INCORPORATION OF JASSID, *Amrasca biguttula biguttula* (Ishida) RESISTANCE IN A BACTERIAL WILT RESISTANT BACKGROUND IN BRINJAL

By

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(2009-12-113)

THESIS

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DECLARATION

I, hereby declare that this thesis entitled **"Incorporation of jassid, *Amrasca biguttula biguttula* (Ishida) resistance in a bacterial wilt resistant background in brinjal"** is a bonafide record of research work done by me during the course of research and that the thesis has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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Certified that this thesis, entitled **"Incorporation of jassid, *Amrasca biguttula biguttula* (Ishida) resistance in a bacterial wilt resistant background in brinjal"** is a bonafide record of research work done independently by **Miss. Seeshma K.S**. **(2009-12-113)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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Dedicated to

My Loving Father

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Introduction

1. INTRODUCTION

Vegetables are the integral part of our balanced daily diet. They are rich source of vitamins, minerals and dietary fibre essential for different metabolic activities. They are considered as 'protective food' as their consumption can protect the human body from many diseases. Role of vegetables as source of antioxidants which can act as scavengers of free radicals reduce the risk of cardiovascular diseases, hypertension and certain forms of cancer. Nature has endowed India with many precious gifts, wherein its immense potential for the agricultural sector lies. The vast diversity of land, soil and agro-climatic conditions has unique competitiveness to grow a wide range of vegetable crops. During the last three decades, India has made a commendable progress in vegetable production, securing the position of second largest vegetable producer in the world, next to China. The productivity of vegetables in the country is only 15 tonnes per hectare. Popularization of multiple disease / pest resistant varieties and adoption of scientific cultural practices are the most viable methods to increase the productivity of vegetables and thus to meet the increasing demand of vegetables (Shanmugasundaram, 2005).

Brinjal (*Solanum melongena* L.) also called as egg plant or aubergine is one of the most important vegetable crops of India for which the country occupies second position for production. In the country, this crop is grown in an area of 6.12 lakh hectares producing 105.63 lakh tonnes with an average productivity of 17.26 tonnes per hectare (NHB database, 2010). The crop is being cultivated in states like Orissa, Bihar, West Bengal, Gujarat, Madhya Pradesh and Tamil Nadu. In egg plant the consumer preference is region specific (Kanthaswami *et al*., 2003). In Kerala the cultivation of brinjal is limited on a commercial scale and is mostly confined to homestead farms, mainly as a rainfed crop.

Brinjal has been considered as staple vegetable in our daily diet since ancient times. Every 100 g of brinjal fruit contains 1.4 g protein, 0.3 g fat, 0.3 g minerals, 4.0 g carbohydrates and 1.3 g fibre. The crop is well known for its medicinal properties also. Fruits, leaves and roots are having medicinal properties like digestive, cardiotonic and constipating effects. The fruits are having constituents like flavonoids and poly unsaturated fatty acids. Brinjal is used in indigenous medicines for stomach disorders especially for indigestion and it increases apetite. Brinjal can cure fever and respiratory diseases. So it is an important ingredient in ayurvedic preparations like 'Brahtyadi kashayam' for respiratory diseases. Since the poly unsaturated fatty acids are present in brinjal, it is having decholesterolising activity and the vegetable is considered as cardiotonic. According to Chaudhary (1976) white and small fruited brinjal is good for diabetic patients.

The main constraint for the cultivation of brinjal is the occurrence of several pests and diseases. This is the main reason for the prevalence of homestead cultivation of brinjal in Kerala rather than its commercial cultivation. The major diseases of egg plant are bacterial wilt, phomopsis blight and little leaf. Among the pests of brinjal shoot and fruit borer, jassids, epilachna beetle, mealy bug and white flies are the major ones. Bacterial wilt caused by *Ralstonia solanacearum* is the most devastating disease of brinjal as far as Kerala is concerned. According to Gopimony and George (1979) the wilt incidence could reach upto 100 per cent in various districts and agricultural farms of Kerala. Development of resistant varieties is the most economic and viable management strategy for bacterial wilt incidence. The popular brinjal varieties from Kerala Agricultural University *viz*. Surya, Swetha and Haritha are resistant to bacterial wilt caused by *Ralstonia Solanacearum*.

During summer the cultivation of brinjal is limited in Kerala due to the severe incidence of sucking insects especially jassids (*Amrasca biguttula biguttula*) which are causing severe yield reduction in brinjal. According to Rawat and Sahu (1973) the extent of jassid damage in brinjal could approach 54 per cent. Both nymphs and adults of jassids suck sap from the lower surface of leaves and inject their toxic saliva into the plant tissues. As a result the infested leaves curl upward along the margin, which may turn yellowish and show burnt appearance better known as “hopper burn” symptoms. This pest can also act as the vector for little leaf and viral disease like mosaic. Since the jassids are highly mobile and are concentrating more on the lower surface of leaves, the chemical control for the pest is not so effective. It was also noticed that some of the insecticides recommended for controlling the pest, are not only having a shift in the status of their toxicity, but also triggers the resurgence of the jassid population. This situation warrants the formulation of an effective management strategy which is environmental friendly and suitable for the prevailing condition. Here comes the relevance of development of jassid resistant / tolerant brinjal varieties with high yield potential, desirable horticultural attributes and resistance to bacterial wilt. The investigation of Malini (2005) which resulted in the identification of seven jassid resistant brinjal genotypes is a clear indication of such a possibility.

Thus the proposed study will pave a way to transfer the jassid resistance traits from the four identified sources (SM 363, SM 364, SM 366, and SM 385) into the bacterial wilt resistant commercial varieties like Surya, Swetha and Haritha through hybridization. This will ultimately result in profitable brinjal cultivation in Kerala during the unfavourable summer season as well.

In this background the present study was undertaken with the following objectives.

- To investigate upon the performance of F_1 hybrids in brinjal.
- To study the feasibility of transferring jassid resistance traits from known sources to bacterial wilt resistant varieties *viz*. Surya, Swetha and Haritha.
- To test the level of jassid resistance and bacterial wilt resistance in the F_1 hybrids in brinjal.

Review of literature

2. REVIEW OF LITERATURE

Egg plant, *Solanum melongena* L. is a common and popular vegetable crop grown in the subtropics and tropics. It is called brinjal in India and aubergine in European countries. The name eggplant derives from the shape of some varieties, which are white and shaped very similarly to chicken eggs.

There is a lot of controversy regarding the origin of brinjal. According to Vavilov (1931) the centre of origin of *Solanum melongena* is Indo- Burma region while Filov (1940) and Coulter (1942) considered India to be the centre of origin. Bhaduri (1951) strongly supported the view of Vavilov.

The major factor contributing the popularity of brinjal is the relative easiness of its cultivation. But insect infestation is one of the limiting factors for accelerating yield potential of egg plant. The crop is prone to damage by various insects, although there is wide variability in the degree of infestation. Among the insect pests, jassid, *Amrasca biguttula biguttula* (Ishida) is the most devastating one during summer season, as it affects the yield and quality of brinjal considerably. Similarly bacterial wilt is another devastating disease ever reported in brinjal. Hence the present study was undertaken to screen out the F_1 hybrids which are resistant to jassid in a bacterial wilt resistant background.

The available literature related to the present study are reviewed under the following headings.

1. Evaluation of brinjal accessions (parents, F_1 hybrids and F_2 generation) for yield components and estimation of genetic parameters.

2. Screening of brinjal accessions for jassid resistance.

3. Screening for bacterial wilt resistance.

2.1. EVALUATION OF BRINJAL ACCESSIONS FOR YIELD COMPONENTS AND GENETIC PARAMETERS

India being the centre of diversity for brinjal, considerable variation exists here, which provide immense scope for its genetic improvement (Ganabus, 1964). Three botanical varieties have been reported under the species *melongena* like the round, egg shaped *Solanum melongena* var. *esculentum*; the long, slender *Solanum melongena* var. *serpentinum*; and the dwarf variety *Solanum melongena* var *depressum* (Chaudhary, 1976).

2.1.1 Variability, Heritability and Genetic Advance in Brinjal

The variation present in the plant population is of three type, viz., phenotypic, genotypic and environmental (Singh, 1983). Co efficient of variation gives an idea about the magnitude of variation present in the population.

Heritability and genetic advance are important selection parameters for crop improvement. The ratio of genotypic variance to phenotypic variance is known as heritability. Heritability (%) was categorized into low (0-30%), moderate (30-60%) and high (above 60%) by Singh (1983). Higher heritability indicates the least influence of environment on that particular character.

Genetic advance is the difference between the mean phenotypic value of the progeny of selected plants and the parental population. The genetic advance was categorized into low (< 20%) and high (> 20%) by Singh (1983). The genetic advance expressed in percentage of mean is called genetic gain. The genetic gain has been classified into low (1-10 %), moderate (11-20%) and high (>20%).

Saraswathi *et.al.* (1995) studied genetic variability and heritability of 12 yield components of brinjal in the parents and F_2 hybrids from six crosses. All the six hybrid populations had high phenotypic coefficient of variation (PCV), indicating large environmental effect on yield components. Among the F_2 populations, WCGR x Taiwan Naga had high heritability and genetic advance for most of the yield components.

Varma (1995) conducted a variability study in 23 green fruited brinjal genotypes and found out considerable variation for plant height, plant spread, primary branches per plant, days to flowering and fruit yield per plant. The characters like fruit yield per plant, total number of fruits per plant, average fruit weight and number of productive flowers were having highest magnitude of genotypic coefficient of variation. She also reported that high heritability coupled with high genetic advance for characters like yield per plant, fruits per plant, average fruit weight and per cent of productive flowers.

Fruit weight of brinjal hybrids had exhibited high estimates of heritability (0.935) along with high genetic advance indicating the presence of additive gene action (Rai *et al*., 1998). Number of primary branches, longitudinal and equatorial fruit length, leaf length and leaf breadth had shown low heritability as well as low estimates of genetic advance which indicate the presence of non additive gene action. Therefore heterosis breeding could be followed for effective improvement of these characters. They also reported that the estimates of phenotypic, genotypic and environmental variances showed a considerable range of variation for most of the characters.

In brinjal, high heritability values were observed for stalk length, plant height, fruit width, fruits per plant and fruit weight (Verma and Sarnaik, 1998).

Information based on 41 genotypes of brinjal (*Solanum melongena* L.) had revealed that highest genetic coefficient of variation was observed for fruit volume followed by seed to pulp ratio. The characters like fruit weight, fruit volume, plant height and seed to pulp ratio had high heritability coupled with high genetic advance which suggested that these traits are under the control of additive gene action and could be improved through simple selection (Patel *et.al*., 1999).

Heritability values were high for the characters like fruit weight, fruit diameter, plant height and number of fruits per plant (Rajyalakshmi *et.al*., 1999). Heritability and genetic advance were high for fruits per plant and fruit weight.

Singh and Gopalakrishnan (1999) reported high heritability for fruit weight and days to last harvest. Yield per plant had high values of heritability and genetic advance both in terms of number and weight of fruits. Genetic advance was very low for days to flower and fruit set. They also reported the maximum phenotypic coefficient of variation for number of fruits per plant (60.09 %) followed by yield per plant (57.12 %). Genotypic variation was also maximum for the above two characters (54.8 % and 52.67 % respectively). All characters other than yield per plant gave a coefficient of variation below 50 per cent.

Kumar et al. (2000) assessed 14 genotypes of brinjal for genetic diversity for ten yield components in three different environments created by manipulating the date of sowing and they observed highly significant differences for all characters under study. Higher values of phenotypic coefficient of variation were observed than genotypic coefficient of variation in all the three environments indicating the rate of environmental influence on the expression of various characters.

Sharma and Swarup (2000) reported that heritability estimates were higher for length of fruit, number of fruits per plant, mean fruit weight and yield per plant. Another finding after the study was that the characters like number of fruits per plant, mean fruit weight and yield per plant recorded higher values for genotypic coefficient of variation.

Components of genetic variation for eleven quantitative traits were studied in an eight parental half diallel of brinjal. Both combining ability and component analysis showed presence of additive and non additive gene effects. Heritability estimates in narrow sense were moderate to high for most of the component traits except days to 50 % flowering, days to first picking and fruit yield. Dominant and recessive alleles were symmetrically distributed among the parents for fruit length, days to 50 % flowering, yield per plant, days to first picking and fruit weight (Chaudary, 2001).

High heritability coupled with high genetic advance was observed for number of fruits per plant, number of harvests and yield per plant. High genotypic and phenotypic coefficients of variation were observed for these characters (Daliya, 2001).

Fifteen cultivars of aubergine were evaluated by Mohanty and Prusti in 2002 for six economic characters and PCV was found to b e greater than GCV for all the traits. High heritability accompanied by moderate to high GCV and genetic gain were observed for yield, average fruit weight, number of fruits and branches per plant. Plant height and days to first harvest manifested high heritability coupled with low GCV and genetic gain which required selection for several successive generations.

The extent of genetic variation and associations among different components in three aubergine cultivars and their F_1 and F_2 generations from each of the two crosses were studied by Kamani and Monpara (2006). Heritability and associations for ten characters were determined and found out that all the characters in both the crosses were largely under genetic control. The heritability for days to first picking and plant height was erratic due to large environmental variance. The F_2 generations of four crosses along with their five parents were studied by Kamani and Monpara (2007) for variability, heritability and genetic advance for ten characters in brinjal. Both GCV and PCV were low for days to first picking, moderate for days to first flower, plant height and fruit girth and high for branches per plant, fruit length, fruit shape index, fruits per plant, fruit weight and fruit yield per plant. High heritability along with high genetic advance and GCV for fruit length, fruit shape index, fruits per plant, fruit weight and fruit yield per plant in all the crosses suggested preponderance of additive gene action for these traits.

Kaur and Thakur (2007) conducted genetical studies on biparental progenies developed in F_2 generation of an intervarietal cross, Punjab Neelam x Punjab Barsati of brinjal. Additive genetic variance was more pronounced than dominance variance for number of fruits per plant and plant height while for fruit weight both additive as well as dominance components of variance were important. They also reported that fruit weight and plant height exhibited moderate heritability along with high genetic advance which indicated the importance of additive factors in the inheritance of both these characters.

The components of genetic variance, heritability and genetic advance for fruit yield and related characters were estimated in a cross GBL 1 x GCL 991 of brinjal. Additive variance was more pronounced than dominance genetic variance for all the traits indicating the importance of additive gene effects. The estimates of heritability and genetic advance were high for number of fruits per plant, plant height, days to first picking and fruit yield per plant (Dhameliya and Dobariya, 2007).

In a study conducted by Kamani *et al.* (2008), the F_1 and F_2 generations of four crosses along with their respective parents were grown in randomized block design with four replications to study the inheritance and association of 10 quantitative traits in brinjal. Only the fruit weight gave significant positive correlations with fruit yield per plant in the F_2 generations of all the crosses studied. This indicated that fruit weight should be the most important component of fruit yield in brinjal and due consideration should be given to this trait in selection programme.

A high degree of genetic variability, heritability and genetic advance were observed for the characters like average fruit weight, fruit length, number of flowers per inflorescence, number of fruits per cluster, fruits per plant and fruit yield per plant in brinjal. Some characters like days to first flowering, days to first fruiting, plant height and number of primary branches per plant showed low to moderate variability coupled with high heritability and low to moderate genetic advance (Sao and Mehta, 2009).

2.1.2 Heterotic Studies in Brinjal

Heterosis is the superiority of the F_1 hybrid over mid parent value (relative heterosis) or better parent (heterobeltiosis) or standard variety (standard heterosis). Shull (1914) coined the classical term "heterosis" implying extra vigour on crossing two inbreds.

Hybrid vigour in brinjal was probably first reported by Nagai and Kida (1926) in a cross combination of some Japanese varieties of brinjal.

In India the first attempt to hybridize eggplant appears to have been made by Rao in1934, however, in the cross between two wide varieties, a high degree of partial sterility due to abortive pollen was observed.

Venkataramani (1946) reported that hybrid egg plants were taller, spread more, flowered earlier than the early parent and yielded more than either parent. In the same year, Pal and Singh (1946) reported that majority of the hybrids exhibited heterosis with respect to seed germination, plant height, plant spread, number of branches, early flowering, number of fruits per plant, fruit size and fruit yield.

Singh and Kumar (1988) reported that a diallel cross involving five long fruited varieties revealed best general combiners for fruit yield such as ARU 1 and Sel. 5. They also reported that the cross, Pusa purple cluster x Sel. 5 was the best specific combination for yield and had the highest heterosis over better parent (162.5 %). H4 x Sel.5, Annamalai x Sel. 5 and Sel 5 x ARU 1 also showed significant heterosis for yield.

Varghese (1991) reported that the F1 hybrid of brinjal namely SM 6-2 x Pusa Purple Cluster exhibited maximum relative heterosis (71.42 %) and heterebeltiosis (51.71 %) followed by SM 6-6 x SM 132 (49.99 % and 24.8 % respectively).These hybrids were found to be phenotypically stable over different seasons. Study of inheritance of resistance to bacterial wilt revealed that resistance to bacterial wilt was inherited in a monogenic and recessive manner.

Parents and F1 hybrids of brinjal from a 7 line (wilt susceptible) x 2 tester (wilt resistant) cross were evaluated by Sawant *et al*.(1992) and found out two most promising hybrids for yield and high resistance to wilt (zero per cent wilted plants), Manjari Gola x Local brinjal and Arka Kusumakar x Local brinjal.

Geetha and Peter (1993) crossed three bacterial wilt resistant segregants of SM 6 (SM 6-2, SM 6-6, SM 6-7) with Arka Kusumkar, Arka Navaneeth, SM 132, Pant Rituraj and Pusa Samrat. They reported SM 6-6 x SM 132 and SM 6-2 x Pusa Purple Cluster as early, high yielding and resistant to bacterial wilt hybrids from white and purple group respectively.

Gopalakrishnan and Singh (2000) reported that, out of the 10 brinjal cultivars and their hybrids assessed for their performance, Swetha x SM 63 was the earliest hybrid to flower. Arka Keshav x SM 71 produced longest fruits (21 cm) and exhibited the highest heterosis for that trait. Surya x SM 116 exhibited significant heterosis for fruit diameter and SM 141 x Thiruvalla Green Round exhibited highest yield per plant. Arka Keshav x SM 71 showed the highest heterobeltiosis and standard heterosis for yield per plant.

The exploitation of hybrid vigour in brinjal using 10 parents like Pusa Ankur, Arka Nidhi etc. were studied for manifestation of better and mid parent heterosis for fruit yield per plant and 11 yield attributing traits like, days to 75 % flowering, days to first harvest, leaf area, fruit length, fruit width etc.(Ashwani and Khandelwal, 2003). All the 45 hybrids showed positive and significant heterosis over better and mid parent for fruit yield per plant. They also reported that significant values of heterosis over better parent and mid parent were observed for other attributes indicating their contribution to the heterosis for fruit yield. The best heterotic hybrids were Pusa purple cluster x Udaipur Local, Udaipur Local x Pusa Bhairav and Pusa Uttam x Udaipur Local.

Paikra *et al*. (2003) reported that among the 11 brinjal hybrids which were evaluated to assess the performance in Madhya Pradesh during rabi 2000-01, Pusa hybrid 6 recorded the highest yield, fruit weight, fruit girth and number of branches. Plant height was also found to be highest in Pusa hybrid 6 and was the best for the Chhattisgarh region.

Kumar and Pathania (2004) reported the range of heterobeltiosis for marketable fruit yield per plant from 51.82 % - 118.60 % and 32.53 % - 98.41 % for standard heterosis for the cross CHES – 309 x Hissar Shyamal. According to them CHES – 309 x Hissar Shyamal recorded highest positive heterosis over better parent and standard check for fruit weight and fruit diameter while the hybrid Arka Keshav x Pusa Purple Cluster revealed the highest heterosis over both the parents for fruit length.

Significant desirable heterotic effects were exhibited by 36 F_1 hybrids over better and mid parent for all the traits studied (Singh *et al*., 2004). The range of heterosis percentage in F_1 crosses varied from -68.80 to 27.22 and -72.16 to 33.75 for fruit yield and -61.54 to 67.44 and -58.06 to 160.87 for average fruit weight. They recommended the best heterotic hybrid (yield) Swarna Shree x CH -190 for commercial cultivation.

