), number of secondary branches (0.0145), days to 50 % flowering (0.0024), plant height (-0.0017) and canopy spread (-0.0010).

The residue was 0.2212 indicating that the selected eight characters contributing the remaining seventy eight per cent.

4.2.6 Selection Index

Discriminate function technique was adopted for the construction of selection index for yield using fruit yield per plant (X_9) and the component characters *viz.*, plant height (X_1), canopy spread (X_2), number of primary branches (X_3), number of secondary branches (X_4), days to 50% flowering (X_5), % of long and medium styled flowers (X_6), fruit length (X_7), fruits per plant(X_8),fruit and shoot borer shoot damage (X_{10}), fruit and shoot borer fruit damage (X_{11}), vitamin C (X_{12}) and protein content (X_{13}). These component characters showed relatively stronger association with yield and could form a valuable selection index for yield in this crop.

The selection index, worked out in the present study is given below.

$$I = 1.288054\ X_1 + 0.5745675\ X_2 + 3.048327\ X^3 + 1.945085\ X_4 + 0.784041\ X_5 + 4.877941\ X_6 + 5.990136\ X_7 + 1.799063\ X_8 + 0.9384907\ X_9 + 1.748492\ X_{10} + -0.385602\ X_{11} + -20.45568\ X_{12} + 179.2161\ X_{13}$$

The index value for each land race was determined and they were ranked accordingly (Table 30). Ten land races *viz.*, SM 49 (8496.2), SM 44 (6995.7), SM 23(6318.7), SM 41 (6128.1), SM 30 (5516.9), SM 42 (4997.2), SM 45(4618.3), SM 36(4378.1), SM 7(4327.1) and SM 39 (4279.0) recorded top index values.

Table 30 Brinjal accessions ranked according to selection index

(based on discriminante function analysis)

Sl No.	Accession	Index	Rank
1	SM 2	4110.3	12
2	SM 6	3696.0	17
3	SM 7	4327.1	9
4	SM 8	3059.1	25
5	SM 9	3650.7	19
6	SM 10	3652.6	18
7	SM 14	3030.3	26
8	SM 15	3118.4	24
9	SM 18	3724.0	15
10	SM 20	4145.0	11
11	SM 22	3562.9	22
12	SM 23	6318.7	3
13	SM 24	3854.8	14
14	SM 28	3718.4	16
15	SM 29	3888.0	13
16	SM 30	5516.9	5
17	SM 34	2547.4	27
18	SM 36	4378.1	8
19	SM 39	4279.0	10
20	SM 40	3617.3	20
21	SM 41	6128.1	4
22	SM 42	4997.2	6
23	SM 44	6995.7	2
24	SM 45	4618.3	7
25	SM 46	3571.9	21
26	SM 48	3468.5	23
27	SM 49	8496.2	1

4.2.7 Genetic Divergence analysis

Following Mahalanobis's statistic, the 27 accessions of brinjal were subjected to D^2 analysis based on nine characters, viz., plant height, canopy spread, number of primary branches, number of secondary branches, days to 50 % flowering, % of long and medium styled flowers, fruit length , fruits per plant and yield per plant.

The 27 accessions were grouped into five clusters (Fig. 7). The clustering pattern is furnished in Table 31. Dendrogram generated by UPGMA cluster analysis is shown in Fig. 8.

Cluster I was the largest with twenty accessions, closely followed by cluster II with one genotype. Cluster V, cluster IV and cluster III had one, three and two accessions respectively.

Cluster means of the seven characters are presented in Table 32. The highest mean for plant height (94.65 cm) was shown by cluster V, while lowest was seen in cluster III (58.33).

Cluster III had the maximum cluster mean for canopy spread (90.93) and cluster I had the minimum value. Cluster mean for number of primary branches was highest in cluster III (7.77) and lowest in cluster II (3.36).

Cluster V exhibited the maximum values for secondary branches , percentage of long and medium styled flower, fruits per plant and yield (9.69, 68.45, 46.41 and 3617.15) while cluster II had minimum values(4.17, 41.15, 11.03 and 661.66) respectively.

Cluster mean for days to 50 per cent flowering was highest in cluster V (56.42) and lowest in cluster IV (50.44). The maximum value for fruit length was seen in cluster V (12.17) and minimum value in cluster I (8.57).

Table 31 Clustering of brinjal accessions based on D^2 analysis

Clusters	Accessions
I	SM 2, SM 6, SM 7, SM 8, SM 9, SM 10, SM 14, SM 15, SM 18, SM 20 , SM 22, SM 24, SM 28, SM 29, SM 36, SM 39, SM 40, SM 45, SM 46 and SM 48
II	SM 34
III	SM 30 and SM 42
IV	SM 23, SM 41 and SM 44
V	SM 49

Table 32 Cluster means for nine biometric characters in brinjal

Character	Clusters				
	I	II	III	IV	V
Plant height (cm)	65.22	75.63	58.33	76.31	94.65
Canopy spread (cm)	64.85	81.21	90.93	78.35	79.91
Primary branches	4.69	3.36	7.77	7.1	6.69
Secondary branches	6.59	4.17	5.61	9.01	9.69
Days to 50 per cent flowering	53.03	54.76	52.31	50.44	56.42
Long and medium styled flowers (%)	46.75	41.15	55.05	60.95	68.45
Fruit length (cm)	8.57	8.63	10.61	11.47	12.17
Number of fruits per plant	16.86	11.03	21.25	17.62	46.41
Yield per plant (g)	1297.56	661.66	2022.90	2607.19	3617.15