According to Baig *et al*. (2005) the extent of heterobeltiosis, useful heterosis and standard heterosis for fruit yield per plant over environment were in the range of -56.76 to -93.32 %, -18.85 to 190.77 % and -39.98 to 118.64 % respectively. The hybrids ABV1 x Anuradha, ABV1 x Vaishali showed maximum fruit yield with maximum heterosis. They also reported that the magnitude and nature of heterosis for fruit yield and its components were high over environment for ten hybrids.

The manifestation of hybrid vigour in F_1 crosses for six characters in brinjal was studied by Bavege *et al*. (2005) and found that the extend of heterosis over commercial control (Kalpataru) was 30.74 % for plant height, -10.82 % for days to 50 per cent flowering, -2.25 % for fruit length diameter ratio, 87.06 % for early number of fruits per plant and 59.74 % for total yield per plant. The study revealed that the cross Malapur Local x Melavanki Cluster II, Manjary Gota x Malapur Local and Malapur Local x Melavanki Cluster II exhibited the highest significant positive heterosis for total yield. Malavapur Local x Melavanki Cluster

II also showed the highest positive heterosis for early number of fruits per plant and total yield per plant.

According to Panda *et al.* (2005) appreciable heterosis was recorded by ten brinjal hybrids over mid, better and standard parents for all the characters. They had reported heterosis to the extent of 8.80, 18.60, 28.00, 41.10 and 59.50 per cent over standard parent for fruit length, fruit diameter, total number of fruits per plant, total weight of fruits per plant and early yield respectively. PB-62 x T-3 was reported as the highest yielding hybrid with 41.10 per cent standard heterosis and the hybrid PR x PB-61 was found to be earlist in maturity with 59.50 per cent standard heterosis.

Prabhu *et al*. (2005) studied the heterosis and mean performance of five brinjal hybrids during 2003 -04 in Tamil Nadu for the following traits like plant height, branches per plant, fruit number per plant, mean fruit weight, marketable yield per plant and fruit borer infestation. They reported that the hybrid EP 65 x Pusa Uttam as the best hybrid with more fruit number per plant and lesser fruit borer infestation.

Paikra and Lavatre (2005) evaluated 22 brinjal hybrids from diverse sources constituting 11 round and 11 long types during rabi 2000-01 in Raipur. They had recorded plant height, number of branches, days to 50 per cent flowering, fruit set percentage, number of fruits per plant, fruit girth, fruit weight, yield per plant and yield per hectare and found out that Pusa Hybrid 6 and KBHL-1 recorded the highest yield among round and long type hybrids respectively.

Twenty four crosses resulting from a Line x Tester mating design comprising of six lines and four testers were studied by Shafeeq *et al*. (2006) to know the magnitude of heterosis over mid parent, better parent and commercial check Kalpatharu. Among the 24 hybrids, Arka Shirsh x Kudchi A, AR x Green Round and Budihal Local x Kudchi A exhibited significantly positive heterosis for fruit yield per plant over mid parent, better parent and commercial check respectively. The maximum heterosis for fruit yield per plant was observed with hybrid Arka Shirsh x Green Round (175 .87 %) followed by Arka Shirsh x Kudchi A. The hybrid Arka Shirsh x Green Round also exhibited highly significant heterosis for number of fruits per cluster and average fruit weight.

In an experiment conducted by Suneetha and Kathiria in 2006 to determine the extent of heterosis during late summer season, the hybrids were found to be high yielding, early and tall with greater plant spread and leaf area per plant compared to parents. Among these maximum heterosis was reported for total soluble sugars followed by total phenols, leaf area per plant and fruit yield per plant. Significant and desirable levels of heterobeltiosis for fruit yield per plant were observed in 20 hybrids while six hybrids exhibited significant and desirable levels of heterosis over both better parent and standard cultivar. The study also revealed the potential of KS 224 and PLR 1 for the production of heterotic and high yielding hybrids for the late summer season.

Suneetha *et al*. (2006) reported the manifestation of heterosis in 45 round aubergine hybrids for fruit yield, other yield components and quality traits during kharif and summer seasons. The performance of the genotypes varied with the season and the maximum fruit yield was recorded during the kharif season. The hybrids were high yielding with other yield contributing characters compared to parents during all seasons. They had reported that the heterobeltiotic effects were pronounced during summer while standard heterosis was higher during kharif. They also reported the combination PLR x JBPR 1 as the best hybrid for cultivation during all the three growing seasons.

According to Vaddoria *et al*. (2007) the range of mean performance of hybrid was higher than the parents for days to first picking, plant height, plant spread and fruit yield per plant. The magnitude of heterosis ranged from -48.15 to 23.17 % over standard parent for fruit yield per plant. They had recommended that the hybrids ABCL 0014 x PB and ABCL 004 x PR could be exploited for higher fruit yield and plant stature while the hybrids PBL 21 x PLR 1 could be useful for earliness and plant stature in future breeding programmes in brinjal.

Prabhu *et al*. (2008) reported the potential of heterosis breeding for improving shoot and fruit borer resistance in brinjal.

In brinjal heterosis was manifested mainly for enhanced fruit yield and other important economic traits like earliness, adaptability and prolonged fruiting period (Roy *et al.,* 2009). Considering the heterobeltiosis desirable heterosis was observed in fruit yield per plant, plant height, primary branches per plant, fruit weight and fruits per plant. The magnitude of desirable heterobeltiosis effect was highest in fruit yield per plant followed by plant height. They have also reported that high fruit yield in the hybrids was manifested through enhancement in the vegetative and fruit characters particularly plant height, primary branches per plant and fruit weight.

Shanmugapriya *et al*. (2009) reported three brinjal hybrids *viz*. White Brinjal x Annamalai, White Brinjal x PLR 1, Kunnam x Annamalai which are promising for heterosis breeding based on the per se performance, sca effects and standard heterosis.

Vaddoria *et al*. (2009) evaluated 48 brinjal hybrids along with their 16 parents and a check variety GBH 1 for fruit borer infestation and fruit yield per plant. They identified six hybrids namely JBSR 98-2 x Pant Rituraj, ABL 98-1 x Pant Rituraj, ABL 98-1 x GBL 1, Morvi 4 - 2 x GBL 1, Morvi 4 – 2 x PLR 1 and Green Round x GBL 1 as most widely adapted hybrids for yield and resistance to fruit borer infestation. According to them these hybrids could be used either for resistance breeding or be utilized for commercial exploitation of hybrid vigour in brinjal.

Diversity is an important criterion in the selection of elite germplasm lines to develop highly heterotic F_1 hybrids (Patil *et al.,* 2010). Fruit weight, number of fruits per plant and fruit yield exhibited high magnitude of heterosis in the heterotic and diversity study conducted by them.

Sao and Mehta (2010) reported a genetical study on fruit yield per plant and its attributing traits along with quality traits like TSS by following line x tester mating design. The analysis revealed that all the parents were good general combiners for most of the characters. However line IGBO 65 and tester KS 327 were found best combiners for fruit yield per plant. The hybrid IGBL 70 x PPL was found best on the basis of sca and heterosis for fruit yield per plant.

In a heterosis and diversity study conducted by Nalini *et al*. (2010) by using 28 F_1 hybrids of brinjal, high magnitude of heterosis was exhibited by the characters like fruit weight, number of fruits per plant and fruit yield. High heterosis for fruit yield attributed to increased fruit weight and number of fruits per plant.

2.1.3. Combining Ability in Brinjal

The knowledge of combining ability, a concept first proposed by Sprague and Tatum (1942) in corn is useful in selection of parents, which can produce superior hybrids. It is also useful in measuring hybrid performance and genetic architecture of metric traits. They coined two terms: General Combining Ability (gca) and Specific Combining Ability (sca).

Earliest studies concerned to brinjal combining ability were reported by Odland and Noll (1948). They reported that, the hybrid combination between lower yielding parents produced more yield.

Kumar *et al*. (1996) found additive gene effects were significant for fruit weight in all the crosses and were higher in magnitude than dominance gene effects. Bulgundi (2000) noticed the cross MG × W-8, which was early in flowering had parents with negative and significant positive gca effects.

General and specific combining ability variances and effects for six characters were studied involving seven parent varieties of egg plant in all possible combinations excluding reciprocals (Patil 1998). The gca variances were higher for all the characters, suggesting the predominance of additive gene action. The gca effects indicated that none of the parents was a good general combiner for all characters, suggesting that separate parent will have to be used for improvement of different traits studied. They also promoted the use of varieties Pusa Purple Long and Dotty for breeding programme, as they are expected to give high yielding performance.

Chaudhary and Malhotra (2000) conducted combining ability studies on brinjal to isolate desirable parents and F_1 cross combinations for yield and physiological growth parameters. Both additive and non-additive types of gene effects were observed to be operative for various characters. Parental lines SM6-6, Punjab Barsati, Hisar Shyamal and Arka Nidhi were observed to be good general combiners for yield, crop growth rate, leaf weight ratio, specific leaf weight, net assimilation rate and leaf area. The mean squares for sca were greater than those for gca in all the characters except leaf area, leaf weight ratio (45 DAT) and specific leaf weight (45 DAT).

Bavage (2002) reported that the sca effects were significant for days to 50 % flowering for eight crosses, out of which three crosses had useful negative sca effects and 5 crosses had positive specific combining effects. He also observed significant positive sca effect for plant height.

Karaganni (2003) noticed a good amount of mean performance; highly significant gca effects coupled with moderately high gca variance and sca variance were manifested by parent SCHN 2. Vinodkumar and Pathania (2003) observed highly significant sca effects in the cross Arka Keshav × Pusa Purple Cluster for plant height and highly significant positive gca effects in the lines Arka Keshav, Pusa Anupam and Punjab Barsati for fruit length. The cross Arka Keshav × Pusa Purple Cluster exhibited best sca effects for fruit length also.

Suneetha *et al*. (2005) observed that non-additive gene action was pre-ponderant for yield and yield contributing characters and the study also revealed significant and desirable effects for several hybrids.

Bisht *et al*. (2006) identified the line Uttara as the promising combiner for branches per plant. The good specific combiners for this trait were Punjab Barsati × Green Long Cluster and Punjab Sadabahar × DBL-24. They also reported that the parents Uttara, Green Long Cluster and Nessppe were good general combiners for the trait fruits per plant and also observed the best three crosses with high specific combining ability effects.

Shanmugapriya *et al*. (2009) reported the lines *viz*. EP 378, White Brinjal and Pusa Sadabahar and the tester *viz*. Hisar Pragath as good general combiners for fruit yield per plant, days to first flowering, number of branches per plant, plant height, number of fruits and fruit weight.

A study of combining ability for tolerance to brinjal shoot and fruit borer infestation and other yield attributes was conducted by Das *et al*. in 2010 to identify the nature of gene action operating for these traits. Prevalence of additive variance was found for most of the traits. They have also reported that the heterosis breeding approach would not be possible for fruit borer infestation as no cross was found to have significant negative sca effect but the parents like BCB 38, BCB 23, BCB 14 showed negative gca effect.

2.2. SCREENING OF BRINJAL ACCESSIONS FOR JASSID RESISTANCE

2.2.1. About the Pest

Cotton jassid, *Amrasca biguttula biguttula* (Ishida) = *Sundapteryx biguttula biguttula* (Ishida) = *Empoasca devastans* (Distant) = *Amrasca devastans* (Distant) was described by Distant (1918). It is a green wedge shaped leaf hopper and the adult insects can be recognized by the presence of prominent black spots on either side of head. The adult hoppers lay about 15 eggs on the under surface of leaves, embedding them into the leaf veins. Nymphs of this insect are light green translucent and move diagonally when disturbed. The nymphal period last for seven days and the total life cycle is completed in 15 – 46 days (Ambrose, 2007).

According to Singh (1996) heavy incidence of jassids was a serious problem of brinjal during summer months in Kerala. Sharma *et al*. (2001) reported that the threshold level of jassids was found to be two nymphs per leaf. Damage to the crop is caused by the adults and nymphs and they suck the cell sap from the under surface of the leaves and inject toxic saliva to the plant. As a result the leaves turned pale and then rust red, with change in appearance of leaves like yellowing, browning, crumbling and withering of the leaves. This characteristic symptom is called 'hopper burn' and gradually it would lead to the death of plants (Atwal and Daliwal, 2008). They also reported that the pest could cause an yield reduction upto 35 per cent.

Ghouri (1976) and Yunus (1976) reported that the infestation of two leaf hoppers per leaf on cotton formed an economic threshold. Mahmood *et al*. (2002) reported that since economic threshold level (ETL) of jassid was not available, the finding of Ghouri (1976) and Yunus (1976) might be good for comparing resistance of different brinjal cultivars. But according to Ambrose (2007) the ETL for jassid is 50 nymphs per 50 leaves.

2.2.2. Distribution of the Pest

According to Atwal and Dahliwal (2008) the cotton jassid is widely distributed in India and is a most destructive pest of American cotton in the North Western region. It is a polyphagous insect which feeds on brinjal, okra, bitter gourd, potato and some wild plants apart from cotton.

. Jasssids were reported to be the serious pest of brinjal in New Delhi (Subbaratnam *et al*., 1983), Kerala (Singh, 1996), Gujarat (Jyani *et al*., 1997), Andra Pradesh (Sudhakar *et al*., 1998), Bihar (Mandal *et al*., 2000), Bangalore (Reddy and Srinivasa, 2001), Tamil Nadu (Raja *et al*., 2001), West Bengal (Ghosh and Senapati, 2001) and Rajasthan (Kumar *et al*., 2002).

Bhindi (*Abelmoschus esculentus* L.) is another important host of jassids, (*Amrasca biguttula biguttula)* which was noticed to be attacked by jassids in Madhya Pradesh (Dhamdhere *et al*., 1995), Haryana (Hooda *et al*., 1999) and Assam (Gogoi and Dutta, 2000). Jassid infestation was also observed on *Hibiscus subdariffa* L.(Rao *et al*., 1983).

2.2.3. Seasonal Distribution

Senapaty and Khan (1978) reported that high population of jassids on okra was noticed from November to February with its peak in December. Gangwar and Sachan (1981) reported the appearance of jassids during second and third week of July. According to Patel and Thanki (1987) the January transplanted brinjal crop was found to be infested with jassids and maximum population occured during March to June. Shukla (1989) found that the population of jassid increasing from the first week of June and reaching peak during last week of August in brinjal.

Dhamdhere *et al*., (1995) noticed that the jassids remain active during summer as well as kharif season on brinjal, but most favourable condition for pest build up was summer season. Field plot tests in Diphu, Assam, India, in 1992 showed that the incidence of *Amrasca biguttula biguttula* on brinjal crops planted at various dates from 20 July to 20 December was higher on early planted crops than on late planted ones (Borah, 1995).

Singh (1996) reported heavy incidence of jassids as a serious problem for summer cultivation of brinjal in Kerala. Peak incidence of jassid was recorded during September - October and from April onwards in summer at Madurai, Tamil Nadu (Prasad and Logiswaran, 1997). Mahmood *et al*. (2002) reported that serious activity of jassids on brinjal was from May to August.

According to Gogoi and Dutta (2000) the jassid population on okra was maximum in the last week of May in 1998 and middle of April in 1999. American cotton was severely attacked by jassids from the end of July and population level declined after mid September. Singh and Singh (2002) noticed that the population of jassids was found highest in the first and second week of August during 1994 and 1995.

The seasonal abundance of jassid infesting aubergines in West Bengal was investigated in 1996-98. Life cycle duration was lowest (25.11 days) in June-July and highest (36.36 days) in October-November (Ghosh and Senapati, 2003). Duration of all developmental stages was correlated with temperature and relative humidity. The highest jassid population (4.63/leaf) was recorded in April-May and the lowest (0.50/ leaf) in mid-July.

The field density of *Amrasca biguttula biguttula* along with their associated abiotic and biotic factors were observed by Yadav *et al*. (2009) in okra field at Kanpur. The incidence of jassid, began from July and continued till October.

Naik *et al*. (2009) conducted a field trial to study the incidence and management of *Bemisia tabaci* and *Amrasca biguttula biguttula* and revealed that peak incidence was recored during the third week of February 2006 and the incidence had non significant relationship with abiotic factors but significant relationship with abundance of coccinellid predatory beetles as well as spiders.

2.2.4. Preferred Stage of the Crop

Patel and Thanki (1987) conducted a study on the jassid infestation in brinjal and found out that infestation started on six to seven weeks old crop, which continued until 13 to 30 weeks after transplanting**.** According to Shukla (1989) the pest infestation started from 10 days after transplanting and reached peak at 75 DAT and then started declining gradually.

During summer, the jassid population in brinjal plants started increasing at 45 DAT, peaked at 60 DAT and gradually declined as the plant was getting matured (Lit *et al*., 2000). A Study conducted by Reddy and Srinivas (2001) revealed that the critical population of jassid was between 30 and 90 days after transplanting.

Mahmood *et al*. (2002) reported that the leaf hopper infestation started at early stages of crop growth in brinjal. The observations taken by Singh and Singh (2002) on the pest succession revealed that the appearance of jassids started after a week of transplanting.

As per the findings of Sivanandan (2003), the time required to develop characteristic symptoms of damage on cotton plants by *Amrasca biguttula*

biguttula was positively correlated with the age of plants. Younger plants were found to be more susceptible to jassid attack.

Malini (2005) reported that during *rabi* season the infestation of jassid started from 45 DAT, peaked at 80 DAT and then started declining in brinjal. But during summer, the infestation started from 20 DAT and peaked at 35 DAT.

2.2.5. Distribution on Plant Parts

Spatial distribution of insects was studied to understand and predict the distribution, abundance and interaction of population with the host crop and finally to develop management strategies.

Subbaratnam *et al*. (1983) opined that jassid nymphs were found to be aggregated along the sides of midrib of brinjal leaves since they used to oviposit along the midrib. In field studies conducted in India during 1991-92 by Simwat and Dhawan (1995), the time of observation during the day did not affect the population distribution of *Amrasca biguttula biguttula* on cotton. Number of nymphs of *Amrasca biguttula biguttula* was significantly higher in the lower and upper canopy of the cotton varieties 'LH 1134' and 'LH 900', respectively. According to Lit *et al*. (1999) fifth leaf from the growing tip of brinjal plants was more infested by jassid than other leaves.

Sharma and Singh (2002) opined that lateral veins of brinjal leaves received more eggs of jassids compared to main and sub veins. They observed similar result on cotton and okra leaves for jassid population. According to Ambrose (2007) the nymphs of jassids were found between veins on the under surface of leaves and move diagonally when disturbed.

Spatial distribution of jassid, *A. bigutulla bigutulla*, was studied in Umerkote (Orissa, India) on cotton cv. MCU-5 during kharif 2001 and 2002 using various distribution parameters such as variance mean ratio, dispersion parameter (K), Lloyd's Index of mean crowding, patchiness index, Taylor's power law and Chisquare test. The pest followed mostly aggregated distribution when population was high and random distribution when population was low (Mohapatra, 2007).

2.2.6. Influence of Weather Parameters on Jassid Incidence

A maximum temperature of 20^0 C with less than 15^0 C variation between maximum and minimum temperatures, favoured the build up of leaf hopper population in brinjal (Patel and Thanki, 1987).

According to Shukla (1989) and Prasad and Logiswaran (1997) the jassid (*Amrasca biguttula biguttula*) population showed a significant positive correlation with maximum temperature and a negative correlation with rain fall.

As per the report of Ratnapara *et al*. (1994) the minimum temperature and vapour pressure were negatively associated with the population build up of jassids. They also reported that the sun shine hours had a positive association with increasing numbers of the pest, jassids in brinjal.

Dhamdhere *et al*. (1995) opined that the jassids remain active during summer as well as kharif season, but summer was the most favourable condition for pest build up. Singh and Sekhon (1998) reported a weak negative correlation of leaf hopper population with sun shine. Leaf hopper population increased on okra plants whenever the mean temperature was near 30^0 C coupled with 5-8 hours of sun shine per day.

Bernice (2000) recorded that an increase of 10^0 C in maximum temperature and 1mm in rain fall would lead to an increase of 2.10 nymphs and adults per three leaves and a decrease of 1.44 nymphs and adults per three leaves respectively in brinjal.

Gogoi and Dutta (2000) reported that high temperature (30^0 C – 36^0 C) and evening relative humidity (below 80 %) and low rainfall period coupled with bright sunshine hours favoured the development of jassid population on okra plants.

A study was conducted on the population of leaf hopper, *Amrasca biguttula biguttula* on brinjal crop and effects of abiotic factors on its dynamics by Mahmood *et al*. in 2002. Mean maximum and minimum temperatures were found to be positively and significantly correlated with population change. But a non significant and negative correlation was observed between relative humidity and rain fall with jassid population. Sunshine hours was also a positively but non - significantly correlated factor.