Fig.7 Cluster diagram

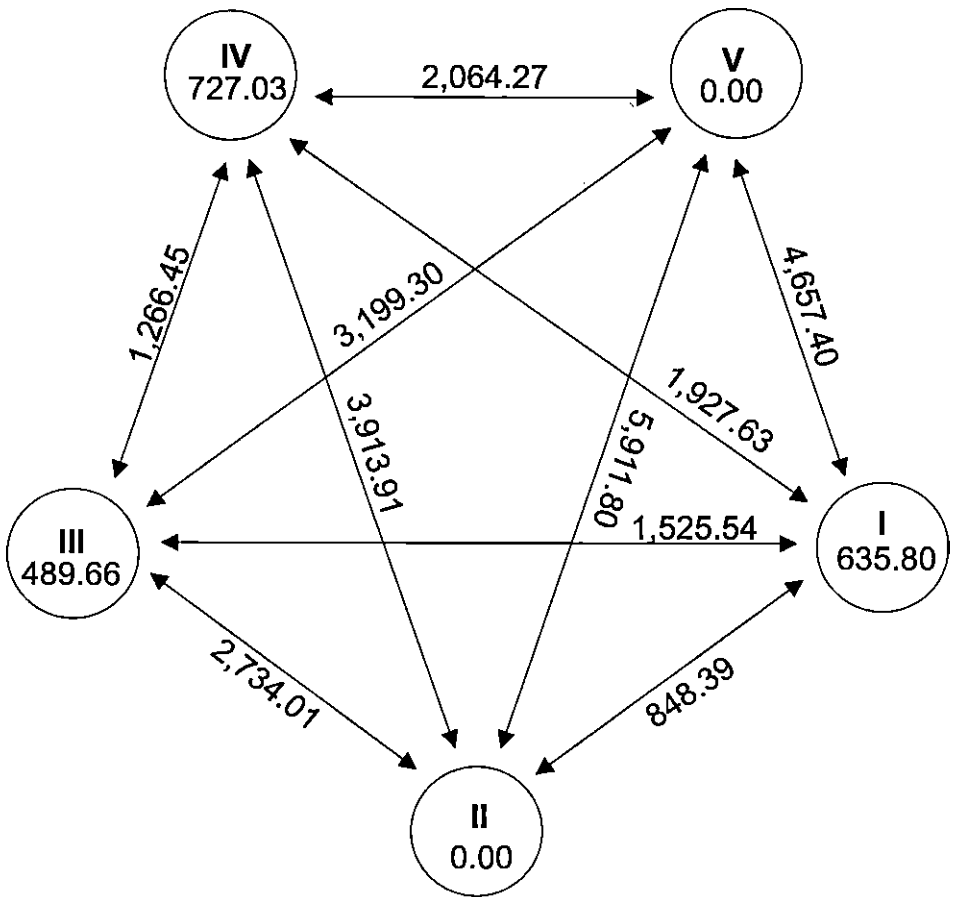
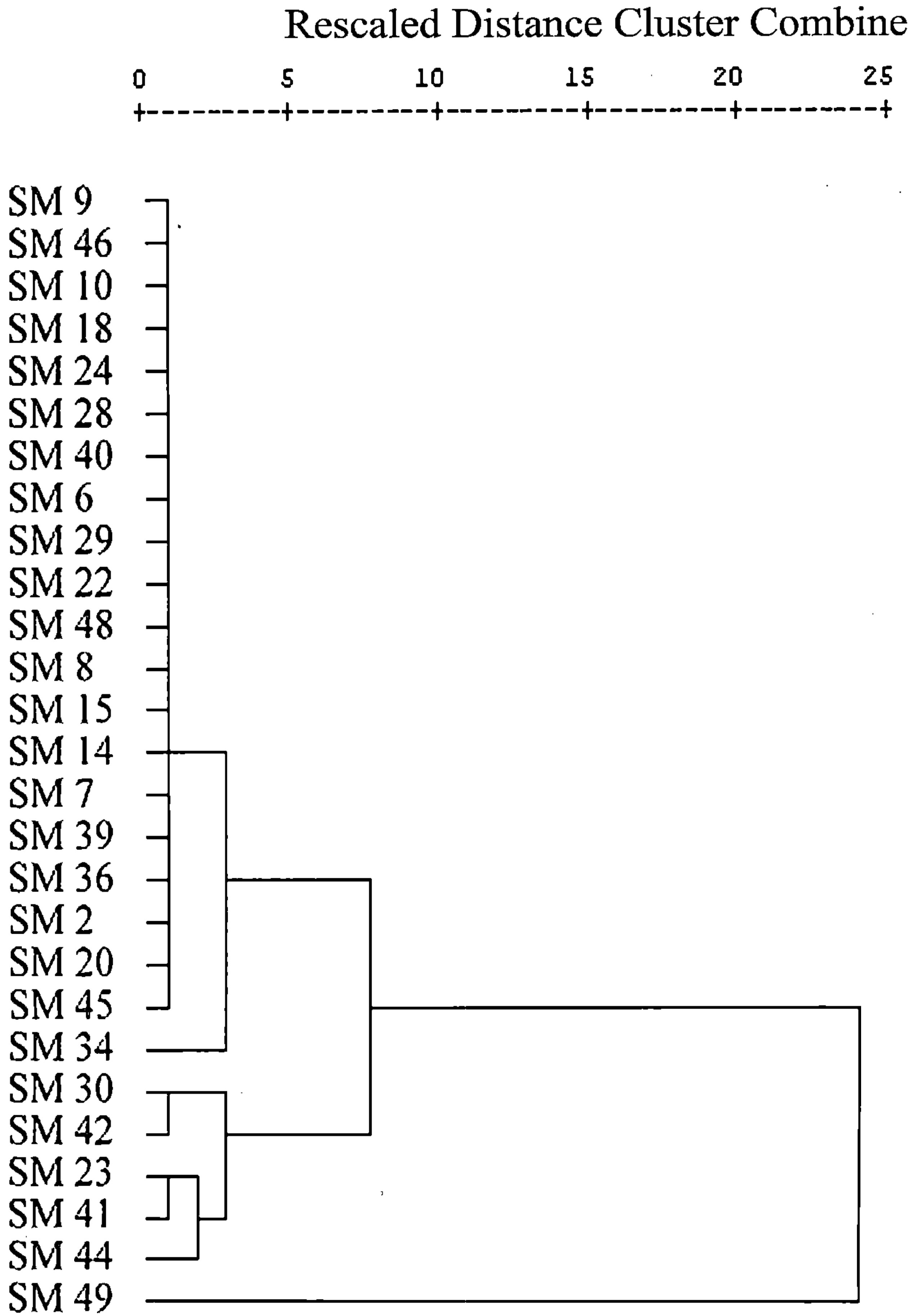


Fig. 8 Dendrogram of different brinjal accessions constructed using UPGMA hierarchial cluster analysis (Between Groups) based on squared Euclidean dissimilarity



The average intra and inter cluster distances are furnished in Table 33.

The average inter and intra cluster distances were estimated based on total D^2 values. The intra cluster (D value) distances varied from 0 to 727.03 .whereas the intercluster (D value) distances ranged from 848.39 to 5911.80. The intracluster distances seen to be lower than intercluster distances. The maximum intracluster distance was observed in cluster IV (727.03). Clusters II and V had only one genotype each and hence intra cluster distance was 0. The maximum intercluster distance was noticed between cluster II and V (5911.80) while the minimum distance was between cluster I and II (848.39).

4.2.8 Cataloguing of germplasm

All the 27 accessions were distributed morphologically using the modified descriptor developed from the standard descriptor for brinjal by IPGRI. The accessions were scored for 23 morphological characters on appropriate scales ranging from 0-9 (Table 34).

Plant height showed considerable variation among the accessions with a range of 40-90 cm. Regarding canopy spread, present accessions include narrow(9), intermediate (16) and broad(2). Almost all accessions showed weak and intermediate branching.

Considerable variation was noticed among the accessions for leaf characters like length, width and lobing. All accessions except SM 9, SM 14, SM 18, SM 20, SM 36 and SM 39 had short leaves. All Accessions had intermediate leaf width except SM 9, SM 10, SM 18, SM 20, SM 22, SM 36, SM 39 and SM46 which had broad leaves. All accessions have weak or intermediate lobing except SM 36 which had very weak lobing.

Table 33 Average intra and inter cluster distances (D values)

Clusters	I	II	III	IV	V
I	635.80	848.39	1525.54	1927.63	4657.40
II		0.00	2734.01	3913.91	5911.80
III			489.66	1266.45	3199.30
IV				727.03	2064.27
V					0.00

Table 34 Genetic cataloguing of accessions of brinjal used for the study

Sl. No	Descriptor	SM 2	SM 6	SM 7	SM 8	SM 9	SM 10	SM 14	SM 15	SM 18	SM 20	SM 22	SM 23	SM 24	SM 28
1	Growth habit	5	5	7	5	5	7	3	3	3	3	5	7	3	3
2	Plant height	3	3	3	3	3	5	5	3	5	5	5	5	5	5
3	Plant breadth	3	3	5	5	5	5	5	3	3	3	3	5	5	3
4	Plant branching	1	1	1	1	1	1	1	1	3	1	3	3	1	1
5	Leaf blade length	3	3	3	3	5	3	5	3	5	5	3	3	3	3
6	Leaf blade width	5	5	5	5	7	7	5	5	7	7	7	5	7	5
7	No. of leaf prickles	3	0	3	0	5	5	0	1	0	0	0	0	0	0
8	Leaf blade lobing	5	5	5	5	7	5	5	5	5	5	5	5	5	5
9	Leaf blade colour	1	1	1	1	1	1	1	1	0	0	0	0	1	1
10	Leaf pubescence	2	2	2	2	2	1	1	2	2	2	2	2	2	2
11	General leaf surface characters	1	1	1	1	1	2	2	1	1	1	1	1	1	1
12	Spine density	5	1	5	1	9	5	1	5	1	1	1	1	1	1
13	Corolla colour	2	2	2	2	2	2	2	2	2	2	2	2	2	2
14	No. of flowers per axil	3	2	3	2	2	2	2	2	2	2	2	3	2	2
15	Fruit length	3	3	3	3	3	3	7	3	7	3	7	3	3	3
16	Fruit girth	5	5	5	5	5	7	5	3	7	7	7	7	5	7
17	Fruit predominant colour	3	3	3	3	7	7	7	3	7	7	7	6	3	6
18	Fruit colour distribution	7	7	7	7	1	1	1	1	1	1	1	1	7	7
19	Fruit flesh colour	1	2	2	2	2	2	2	2	2	2	2	2	2	2
20	Fruit anthocyanins underneath calyx	3	3	3	3	3	7	3	3	5	5	5	5	3	3
21	Fruit calyx prickles	1	0	3	0	1	1	0	0	0	0	0	1	0	0
22	General fruit shape	1	5	5	5	5	1	3	3	1	1	5	5	5	1
23	Fruit yield per plant	5	5	5	3	5	5	3	3	5	5	5	5	5	5

Table 34 Continued.....