The highest jassid density, which was recorded on the 1st week of November, coincided with the presence of 22.57^{0}C average temperature and 69.0% relative humidity. The jassid population was significantly affected by 21-25^0 C, 62-75% relative humidity, and dry season (Singh *et al*., 2005)

2.2.7. Host Plant Resistance

According to Painter (1951) plant resistance was the relative amount of heritable qualities that influence the ultimate degree of damage done by the insects. He had categorized plant resistance phenomenon into non preference, antibiosis and tolerance. Antibiosis is the mechanism of interfering or destructing the life cycle of insects. It is manifested by the presence of some allelochemicals present in the plant body (Singh, 1986). Kogan and Ortman (1978) suggested the term 'antixenosis' by replacing the term non preference. It is the avoidance of plants by insects in search of food, shelter or ovipositional site (Singh, 1986). Tolerance refers to the ability of the host plant to withstand an insect population sufficient to damage severely the susceptible plants, without loss of vigour.

Beck (1965) defined host plant resistance as the collective heritable characters by which a plant species, race, clone or individual may reduce the possibility of successful utilization of that plant as a host by pest species, race, biotype or individual. Reaction of host plant to insect pest may vary from high level of resistance to extreme susceptibility.

Ananthakrishnan (1992) opined that there can be morphological, anatomical or genetic factors determining pest resistance reactions. Daliwal *et al*. (1993) proposed a definition of host plant resistance which refers to the heritable qualities of a cultivar to counteract the activities of insects so as to cause minimum per cent reduction in yield as compared to other cultivars of the same species under similar conditions.

2.2.8. Resistance to Jassid Infestation

Gaikwad *et al*. (1991) reported two aubergine varieties, Manjari Gota and Vaishali which were resistant to jassid, *Amrasca biguttula biguttula*, after conducting a field screening in Maharashtra.

Experiments were conducted in a farmer's field by Mukhopadhyay and Mandal (1994) to evaluate the relative degree of resistance offered by 41 cultivars of brinjal to the major insect pests like shoot and fruit borer (*Leucinodes orbonalis*), cotton leaf hopper (*Amrasca biguttula biguttula*), cotton aphid (*Aphis gossypii*) and spotted leaf beetle (*Epilachna vigintioctopunctata*). The data on insect population and damage were recorded at 20 days intervals throughout the period of crop growth and they observed significant differences in reaction to the pests among the cultivars, although no cultivar was observed to be resistant to any of the four pests. Navkiran showed tolerance to all the pests studied.

Twenty eight varieties of brinjal were screened for resistance to insect pests by Patel *et al*. (1995). Of these, the variety Manjari Gota was found to be resistant to *Amrasca biguttula biguttula* and *Bemisia tabacci*. Singh (1996) reported that BB7 and Pusa Kranti were resistant to jassid infestation and the pest was below the economic threshold level on these plants.

Jyani *et al*. (1997) evaluated some brinjal varieties for jassid resistance and found out that none of them showed resistance to pest infestation. The varieties like Suphal, Punjab Barsati, GB-6, Ravedi, Round – 14, Gujarat Brinjal Hybrid 1 and Chaklasi Doli were equally susceptible to *Amrasca biguttula biguttula*.

Lit *et al*. (2000) screened ninety nine egg plant genotypes for field resistance to jassids at vegetative and reproductive stages. They found that the accession 658 had higher jassid count followed by 356, 483, 544 White, Mars, Dumaguete Long Purple and Claveria Long Purple. Leaf hoppers were not observed on NBPGR accessions like 566, 651, 671, 672, 682 and Phl 9405. Abar was a brinjal accession which was found resistant to leaf hopper and 544 white was the most susceptible accession.

In 2001, Raja *et al*. screened 153 brinjal genotypes against jassids and revealed that none of them were found either immune or resistant. But 23 genotypes were graded as moderately resistant and all others were graded as moderately susceptible, susceptible and highly susceptible. In a study conducted by Reddy and Srinivas (2001) leaf hoppers were found abundantly on brinjal varieties Green Long, Arka Neelakant and Arka Sheel while on MHB 10, Pusa Purple Round, Pusa Purple Long and Arka Shirish the population was less.

According to Kumar *et al*. (2002) brinjal F_1 hybrid was least preferred by jassids while local variety was most preferred by jassids. The preference in an ascending order was F_1 Hybrid, Chyamla, Egglester, Pusa Purple Long, Jhumka, MHB-2, Brinjal F-2, Kanahya, MHB-3, Navchetan, Pusa Purple Round and local cultivar.

Malini (2005) screened thirty six brinjal accessions collected from different parts of the country and found that out of these 36 accessions, five accessions namely SM 363, SM 364, SM 366, SM 384 and SM 385 were resistant to jassid infestation in the field screening and under cage studies.

A field experiment was conducted in 2006 at Madurai, Tamil Nadu, India, to study the influence of cultivars/hybrids/germplasm of brinjal to major insect pests and their natural enemies. The hybrid, Sweta was the best in reducing the shoot and fruit borer damage by *Leucinodes orbonalis*, recording a mean shoot and fruit damage of 8.0 and 8.7% (number basis) and populations of aphid, *Aphis gossypii*, leafhopper, *Amrasca devastans* (*A. biguttula biguttula*) and whitefly, *Bemisia tabaci*, recording 6.3, 0.0 and 0.0 numbers /3 leaves respectively (Elenchezhyan *et al*., 2008).

Deole (2008) screened fifty-four cultivars of brinjal for jassid (*Amrasca biguttula biguttula*) infestation based on the leaf texture of the plant, i.e. (i) cultivars with leaves of smooth texture (ii) cultivars with leaves of leathery texture and (iii) cultivars with leathery leaf texture having spines. The results indicated that the mean jassid population among the cultivars varied significantly and ranged between 6.37 to 12.62 jassids per plant in IBR-174 and IBR-7, respectively. 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. IBR-7 with leaves of smooth texture was the most infested cultivar.

A study was conducted at Kanpur to evaluate the resistance of 129 cotton accessions against the cotton jassid (*Amrasca biguttula biguttula)*. Only 26 cultivars were resistant to the pest. The remaining cultivars were categorized as moderately susceptible, susceptible and highly susceptible (Singh *et al*., 2010).

2.2.9. Mechanisms of Jassid Resistance

Non preference and antibiosis are the two important mechanisms of leaf hopper resistance in brinjal. According to Ruzzel (1978) the non preference in brinjal was decided by morphological and biochemical factors.

Uthamasamy and Subramaniam (1985) reported that the insect takes only fewer days to complete life cycle in susceptible varieties, which means a quicker multiplication and greater number of generations in a given period than on the resistant variety.

Lit and Bernado (1990) emphasized that the jassid resistance in brinjal varieties were due to antixenosis and antibiosis. Bernado and Taylo (1990) suggested the potential use of okra as a trap crop to prevent severe jassid attack on brinjal.

F_1 hybrids obtained from the cross Punjab Padmini (tolerant to cotton jassid and yellow vein mosaic virus (YVMV) x Pusa Sawani (susceptible to cotton jassid and YVMV), the 21 generations derived from them and the parents were evaluated for resistance to cotton jassid and fruit borer. Gene effects for reaction to the pests were calculated using the additive dominance, digenic epistatic and trigenic epistatic models. All three models were inadequate for explaining the variation in resistance to the pests between generations, suggesting non-allelic interaction or linkage between non-allelic genes (Ghai *et al*., 1993).

Bhaskaran and Ravikeshavan (2008) conducted a study to observe the leaf anatomy of the introgressed lines and their hybrids for the heterotic expression of leaf anatomical characters which contribute towards jassid resistance. Many of the hybrids exhibited positive and significant relative heterosis, heterobeltiosis and standard heterosis for characters like phloem distance, phloem thickness, number of palisade cells while negative heterosis for the characters *viz.*, spongy parenchyma thickness and tissue ratio. The hybrids MCU 2 x MCU 5 had high heterosis for jassid tolerance associated characters. In addition, the hybrids KC 2 x MCU 12 and MCU 5 x MCU 12 were also found to exhibit positive and significant heterosis for resistant characters coupled with yield.

2.2.10. Influence of Leaf Thickness and Midrib Thickness with Jassid Resistance

Thickness of leaf lamina and midrib were positively correlated with jassid infestation in brinjal (Subbaratnam *et al*., 1983). According to Gaikwad *et al*. (1991) leaf thickness, midrib thickness and leaf area were positively correlated with jassid infestation level on brinjal.

Kumar *et al*. (2002) reported that F_1 hybrids of brinjal with tough surface and thin and hard midrib were resistant to jassid attack. Sharma and Singh (2002) opined that the leaf vein thickness and length were positively correlated with jassid resistance in cotton.

Malini (2005) woked out simple correlations between jassid intensity and leaf thickness and between jassid intensity and midrib thickness and revealed a negative but non significant association between these characters.

2.2. 11. Leaf Pubescence and Jassid Resistance

Subbaratnam *et al*. (1983) opined that the angle of insertion of midrib hairs had significant influence on egg laying preference of jassids on brinjal.

Uthamasamy (1985) revealed that leaf hopper population had highly significant negative correlation with hair density and hair length. The density and length of midrib hair increased with age of the crop. He also added that inadequate density of hairs on lamina is not effective in imparting resistance.

Lit (1989) reported a highly significant and negative linear association between the trichome characters like number of branches of leaf trichomes, length and density of trichomes and adult oviposition or nymphal feeding of the leaf hopper on brinjal.

Studies on the ovipositional preference of adults of *Amrasca biguttula biguttula* on different plant ages of two varieties of okra revealed that fewer nymphs were emerged from the leaves of the resistant variety IC 7194 (9.83) compared to 13.23 nymphs for the susceptible variety Pusa Sawani. There was an inverse relationship between the emergence of nymphs with the density of trichomes on the mid-vein of leaves of different plant ages (Mahal *et al*., 1993).

The role of plant characters (hair density, hair length and gossypol glands on midrib, vein and leaf lamina, and thickness of leaf lamina) was studied towards resistance against sucking insect pests in cotton by Aheer and Saeed (1999) and found significantly negative correlation between hair density on leaf lamina and jassid population.

According to Arif and Sanpal (2005) hair density on the vein and lamina of upper, middle and bottom leaves and thickness of leaf lamina on the middle and bottom leaves played a significant and negative role towards resistance for jassid adult population in cotton. Gossypol glands on the lamina of the middle leaf only resulted in significant negative correlation, while the other morphological traits showed non significant correlation to the adult and nymph population of jassid.

Malini (2005) worked out a simple correlation between nymphal population on brinjal plants with number of midrib hairs present in 25 mm^2 area on ventral surface of leaf. The correlation coefficient revealed a significant and positive association of jassid resistance with leaf pubescence.

A study was taken up by Kannan *et al*. (2006) to evaluate the number of trichomes present in the leaf of cotton as related to jassid resistance. Three cultivars KC 2, MCU 5 and MCU 12, their F_1 and segregating populations F_2 and F_3 and backcrosses BC_1 F_1 were screened. Among the parents KC 2 recorded highest trichome density of 26.02, when compared to 14.11 and 17.88 per microscopic field of observation in MCU 5 and MCU 12 respectively. The F_1 KC 2 x MCU 12 registered more trichome density of 21.48 than KC 2 x MCU 5 (15.47) and MCU 5 x MCU 12 (14.33).

Resistance to leaf hopper (*Amrasca biguttula biguttula*) and white fly (*Bemisia tabaci*) was evaluated in 13 aubergine cultivars grown in Rajasthan, during 2002 and 2003 (Naqvi *et al*., 2008). Leaf area, leaf thickness, trichome density and chlorophyll content were correlated with leaf hopper and white fly population. Leaf area, leaf thickness and chlorophyll content had no effect on leaf hopper population, while trichome density had a negative correlation. The trichome density in the different cultivars ranged from 550.8 to 1068.5/cm^2. The leaf area had a positive effect on white fly population, whereas leaf thickness, trichome density and chlorophyll content had no significant effect.

2.3. SCREENING FOR BACTERIAL WILT RESISTANCE

2.3.1. About the Disease

Brinjal (*Solanum melongena* L.) is an important and widely consumed solanaceous vegetable of India grown round the year. Among the diseases of brinjal, bacterial wilt is a major one caused by *Ralstonia solanacearum*, a soil borne pathogen, which invades the host through wounds in roots or underground parts of the plant (Kelman, 1953).

Plants rapidly dry up and die without showing symptoms of leaf yellowing. As the disease progresses, wilting on the leaves increases, until the plant eventually dies. The symptom occurs as discolouration of the vascular system from pale yellow to dark (Gota, 1992).

2.3.2. Occurrence and Host Range

The first record of bacterial wilt caused by *Ralstonia solanacearum* in the world was reported by Burrill in Japan. In India, bacterial wilt was first observed in 1892 by Cappel (Cappel, 1892) in potato, four years before Smith could describe the disease and its causal agent.

In India it assumes serious problem in parts of Karnataka, Kerala, Orissa, Maharashtra, Madhya Pradesh, Bihar and West Bengal (Rao, 1972).

Hayward (1991) reported that across the world there were differences between *Ralstonia solanacearum* races and biovars depending on the geographical distribution. He listed more than 450 plant species including solanaceous vegetables like tomato, brinjal and chilli as the host plants for *Ralstonia solanacearum*.

According to Rao and Sohi (1977) the incidence of bacterial wilt ranged from 15 % to 60 % during different seasons. Gopimony and George (1979) reported that in various districts and agricultural farms in Kerala, the percentage of wilt incidence in a few improved varieties like Arka Ksumkar and Banaras Giant was as high as 100 per cent whereas in local varieties this varied from 6 to 20 per cent only. The host reaction varies at different places due to variation in environmental factors (Michal, 1997).

Bacterial wilt disease is prevalent in all parts of the country where solanaceous vegetables are grown. In the states of Kerala, Karnataka, Madhya Pradesh, West Bengal etc., the disease often possess serious problems for the cultivation of solanaceous vegetables causing total crop loss (Peethambaran *et al*., 2008).

Host range of *Ralstonia solanacearum* includes several hundred species representing 44 families of plants and many newly recognized hosts which included egg plant, tomato, pepper, geranium, ginger etc. (Tahat and Sijam, 2010). They also reported that apart from the crop plant species some weed plants like night shade and stringing nettle were acting as the host plants for the bacteria *Ralstonia solanacearum*.

2.3.3. Breeding and Screening for Bacterial Wilt Resistance

Resistance and susceptibility to the disease are conditions with defined metabolic, environmental and genetic conditions. Bell (1981) stated that factors which influence resistance may include intensity, duration and quality of light, moisture levels, nutrient levels and agricultural and industrial chemicals. He also reported that long photoperiods generally result in higher level of resistance.

Gopimony (1983) studied inheritance of bacterial wilt resistance in brinjal and concluded that it was monogenically and dominantly controlled. Narayanan (1984) reported that resistance to bacterial wilt was inherited as a dominant character.

Gopinath and Madalageri (1986) reported that resistance to bacterial wilt was inherited as single dominant gene character in the cross WCGR-112-8 and Pusa kranti in brinjal.

Gowla and Shivashankara (1990) reported the details of agronomic characters and resistance to *Pseudomonas solanacearum* in an F_1 hybrid from the parent aubergine cultivars WCGR (resistant) and P-18 (susceptible). According to them the inheritance of bacterial wilt was governed by single dominant gene.

Persely (1992) reported breeding as the best strategy to control bacterial wilt caused by *Ralstonia solanacearum*. When parents and F_1 hybrids were evaluated for wilt resistance by Geetha and Peter (1993) SM 132, SM 6-2, SM 6-

6, SM 6-7, Pusa purple cluster, SM 6-6 x SM 132 and SM 6-2 x Pusa Purple Cluster were classed as resistant. SM 6-7 x Pant Rituraj and SM 6-7 x Arka Navaneeth were moderately resistant.

Bora *et al*. (1993) screened 29 brinjal cultivars for resistance to bacterial wilt and reported that cultivars BWR 34, Pusa Purple Cluster, Yein and Rathaiah were resistant, BB 49, BG-1, JC-1, JC-2 and HOE 404 were moderately susceptible and the remaining cultivars and breeding lines were either susceptible or highly susceptible.

In a line x tester analysis, 11 parents and 18 crosses of brinjal were evaluated for bacterial wilt resistance by Prakash *et al.* in 1994. Out of the 18 hybrids, only three hybrids *viz*., WCGR x Taiwan Naga, SM-6 x Taiwan Naga and WCGR x Ceylon were resistant and two hybrids, WCGR x P-18 and SM-6 x Ceylon were moderately resistant. High percentage survival was recorded among the resistant lines West Coast Green Round (WCGR) and SM-6. Among the testers, only Taiwan Naga exhibited high survival percentage.

A total of 95 egg plant (*Solanum melongena*) accessions, and resistant (TS56B) and susceptible (Bonne) controls were sown in plastic pots in 3 batches (26 April, 14 June and 12 August 1994) and inoculated with *Ralstonia solanacearum* strain Pss 97 by root cutting and soil drench methods. Of the 95 accessions, 12 demonstrated a high level of resistance to bacterial wilt, of which 8 accessions *viz*., Arka Nidhi, Arka Keshav, Arka Neelkanth, BB1, BB44, BB49, EP143 and Surya showed no symptoms at all (Ponnuswami, 1997).

Chaudhary and Sharma (2000) observed that the brinjal genotypes Arka Keshav, Arka Neelkanth, Arka Nidhi and SM6-6 were resistant to bacterial wilt and the cultivars also possessed good agronomic traits. Gopalakrishnan and Singh (2000) assessed 10 brinjal cultivars and their hybrids for their resistance to bacterial wilt and it was observed that most of the genotypes were not infected by bacterial wilt except a few like Composite 2, SM 63, Surya x Composite- 2, Arka Keshav x Composite 2 and Swetha x SM 63.

Sadashiva *et al.* (2001) observed twelve bacterial wilt resistant (BWR) aubergine lines on wilt-infested soil, followed by artificial inoculations with bacterial suspension, for three years. Of the twelve entries, only two lines *viz.,* EG 191 and TS-3, had 100% survival in all the three years. Seven entries *viz.,* EG 190, EG 192, EG 193, EG 203, EG 219, TS-7 and TS-69 recorded less than 5% mean wilt incidence.

Dalal *et al.* (2002) reported the varieties SM-141, SM-6-6-C, DPL-B-4 and Arka Keshav had shown least mortality due to bacterial wilt (0.01%) in brinjal.

Manna *et al.* (2003) evaluated fifty genotypes of aubergine, including promising cultivars, lines and local cultivars for resistance to bacterial wilt. Eleven genotypes showed resistance to the disease *viz.,* Makra Round, Singhnath, Makra, Kata Makra, Pusa Anupam, Bhagyamati, NDBS-26, BB-40, Sada Lamba, Melwanki local and Co 2.

Hussain *et al*. (2005) screened 15 brinjal accessions in the sick bed preinoculated with *Ralstonia solanacearum*. Wilt symptom and number of wilted plants for each accession was recorded and graded on a 0-5 scale and the accession EG 203 was found resistant to bacterium with lowest wilt incidence. EG 193 was declared as moderately susceptible and the rest of the accessions were susceptible to wilt.

Genetics of bacterial wilt was studied by Ajjappalavara *et al*. in 2008 in four F_2 population selected from 20 F_1 hybrids derived from line x tester crosses of five female x four male parents. The scoring of bacterial wilt incidence on four F_2 population noticed that the segregation of population to the inheritance of bacterial wilt resistance was in 3 (non-wilted):1 (wilted) ratio which suggested single gene inheritance for bacterial wilt resistance.

In an experiment conducted by Rahman *et al.* (2011) in Dhaka, eight brinjal cultivars like Nayantara, Singhnath, Dhundul, Kazla, Marich Begun Luffa, Kata Begun and Uttara were screened for bacterial wilt incidence. At 45 days after transplanting the cultivar Marich Begun Luffa exhibited the highest incidence of bacterial wilt (80 %) while the lowest wilt incidence was recorded in the cultivar Kata Begun (30 %).

Materials and methods

3. MATERIALS AND METHODS

The study was conducted in the Department of Olericulture, College of Horticulture, Vellanikkara during 2009-2011. The experiments were laid out in the experimental plots of Department of Olericulture. The field was located at an altitude of 22.5 m above MSL and 10 º 30" N and 76 º 17" E longitudes. The study comprised of the following components.