Sl. No	Descriptor	SM 29	SM 30	SM 34	SM 36	SM 39	SM 40	SM 41	SM 42	SM 44	SM 45	SM 46	SM 48	SM 49
1	Growth habit	3	5	3	7	3	3	5	3	7	3	3	5	3
2	Plant height	5	5	5	5	5	3	5	3	3	5	3	3	5
3	Plant breadth	3	7	5	7	5	3	5	5	5	5	5	5	5
4	Plant branching	3	3	1	3	1	3	3	3	3	3	1	3	3
5	Leaf blade length	3	3	3	5	5	3	3	3	3	3	3	3	3
6	Leaf blade width	5	5	5	7	7	5	5	5	5	5	7	5	5
7	No. of leaf prickles	0	0	0	0	0	0	0	0	0	7	7	0	0
8	Leaf blade lobing	5	5	5	1	5	5	5	5	5	5	5	5	5
9	Leaf blade colour	0	0	0	1	1	0	0	0	0	0	0	1	0
10	Leaf pubescence	2	2	2	1	2	2	2	2	2	2	2	2	2
11	General leaf surface characters	1	1	1	2	1	1	1	1	1	1	1	1	1
12	Spine density	1	1	1	1	1	1	1	1	1	9	9	1	1
13	Corolla colour	2	2	2	2	2	2	2	2	2	2	2	2	2
14	No. of flowers per axil	2	3	2	3	3	3	3	3	3	3	3	4	4
15	Fruit length	3	3	3	3	3	3	7	7	7	3	7	2	7
16	Fruit breadth	7	5	5	7	5	5	5	5	7	7	7	3	5
17	Fruit predominant colour	7	7	7	6	1	6	6	6	7	7	7	3	6
18	Fruit colour distribution	1	1	1	7	1	7	7	7	1	1	1	1	1
19	Fruit flesh colour	2	2	2	1	2	2	2	2	2	2	2	1	2
20	Fruit anthocyanins colour underneath calyx	3	3	3	3	3	3	3	3	5	5	5	3	5
21	Fruit calyx prickles	0	0	0	0	0	1	1	1	0	5	5	0	0
22	General fruit shape	1	5	5	1	5	5	4	5	5	1	1	1	3
23	Fruit yield per plant	5	5	3	5	5	5	5	5	7	5	5	5	7

All accessions had either mixed (14) or green (13) leaf blade colour. Though seven accessions had prickles on leaf surface the spine density was more in SM 9, SM 45 and SM 46

All accessions had pubescent leaves except SM 10, SM 14 and SM 36. Except SM 36 (smooth and glabrous) all accessions had smooth and dull leaf character. All accessions had violet colour corolla. Flowers were borne in 1's, 2's and 3's in all accessions except SM 48 and SM 49 which had flowers in clusters.SM 45 and SM 46 had high spine density on calyx also.

Accessions varied in fruit colour also. Types with milky white (1), green (7), purple (7), and purple black (12) fruits were noticed. SM 2, SM 36 and SM 48 were white fleshed whereas intermediate flesh colour was noticed in all others.

4.2.9 Weather parameters

There was not much variation in weather parameters during two cropping periods (Fig. 9 and Fig. 10).

Fig. 9

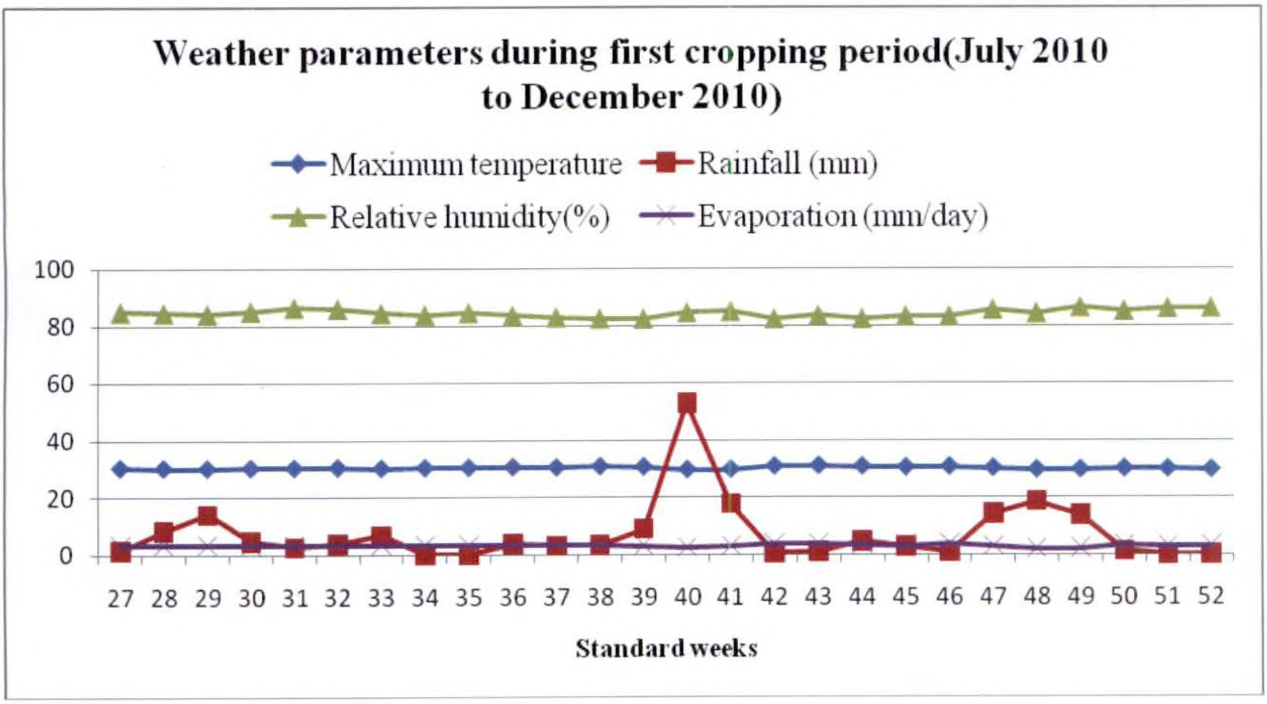
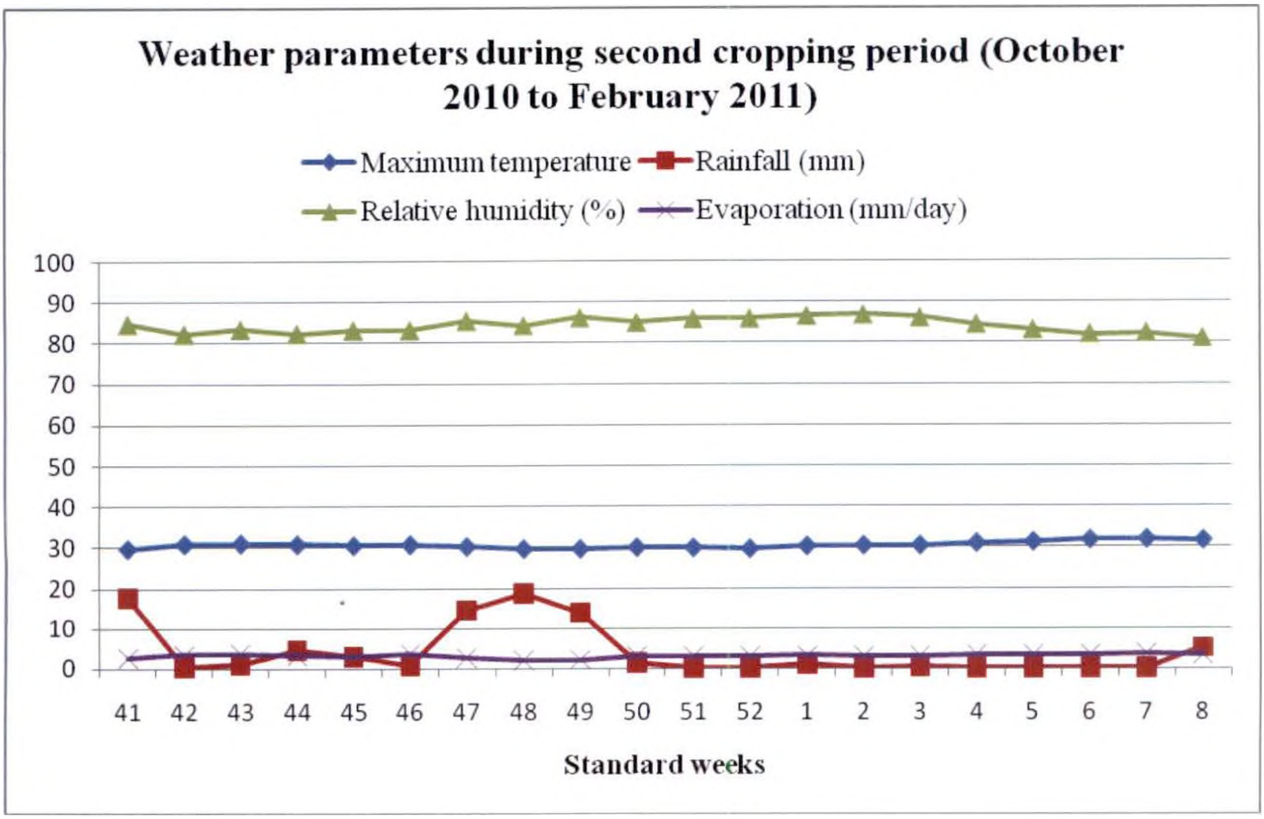


Figure 10



Discussion

5. DISSCUSION

Investigations were conducted at Department of Olericulture, College of Agriculture, Vellayani to study the variability in round fruited brinjal genotypes for yield, quality and resistance to fruit and shoot borer and elucidate the morphological, anatomical and biochemical basis of resistance. The study was carried out in two experiments *viz.*,

1. Screening brinjal genotypes for yield and fruit and shoot borer resistance
2. Evaluation of genotypes for genetic variability, yield, quality and tolerance to pests and diseases.

The experimental results are discussed under different headings.

5.1 Performance of the accessions

In present study, significant differences were recorded among the accessions of brinjal for all the characters studied. The results suggested the importance of selecting brinjal accessions based on the characters *viz.*, plant height, canopy spread, number of primary branches, number of secondary branches, percentage of long and medium styled flowers, fruit length, fruit girth, fruit weight, fruits per plant, yield, quality, biochemical and anatomical characters, incidence of fruit and shoot borer, bacterial wilt and other pests in formulating a systematic breeding programme.

5.1.1 Growth and yield characters

Yield is the most important character of a crop which varies with genotypes. In the present study, accessions SM 49 and SM 44 were superior in yield. Percent of long and medium styled flowers were also high in these accessions. In the case of plant height, SM 45 and SM 49 were superior. SM 48 and SM 49 were superior in fruits per plant. Similar differential response for yield and yield attributes in different genotypes of brinjal was reported by Rajput *et al.* (1996), Patel *et al.*

(2004), Singh and Kumar (2005), Ramesh Babu and Patil (2008) and Prabhu *et al.* (2009).

5.1.2 Morphological and anatomical characters

Morphological characters like pigmentation on leaf, stem and fruit, leaf spinyness, hairiness, RLPS, RLSA, shape index and volume index and anatomical characters like area of pith and number of vascular bundles showed variation in the genotypes studied. Similar findings were reported by Panda *et al.* (1971), Mishra *et al.* (1988), Hossain *et al.* (2002), Hazra *et al.* (2004), Senapathi and Senapathi, (2006) and Gupta and Kauntey *et al.* (2008).

5.1.3 Quality and Biochemical characters

Quality and biochemical characters are very important in any crop because quality characters impart nutritional quality and biochemical characters impart for biotic stress tolerance.

In the present study, different accessions showed variation in quality characters like shelf life, protein content, sugars and vitamin C content and biochemical characters *viz.*, proline content, phenol, and chlorophyll content. The findings of by Jat and Pareek, (2003), Doshi (2004), Hazra *et al.* (2004), Martin, (2004), Prabhu *et al.* (2009), Elanchezhyan *et al.* (2009) and Khorsheduzzaman *et al.* (2010).

5.2 Variability studies

The magnitude of variability present in a population is of utmost importance as it provides the basis for effective selection. Since the observed variability in a population is the sum of variation arising due to the genotypic and environmental effects, knowledge on the nature and magnitude of genetic variation contributing to gain under selection is essential. The PCV and GCV are the components used to measure the variability present in a population.

In the present investigation, for majority of the characters, magnitude of GCV and PCV were closer, suggesting greater contribution of genotype rather than environment. So the selection can be very well based on the phenotypic values. Such a closer PCV and GCV for different characters were earlier reported by Chadha and Paul (1984), Rajput *et al.* (1996), Bora and Shadeque (1993), Dash and Mishra (1995) and Singh and Kumar (2005).

High values of PCV with corresponding high values of GCV for fruit weight followed by bacterial wilt infestation, shoot infestation by fruit and shoot borer, fruits per plant, non reducing sugars, shape index, yield per plant, volume index, fruit damage by fruit and shoot borer, number of secondary and primary branches indicated greater extent of variability that could be ascribed to genotype. Similar results were obtained for number of fruits per plant and yield per plant by Singh and Kumar (2005), fruit weight by Baswana *et al.* (2002) and Kushwah Bandhyopadya (2005), number of secondary branches per plant by Rajyalakshmi *et al.* (1999), fruit and shoot borer infestation by Prabhu *et al.* (2009).

Proline, chlorophyll and protein content recorded lowest GCV indicating limited scope for improvement of these traits, due to low magnitude of variability. The difference between PCV and GCV was maximum for non reducing sugars and number of larvae per fruit revealing the influence of environment on this character.

From the foregoing discussions, it is clear that the characters *viz.*, fruit weight, fruits per plant, yield per plant and branches offer good scope for selection in brinjal.

5.3 Heritability and Genetic Advance

The variability existing in a population is the sum total of heritable and non heritable components. A high value of heritability indicates that the phenotype of that trait strongly reflects its genotype. The magnitude of heritability indicates the effectiveness with which selection of the genotypes can be made based on the phenotype.

In the present investigation, the heritability estimates were high for all characters studied except for non reducing sugars, which have moderate heritability. High heritability for yield and yield attributes in brinjal were reported by many workers (Kalda *et al.*,1988; Behera *et al.*, 1999; Rai *et al.*, 1999; Singh and Gopalakrishnan, 1999; Sharma and Swaroop, 2000 and Patel *et al.*, 2004). Contrary to these findings, low heritability was reported for yield per plant (Nulsari *et al.*, 1986), primary branches per plant, fruit length and fruit girth (Rai *et al.*, 1998).

Sinha (1983) reported high heritability in brinjal for fruit length: circumference ratio. High heritability for fruit index (fruit volume) was reported by Bora and Shadeque (1993), Patel *et al.* (1999) and Singh and Kumar (2005).

Environment has least influence for the characters with high heritability and there could be greater correspondence between phenotypes and breeding value while selecting individuals. High heritability estimates indicate the effectiveness of selection based on good phenotypic performance but does not necessarily mean high genetic gain for the particular character. Johnson *et al.* (1955) pointed out that high heritability along with high genetic advance would be useful than heritability values alone in predicting the resultant effect of selecting the genotype.