3. 1. Development of F_1 hybrids.

3.2. Performance study of parents and F_1 hybrids and production of F_2 generations.

3. 3. Screening of parents, F_1 hybrids and F_2 plants for resistance to jassids.

3.4. Screening for resistance to bacterial wilt.

3.5. Studying morphology of the jassid resistant accessions.

3.1. DEVELOPMENT OF F_1 HYBRIDS

3.1.1. Experimental Materials

The parents used for developing F_1 hybrids of brinjal were obtained from the Department of Olericulture, College of Horticulture, Vellanikkara. Three bacterial wilt resistant varieties developed by Kerala Agricultural University namely Surya, Swetha and Haritha were used as female parents. The male parents used were SM 363, SM 364, SM 366 and SM 385 which are resistant to jassids, *Amrasca biguttula biguttula* (Malini, 2005).

These seven parents were raised in pots and the bacterial wilt resistant varieties were crossed directly with jassid resistant accessions to develop 12 brinjal hybrids. The experiment was started in November 2009, and by January they started flowering and hybrids were developed by hand emasculation and

Plate 1. Female parents

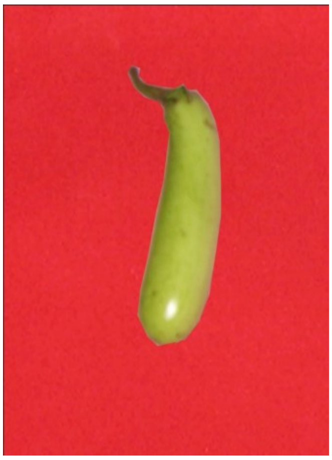
Surya : plant

Surya : Fruit

Swetha : Plant

Swetha : Fruits

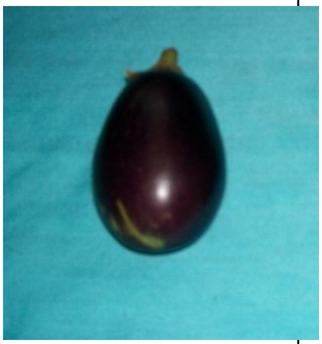
Haritha : Plant



Haritha : Fruit

Plate 2. Male parents.

SM 363: Plant



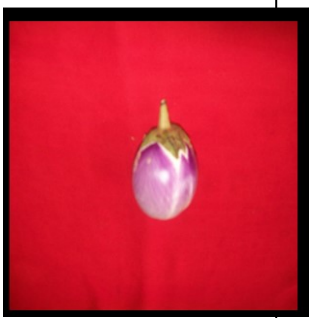
SM 363: Fruit

SM 364: Plant

SM 364: Fruit

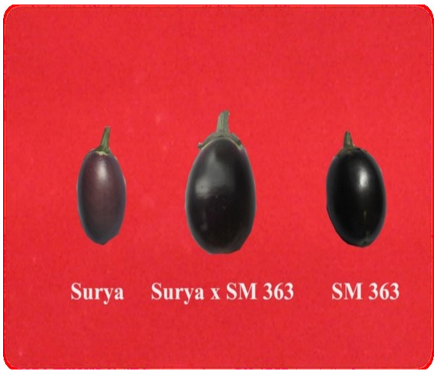
SM 366: Plant

SM 366: Fruit



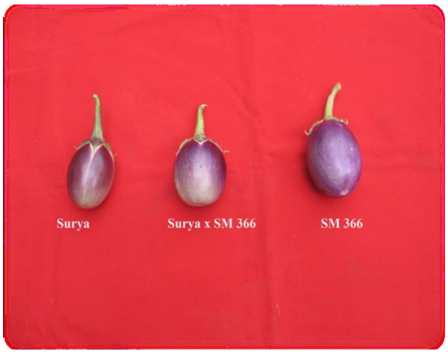
SM 385: Plant and Fruit

Plate 3. F_1 hybrids of Surya



Surya x SM 363

Surya x SM 364



Surya x SM 366

Surya x SM 385

Plate 4. F_1 hybrids of Swetha

Swetha x SM 363

Swetha x SM 364

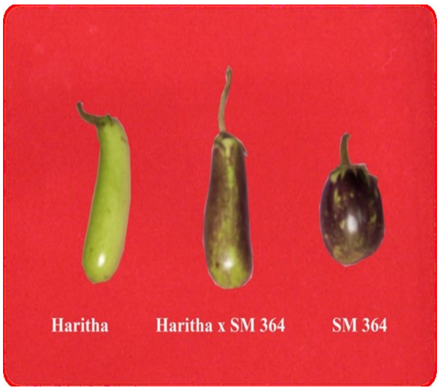
Plate 4. Continued....

Swetha x SM 366

Swetha x SM 385

Plate 5. F_1 hybrids of Haritha

Haritha x SM 363



Haritha x SM 364

Plate 5. Continued..

Haritha x SM 366

Haritha x SM 385

pollination method. The hybrid seeds were collected from the crossed fruits and stored. The following F_1 hybrids were generated.

(1) Surya x SM 363

(2) Surya x SM 364

(3) Surya x SM 366

(4) Surya x SM 385

(5) Swetha x SM 363

(6) Swetha x SM 364

(7) Swetha x SM 366

(8) Swetha x SM 385

(9) Haritha x SM 363

(10) Haritha x SM 364

(11) Haritha x SM 366

(12) Haritha x SM 363

3.2. PERFORMANCE STUDY OF F_1 HYBRIDS

Nineteen accessions including 12 F_1 hybrids and seven parents were grown in Randomized Block Design with two replications during June 2010 to November 2010 for comparative study of the performance of F_1 hybrids and parents. The plants were grown in ridges at a spacing of 75 x 60 cm. Twelve plants per accession / F_1 hybrid per replication were maintained within a plot size of 5.4 m^2. The crop was raised as per Package of Practices Recommendations (KAU, 2007).

3.2.1. Observations Recorded

Five plants per accession per replication were selected randomly to observe the quantitative and qualitative characters. Descriptions were made as per the minimal descriptor list of NBPGR (Srivastava *et al*., 2001).

3.2.1.1. *Quantitative Characters*

i) Plant height (cm) - Recorded at peak fruiting stage. Height was measured from ground level up to the level of topmost young flushes in its natural standing stature.

ii) Plant spread (cm) - Recorded at peak fruiting stage. Spread was measured from the widest portion of plant canopy.

iii) Number of primary branches – Recorded at peak fruiting stage.

iv) Leaf length (cm) - Length of lamina along with petiole was recorded on fifth leaf from top at full foliage stage.

v) Days to first flowering – Recorded as number of days from transplanting to the anthesis of first flower in the plot.

vi) Days to 50 per cent flowering – Recorded as number of days from transplanting to the opening of flowers in 50 per cent plants of the accession.

vii) Days to first harvest - Recorded as the number of days from transplanting to the first harvest of the fruits at marketable stage.

viii) Days to 50 per cent harvest - Recorded as number of days from transplanting to the date when 50 per cent of fruits were harvested.

ix) Days to last harvest - Recorded as the number of days from transplanting to the last harvest of the plot.

x) Number of economic harvests - Recorded as the number of harvests where yield was more than 100g per plant.

Plate 6. Main field of the study

xi) Total number of harvests

xii) Fruit length (cm) - Recorded as the average length of five fruits at marketable stage excluding stalk.

xiii) Fruit girth (cm) - Recorded as the average of same five fruits at marketable stage at the widest region of fruit.

xiv) Average fruit weight (g) - Recorded as the average weight of same five fruits at marketable stage.

xv) Number of fruits per plant – Number of fruits per plant was recorded as cumulative number of fruits from five plants in each accession and the average was calculated.

xvi) Yield per plant (kg) - Recorded as average of cumulative yield of all pickings from five plants in each accession.

xvii) Yield per plot (kg) - Recorded as cumulative yield of the plot.

3.2.1.2. *Qualitative Characters*

i) Plant growth habit – Recorded at peak fruiting stage - Prostrate/ intermediate / upright.

ii) Leaf and petiole colour – Noted at full foliage stage - Green / purple.

iii) Presence of prickles on leaves, stem or calyx – Prickly / non prickly

iv) Flower colour – Violet/ white

v) Fruit colour – Green / white / violet / striated

vi) Fruit shape - Round / oval / oblong/ long

Fruit characters were noted at marketable stage of fruits.

3.2.2. Statistical Analysis

The average of the values obtained from five randomly selected plants in each replication was used for statistical analysis. The data were subjected to analysis of variance described by Panse and Sukhatme (1978) with the help of the statistical package MSTAT –C.

3.2.3. Estimation of Genetic Parameters

3.2.3.1. *Estimation of Heterosis*

Heterosis over better parent (heterobeltiosis), standard variety (standard heterosis) and mid parent (relative heterosis) were calculated as per Hayes *et.al.* (1965). Here Haritha was taken as the standard variety which is common among Kerala farmers.

i) Heterobeltiosis (HB) $= \frac{\bar{F_1} - \bar{BP}}{\bar{BP}} \times 100$

ii) Standard heterosis (SH) $= \frac{\bar{F_1} - \bar{SV}}{\bar{SV}} \times 100$

iii) Relative heterosis (RH) $= \frac{\bar{F_1} - \bar{MP}}{\bar{MP}} \times 100$

Where $\bar{F_1}$, $\bar{BP}$, $\bar{SV}$, $\bar{MP}$ were the means performance of F_1 hybrid, better parent, standard variety and mid parent respectively. The respective CDs were also calculated.

CD = SE x t value

SE for HB and SH $= \frac{3/2\ EMS}{r}$ and SE for RH = $\frac{2EMS}{r}$

Where EMS = Error mean square and r = replication

3.2.3.2. ***Estimation of Variability***

The variance components were estimated by the method suggested by Singh and Chaudhary (1985) as given below.

(i) Phenotypic variance (Vp)

Vp = Vg + Ve where Vg = Genotypic variance

Ve = Environmental variance

(ii) Genotypic variance (Vg)

$Vg = \frac{VT - VE}{N}$ where VT = Mean sum of squares due to treatments

VE = Mean sum of squares due to error

N = Number of replications

(iii) Environmental variance (Ve)

Ve = VE where VE = Mean sum of squares due to error

(iv) Phenotypic and genotypic coefficients of variation

The phenotypic and genotypic coefficients of variation were calculated by the formula suggested by Burton (1952) with the help of statistical package SPAR 1.

(a) Phenotypic coefficient of variation (PCV)

$$PCV = \frac{\sqrt{Vp}}{\bar{x}} \times 100$$

Where Vp = Phenotypic variance

$\bar{x}$ = Mean of the character under study

(b) Genotypic coefficient of variation (GCV)

$$GCV = \frac{\sqrt{Vg}}{\bar{x}} \times 100$$

Where Vg = Genotypic variance

(v) Heritability (H)

Heritability in the broad sense was estimated by following the formula suggested by Burton and Devane (1953) with the help of the statistical package SPAR 1.

$$H = \frac{Vg}{Vp} \times 100$$

Where Vg = Genotypic variance

Vp = Phenotypic variance

(vi) Genetic advance (GA)

The expected genetic advance of the accession was measured by the formula suggested by Lush (1949) and Johnson *et al.* (1955) at 5 per cent selection intensity using the constant K as 2.06 as given by Allard (1960).

$$GA = \frac{Vg}{\sqrt{Vp}} \times K$$

Where K = Selection differential

(vii) Genetic gain (GG)

Genetic advance calculated by the above method was used for estimating genetic gain.

$$GG = \frac{GA}{\bar{x}} \times 100$$

3.2.4. Development of F_2 generations

F_2 generations were also produced from the F_1 hybrids by selfing the flowers by covering the flower buds with butter paper cover before opening. These F_2 generation plants, F_1 hybrids and parents were again raised in field for screening for jassid and bacterial wilt resistance during summer 2011.

3.2.5. Pot culture experiment

F_1 hybrids and parents were also raised in sterilized pots for their performance analysis. This was to ensure the availability of brinjal accessions (F_1 and parents) for their performance study to avoid the loss of plants due to bacterial wilt. Pots were sterilized with formalin (2 %) and covered with polythene cover. After 10 days covers were removed, potting mixture in pots was raked and exposed to sun for 3 days and then seedlings were transplanted.

3.3. SCREENING FOR RESISTANCE TO JASSID (*Amrasca biguttula buguttula)*

Field screening for jassid tolerance / resistance was carried out for two seasons, kharif 2010 (June – November) and summer 2011 (January – May). But due to the continuous rain in the first season, jassid count was too low to express any symptom and hence effective screening could not be carried out. The plants were healthy and hence observations on horticultural characters were recorded.

During summer season F_1, F_2 and parents were screened for jassid population in plants. Jassid population was assessed by noting the number of nymphs on top, middle, and lower leaves of five plants each at weekly intervals from the starting of pest infestation. Adult insects were excluded from observations as the adult hoppers are highly mobile and their count on individual leaves would not give a reliable estimation of intensity of pest infestation. Nymphal counting was continued at weekly intervals until there was a sharp decrease in the number of nymphs.

Based on the intensity of hopper burn symptoms on leaves, the brinjal accessions were categorized into different resistant / susceptibility classes during the final stages of the crop. The visual assessment of hopper burn intensity was converted into numerical values by calculating the per cent intensity of infestation by adopting the formula given below.

$$\% \text{ intensity} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves assessed}} \times \frac{100}{\text{Maximum grade}}$$

Scoring of plants for hopper burn symptom on the leaves was done using 0 - 4 scale as suggested by Singh and Rai (1995) and the grades are given below.

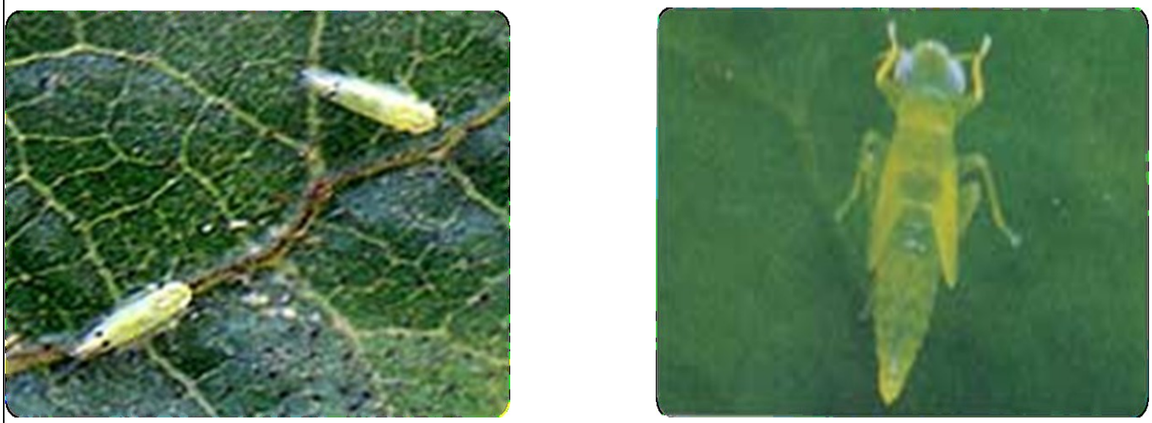


Plate 7. Adults and nymph of jassid

Plate 8. General symptom of jassid infestation.

Grade	Intensity of infection
0	Healthy leaves
1	Slight yellowing of leaf margin
2	Yellowing and necrosis of leaf margin
3	Intensive yellowing and necrosis of leaves
4	Complete necrosis of leaves

Based on the per cent of intensity, the accessions were grouped into five categories as suggested by Singh (1996).

Per cent Intensity	Category
0	Immune
1-10	Highly resistant
10.1- 25	Moderately resistant
25.1- 50	Moderately susceptible
Above 50	Highly susceptible

3.3. 1. Artificial Infestation of Plants Under Cages

The artificial infestation of plants with jassid colonization was done to confirm the resistance showed in the natural environment. The brinjal lines, identified as resistant to jassid infestation in the field trials on the basis of hopper burn symptoms and nymphal population were subjected to artificial infestation under cages during summer (2011). Single plant was maintained in each pot and was covered with insect proof cage. Cages were made by stitching transparent

Plate 9. Cage study of brinjal accessions for confirming resistance to jassid.

light penetrable cloth on iron frames. A closable window was cut on the cloth for taking observations. When the plants reached at eight to ten leaves stage 20 nymphs of medium size were released on each caged plant. Nymphs of same size were collected and carefully released on to the leaves of caged plants by means of a camel hair brush. Survival and reproductive ability of the nymphs were noted by recording the number of surviving nymphs after four days and number of adults formed and newly emerged nymphs after 10 days and 16 days respectively. The frequency of observations was fixed based on the report that leaf hoppers take a duration of eight days for nymphal development (Mahal and Singh, 1982). Insect releases were repeated three times on the same plants for confirmation.

3.4. SCREENING FOR RESISTANCE TO BACTERIAL WILT.

Field screening for bacterial wilt resistance was done during both cropping seasons. Wilted plants were counted after conducting ooze test. The progenies and parents were scored for bacterial wilt incidence as suggested by Mew and Ho (1976).

Resistant	: < 20% plants wilted
Moderately resistant	: 20-40% plants wilted
Moderately susceptible	: 40-60% plants wilted
Susceptible	: > 60% plants wilted

3.5. STUDYING THE MORPHOLOGY OF THE JASSID RESISTANT ACCESSIONS

Morphological parameters like leaf thickness, midrib thickness and density of midrib hairs were observed for unravelling the mechanisms of jassid resistance.

3.5.1. Leaf Thickness (mm)

The leaf lamina thickness of fifth leaf from top was measured using a screw gauge. Laminar portion excluding veins was separated from the middle portion of the leaf. After inserting the separated lamina piece into the screw gauge, the head scale and pitch scale readings were noted. The lamina thickness was measured using the formula,

Leaf thickness = Pitch scale reading + (Head scale reading x Least count)

Least count is the distance through which the screw advances when it is rotated through one division of the head scale. It is taken as 0.01mm.

3.5.2. Midrib Thickness (mm)

The midrib thickness at middle portion of the fifth leaf from top was measured using a screw gauge by adopting the same method mentioned above.

3.5.3. Density of Midrib Hairs

Number of midrib hairs present per unit area of midrib was counted using a stereomicroscope. Midrib peels from ventral surface of leaves from top, middle and basal portion of plants were observed under stereomicroscope, whose eye piece was marked with a square of 25mm^2 area. The number of midrib hairs on peels of these leaves was counted in an area of 25mm^2 each and its average was calculated.

Results

4. RESULTS

The results of the present study are presented under the following heads.

4.1. Evaluation of brinjal accessions and hybrids for horticultural traits and estimation of genetic parameters.

4.2. Screening for jassid resistance.

4.3. Screening for bacterial wilt resistance.

4.4. Studying the morphological characters confirming resistance in brinjal against jassids.

4.1. EVALUATION OF BRINJAL ACCESSIONS AND HYBRIDS FOR HORTICULTURAL TRAITS AND ESTIMATION OF GENETIC PARAMETERS

A total of 19 accessions of brinjal, including seven parents and 12 F_1 hybrids were utilized for the field experimentation during the first season (June – November 2010). In the second season (January – May 2011) also 19 brinjal accessions were evaluated for comparing horticultural and genetic characters.

4.1.1. Evaluation of Brinjal Accessions for Horticultural Traits

Six qualitative and seventeen quantitative characters of 19 accessions (7 parents and 12 F_1 hybrids) were evaluated during kharif, 2010 and summer, 2011. The observations of the qualitative characters are given in Table 1.

There are three types of growth habit in brinjal viz., spreading, intermediate and upright. Most of the accessions had intermediate growth habit except Swetha and its hybrids which were upright in stature. Among the parents, Surya, Haritha, SM 363, SM 364, SM 366 and SM 385 were having intermediate growth habit and Swetha was having upright growth habit. Eight hybrids viz., Surya x SM 363, Surya x SM 364, Surya x SM 366, Surya x SM 385, Haritha x SM 363, Haritha x SM 364, Haritha x SM 366, Haritha x SM 385 had

Table 1. Qualitative characters of brinjal accessions evaluated

Accession	**Plant growth habit**	**Leaf and petiole colour**	**Presence of prickles**	**Flower colour**	**Fruit colour**	**Fruit shape**
Surya	Intermediate	Green and purple petiole	Non prickly	Violet	Purple	Oval
Swetha	Upright	Green and purple petiole	Non prickly	Violet	White	Long
Haritha	Intermediate	Green	Non prickly	White	Green	Long
SM 363	Intermediate	Green and purple petiole	Prickly	Violet	Purple and green	Oblong
SM 364	Intermediate	Green and purple petiole	Prickly	Violet	Green and Purple	Oval
SM 366	Intermediate	Green and purple petiole	Prickly	Violet	Purple	Oval
SM 385	Intermediate	Green and purple petiole	Prickly	Violet	striated	Round

Table 1. Continued......