High values of genetic advance as percentage of mean (> 20 %) were obtained in the present study for all the biometric characters studied. The results are in line with the findings of Patel *et al.* (2004), Kushwah and Bandhyopadhya (2005) and Singh and Kumar (2005). On the other hand, Rai *et al.* (1998) reported low genetic advance for number of primary branches per plant which is contradictory to the present findings.

Biochemical characters like vitamin C, phenol and sugars also showed high genetic advance whereas, chlorophyll content, proline and protein content had moderate genetic advance.

In present study yield per plant, plant height, canopy spread, number of primary branches, secondary branches, days to 50 per cent flowering, percentage of long and medium styled flowers, fruit length, fruits per plant, fruit weight, days to anthesis, fruit girth, shape index, volume index, recorded high heritability coupled with high genetic advance. These results confirms the findings of Singh and Gopalakrishnan (1999), Patel *et al.* (2004) , Kushwah and Bandhyopadhya (2005) and Singh and Kumar (2005) who reported high heritability coupled with high genetic advance for plant height, number of branches, fruit length, fruit girth, fruit weight, fruits per plant and yield per plant. But Rai *et al.* (1998) reported low heritability and genetic advance for primary branches, fruit length and fruit girth which is contradictory to the present findings.

High heritability coupled with high genetic advance was also reported for biochemical characters like vitamin C and phenol content. Non reducing sugars recorded moderate heritability with high genetic advance. Chlorophyll, protein and phenol content recorded moderate genetic advance with high heritability.

Fruit and shoot borer infestation, RLPS and RLSA also had high heritability coupled with high genetic advance. As in the present study, Dhankar *et al.* (1977) and Prabhu *et al.* (2009) reported high heritability with high genetic advance for fruit and shoot borer infestation.

High heritability coupled with high genetic advance indicates the presence of flexible additive gene effects and will be a useful criterion for selection.

5.4 Correlation Studies

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. Correlation provides information on the nature and extent of relationship between all pairs of characters. So when the breeder applies selection for a particular character, not only it improves that trait, but also those characters provides a reliable measure of genetic association between them, which is useful in the breeding programmes.

In the present study, high and positive phenotypic and genotypic correlation of fruit yield with percent of long and medium styled flowers, primary branches, fruit length, plant height, secondary branches, canopy spread and fruits per plant, while high and negative correlation with fruit and shoot borer infestation.

Positive genotypic correlation of yield with fruits per plant was in line with the results reported by Mishra and Mishra (1990), Vadivel and Bapu (1990b), Gautham and Srinivas (1992), Ushakumari and Subramanian (1993), Ponnuswami and Irulappan (1994), Narendrakumar (1995), Varma (1995), Sharma and Swaroop (2000), Kushwah and Bandhyopadhya (2005), Senapathi and Senapathi (2006), Bansal and Mehta (2008), Lohakare *et al.* (2008a) and Jadhao *et al.*(2009).

Mishra and Mishra (1990), Ponnuswami and Irulappan (1994), Vadivel and Bapu (1998), Bansal and Mehta (2008) and Jadhao *et al.* (2009) reported that plant height was positively correlated with yield per plant.

Positive correlation of yield with number of branches was in line with the results reported by Mishra and Mishra (1990), Vadivel and Bapu (1990b), Randhawa *et al.* (1993), Ushakumari and Subramanian (1993), Ponnuswami and Iruppalan (1994), Narendrakumar (1995), Vadivel and Bapu (1998), Bansal and Mehta (2008) and Jadhao *et al.* (2009).

Positive correlation of canopy spread with yield was in line with results reported by Gautham and Srinivas (1992) and Bansal and Mehta (2008).

Mishra and Mishra (1990), Nainar *et al.* (1990), Ponnuswami and Irulappan (1994), Varma (1995), Lohakare *et al.* (2008) and Jadhao *et al.* (2009) reported that fruit weight has significant positive correlation with yield. In present study it was positive but not significant.

Positive and high phenotypic and genotypic correlation of fruit yield per plant with number of fruits per plant imply that selection for this character would lead to simultaneous improvement of yield in brinjal. The other characters that can be taken into consideration for indirect selection for yield include plant height, canopy spread, primary and secondary branches.

In general magnitude of genotypic correlation coefficients was higher than the corresponding phenotypic correlation coefficients for the characters positively correlated with yield indicating low environmental influence on these characters.

5.5 Path analysis

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 programmes 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 another component trait, the breeder has to select the latter trait through which the indirect effect is exerted.

In the present study number of primary branches, fruit length and fruits per plant showed positive direct effect on yield. This is in line with the findings of Sharma and Swaroop (2000) and Jadhao *et al.* (2009).

Percentage of long and medium styled flowers also showed high and positive direct effect on yield.

Canopy spread and days to fifty per cent flowering had negative direct effect on yield. Contrary to the present findings, Lohakare *et al.* (2008) reported that plant spread had positive direct effect on yield and Bansal and Mehta (2008) observed that days to fifty per cent flowering showed positive direct effect on yield.

Fruits per plant, primary branches, fruit length and percentage of long and medium styled flowers can be identified as major characters contributing towards yield directly and indirectly and selection based on these characters are effective in developing high yielding brinjal varieties.

5.6 Selection index

Discriminant function analysis developed by Fisher (1936) gives information on the proportionate weight age 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, plant width, number of primary branches, number of secondary branches, days to 50 per cent flowering, percentage of long and medium styled flowers, fruit length, fruits per plant, fruit and shoot borer shoot damage, fruit and shoot borer fruit damage, vitamin C and protein content together with yield per plant used for constructing selection index.

Based on the selection index values, top ranking accessions namely SM 49 (8496.2), SM 44 (6995.7), SM 23 (6318.7), SM 41 (6128.1), SM 30 (5516.9), SM 42 (4997.2), SM 45 (4618.3), SM 36 (4378.1), SM 7(4327.1) and SM 39 (4279.0) were identified as superior ones in terms of yield and resistance against fruit and shoot borer. Vadivel and Bapu (1991) also constructed an index score character analysis of some exotic eggplants and the types Murena, Solara, Nagpur Type and Annamalai recorded the highest index score values.

5.7 Genetic divergence analysis

One of the present techniques of measuring genetic divergence is by Mahalanobis's D^2 statistic. This technique measures the force of differentiation at the intracluster and intercluster levels and thus provides a reasonable basis for selection of genetically divergent parents in breeding programmes.

The 27 accessions of brinjal were subjected to D^2 analysis based on seven characters. They were grouped into five clusters on the basis of relative magnitude of D^2 values. The greater the distance between two clusters, greater is the divergence between the accessions belonging to the two clusters and vice versa.

Cluster V was superior in plant height, number of secondary branches, days to 50% flowering, per cent of long and medium styled flowers, fruit length, number of fruits per plant and yield per plant. Cluster III had highest value for canopy spread and number of primary branches. This indicates the superiority of these characters with respect to those particular characters.

The highest intercluster distance was seen between cluster II and V meaning that these two clusters show the maximum genetic divergence which can be utilized in hybridization programmes to get heterotic advantage. Cluster I and cluster II with least intercluster distance are genetically most similar. The intracluster distances were seen to be lower than intercluster distances thereby suggesting homogeneity among the genotypes within a cluster and heterogeneity between clusters.

Similar divergence analysis was reported in different accessions of brinjal by Gunjeet Kumar *et al.* (2008), Quamruzzaman *et al.* (2009), Polignano *et al.* (2010) and Islam *et al.* (2011).

5.8 Genetic Cataloguing

Genetic cataloguing of germplasm based on standard descriptors helps in international exchange of information in a more scientific way. This also helps in locating some accessions with specific morphological characters which can be used for crop improvement. Attempts to collect and characterize eggplant have made by scientists like Perrino *et al.* (1992), Olufolaji and Makinde (1994) and Reifschneider *et al.* (1997).

In the present investigation, accessions of brinjal collected from different parts of India showed wide range of variations for characters like fruit shape, colour, leaf lobing, spininess, etc. Similar variations in agromorphological characters were reported by Rai *et al.* (1995) and Sivaraj *et al.* (1998).

The database formulated reflected a highly variable collection which in turn gives idea about the wealth of the accessions of brinjal in India. This basic materials would be required to locate new genes while facing unforeseen challenges of crop breeding in future. If not saved now, this gene pool for important traits may be lost for ever. Hence, further collections and studies are needed to cover new areas and new aspects for evaluation.

5.9 Screening for incidence of pest and diseases

Resistant varieties have long been acknowledged as the most effective means of controlling pest and diseases. They have a significant role in the integrated pest management practices. Genotypic differences noticed in the present study indicated scope for the selection of plants with resistance against pest and diseases incidence of brinjal.

5.9.1 Fruit and shoot borer

It is the major constraint in the commercial production of brinjal rendering the fruits unfit for consumption which results in a total crop loss.

Screening experiments by various workers have indicated highly differential response of brinjal germplasm to the attack of this pest (Singh and Chadha, 1991; Hazra *et al.* 2004; Senapathi and Senapathi, 2006; Prabhu *et al.* 2009 and Khorsheduzzaman *et al.* 2010). In the present investigation also, the accessions showed significant variation for the incidence of fruit and shoot borer. It ranged from 4.77 to 31.97 per cent and 10.83 to 63.01 per cent on shoot and fruit respectively. However accessions *viz.*, SM 49 (Pusa Purple Cluster) and two local accessions like SM 44 (Vellayani local) and SM 36 (Madavoor local) showed moderate resistance to fruit borer. This could be very well utilized in the intervarietal crossing programme in brinjal for combining high yield and borer resistance.

5.9.1.1 Role of plant characters in borer resistance

Discernment of morphological characters of plants conferring resistance to insect pests is important in breeding for resistance. Morphological basis of resistance include factors such as colour, shape, size, calyx length, pedicel length, spiny nature hairy nature and pigmentation on leaf, stem and fruit.

In the present investigation pigmentation on leaf and stem, hairy nature and spiny nature had no correlation to fruit and shoot borer infestation. Shape index also, had no correlation with degree of fruit infestation. Therefore, it may be suggested that shape of the fruit not associated with fruit borer infestation. But there was a negative correlation between volume index and fruit borer infestation (-0.3247). Based on volume index, most of the small and medium sized accessions were highly susceptible to fruit and shoot borer while varieties with high volume index were comparatively less susceptible. It is contradictory to the reports of previous studies (Panda *et al.*, 1971 and Hazra *et al.*, 2004).

In the case of fruit colour, dark green, mixed colours and dark purple fruits were severely infested with fruit borer compared to light green, purple and white fruits. This may be due to non preference of less coloured and less attractive fruits by the insect for egg laying. Contrary to the present findings Hazra *et al.* (2004) reported those varieties with dark purple or white fruits were more susceptible and those with light purple, purple or green colour were less susceptible.

Though correlation coefficients of infested fruit percentage with calyx (-0.0963) and pedicel length (-0.0949) were non- significant it was negative. Hence, fruit having long calyx were prone to fruit borer attack. It is in line with the result of Hazra *et al.* (2004).

In general varieties with high shoot infestation were showing high fruit infestation also. These results are highly supported by Darekar *et al.* (1991) and Khorsheduzzaman *et al.* (2010).

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

5.9.1.2 Role of anatomical and biochemical characters in borer resistance

In the present study, area of pith had no relevance to fruit and shoot borer infestation. This is in contradiction to the earlier studies of Panda *et al.* (1971) and Hossain *et al.* (2002). More number of well developed vascular bundles was observed in moderately resistant and tolerant accessions compared to susceptible ones. This is in line with findings of Hossain *et al.* (2002). This may be due to the mechanical protection by vascular bundles.

Total phenol content of fruit was markedly and negatively correlated with susceptibility to the attack of borer, which was in conformity to earlier works of Doshi (2004) and Hazra *et al.* (2004). 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.

Lower sugar, protein content and vitamin C contents in the fruits were associated with tolerance to fruit and shoot borer. Earlier, Panda and Das, (1975) and Hazra *et al.* (2004) also reported that concentration of feeding stimulants like sugars, protein and free amino acids in the fruits will lead to susceptibility to fruit infestation.

The present study clearly shows that genotypes having high phenols and low sugars, protein and vitamin C imparts resistance and could be utilized in breeding brinjal tolerant to shoot and fruit borer. 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.

5.9.2 Bacterial wilt

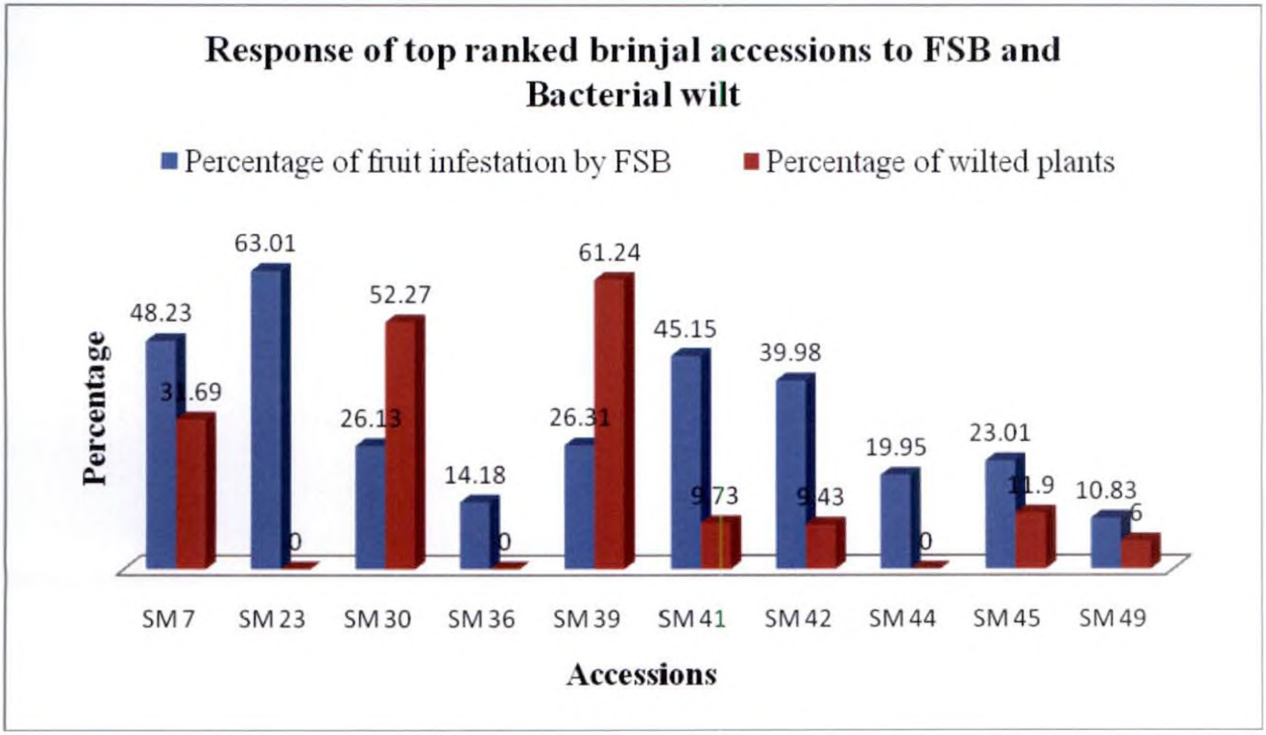
Bacterial wilt caused by *Ralstonia solanacearum* has become a major bottle neck in successful cultivation of brinjal in Kerala. Since the bacterium is soil borne, its chemical control through soil treatment is both cumbersome and uneconomical (Madalageri *et al.* 1983). Hence, a fruit and shoot borer resistant variety will be of commercial significance only if it is resistant to bacterial wilt also. The present investigation resulted in the identification of eight lines with bacterial wilt resistance. Bacterial wilt resistance in brinjal was also reported earlier by Jessykutty and Peter (1986), Pathania *et al.* (1996), Ponnuswamy (1997), Alam *et al.*(2000), Manna *et al.* (2003), Sharma *et al.* (2005) and Sharma and Kumar (2007). The moderately fruit borer resistant lines *viz.,* SM 36, SM 44 and SM 49 were resistant to bacterial wilt also indicating the combined resistance in these lines. (Fig. 11)

5.9.3 Other pests

In the present study, other pests observed were jassids and ash weevils but not in alarming proportions. The present genotypes showed variation in number of jassids per leaf (2.81 to 13.38) and number of ash weevils per plant varied (1.20 to 19.34) which is in agreement with the findings of Cassi-Lit *et al.* (2000) and Sonali Deole, (2008) and ash weevils by Elanchezhyan *et al.* (2008).