Accession	**Plant growth habit**	**Leaf and petiole colour**	**Presence of prickles**	**Flower colour**	**Fruit colour**	**Fruit shape**
Surya x SM 363	Intermediate	Green and purple petiole	Prickly	Violet	Purple	Oblong
Surya x SM 364	Intermediate	Green and purple petiole	Prickly	violet	Purple	Oval
Surya x SM 366	Intermediate	Green and purple petiole	Prickly	White	Purple	Oblong
Surya x SM 385	Intermediate	Green and purple petiole	Prickly	Violet	Purple	Oval
Swetha x SM 363	Upright	Green and purple petiole	Non prickly	Violet	Striated	Long
Swetha x SM 364	Upright	Green and purple petiole	Non prickly	Violet	Striated	Long

Table 1. Continued…

Accession	**Plant growth habit**	**Leaf and petiole colour**	**Presence of prickles**	**Flower colour**	**Fruit colour**	**Fruit shape**
Swetha x SM 366	Upright	Green and purple petiole	Non prickly	Violet	Striated	Long
Swetha x SM 385	Upright	Green and purple petiole	Non prickly	Violet	Strated	Long
Haritha x SM 363	Intermediate	Green and purple petiole	Non prickly	White	Striated	Long
Haritha x SM 364	Intermediate	Green and purple petiole	Non prickly	Violet	Striated	Long
Haritha x SM 366	Intermediate	Green and purple petiole	Non prickly	Violet	Striated	Long
Haritha x SM 385	Intermediate	Green and purple petiole	Non prickly	Violet	Striated	Long

intermediate growth habit. All the four hybrids of Swetha namely Swetha x SM 363, Swetha x SM 364, Swetha x SM 366 and Swetha x SM 385 had upright growth habit.

The accessions varied in their foliage characters. The female parent Haritha had uniformly green lamina and petiole. All the remaining accessions evaluated in the first season including the six parents and twelve F_1 hybrids had green leaves with purple tinched midribs, veins and petiole.

The brinjal accessions can be classified as prickly and non prickly types based on the presence of prickles on any of the plant parts like stem, leaves or calyx. The released varieties Surya, Swetha and Haritha and F_1 hybrids like Swetha x SM 363, Swetha x SM 364, Swetha x SM 366, Swetha x SM 385, Haritha x SM 363, Haritha x SM 364, Haritha x SM 366, Haritha x SM 385 had prickleless stem, petiole, leaves and calyx. All the male parents (SM 363, SM 364, SM 366 and SM 385) and the F_1 hybrids of Surya (Surya x SM 363, Surya x SM 364, Surya x SM 366, Surya x SM 385) could be categorized into prickly group since they had with prickles on calyx.

Brinjal flowers were basically of two colours either white or violet. Among the accessions under investigation, Haritha was the only accession with white flowers. All the other parents and F_1 hybrids were having violet flowers.

Accessions varied greatly in their fruit characteristics like fruit colour and fruit shape. There were purple, white, green and striated fruits among the accessions. Haritha was the only accession with green fruits among parents. Swetha was having white fruits. Surya, SM 363, SM 364, SM 366, SM 385, Surya x SM 363, Surya x SM 364, Surya x SM 366 and Surya x 385 were purple fruited. All the remaining F_1 hybrids had variegated or striated fruits. Shape of the fruits ranged from round to long with other intermediate shapes like oval and oblong. SM 385 was the only accession (male parent) with round shaped fruits and other male parents like SM 364 and SM 366 were observed with oval shaped fruits. SM 363 was found to have oblong fruits. Among the three female parents Swetha and

Haritha were having elongated fruits while the fruits of Surya were oval shaped. Among the four F_1 hybrids of Surya, Surya x SM 363 and Surya x SM 366 were having oblong fruits and the remaining hybrids like Surya x SM 364 and Surya x SM 385 had produced fruits with oval shape. All the four hybrids of Swetha produced long fruits. The released variety Haritha also produced four F_1 hybrids with elongated fruits in combination with SM 363, SM 364, SM 366 and SM 385.

4.1.1.1 *General Analysis of Variance for Quantitative Characters*

General analysis of variance showed significant differences among parents and hybrids for majority of characters in the first season (June – November, 2010). The accessions differed significantly for plant spread, leaf length, days to first flowering, days to 50% flowering, days to first harvest, number of economic harvests, total number of harvests, fruit length, fruit girth, fruit weight, number of fruits per plant, yield per plant and yield per plot. During the second crop season (January – May) all the 17 characters differed significantly among the 19 brinjal accessions (7 parents and 12 hybrids). Mean values of quantitative characters observed during kharif and summer seasons are given in Table 2 and Table 3 respectively.

4.1.1.1.1 *Plant height (cm)*

There was no significant difference for plant height among the brinjal hybrids and parents for the first season. During the first crop season, the plant height ranged from 67.60 cm to 107.30 cm and the hybrid Swetha x SM 366 was the tallest plant (107.30 cm). This was followed by Surya x SM 385 (105.50 cm) and Haritha x SM 363 (105.00 cm). Swetha was the shortest plant (67.60 cm). In the case of summer crop, there was significant difference for plant height among different accessions. Maximum value for plant height was observed in the F_1 hybrid Swetha x SM 366 (109.00 cm) followed by Swetha x SM 364 (104.00 cm), Haritha x SM 366 (103.00 cm) and Surya x SM 385 (103.00 cm) which were at par. Swetha was the variety with shortest plants (55.50 cm) in summer also.

4.1.1.1.2 ***Plant spread (cm)***

This character showed significant difference among the accessions (parents and hybrids) during the first season. Plant spread ranged between 35.00 cm and 84.60 cm. Maximum spread was recorded in the F_1 hybrid Haritha x SM 364 (84.60 cm) which was on par with Haritha, Haritha x SM 385, Haritha x SM 363, Surya x SM 363, Surya x SM 385, Swetha x SM 366, Surya x SM 364, Swetha x SM 363, Haritha x SM 366, SM 366, SM 385 and Swetha x SM 364. The lowest value of plant spread was observed in the hybrid Swetha x SM 385 (35.00 cm) which was on par with Surya, Swetha and SM 364. During summer the values ranged from 32.50 cm in Swetha x SM 385 and 82.00 cm in Haritha x SM 364. Thus during the both the seasons Haritha x SM 364 recorded maximum plant spread (84.60 cm and 82.00 cm during kharif and summer seasons respectively).

4.1.1.1.3 ***Number of primary branches***

In the case of number of primary branches, there was no significant difference among the parents and F_1 hybrids during the first season. Swetha x SM 364 was the hybrid with maximum number of primary branches (7.35). This was followed by Swetha x SM 366 and Surya x SM 366 (7.00 each). Swetha x SM 385 was the hybrid with lowest number of primary branches (3.90). During summer significant difference was observed for the number of primary branches among the parents and F_1 hybrids of brinjal. The cross Swetha x SM 364 recorded maximum number of primary branches (7.75) followed by Swetha x SM 366 (6.75) and Surya x SM 366 (6.70) which were at par. Swetha x SM 385 was having minimum number of branches (3.00).

4.1.1.1.4 ***Leaf length (cm)***

Leaf length showed significant difference among accessions during both the seasons. The variety Haritha recorded maximum leaf length in both seasons (17.58 cm and 17.47cm during first and second season respectively) which was significantly different from all other accessions. The smallest leaves were observed in the variety Swetha (9.20 cm) which was on par with Surya, SM 363 and Swetha x SM 385. In summer also Swetha was observed with smallest leaves (8.35 cm) which was on par with Swetha x SM 385 (9.50 cm) and Surya (11.00 cm)

4.1.1.1.5 ***Days to first flowering***

During the first crop season, significant difference was observed among the parents and hybrids of brinjal for the number of days to first flowering. Surya x SM 366 was the earliest to flower taking 34.50 days which was on par with Haritha x SM 366, Surya, Haritha x SM 363, Surya x SM 363, Surya x SM 385, Swetha x SM 363 and Swetha x SM 366. But during summer season Haritha x SM 363 was the earliest to flower taking 31.50 days followed by Surya x SM 363 (32.00 days), Haritha x SM 366 (33.50 days) and Surya x SM 366 (36.00 days) which were at par. SM 364 was the last to flower which took 56.50 days in first season and 54.00 days in second season.

4.1.1.1.6 ***Days to 50% flowering***

This character also showed significant difference among 19 accessions of brinjal during both the seasons. Surya and Surya x SM 366 (40.00 days) had taken significantly less number of days to attain 50 per cent flowering which were on par with Haritha x SM 366, Surya x SM 363, Surya x SM 385, Haritha x SM 363, Haritha x SM 364, Swetha and Haritha. During summer season, Haritha x SM 363 recorded minimum number of days for 50 per cent flowering (37.00 days) which was on par with Haritha x SM 366 (37.50 days) and Surya x SM 363 (39.00 days). SM 364 was the last one which took longer days for 50 per cent flowering (65.50 days for kharif season and 58.00 days for summer season) which was on par with SM 363 (60.50 days and 56.00 days during first and second season respectively).

4.1.1.1.7 ***Days to first harvest***

Accessions varied significantly for days to first harvest during the both seasons. Surya and Haritha x SM 366 recorded minimum number of days for first

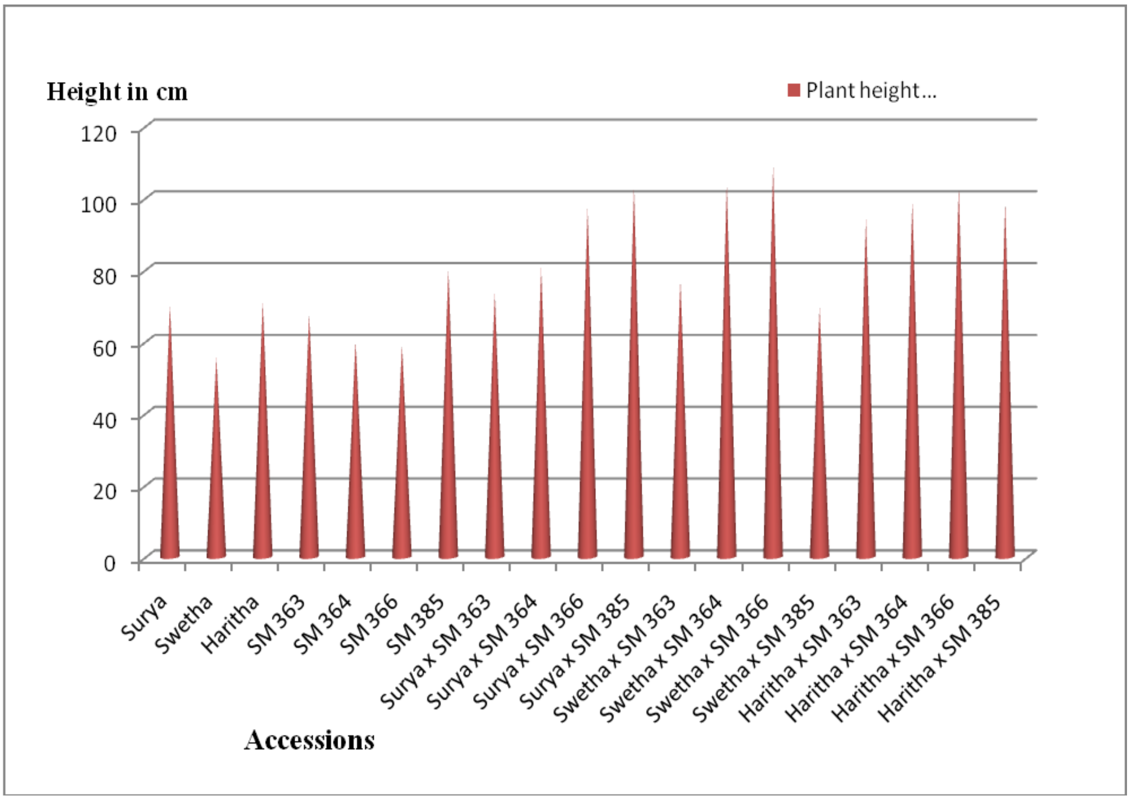


Figure 1. Plant height of 19 brinjal accessions.

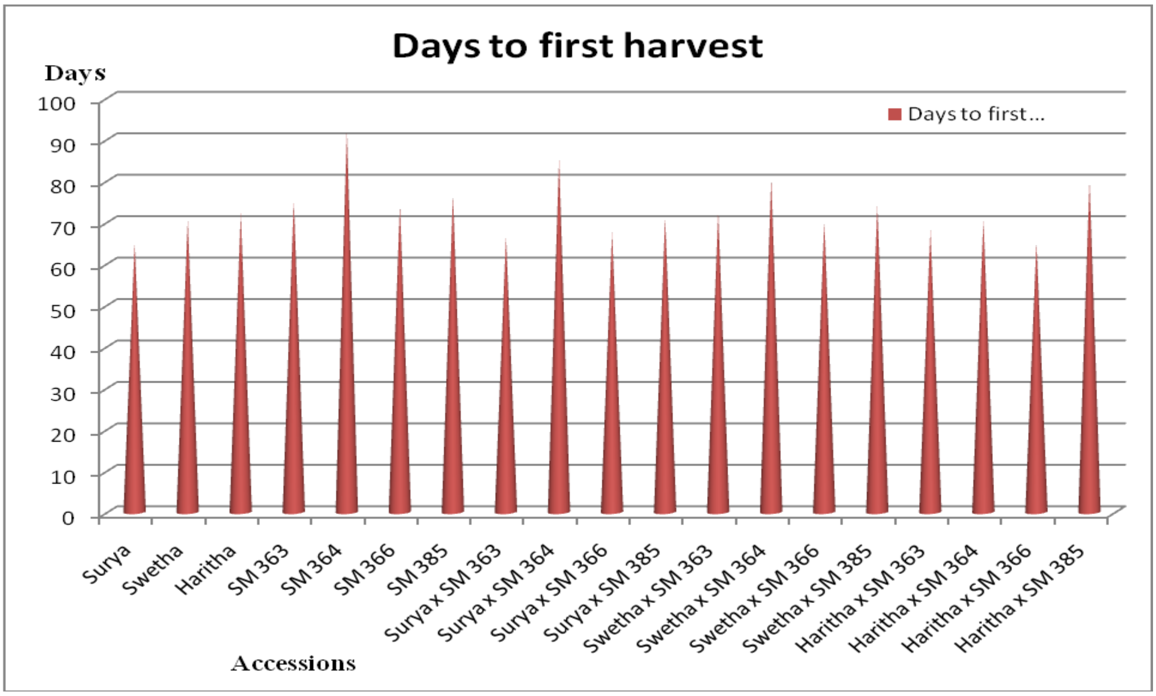


Figure 2. Days to First harvest of 19 brinjal accessions.

harvest (65.00 days each). These were on par with Surya x SM 363, Surya x SM 366, Surya x SM 385, Swetha x SM 366, Haritha x SM 363 and Haritha x SM 364. In the second crop season, Haritha x SM 363 was observed with comparatively less number of days for first harvest (48.50 days) followed by Surya x SM 366 (49.50 days), Haritha x SM 366 (49.50), Surya x SM 385 and Swetha x SM 366 (50.00 days each) which were at par. During first season accession SM 364 had taken significantly longer duration (92.00 days) for first harvest and during second season SM 363 had taken maximum number of days (70.50 days) for first harvest.

4.1.1.1.8. ***Days to 50% harvest***

There was no significant difference in days to 50 per cent harvest among the 19 accessions of brinjal for the first season. However, Surya x SM 366 was having highest value (145.00 days) for days to 50 per cent harvest followed by Haritha, Surya x SM 363 and Haritha x SM 363. The accession SM 363 took comparatively lesser time to attain 50 per cent harvest (108.50 days). During summer season significant difference was seen in the observations for days to 50 per cent harvest. From the statistically analysed data it was clear that the F_1 hybrid Surya x SM 363 was having highest value (97.00 days) for days to 50 per cent harvest followed by Surya x SM 366 (96.50 days) and Surya x SM 385 (94.00 days) which were at par. In summer also, Haritha x SM 363 recorded minimum number of days for 50 per cent harvest (80.00 days).

4.1.1.1.9. ***Days to last harvest***

No significant difference was observed for days to last harvest also, for the first season though this character ranged from 142.00 days (SM 363) to 187.50 days (Surya x SM 363 and Surya x SM 366). Harvesting of SM 363 was extended only upto 142.00 days which was declared as the genotype with shortest harvesting period. But in the summer crop, there was significant difference among accessions for days to last harvest. Here Haritha, Swetha x SM 366 and Haritha x SM 385 were the accessions which took longest days for last harvest (121.00 days each) which were on par with Surya x SM 385 (120.00 days) and Surya x SM 363 (118.00 days).

4.1.1.1.10. ***Number of economic harvests***

Harvest was considered as economic when yield per plant was more than 100 g. This character showed significant variation among the parents and hybrids during both seasons which ranged from 4.50 to 11.00 in the first crop and 3.00 to 8.00 in the second crop. During first season the F_1 hybrids namely Surya x SM 366, Swetha x SM 366 and Haritha x SM 364 performed best with a significantly higher number of economic harvests (11.00). But they were on par with Surya, Surya x SM 385, Haritha x SM 366, Haritha x SM 363, Haritha, Haritha x SM 385 and Surya x SM 363. In the second season, one of the female parents, Haritha recorded maximum number of economic harvests (8.00) followed by Surya x SM 385, Surya (7.50 each), Surya x SM 363, Haritha x SM 364, Surya x SM 366 and Haritha x SM 385 (7.00 each) which were at par.

4.1.1.1.11. ***Total number of harvests***

Brinjal lines showed a noteworthy variation for this character also. During first crop season, the F_1 hybrid Haritha x SM 366 recorded maximum number of harvests which was significantly higher than other accessions (13.00) followed by Surya x SM 366 (12.50), Swetha x SM 366 (12.00) and Haritha x SM 363 (12.00) which were at par. SM 364 recorded minimum number of harvests (5.50 and 4.50 in first and second crop seasons respectively). During summer, the F_1 hybrids like Haritha x SM 385, Surya x SM 385 and Swetha x SM 366 were observed with higher number of harvests (9.00 each) followed by Surya x SM 363, Haritha, Surya and Surya x SM 366 which were at par (8.5 each).

4.1.1.1.12. ***Fruit length (cm)***

During the first season, the hybrids like Swetha x SM 366 and Haritha x SM 366 produced significantly longer fruits (12.55 cm each) than all other accessions which were on par with Haritha, Haritha x SM 364, Haritha x SM 363,

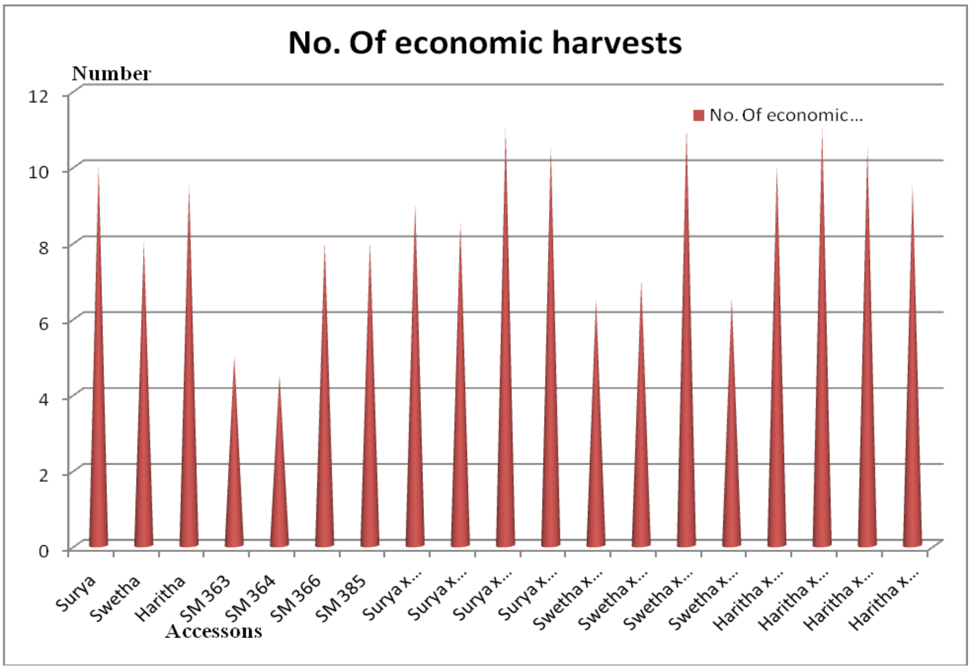


Figure 3. Number of economic harvests of 19 brinjal accessions.