In the present study a high yielding large round fruited accession SM 44 with dual resistance to fruit and shoot borer and bacterial wilt was identified which may be promoted as promising line for cultivation in southern Kerala after further confirmatory studies.

Fig. 11


Response of top ranked brinjal accessions to FSB and Bacterial wilt
Percentage of fruit infestation by FSB
Percentage of wilted plants
Percentage
48.23
31.69
63.01
0
26.13
52.27
14.18
0
26.31
61.24
45.15
9.73
39.98
9.43
19.95
0
23.01
11.9
10.83
6
SM 7
SM 23
SM 30
SM 36
SM 39
SM 41
SM 42
SM 44
SM 45
SM 49
Accessions

Summary

6. SUMMARY

The study entitled "Evaluation of round fruited brinjal genotypes for yield, quality and tolerance to fruit and shoot borer" was conducted at the Department of Olericulture, College of Agriculture, Vellayani, during the period 2010-2011. The data for the study were collected from two field experiments.

In experiment I, 34 brinjal accessions collected from different parts of the country were screened for yield and resistance to fruit and shoot borer laid out in randomized block design with three replications. Out of 34 accessions, 19 showed 100 per cent wilting caused by *Ralstonia solanacearum.* Hence biometric observations were recorded for 15 accessions which survived the onslaught of the disease.

Observations were recorded on different biometric characters *viz*., plant height, canopy spread, primary branches, secondary branches, leaf length, leaf width, days to first flowering, days to 50 per cent flowering, percentage of long and medium styled flowers, fruit length, fruit girth, fruit weight, fruits per plant and yield per plant. In screening for fruit and shoot borer, observations were recorded on damage parameters *viz.,* percentage of plants infested, percentage of shoots infested, percentage of fruits infested, larvae per fruit, bore holes per fruit.

Analysis of variance revealed significant difference among the accessions for all the characters studied. SM 49 (Pusa Purple Cluster) recorded highest yield per plant (3483.35 g) and SM 48 recorded highest fruits per plant. Fruit weight was highest in SM 44 (378.75 g) whereas SM 48 recorded the lowest value (20.12 g).

Screening for fruit and shoot borer revealed that remarkable variation exists in the incidence of the pest. SM 49 was rated as highly resistant; SM 36 was moderately resistant and SM 30 and SM 45 were tolerant. In terms of severity of fruit damage SM 48 and SM 42 were the best based on larvae per fruit and SM 40 and SM 45 based on bore holes per fruit.

In bacterial wilt screening, the accessions SM 23, SM 36, SM 42, SM 44, SM 45 and SM 49 were resistant with lowest percentage of wilted plants. The accessions SM 49 and SM 18 showed lowest number of jassids and ash weevils respectively.

In experiment II, the brinjal accessions were subjected to detailed evaluation for variability in yield, quality and tolerance to pests and diseases and to elucidate the morphological, anatomical and biochemical basis of resistance to fruit and shoot borer.

The analysis of variance revealed that significant variation among all the characters studied. Pusa Purple Cluster recorded highest yield per plant (3617.15g) while SM 34 recorded lowest yield (661.66g). SM 48 recorded highest fruits per plant while SM 22 was the lowest. SM 44 recorded highest fruit weight (371.99 g) while lowest fruit weight was recorded in SM 48 (20.03 g). Fruit girth ranged from 27.25 cm to 7.23 cm.

Phenotypic and genotypic coefficients of variation were high for yield per plant, branches per plant, fruits per plant and fruit and shoot infestation while genotypic coefficient of variation was low for proline, chlorophyll and protein content.

Heritability estimates were high for all the characters studied except for non reducing sugars with maximum value for yield per plant (99.83 %) and minimum for non reducing sugars (35.24%). Genetic advance as percentage of mean was high for all the characters except chlorophyll, proline and protein content

At genotypic level yield per plant showed high positive correlation with percentage of long and medium styled flowers, primary branches, fruit length, plant height, canopy spread and fruits per plant. Percentage of long and medium styled flowers recorded the highest genotypic correlation with yield.

Path coefficient analysis revealed that fruits per plant, primary branches, fruit length and percentage of long and medium styled flowers had high direct effect as well as indirect effect through other characters on yield per plant. The characters selected for path analysis would explain the major portion of variation in yield as the residual effect obtained was very low (R = 0.2212).

In the present study selection index was worked out and the top ranking accessions were SM 49, SM 44, SM 23 and SM 41.

Genetic divergence analysis was carried out using Mahalanobis's D^2 statistic and the 27 accessions were grouped into five clusters. Cluster I had the maximum number of accessions (20) followed by cluster IV (3). Cluster III had three accessions while clusters II and V had only one accession each. The intercluster diastance was maximum between clusters II and V (5911.80) followed by clusters I and V. Intracluster distance was maximum in cluster IV.

The accessions were morphologically catalogued using the standard descriptor developed by IPGRI. The results revealed distinct variations among the accessions with respect of vegetative, floral and fruit characters.

In fruit and shoot borer screening, SM 36, SM 44 and SM 49 were categorized as moderately resistant. SM 28 and SM 10 recorded lowest number of larvae per fruit and bore holes per fruit respectively. This indicates less severity of infestation in these accessions.

Morphological characters like fruit colour, volume index, RLPS and RLSA were related to fruit and shoot borer resistance. Light coloured fruits were comparatively less susceptible than bright coloured ones. This may be due to non preference of less coloured and less attractive fruits by the insect for egg laying. RLSA showed positive correlation and RLPS showed negative correlation with fruit borer infestation. Long peripheral seed ring forms a sort of mechanical barrier against easy entry of the borer.

More number of well developed vascular bundles was observed in moderately resistant accessions compared to susceptible ones whereas presence or absence of trichomes was not related with shoot borer resistance.

Biochemical characters like phenol, proline, sugars and protein content were responsible for resistance to fruit and shoot borer resistance. High amount of phenol and proline and low content of sugars and protein were responsible for tolerance.

SM 23, SM 36 and SM 44 were highly resistant to bacterial wilt which showed zero per cent wilting.

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Abstract

EVALUATION OF ROUND FRUITED BRINJAL GENOTYPES FOR YIELD, QUALITY AND TOLERANCE TO FRUIT AND SHOOT BORER

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**Abstract of the
thesis submitted in partial fulfillment of the requirement
for the degree of**

**Master of Science in Horticulture
(Olericulture)**

**Faculty of Agriculture
Kerala Agricultural University, Thrissur**

2011

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ABSTRACT

The present investigation on "Evaluation of round fruited brinjal genotypes for yield, quality and tolerance to fruit and shoot borer" was conducted at the Department of Olericulture, College of Agriculture, Vellayani, during the period 2010-2011. The objective of the study was to assess the genetic variability for yield, quality and resistance to fruit and shoot borer and elucidating the morphological, anatomical and biochemical basis of fruit and shoot borer resistance. The study was conducted in two separate experiments.