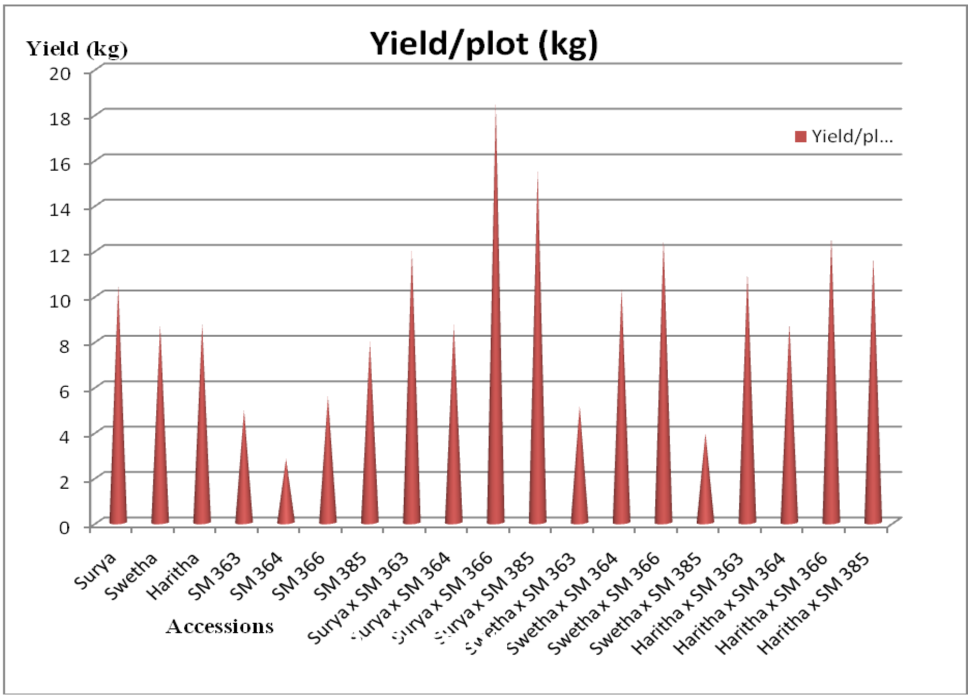


Figure 4. Yield per plot of 19 brinjal accessions.

Swetha x SM 363, Swetha x SM 385 and Haritha x SM 385. Surya recorded significantly lower value for fruit length (8.85 cm) in the first season followed by SM 363, SM 364, SM 366 and SM 385 which were at par. During second season Swetha x SM 363 and Haritha x SM 385 recorded longer fruits (12.75 cm each) followed by Haritha x SM 363 (12.50 cm) and Haritha (12.00 cm) which were at par. SM 385 recorded significantly shorter fruits (8.75 cm) followed by Surya x SM 364 (9.11 cm), Surya (9.25 cm), SM 363 (9.65 cm).

4.1.1.1.13. *Fruit girth (cm)*

The accessions varied significantly among themselves in their fruit girth during both seasons. SM 364 recorded maximum fruit girth (21.15 cm) followed by SM 363, Surya x SM 385, SM 366 and SM 385 which were at par with SM 364. Swetha was observed as the accession with lowest value of fruit girth (10.80 cm). In the second crop season also SM 364 recorded maximum fruit girth (19.50 cm). This was followed by Surya x SM 363 (18.75 cm), Surya x SM 385 (18.50 cm) and SM 385 (18.48 cm) which were at par. During summer also Swetha recorded minimum value for fruit girth (10.70 cm).

4.1.1.1.14. *Fruit weight (g)*

This character was having significant difference among the lines in both seasons. The average fruit weight ranged from 63.20 g in Swetha to 86.50 g in SM 364. SM 364 was on par with Haritha, Surya x SM 363, Surya x SM 366, SM 385, Haritha x SM 366, SM 366 and Surya x SM 385. The lowest value for fruit weight was observed in Swetha followed by Swetha x SM 364 and Swethax SM 385 which were at par with Swetha. In summer crop also, SM 364 recorded maximum value for fruit weight (88.20 g) which was on par with SM 385 (85.00 g), SM 366 (81.00 g), Surya x SM 366 (79.00 g) and Surya x SM 363 (78.60 g). Lowest fruit weight was observed in Swetha x SM 364 (58.90 g).

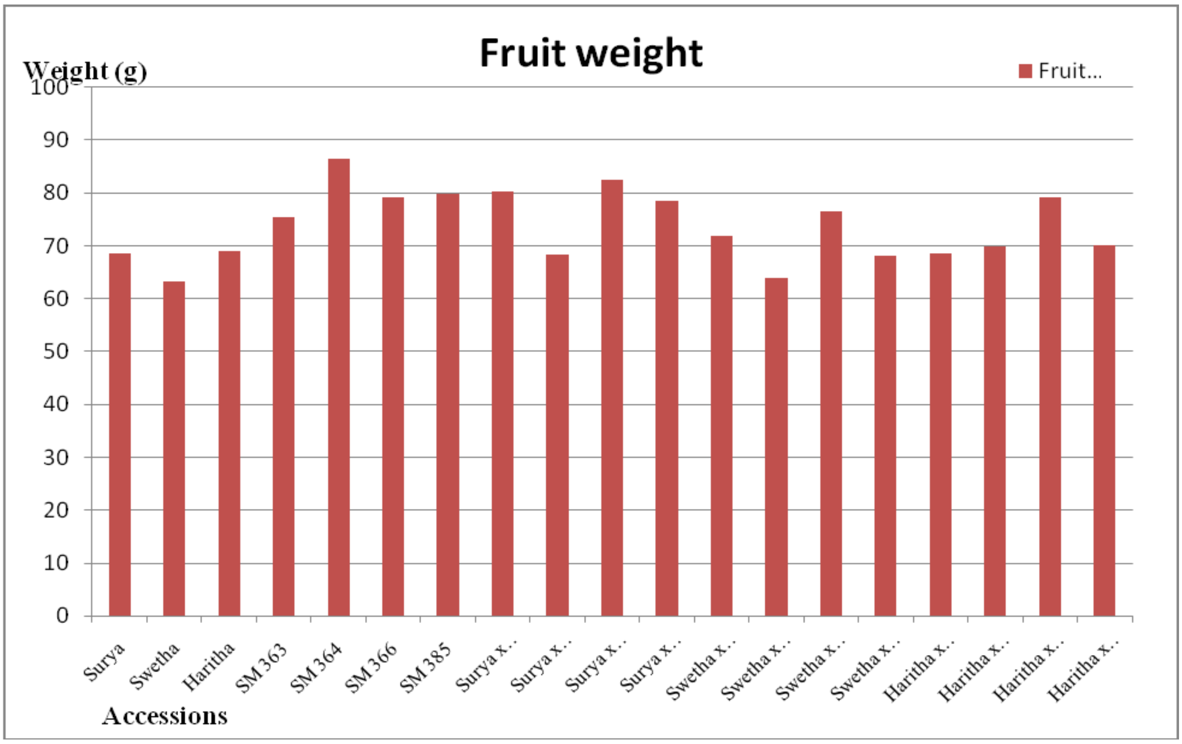


Figure 5. Fruit weight of 19 brinjal accessions.

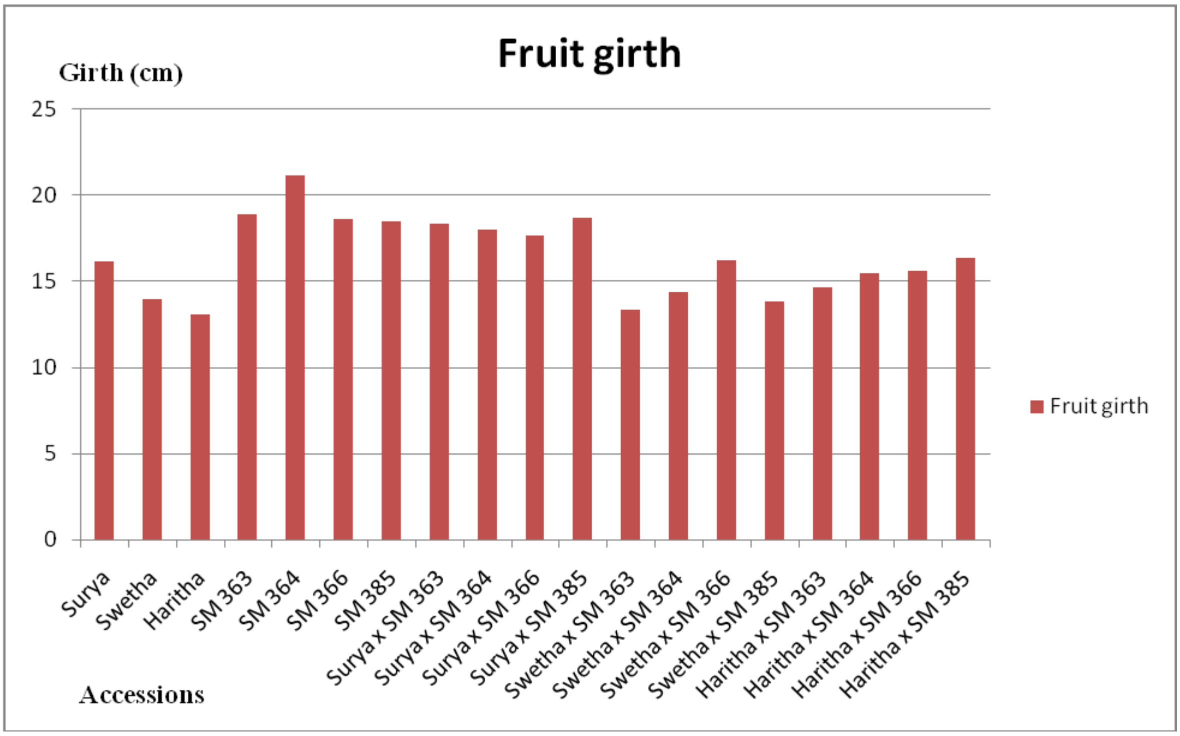


Figure 6. Fruit girth of 19 brinjal accessions

4.1.1.1.15. ***Number of fruits per plant***

The number of fruits per plant ranged from 5.50 to 14.50 with a mean of 11.15 during the first season. The observations showed that the accessions varied significantly in the number of fruits per plant during the first season. Surya x SM 385 recorded maximum number of fruits per plant (14.50). Surya, Surya x SM 363, Surya x SM 366 and Haritha x SM 363 followed this with on par values. SM 363 recorded the minimum number of fruits per plant (5.50). In summer crop also, the accessions varied significantly for number of fruits per plant. Here also, maximum number of fruits per plant was exhibited by the cross Surya x SM 385 (14.00) which was on par with Haritha x SM 366 (13.00). Minimum number of fruits per plant was exhibited by the genotypes SM 363 and SM 366 (5.00 each).

4.1.1.1.16. ***Yield per plant (kg)***

Yield per plant showed significant difference among 19 accessions (parents and F_1 hybrids) in both seasons. The F_1 hybrid Surya x SM 366 recorded maximum yield per plant (1.54 kg) which was significantly higher than all other accessions. This was followed by Surya x SM 385 (1.28 kg), Haritha x SM 366 (1.05 kg) and Swetha x SM 366 (1.04 kg). Yield per plant was observed as minimum in the genotype SM 364 (0.38 kg). During summer, Surya x SM 385 recorded maximum yield per plant (1.12 kg) followed by Surya x SM 366 with on par values (1.01 kg). SM 366 was the genotype with minimum yield per plant (0.27 kg).

4.1.1.1.17. ***Yield per plot (kg)***

Yield from a plot area of 5.4 m^2 varied significantly among accessions. The value ranged from 3.60 kg to 18.49 kg during the first season. The F_1 hybrid Surya x SM 366 yielded better than all other accessions (18.49 kg per plot). The second and third high yielding accessions were Surya x SM 385 (15.52 kg per plot) and Haritha x SM 366 (12.60 kg per plot). The lowest yield per plot was observed in SM 364 (3.60 kg per plot), Swetha x SM 385 (3.94 kg per plot), SM 363 (4.94 kg per plot) and Swetha x SM 363 (5.15 kg per plot) which were

Table 2. Comparison of yield and yield contributing characters of brinjal accessions (kharif, 2010)

Accessions	**Plant height (cm)**	**Plant spread(cm)**	**No. of primary branches**	**Leaf length(cm)**	**Days to 1^{st} flowering**	**Days to 50% flowering**
Surya	84.00	52.00 ^{bcde}	4.00	11.01 ^{defg}	35.50 ^{ef}	40.00 ^{g}
Swetha	67.60	36.10 ^{de}	4.20	9.20 ^{g}	41.50 ^{cdef}	46.00 ^{efg}
Haritha	90.50	83.80 ^{a}	5.40	17.58 ^{a}	40.50 ^{cdef}	46.50 ^{efg}
SM 363	85.05	58.38 ^{abcde}	4.17	10.70 ^{efg}	47.50 ^{bc}	60.50 ^{ab}
SM 364	68.88	46.60 ^{cde}	5.00	11.90 ^{cdef}	56.50 ^{a}	65.50 ^{a}
SM 366	87.75	68.90 ^{abc}	5.00	12.64 ^{bcde}	45.00 ^{bcd}	52.50 ^{cde}
SM 385	91.50	66.13 ^{abc}	5.45	13.73 ^{bc}	48.00 ^{bc}	59.00 ^{abc}
Surya x SM 363	96.60	76.80 ^{ab}	4.50	13.01 ^{bcde}	37.50 ^{def}	43.50 ^{fg}
Surya x SM 364	90.05	73.15 ^{ab}	5.95	11.63 ^{cdefg}	51.00 ^{ab}	56.00 ^{bcd}
Surya x SM 366	103.8	67.30 ^{abc}	7.00	12.30 ^{bcdef}	34.50 ^{f}	40.00 ^{g}
Surya x SM 385	105.5	74.90 ^{ab}	6.30	13.26 ^{bcde}	39.50 ^{cdef}	44.00 ^{fg}
Swetha x SM 363	88.70	70.70 ^{abc}	4.50	12.37 ^{bcdef}	39.50 ^{cdef}	45.00 ^{efg}
Swetha x SM 364	95.05	60.95 ^{abcd}	7.35	13.63 ^{bcd}	47.50 ^{bc}	51.50 ^{cdef}
Swetha x SM 366	107.3	73.40 ^{ab}	7.00	13.32 ^{bcde}	41.00 ^{cdef}	46.00 ^{efg}
Swetha x SM 385	69.30	35.00 ^{e}	3.90	9.85 ^{fg}	44.00 ^{bcde}	49.00 ^{def}
Haritha x SM 363	105.0	76.70 ^{ab}	5.90	14.88 ^{b}	38.50 ^{def}	43.50 ^{fg}
Haritha x SM 364	102.4	84.60 ^{a}	6.00	14.84 ^{b}	42.00 ^{cdef}	47.00 ^{efg}
Haritha x SM 366	103.9	69.00 ^{abc}	5.50	14.61 ^{b}	35.50 ^{ef}	40.50 ^{g}
Haritha x SM 385	102.7	80.70 ^{a}	4.90	13.92 ^{bc}	46.00 ^{bcd}	51.00 ^{def}

Table 2. Continued....

Accessions	**Days to first harvest**	**Days to 50%harvest**	**Days to last harvest**	**No. of economic harvests**	**Total no. of harvests**	**Fruit length(cm)**
Surya	65.00 g	136.00	185.00	10.00 abc	10.50 bcdef	8.85 h
Swetha	70.50 defg	126.50	169.00	8.00 cde	11.00 abcde	10.70 bcdef
Haritha	72.00 def	142.50	182.50	9.50 abc	10.50 bcdef	12.10 ab
SM 363	75.00 cd	108.50	142.00	5.00 fg	7.00 gh	9.15 gh
SM 364	92.00 a	135.00	175.00	4.50 g	5.50 h	9.35 fgh
SM 366	74.00 cde	142.50	180.00	8.00 cde	9.50 def	9.50 fgh
SM 385	76.50 cd	135.00	179.50	8.00 cde	9.00 ef	9.50 fgh
Surya x SM 363	66.50 fg	142.50	187.50	9.00 abcd	11.50 abcd	9.65 efgh
Surya x SM 364	85.00 b	129.50	169.00	8.50 bcde	11.00 abcde	9.80 defgh
Surya x SM 366	67.50 efg	145.00	187.50	11.00 a	12.50 ab	10.35 cdefg
Surya x SM 385	71.00 defg	137.50	180.00	10.50 ab	11.00 abcde	10.10 defgh
Swetha x SM 363	72.50 def	127.00	165.50	6.50 ef	10.00 cdef	11.70 ab
Swetha x SM 364	80.50 bc	127.50	166.00	7.00 de	9.50 def	11.05 bcd
Swetha x SM 366	70.00 defg	134.00	185.00	11.00 a	12.00 abc	12.55 a
Swetha x SM 385	74.00 cde	113.0	148.00	6.50 ef	8.50 fg	11.90 ab
Haritha x SM 363	68.00 efg	139.00	181.00	10.00 abc	12.00 abc	11.85 ab
Haritha x SM 364	70.50 defg	132.50	175.00	11.00 a	11.50 abcd	11.90 ab
Haritha x SM 366	65.00 g	142.50	186.00	10.50 ab	13.00 a	12.55 a
Haritha x SM 385	80.00 bc	123.50	163.50	9.50 abc	11.50 abcd	11.50 abc

Table 2.Continued....