1. Screening brinjal genotypes for yield and fruit and shoot borer resistance
2. Evaluation of genotypes for genetic variability, yield, quality and tolerance to pests and diseases.

In experiment I, thirty four accessions of brinjal were collected from different parts of country and grown in the field in RBD with three replications. Analysis of variance revealed that significant difference among the accessions for all the characters studied. SM 49 and SM 36 showed lowest infestation to fruit and shoot borer while SM 23 showed highest. Among other pests, SM 36 and SM 40 had severe incidence of jassids and ash weevils respectively.

In experiment II, the yield ranged from 3.62 kg to 0.66 kg. SM 49 was superior for plant height, percentage of long and medium styled flowers and yield. Highest fruit weight was in SM 44.

High phenotypic coefficient of variation and genotypic coefficient of variation were observed for yield per plant, fruits per plant, fruit weight and branches per plant. High heritability and high genetic advance also observed for these characters.

At genotypic level, yield per plant had high positive correlation with percentage of long and medium styled flowers, branches per plant, fruit length and plant height. The path analysis showed that percentage of long and medium styled

flowers, branches per plant, fruit length and fruits per plant had direct effect on yield per plant.

SM 49 followed by SM 44, SM 23, SM 41 and SM 30 was having the highest selection index values based on discriminant function analysis.

Based on Mahalanobis D^2 analysis the current genotypes were grouped into five clusters. Cluster I being the largest including with twenty accessions and cluster II and V had one each. Cluster V had highest values for seven characters *viz.,* plant height, secondary branches, percentage of long and medium styled flowers, fruit length, fruits per plant and yield per plant. Highest inter cluster distance was between cluster II and V. Maximum intra cluster distance was in cluster IV.

In screening for fruit and shoot borer resistance, the incidence ranged from 4.77 to 31.97 per cent and 10.83 to 63.01 per cent for shoot and fruit respectively. However accessions *viz.,* SM49 and two local collections SM 44 and SM 36 showed moderate resistance to fruit and shoot borer.

Fruit colour was related to fruit and shoot borer tolerance. Light coloured fruits were less susceptible. More RLPS and less RLSA led to tolerance. In moderately resistant accessions there was more number and well developed vascular bundles compare to susceptible ones. High phenol and proline content and less sugars and protein content were responsible for resistance to fruit and shoot borer incidence.

Accession like SM 23, SM 36, SM 40, SM 44, SM 45 and SM 49 showed high level of resistance to bacterial wilt. The accessions SM 36, SM 44, SM 45 and SM 49 showed resistance to both fruit and shoot borer and bacterial wilt. The study identified the high yielding, large fruited SM 44 with resistance to fruit and shoot borer and bacterial wilt as a promising line for cultivation in Kerala after further confirmatory studies.

Appendices

APPENDIX - I

Descriptor for brinjal

1. Plant growth habit

    1 Vey upright

    3 Upright

    5 Intermediate

    7 Prostrate

    9 Very prostrate

2. Plant height

    1 Very short (< 30 cm)

    3 Short (30-60 cm)

    5 Intermediate (60-100 cm)

    7 Tall (100-150 cm)

    9 Very tall (>150 cm)

3. Plant breadth (flowering stage)

    1 Very narrow (< 40 cm)

    3 Narrow (40-60 cm)

    5 Intermediate (60-90 cm)

    7 Broad (90-150 cm)

    9 Very broad (>150 cm)

4. Number of primary branches

    1 Very weak (< 5)

    3 Weak (5-10)

    5 Intermediate (10-20)

    7 Very strong (20-30)

9 Very Strong (> 30 cm)

5. Leaf blade length

3 Short (< 20 cm)

5 Intermediate (20-30 cm)

7 Long (> 30 cm)

6. Leaf blade width

3 Narrow (< 10 cm)

5 Intermediate (10-20 cm)

7 Wide (> 20 cm)

7. Number of leaf prickles (upper surface)

0 None

1 Very few (< 4)

3 Few (4-8)

5 Intermediate (8-15)

7 Many (15-20)

9 Very many (> 20)

8. Leaf blade lobing

1 Very weak

3 Weak

7 Intermediate

9 Very strong

9. Leaf blade colour (upper surface)

0 Mixed (Green with purple viens)

1 Green

2 Intermediate

3 purple

10. Leaf pubescence

1 Glabrous

2 Pubescent

11. General leaf surface characters

1 Smooth, Dull

2 Smooth, Glossy

12. Spine density

1 No spines

5 Moderate spines

9 Heavy

13. Corolla colour

0 Mixed

1 White

2 Lavender

3 Purple

4 White with purple stripes

5 Yellow

14. Number of flowers per cluster

1 Flowers borne singly

2 Flowers in 1's and 2's

APPENDIX – I Continued

3 Flowers in 1's and 2's and 3's

4 Flowers in clusters

5 Flowers borne variably

15. Fruit length

1 Very short (< 1 cm)

2 Short (2-5 cm)

3 Intermediate (5-10 cm)

7 Long (10-20 cm)

9 Very long (> 20 cm)

16. Fruit girth

1 Very small (< 2cm)

3 Small (2-3 cm)

5 Intermediate (3-5 cm)

7 Large (5-10 cm)

9 Very large (>10 cm)

17. Fruit predominant colour

1 Milk white

2 Yellowish

3 Green

4 Reddish

5 Lilac grey

6 Purple

APPENDIX – I Continued

7 Purple black

8 Black

9 Other

18. Fruit colour distribution

1 Uniform

3 Mottled

5 Netted

7 Striped

9 Other

19. Fruit flesh colour

1 White

2 Intermediate

3 Green

20. Fruit anthocyanin colour underneath calyx

0 None

1 Very weak

3 Weak

5 Medium

7 Strong

9 Very strong

21. Fruit calyx prickles

0 None

1 Very few (1-5)

APPENDIX – I Continued

3 Few (5-10)

5 Intermediate (10-20)

7 Many (20-30)

9 Very Many (> 30 cm)

21. General fruit shape

0 Mixed

1 Round

2 Oblate

3 Oblong

4 Elongate

5 Oval

22. Fruit yield per plant

1 Very low (<500 g)

3 Low (500-1000 g)

5 Intermediate (1000-2500 g)

7 High (2500-5000 g)

9 Very weak (> 5000 g)

APPENDIX - II

Weather data for the cropping period

(July 2010 to Feb. 2011)

Standard week	Temperature (^{o}C) (maximum)	Rainfall (mm)	Relative Humidity (%)	Evaporation (mm/day)
27	30.37	1.51	84.79	3.14
28	30.26	8.26	84.50	3.46
29	30.17	14.07	84.14	3.40
30	30.34	4.73	85.07	3.42
31	30.34	2.60	86.29	3.46
32	30.46	3.80	85.86	3.51
33	30.20	6.69	84.36	3.29
34	30.37	0.00	83.79	3.51
35	30.46	0.00	84.50	3.51
36	30.60	3.83	83.49	3.49
37	30.43	3.03	82.86	3.40
38	30.80	3.37	82.43	3.51
39	30.66	8.97	82.36	3.11
40	29.63	53.03	84.43	2.60
41	29.69	17.74	84.79	2.80
42	30.80	0.46	82.29	3.60
43	30.97	0.91	83.43	3.69
44	30.74	4.60	82.36	3.34
45	30.46	2.94	83.21	3.11
46	30.66	0.77	83.21	3.77
47	30.17	14.43	85.50	2.80
48	29.60	18.66	84.29	2.06
49	29.60	13.85	86.21	2.23
50	29.94	1.29	85.00	3.20
51	29.86	0.00	85.86	3.03
52	29.60	0.00	86.00	3.11
1	30.23	0.86	86.64	3.29
2	30.37	0.00	86.93	3.07
3	30.37	0.19	86.21	3.03
4	30.94	0.00	84.57	3.31
5	31.20	0.00	83.21	3.43
6	31.71	0.00	82.14	3.51
7	31.86	0.00	82.43	3.66
8	31.60	5.03	81.07	3.40