Accessions	**Fruit girth(cm)**	**Fruit weight(g)**	**Number of fruits per plant**	**Yield per plant (kg)**	**Yield per plot (kg)**
Surya	16.15 ^{bcde}	68.50 ^{def}	14.00 ^{ab}	0.86 ^{cdef}	10.46 ^{cde}
Swetha	10.80 ^{f}	63.20 ^{f}	11.50 ^{bc}	0.71 ^{ef}	8.70 ^{de}
Haritha	13.05 ^{de}	78.80 ^{abcd}	13.50 ^{ab}	0.81 ^{def}	8.75 ^{de}
SM 363	18.90 ^{ab}	75.40 ^{abcde}	5.50 ^{f}	0.41 ^{hi}	4.94 ^{g}
SM 364	21.15 ^{a}	86.50 ^{a}	7.50 ^{def}	0.38 ^{i}	3.60 ^{g}
SM 366	18.65 ^{ab}	79.30 ^{abcde}	6.00 ^{ef}	0.46 ^{gh}	5.56 ^{fg}
SM 385	18.48 ^{ab}	79.80 ^{abcd}	8.50 ^{de}	0.66 ^{fg}	7.97 ^{ef}
Surya x SM 363	18.35 ^{ab}	80.30 ^{abc}	14.00 ^{ab}	0.98 ^{cd}	11.96 ^{c}
Surya x SM 364	18.00 ^{abc}	68.30 ^{ef}	8.50 ^{de}	0.73 ^{ef}	8.72 ^{de}
Surya x SM 366	17.65 ^{bcd}	82.45 ^{ab}	14.00 ^{ab}	1.54 ^{a}	18.49 ^{a}
Surya x SM 385	18.70 ^{ab}	78.50 ^{abcde}	14.50 ^{a}	1.28 ^{b}	15.52 ^{b}
Swetha x SM 363	13.38 ^{de}	71.80 ^{bcdef}	10.00 ^{cd}	0.46 ^{gh}	5.15 ^{g}
Swetha x SM 364	14.40 ^{de}	63.90 ^{f}	12.50 ^{abc}	0.86 ^{cdef}	10.33 ^{cde}
Swetha x SM 366	16.20 ^{bcde}	76.55 ^{abcde}	13.00 ^{ab}	1.04 ^{c}	12.47 ^{c}
Swetha x SM 385	13.85 ^{de}	68.10 ^{ef}	8.50 ^{de}	0.36 ^{hi}	3.94 ^{g}
Haritha x SM 363	14.65 ^{cde}	68.60 ^{def}	14.00 ^{ab}	0.91 ^{cde}	10.98 ^{cde}
Haritha x SM 364	15.45 ^{bcde}	70.00 ^{cdef}	12.50 ^{abc}	0.73 ^{ef}	8.760 ^{de}
Haritha x SM 366	15.65 ^{bcde}	79.20 ^{abcde}	12.00 ^{abc}	1.05 ^{c}	12.60 ^{c}
Haritha x SM 385	16.40 ^{bcde}	70.10 ^{cdef}	12.50 ^{abc}	0.97 ^{cd}	11.70 ^{cd}

Table 3.Comparison of yield and yield contributing characters of brinjal accessions (summer, 2011)

Accessions	**Plant height (cm)**	**Plant spread (cm)**	**No. of primary branches**	**Leaf length (cm)**	**Days to 1st flowering**	**Days to 50% flowering**
Surya	70.00 ^{def}	55.00 ^{d}	4.00 ^{def}	11.00 ^{cde}	39.00 ^{cdefgh}	44.00 ^{cdef}
Swetha	55.50 ^{f}	35.00 ^{e}	3.70 ^{ef}	8.35 ^{e}	40.00 ^{bcdefg}	47.00 ^{cde}
Haritha	71.00 ^{def}	70.00 ^{abcd}	4.90 ^{bcdef}	17.47 ^{a}	41.00^{bcdefg}	48.00 b^{cd}
SM 363	67.50 ^{def}	57.50 ^{cd}	4.05 ^{def}	11.20 ^{cde}	47.50 ^{ab}	56.00 ^{ab}
SM 364	60.00 ^{ef}	37.50 ^{e}	5.19 ^{abcdef}	11.58 ^{bcd}	54.00 ^{a}	58.00 ^{a}
SM 366	59.00 ^{ef}	55.00 ^{d}	4.60 ^{bcdef}	12.57 ^{bcd}	44.50 ^{bcd}	50.50 ^{abc}
SM 385	80.00 ^{bcd}	66.50 ^{abcd}	5.20 ^{abcdef}	12.90 ^{bc}	45.00 ^{bc}	51.50 ^{abc}
Surya x SM 363	73.50 ^{def}	77.00 ^{ab}	4.10 ^{cdef}	12.15 ^{bcd}	32.00 ^{h}	39.00 ^{ef}
Surya x SM 364	80.50 ^{bcd}	71.50 ^{abcd}	5.50 ^{abcdef}	11.35 ^{cde}	45.00 ^{bc}	51.00 ^{abc}
Surya x SM 366	97.30 ^{ab}	67.00 ^{abcd}	6.70 ^{abc}	12.80 ^{bc}	36.00 ^{fgh}	41.00 ^{def}
Surya x SM 385	103.00 ^{a}	71.00 ^{abcd}	6.40 ^{abcd}	14.00 ^{bc}	36.50 ^{efgh}	41.50 ^{def}
Swetha x SM 363	77.00 ^{cde}	67.50 ^{abcd}	4.40 ^{bcdef}	13.40 ^{bc}	38.50 ^{cdefgh}	44.00 ^{cdef}
Swetha x SM 364	104.00 ^{a}	60.00 ^{bcd}	7.75 ^{a}	13.10 ^{bc}	44.00 ^{bcde}	49.00 ^{bcd}
Swetha x SM 366	109.00 ^{a}	73.50 ^{abc}	6.75 ^{ab}	13.15 ^{bc}	37.00 ^{defgh}	41.50 ^{def}
Swetha x SM 385	69.30 ^{def}	32.50 ^{e}	3.00 ^{f}	9.50 ^{de}	41.50 ^{bcdef}	46.00 ^{cde}
Haritha x SM 363	94.30 ^{abc}	70.50 ^{abcd}	5.50 ^{abcdef}	13.50 ^{bc}	31.50 ^{h}	37.00 ^{f}
Haritha x SM 364	99.00 ^{ab}	82.00 ^{a}	6.40 ^{abcd}	14.62 ^{b}	40.50 ^{bcdefg}	45.00 ^{cdef}
Haritha x SM 366	103.00 ^{a}	68.00 ^{abcd}	5.75 ^{abcde}	14.01 ^{bc}	33.50 ^{gh}	37.50 ^{f}
Haritha x SM 385	98.65 ^{ab}	77.50 ^{ab}	5.35 ^{abcdef}	14.10 ^{bc}	47.00 ^{ab}	52.50 ^{abc}

Table 3. Continued....

Accessions	Days to first harvest	Days to 50%harvest	Days to last harvest	No. of economic harvests	Total no. of harvests
Surya	54.50 fghij	92.50 abcd	117.50 abcd	7.50 ab	8.50 ab
Swetha	60.50 cde	89.00 bcdef	110.50 abcde	5.50 bcde	7.50 abc
Haritha	59.00 cdefg	92.00 abcd	121.00 a	8.00 a	8.50 ab
SM 363	70.50 a	86.00 defgh	102.50 def	4.00 def	5.50 cde
SM 364	64.50 bc	81.00 gh	94.00 f	3.00 f	4.50 e
SM 366	67.00 ab	87.50 bcdef	101.00 ef	3.50 ef	5.00 de
SM 385	67.00 ab	93.00 abc	111.00 abcde	5.50 bcde	7.00 abcd
Surya x SM 363	51.50 hij	97.00 a	118.00 abc	7.00 abc	8.50 ab
Surya x SM 364	63.00 bc	85.00 efgh	105.00 bcdef	5.50 bcde	7.00 abcd
Surya x SM 366	49.50 ij	96.50 a	117.50 abcd	7.00 abc	8.50 ab
Surya x SM 385	50.00 ij	94.00 ab	120.00 ab	7.50 ab	9.00 a
Swetha x SM 363	56.50 defgh	86.50 cdefg	110.50 abcde	6.00 abcd	7.50 abc
Swetha x SM 364	62.00 bcd	87.00 cdefg	103.00 cdef	5.00 cdef	6.50 bcde
Swetha x SM 366	50.00 ij	92.50 abcd	121.00 a	6.50 abc	9.00 a
Swetha x SM 385	55.00 efghi	83.00 fgh	105.00 bcdef	6.00 abcd	7.00 abcd
Haritha x SM 363	48.50 j	80.00 h	104.00 cdef	5.50 bcde	7.00 abcd
Haritha x SM 364	54.00 ghij	89.50 bcde	115.00 abcde	7.00 abc	8.00 ab
Haritha x SM 366	49.50 ij	92.00 abcd	111.00 abcde	6.00 abcd	8.00 ab
Haritha x SM 385	60.00 cdef	89.00 bcdef	121.00 a	7.00 abc	9.00 a

Table 3. Continued.

Accessions	**Fruit length (cm)**	**Fruit girth (cm)**	**Fruit weight (g)**	**No. of fruits per plant**	**Yield per plant (kg)**	**Yield per plot (kg)**
Surya	9.25^{def}	15.75^{bcd}	66.50^{de}	11.00^{cdef}	0.67^{cdefg}	8.11^{cde}
Swetha	11.25^{abcd}	10.70^{e}	60.10^{e}	8.50^{gh}	0.59^{fg}	7.12^{def}
Haritha	12.00^{ab}	13.00^{cd}	77.00^{abc}	10.00^{ef}	0.68^{cdefg}	8.25^{cd}
SM 363	9.65^{cdef}	18.25^{ab}	75.00^{bcd}	5.00^{k}	0.32^{i}	3.86^{hij}
SM 364	9.75^{cdef}	19.50^{a}	88.20^{a}	5.50^{jk}	0.37^{hi}	2.26^{j}
SM 366	9.80^{cdef}	17.25^{abc}	81.00^{abc}	5.00^{k}	0.27^{i}	3.29^{ij}
SM 385	8.75^{f}	18.48^{ab}	85.00^{ab}	8.00^{gh}	0.59^{fg}	7.13^{def}
Surya x SM 363	10.25^{bcdef}	18.75^{ab}	78.60^{abcd}	10.50^{def}	0.74^{cdef}	8.90^{bcd}
Surya x SM 364	9.11^{ef}	16.75^{abc}	68.80^{cde}	6.50^{ij}	0.51^{gh}	6.14^{efg}
Surya x SM 366	10.45^{cdef}	17.40^{abc}	79.00^{abcd}	11.00^{cdef}	1.01^{ab}	12.15^{a}
Surya x SM 385	10.85^{abcde}	18.50^{ab}	77.25^{abc}	14.00^{a}	1.12^{a}	13.50^{a}
Swetha x SM 363	12.75^{a}	13.50^{cd}	69.80^{cde}	8.50^{gh}	0.41^{hi}	5.25^{fgh}
Swetha x SM 364	10.15^{bcdef}	13.30^{cd}	58.90^{e}	12.00^{bcd}	0.72^{cdef}	8.60^{bcd}
Swetha x SM 366	11.95^{ab}	15.80^{bcd}	75.00^{bcd}	12.50^{bc}	0.78^{cde}	8.90^{bcd}
Swetha x SM 385	11.50^{abc}	13.00^{cd}	66.50^{de}	7.00^{hi}	0.38^{hi}	4.65^{ghi}
Haritha x SM 363	12.50^{a}	14.55^{cd}	66.70^{de}	11.50^{bcde}	0.62^{efg}	7.50^{de}
Haritha x SM 364	11.90^{ab}	15.65^{bcd}	71.00^{cde}	12.00^{bcd}	0.65^{defg}	7.90^{cde}
Haritha x SM 366	11.00^{abcde}	14.50^{cd}	75.50^{bcd}	13.00^{ab}	0.81^{cd}	9.82^{bc}
Haritha x SM 385	12.75^{a}	15.75^{bcd}	67.00^{de}	9.50^{fg}	0.85^{bc}	10.25^{b}

significantly lower than all other accessions. In the second crop season, the value for yield per plot ranged from 2.26 kg to 13.50 kg. Surya x SM 385 yielded maximum in summer (13.50 kg) and was on par with Surya x SM 366 (12.15 kg). In summer also, lowest yield per plot was observed in SM 364 (2.26 kg) followed by SM 366 and SM 363 (3.29 and 3.86 kg respectively).

4.1.1.2. *Comparison of Characters in Pot Culture Experiment*

The results of pot culture experiment showed that the 19 brinjal accessions differed significantly for many of the characters except plant height and number of primary branches (Table 4). For plant height and number of primary branches, the F_1 hybrid Swetha x SM 366 recored maximum value (103.00 cm and 7.50 for plant height and number of primary branches respectively).

In the case of plant spread also Swetha x SM 366 was in first position with significant difference (79.00 cm) which was on par with Haritha (77.50 cm), Surya x SM 363 (77.00 cm) and Haritha x SM 364 (76.50 cm). In pot culture experiment also Haritha was recorded with significantly higher value for leaf length than all other accessions (17.65 cm).

Surya and the F_1 hybrid Surya x SM 366 were observed as earlier in first flowering (32.50 each) which were on par with Surya x SM 363, Haritha x SM 366, Swetha and Haritha x SM 363. Similarly in the case of first harvest also Surya was the earliest accession which took only 62.00 days and was on par with Haritha x SM 366, Surya x SM 366, Swetha and Surya x SM 385. For days to last harvest the accessions like Swetha x SM 366, Haritha, Haritha x SM 366, SM 385 were observed with significantly high values (182.50 days each) which were on par with Surya x SM 385, Surya x SM 363, Haritha x SM 363 and Surya x SM 366.

In the case of number of economic harvests the accessions like Surya x SM 385, Haritha, Surya x SM 363, Surya x SM 366 and Haritha x SM 366 were having high values (9.00 harvests each). For total number of harvests Surya x SM

Table 4. Comparison of quantitative characters in pot culture experiment.

Accessions	**Plant height(cm)**	**Plant spread(cm)**	**No. of primary branches**	**Leaf length(cm)**	**Days to first flowering**	**Days to first harvest**
Surya	81.50 ^{def}	56.00 ^{cd}	3.50 ^{gh}	10.93 ^{ghi}	32.50 ^{f}	62.00 ^{k}
Swetha	60.00 ^{gh}	37.50 ^{e}	3.50 ^{gh}	9.75 ^{i}	36.50 ^{def}	64.00 ^{jk}
Haritha	88.00 ^{bcd}	77.50 ^{ab}	5.50 ^{bcdef}	17.65 ^{a}	39.50 ^{cdef}	71.00 ^{efgh}
SM 363	71.00 ^{efg}	57.50 ^{cd}	3.00 ^{h}	11.40 ^{fghi}	46.00 ^{abc}	75.00 ^{cde}
SM 364	52.50 ^{h}	49.00 ^{de}	4.00 ^{efgh}	12.07 ^{efgh}	53.00 ^{a}	91.00 ^{a}
SM 366	80.50 ^{def}	65.00 ^{bc}	5.00 ^{cdefg}	12.76 ^{cdefg}	46.00 ^{abc}	75.00 ^{cde}
SM 385	81.00 ^{def}	65.00 ^{bc}	5.25 ^{cdefg}	13.70 ^{bcde}	46.50 ^{abc}	66.50 ^{hijk}
Surya x SM 363	88.50 ^{abcd}	77.00 ^{ab}	4.50 ^{efgh}	13.49 ^{bcdef}	35.50 ^{ef}	76.50 ^{cd}
Surya x SM 364	85.00 ^{cde}	67.50 ^{abc}	5.50 ^{bcdef}	12.00 ^{efgh}	49.00 ^{ab}	85.00 ^{b}
Surya x SM 366	100.00 ^{ab}	66.50 ^{abc}	7.40 ^{ab}	13.25 ^{bcdef}	32.50 ^{f}	64.50 ^{jk}
Surya x SM 385	96.00 ^{abc}	74.00 ^{ab}	6.95 ^{abc}	12.50 ^{defgh}	39.00 ^{cdef}	65.50 ^{ijk}
Swetha x SM 363	77.50 ^{def}	64.10 ^{bc}	4.40 ^{efgh}	12.35 ^{defgh}	39.00 ^{cdef}	71.50 ^{efg}
Swetha x SM 364	67.50 ^{fg}	60.00 ^{cd}	6.75 ^{abcd}	13.45 ^{bcdef}	46.50 ^{abc}	73.00 ^{def}
Swetha x SM 366	103.00 ^{a}	79.00 ^{a}	7.50 ^{a}	14.23 ^{bcd}	41.00 ^{cde}	69.50 ^{fghi}
Swetha x SM 385	90.00 ^{abcd}	37.50 ^{e}	3.75 ^{fgh}	10.65 ^{hi}	43.50 ^{bcd}	72.50 ^{defg}
Haritha x SM 363	98.00 ^{abc}	69.50 ^{abc}	5.70 ^{abcdef}	14.65 ^{bc}	38.50 ^{cdef}	68.00 ^{ghij}
Haritha x SM 364	96.00 ^{abc}	76.50 ^{ab}	5.75 ^{abcde}	14.90 ^{b}	43.00 ^{bcde}	70.50 ^{efgh}
Haritha x SM 366	99.00 ^{abc}	68.00 ^{abc}	4.75 ^{efgh}	14.80 ^{bc}	35.50 ^{ef}	64.00 ^{jk}
Haritha x SM 385	97.50 ^{abc}	73.50 ^{ab}	4.90 ^{defgh}	14.18 ^{bcd}	46.00 ^{abc}	78.50 ^{c}

Table 4. Continued.

Accessions	Days to last harvest	No. of economic harvests	Total numer of harvests	Fruit length(cm)	Fruit girth(cm)
Surya	172.50 ab	6.50 def	8.50 def	9.00 hij	16.28 cd
Swetha	157.50 bcd	7.00 cde	9.50 bcd	11.50 cde	13.75 e
Haritha	182.50 a	9.00 a	10.50 abc	14.25 a	13.75 e
SM 363	137.50 d	5.00 fg	7.00 f	8.75 ij	19.00 ab
SM 364	162.50 abc	3.50 g	4.50 g	9.75 hij	20.33 a
SM 366	177.50 ab	6.50 def	9.00 cde	9.65 hij	17.25 bc
SM 385	182.50 a	5.50 ef	9.00 cde	8.50 j	18.60 abc
Surya x SM 363	180.00 ab	9.00 a	11.50 a	9.95 ghi	18.50 abc
Surya x SM 364	160.00 abcd	7.50 bcd	10.50 abc	8.93 hij	17.90 abc
Surya x SM 366	180.00 ab	9.00 a	11.50 a	10.20 fgh	17.05 bc
Surya x SM 385	180.00 ab	9.00 a	10.50 abc	11.00 efg	18.70 abc
Swetha x SM 363	161.00 abc	6.50 def	9.00 cde	12.50 bcd	13.18 e
Swetha x SM 364	162.50 ab	5.50 ef	8.00 def	10.20 fgh	14.25 de
Swetha x SM 366	182.50 a	8.50 abc	11.50 a	11.85 cde	13.03 e
Swetha x SM 385	142.50 cd	5.00 fg	7.50 ef	11.25 def	12.93 e
Haritha x SM 363	180.00 ab	8.50 abc	11.50 a	12.75 bc	13.30 e
Haritha x SM 364	165.00 abc	7.50 bcd	10.50 abc	11.90 cde	13.73 e
Haritha x SM 366	182.50 a	9.00 a	11.50 a	13.25 ab	14.43 de
Haritha x SM 385	163.50 abc	9.00 a	11.00 ab	12.25 bcde	13.43 e

Table 4. Continued.

Accessions	Fruit weight(g)	No. of fruits / plant	Yield per plant (kg)
Surya	75.00 bcdefg	13.00 abc	0.96 bcd
Swetha	68.00 ghi	12.50 bcd	0.84 def
Haritha	76.50 bcde	14.50 ab	1.10 ab
SM 363	76.00 bcdef	5.00 h	0.38 k
SM 364	89.50 a	5.00 h	0.45 jk
SM 366	80.00 bc	6.00 gh	0.48 jk
SM 385	82.00 b	7.50 fg	0.62 ghij
Surya x SM 363	82.50 b	13.50 abc	1.11 ab
Surya x SM 364	74.00 cdefgh	8.00 fg	0.59 hij
Surya x SM 366	82.50 b	14.50 ab	1.20 a
Surya x SM 385	82.00 b	15.00 a	1.23 a
Swetha x SM 363	69.00 efghi	9.00 ef	0.62 ghij
Swetha x SM 364	63.50 i	10.50 de	0.67 fghi
Swetha x SM 366	78.50 bcd	13.50 abc	1.06 abc
Swetha x SM 385	66.50 hi	7.50 fg	0.50 ijk
Haritha x SM 363	71.00 defghi	13.00 abc	0.92 cd
Haritha x SM 364	68.50 fghi	11.50 cd	0.79 defg
Haritha x SM 366	79.00 bc	11.50 cd	0.91 cde
Haritha x SM 385	70.50 efghi	10.50 de	0.74 efgh

363, Surya x SM 366, Swetha x SM 366, Haritha x SM 363, and Haritha x SM 366 recorded the maximum values (11.50 harvests each).

The results of fruit characters showed that Haritha recorded highest value for fruit length (14.25 cm) which was on par with Haritha x SM 366 (13.25 cm). For fruit girth and fruit weight SM 364 recorded maximum value (20.33 cm and 89.50 g for fruit girth and fruit weight respectively). Number of fruits per plant was higher in Surya x SM 385 (15.00) which was in confirmation with the results in field trial. This was followed by Surya x SM 366, Haritha, Surya x SM 363 and Swetha x SM 366 with on par values. The F_1 hybrids namely Surya x SM 385 and Surya x SM 366 had good yield per plant (1.23 and 1.20 kg respectively) which were at par with Surya x SM 363, Surya and Swetha x SM 366.

4.1.2. Estimation of Genetic Parameters

Genetic parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance and genetic gain were estimated for 17 quantitative characters and presented in Table 5 and Table 6.

Estimation of GCV and PCV revealed that PCV values were greater than GCV values for all the 17 quantitative characters studied during both seasons. During both seasons, yield per plot recorded highest GCV and PCV values (41.00 and 43.16 in first crop and 37.03 and 39.06 in the summer crop respectively) followed by yield per plant. Number of fruits per plant, number of economic harvests and total number of harvests were the traits having moderate GCV and PCV values. In the second season the characters plant height, plant spread, number of primary branches, number of fruits per plant and total number of harvests showed moderate values of GCV and PCV. Days to 50 per cent harvest (5.14 and 9.30 respectively) and days to last harvest (5.23 and 9.04 respectively) recorded the lowest GCV and PCV values in kharif crop and days to 50 per cent harvest recorded lowest values of GCV and PCV (5.00 and 5.84 respectively) during summer season. Other characters like fruit weight and plant height also

Table 5. Mean, Range, GCV, PCV, Heritability, Genetic advance and Genetic gain for 17 quantitative characters during kharif season

Characters	**Mean± SE**	**Range**	**GCV**	**PCV**	**Heritability**	**Genetic advance**	**Genetic gain**
Plant height(cm)	91.87± 0.14	67.60 – 107.30	8.52	17.63	23.30	7.79	8.47
Plant spread(cm)	66.05± 0.10	35.00 - 84.60	18.83	25.00	56.70	19.30	29.22
No. of primary branches	5.37± 0.13	3.90 -7.35	8.32	26.47	9.90	0.29	5.40
Leaf length(cm)	12.86± 0.11	9.20 – 17.58	14.06	16.47	72.90	3.18	24.72
Days to first flowering	42.86± 0.35	34.50 – 56.50	12.14	14.72	68.00	8.80	20.61
Days to 50% flowering	48.78± 0.34	40.00 – 65.50	13.96	15.60	80.00	12.55	25.72
Days to first harvest	73.44 ± 0.28	65.00 – 92.00	9.11	9.88	85.00	12.71	17.30
Days to 50% harvest	132.60 ± 0.10	108.50 – 145.00	5.14	9.30	30.50	7.76	5.85
Days to last harvest	174.05 ± 0.12	142.00 – 187.50	5.23	9.04	33.50	10.85	6.23

No. Of economic harvests	8.63 ± 0.87	4.50 – 11.00	22.12	24.30	82.90	3.58	41.48
Total harvests	10.36 ± 0.88	5.50 – 13.00	17.15	19.15	80.20	3.28	31.66
Table 5. Continued..							
Character	**Mean ± SE**	**Range**	**GCV**	**PCV**	**Heritability**	**Genetic advance**	**Genetic gain**
Fruit length (cm)	10.67 ± 0.57	8.85 – 12.55	10.55	11.83	79.60	2.07	19.40
Fruit girth (cm)	16.47 ± 0.15	13.05 – 21.15	12.34	15.09	66.90	3.43	20.82
Fruit weight (g)	73.66 ± 0.47	63.20 – 86.50	7.77	10.06	59.80	9.12	12.38
No. Of fruits/plant	11.18 ± 0.12	5.50 – 14.50	24.97	27.14	84.60	5.29	47.13
Yield/ plant (kg)	0.79 + 0.96	0.23 – 1.54	40.28	42.07	91.70	0.63	79.74
Yield/ plot (kg)	9.46 + 0.13	2.80 – 18.49	41.00	43.16	90.20	7.59	80.23

Table 6. Mean, Range, GCV, PCV, Heritability, Genetic advance and Genetic gain for 17 quantitative characters during summer

Characters	Mean± SE	Range	GCV	PCV	Heritability	Genetic advance	Genetic gain
Plant height(cm)	82.71 ±0.81	55.50 - 109.00	19.94	22.24	80.40	30.45	36.82
Plant spread(cm)	62.87 ± 0.76	32.50 - 82.00	21.24	24.41	75.70	23.94	38.08
No. of primary branches	5.22 ±0.11	3.00 - 7.75	18.24	27.46	44.10	1.30	24.90
Leaf length(cm)	12.67 ± 0.13	8.35 - 17.47	13.81	17.35	63.40	2.87	22.65
Days to first flowering	40.74 ± 0.33	31.50 - 54.00	13.00	15.25	72.60	9.29	22.81
Days to 50% flowering	46.31 ±0.35	37.00 - 58.00	11.82	14.05	70.80	9.49	20.49
Days to first harvest	57.50 ±0.25	48.50 - 70.50	11.56	12.36	87.50	12.81	22.28
Days to 50% harvest	89.11 ± 0.27	80.00 - 97.00	5.00	5.84	73.10	7.84	8.79
Days to last harvest	110.97 ± 0.62	94.00 - 121.00	6.11	8.30	54.30	10.30	9.28
No. Of economic harvests	5.94 ± 0.10	3.00 - 8.00	19.79	25.97	58.10	1.84	24.73
Total harvests	7.44 ± 0.96	4.50 - 9.00	15.57	20.19	59.50	1.85	31.14

Table 6. Continued.

Character	**Mean + SE**	**Range**	**GCV**	**PCV**	**Heritability**	**Genetic advance**	**Genetic gain**
Fruit length (cm)	10.82 + 0.83	8.75 - 12.75	10.39	12.91	64.80	1.86	17.19
Fruit girth (cm)	15.96 + 0.13	13.00 - 19.50	12.19	14.61	69.60	3.35	20.99
Fruit weight (g)	72.57 + 0.52	58.90 - 88.20	9.52	11.94	63.60	11.36	15.65
No. Of fruits/plant	9.52 + 0.66	5.00 - 14.00	28.83	29.66	94.50	5.50	57.77
Yield/ plant (kg)	0.64 + 0.77	0.27 - 1.12	34.66	36.68	89.30	0.43	67.18
Yield/ plot (kg)	7.55 + 0.84	2.26 - 13.50	37.43	39.06	91.80	5.58	73.80

recorded lower GCV and PCV values during the first crop season while the characters like fruit length, fruit girth and fruit weight recorded lower GCV and PCV values in summer.

During the both seasons, majority of the yield contributing characters recorded high heritability values (>60%). Characters like yield per plant, yield per plot, days to first harvest, number of fruits per plant and number of economic harvests recorded relatively higher heritability values than all other traits during first season (91.70, 90.20, 85.00, 84.60 and 82.90 respectively). During summer season, the characters like number of fruits per plant, yield per plant, yield per plot, days to first harvest, plant height, plant spread, days to 50 % harvest, days to first flowering, days to 50 % flowering, fruit girth, fruit length, fruit weight and leaf length were observed with high heritability values (94.50, 91.80, 89.30, 87.50, 80.40, 75.70, 73.10, 72.60, 70.80, 69.60, 64.80, 63.60 and 63.40 respectively).

All the characters were categorised as low in genetic advance in the first season since all the characters were having genetic advance less than 20. Among these, plant spread was having maximum genetic advance values (19.30). Yield per plot showed highest genetic gain (80.23) followed by yield per plant (79.74). Lowest genetic gain was shown by number of primary branches (5.40). But in the summer season, plant height and plant spread were observed with high genetic advance of 30.45 and 23.94 per cent respectively. Here also yield per plot showed highest genetic gain (73.80) followed by yield per plant (67.18). Days to 50 % harvest was the trait with lowest genetic gain in summer (8.79).

4.1.2.1. *Heterosis in Brinjal*

Heterosis over better parent (heterobeltiosis), standard variety (standard heterosis) and mid parent (relative heterosis) were calculated for all the 12 hybrids for the 17 characters. Mean performance of parents and F_1 hybrids and extend of heterosis over mid parent, better parent and over standard variety are presented in Table 7 and Table 8.

4.1.2.1.1. ***Plant height (cm)***

Mean plant height for the hybrids ranged from 69.30 cm to 107.30 cm in first season and from 69.30 cm to 109.00 cm in second season. During first season, maximum and significant heterobeltiosis was observed for the cross Swetha x SM 364 (38 %). The cross Swetha x SM 366 exhibited maximum and significant standard heterosis (18.56 %). The combination Swetha x SM 364 also exhibited maximum and significant relative heterosis of 39.29 per cent closely followed by the cross Swetha x SM 366 (38.10 %). Swetha x SM 385 was the hybrid which exhibited lowest percentage of heterobeltiosis, standard heterosis and relative heterosis (-24.26 %, -30.59% and -12.88 % respectively). In the second season, the maximum and significant value for heterobeltiosis, standard heterosis and relative heterosis were recored in Swetha x SM 366 (84.75 %, 34.86 % and 90.39 % respectively) which was closely followed by Swetha x SM 364. In summer season also, Swetha x SM 385 exhibited lowest values for all the three heterosis.

4.1.2.1.2. ***Plant spread (cm)***

Mean plant spread ranged from 35.00 cm to 84.60 cm and 32.50 cm to 82.00 cm in kharif and summer season respectively for F_1 hybrids. Maximum and significant heterobeltiosis was observed for Surya x SM 364 (40.67 %). None of F_1 hybrids showed positive value for standard heterosis which indicated that the hybrid vigour of F_1 hybrids were lower than the performance of standard variety (Haritha). The combination Swetha x SM 363 exhibited maximum and significant relative heterosis of 49.67 per cent followed by Surya x SM 364 (48.39 %) and Swetha x SM 364 (47.40 %). During summer, positive and significant heterobeltiosis was noticed in the cross Surya x SM 364 (90.67 %). The standard heterosis was maximum in Haritha x SM 364 and was significant also. In the case of relative heterosis Surya x SM 364 was in first position with 65.52 per cent heterotic value followed by Swetha x SM 366 (63.33 %).

4.1.2.1.3. ***Number of primary branches***

Swetha x SM 364 was observed as the hybrid with maximum and significant value of heterobeltiosis, standard heterosis and relative heterosis (47.00 %, 26.53 % and 59.78 % respectively) in first crop. The lowest value of heterobeltiosis, standard heterosis and relative heterosis was shown by the cross Swetha x SM 385 (-28.44 %, -38.46 % and –19.17 % respectively). In the second crop also Swetha x SM 364 was observed with maximum positive and significant heterobeltiosis, standard heterosis and relative heterosis (49.33 %, 36.77 % and 74.35 % respectively).

4.1.2.1.4. ***Leaf length***

The leaf length in the F_1 hybrids ranged from 9.85 cm to 14.88 cm in first season and from 9.50 cm to 14.62 cm in second season. The maximum and significant heterobeltiosis was observed for the cross Surya x SM 363 (18.17 %). Positive and significant standard heterosisis was not observed in any of the hybrids during both seasons. The cross Swetha x SM 364 exhibited the highest and significant value for relative heterosis (29.16 %). In the case of summer crop, the cross Swetha x SM 363 exhibited maximum and significant positive value for heterobeltiosis (19.64 %) and relative heterosis (37.08 %).

4.1.2.1.5. ***Days to first flowering***

In first season, F_1 means ranged from 34.50 days (Surya x SM 366) to 51.00 days after transplanting (Surya x SM 364) for days to first flower opening. The maximum and significant negative heterobeltiosis was observed for the cross Haritha x SM 364 (-25.66 %). The highest negative standard heterosis (-17.39 %) was for Surya x SM 366 and relative heterosis (-16.96 %) was observed for the hybrid Haritha x SM 366. In summer, the range for F_1 means was from 31.50 (Haritha x SM 363) to 47.00 days (Haritha x SM 385). Haritha x SM 363 recorded highest and significant negative heterobeltiosis (-33.68 %), standard heterosis (-30.16 %) and relative heterosis (-28.81 %) than all other hybrids evaluated.

4.1.2.1.6. ***Days to 50 per cent flowering***

Number of days to 50 per cent flowering in the F_1 hybrids ranged from 40.00 days (Surya x SM 366) to 56.00 days (Surya x SM 364) from transplanting in first season. The combination Haritha x SM 364 showed the highest negative and significant heterobeltiosis (- 28.24 %) closely followed by Haritha x SM 363 (-28.10 %). Significant and highest negative standard heterosis was exhibited by the cross Surya x SM 366 (- 16.25 %). Haritha x SM 363 and Haritha x SM 366 were the hybrids with highest and significant negative relative heterosis (- 18.69 % and – 18.18 % respectively). During summer, the range for days to 50 per cent flowering was from 37.00 to 52.50 from transplanting in F_1 hybrids. Here Haritha x SM 363 exhibited highest significant value for heterobeltiosis, standard heterosis and relative heterosis (-33.93 %, -28.95 % and -28.85 % respectively).

4.1.2.1.7. ***Days to first harvest***

During first season, the mean values for number of days to first harvests in F_1 hybrids ranged from 65.00 (Haritha x SM 366) to 85.00 (Surya x SM 364) days. All the crosses exhibited negative heterobeltiosis for this character. The highest negative and significant heterobeltiosis of – 23.37 per cent and relative heterosis of -14.02 per cent was exhibited by the cross Haritha x SM 364. The cross Haritha x SM 366 showed the highest negative standard heterosis of –10.77 per cent. During summer, the mean values for this character was ranging from 48.50 (Haritha x SM 363) to 63.00 days (Surya x SM 364) in hybrids. The highest negative and significant heterobeltiosis of -31.21 per cent was exhibited by Haritha x SM 363. The standard heterosis and relative heterosis were also found negative and significantly higher in same hybrid (-21.65 and -25.10 per cent respectively).

4.1.2.1.8. ***Days to 50 per cent harvest***

Number of days to 50 per cent harvests in F_1 hybrids ranged from 113.00 (Swetha x SM 385) to 145.00 (Surya x SM 366) in first season. The cross Surya x SM 363 exhibited the highest and significant value of heterobeltiosis (4.78 %) and relative heterosis (16.56 %). The maximum standard heterosis of 1.72 per cent was shown by the hybrid Surya x SM 366. Swetha x SM 385 was the combination with lowest value of heterobeltiosis (-16.30 %), standard heterosis (-20.70) and relative heterosis (-13.58 %). During the second season the range for days to 50 per cent harvest in F_1 hybrids was from 80.00 to 97.00 days from transplanting. The combination Surya x SM 363 exhibited maximum and significant value for heterobeltiosis, standard heterosis and relative heterosis (4.86 %, 5.15 % and 8.68 % respectively).

4.1.2.1.9. ***Days to last harvest***

The mean values for number of days to last harvest in F_1 hybrids ranged from 148.00 (Swetha x SM 385) to 187.50 days from transplanting (Surya x SM 363 and Surya x SM 366) in first season and 103.00 (Swetha x SM 364) to 121.00 (Swetha x SM 366 and Haritha x SM 385) days from transplanting. The maximum and the significant value of heterobeltiosis was shown by the cross Swetha x SM 366 (2.78 %). Surya x SM 363 and Surya x SM 366 were the F_1 hybrids with maximum significant standard heterosis (2.66 % for each) followed by Surya x SM 385 (2.41 %) whereas Surya x SM 363 had exhibited highest value of relative heterosis (16.48 %). During summer, the cross Swetha x SM 366 showed maximum positive and significant heterobeltiosis (9.50 %) and relative heterosis (14.42 %). But none of the F_1 crosses were noticed with positive standard heterosis for this character in summer.

4.1.2.1.10. ***Number of economic harvests***

In first season the number of economic harvests in the F_1 hybrids ranged from 6.50 (Swetha x SM 363 and Swetha x SM 385) to 11.00 (Surya x SM 366, Swetha x SM 366 and Haritha x SM 364). The maximum positive and significant heterobeltiosis (37.50 %) was exhibited by the F_1 hybrid Swetha x SM 366. Surya x SM 366, Swetha x SM 366 and Haritha x SM 364 were observed with maximum and significant value of standard heterosis (13.64 per cent each). The cross Haritha x SM 364 exhibited maximum relative heterosis of 57.14 per cent.

During summer the means of F_1 hybrids for number of economic harvests ranged from 5.00 to 7.50. The cross Swetha x SM 363 recorded highest heterobeltiosis. In the case of standard heterosis none of the hybrids showed positive value. Relative heterosis was maximum and significant in Swetha x SM 366 (44.44 %).

4.1.2.1.11. *Total number of harvests*

The F_1 means for total number of harvests ranged from 8.50 to 13.00 in first season and from 6.50 to 9.00 in summer season. During first season, the combination Haritha x SM 366 was observed to be the hybrid with maximum and significant value of heterobeltiosis (23.81 %) and standard heterosis (23.81%). The significant value of relative heterosis observed was 43.75 per cent which was shown by the cross Haritha x SM 364. The lowest and negative value of heterosis was shown by the hybrid Swetha x SM 385, which were -22.73 per cent for heterobeltiosis and standard heterosis and -15.00 per cent for relative heterosis. During second season, Swetha x SM 366 exhibited significantly higher heterobeltiosis and relative heterosis (20.00 and 44.00 per cent respectively) than all other hybrids. But the standard heterosis was observed as high and significant in both Surya x SM 385, Swetha x SM 366 and Haritha x SM 385 (5.55 per cent for each).

4.1.2.1.12. *Fruit length (cm)*

The mean values of the F_1 hybrids for length of fruit ranged from 9.65 cm (Surya x SM 363) to 12.55 cm (Swetha x SM 366) in first crop. The highest and significant heterobeltiosis was shown by the F_1 hybrid Swetha x 366 (17.29 %). This hybrid also exhibited significant value for standard heterosis (3.58 %) and relative heterosis (19.26 %). During summer, the mean for fruit length in hybrids ranged between 9.11 cm to 12.75 cm. Maximum positive and significant heterobeltiosis was noticed for the cross Surya x SM 385. The hybrids like Swetha x SM 363 and Haritha x SM 385 were observed with highest and significant standard heterosis (5.88 % for each). Relative heterosis was observed as high and significant in Haritha x SM 385 (22.89 %) followed by Swetha x SM 363 (22.01 %).

4.1.2.1.13. *Fruit girth (cm)*

The highest mean value for fruit girth was shown by the hybrid Surya x SM 385 (18.70 cm) in first season and in Surya x SM 363 during summer. During first crop, the cross Surya x SM 385 showed the highest positive and significant heterobeltiosis of 1.19 per cent, standard heterosis of 30.21 per cent and relative heterosis of 8.00 per cent. In summer season the combination Surya x SM 363 was noticed with high and significant heterobeltiosis, standard heterosis and relative heterosis (2.74, 30.66 and 10.29 per cent respectively).

4.1.2.1.14. *Fruit weight (g)*

The average fruit weight in the F_1 hybrid ranged from 63.90 g (Swetha x SM 364) to 82.45 g (Surya x SM 366) in first season. The highest and significant heterobeltiosis was shown by the hybrid Surya x SM 363 (6.50 %). The maximum and significant value for standard heterosis was shown by the hybrid Surya x SM 366 (4.46 %). In the case of relative heterosis, the cross Surya x SM 363 showed significantly higher value (11.61 %) closely followed by the hybrid Surya x SM 366 (11.57 %). In summer season, the range of mean fruit weight in F_1 hybrids was from 58.90 g (Swetha x SM 364) to 79.00 g (Surya x SM 366). The combination Surya x SM 363 recorded maximum significant heterobeltiosis and relative heterosis (4.80 and 11. 10 per cent respectively). But the standard heterosis was found to be maximum in Surya x SM 366 (2.53 %) followed by Surya x SM 363 (2.03 %).

4.1.2.1.15. *Number of fruits per plant*

The number of fruits per plant in the F_1 hybrids varied from 8.50 to 14.50 in first season. The combination Swetha x SM 366 exhibited maximum and significant value for heterobeltiosis (13.04 %) and relative heterosis (48.57 %). The highest and significant standard heterosis was noticed in Surya x SM 385

(6.89 %). The lowest value for heterobeltiosis (-39.29 %), standard heterosis (-39.29 %) and relative heterosis (-20.93 %) was shown by the cross Surya x SM 364. During second season, the mean value for fruits per plant ranged between 6.50 and 13.00. The highest and significant heterobeltiosis and relative heterosis was observed in the cross Swetha x SM 366 (47.06 and 85.19 per cent respectively). The cross Surya x SM 385 was found to be with maximum value of standard heterosis for this character in summer (28.57 %).

4.1.2.1.16. *Yield per plant (kg)*

The yield per plant of F_1 hybrids ranged from 0.36 kg (Swetha x SM 385) to 1.54 kg (Surya x SM 366) in first season and from 0.38 kg (Swetha x SM 385) to 1.12 kg (Surya x SM 385) in summer season. During first season, the cross Surya x SM 366 also showed the highest positive and significant heterobeltiosis (70.08 %), standard heterosis (48.05 %) and relative heterosis (131.58 %). During summer, the combination Surya x SM 385 was noticed with highest and significant hetrobeltiosis and standard heterosis of 66.67 and 46.42 per cent respectively. Maximum relative heterosis was found in Surya x SM 366 (113.76 %).

4.1.2.1.17. *Yield per plot (kg)*

The yield per plot of F_1 hybrids ranged from 3.94 kg (Swetha x SM 385) to 18.49 kg (Surya x SM 366) in first season and from 4.65 kg (Swetha x SM 385) to 13.50 kg (Surya x SM 385) in summer. During first season the cross Surya x SM 366 showed the highest positive and significant heterobeltiosis (76.77 %), standard heterosis (52.67 %) and relative heterosis (130.48 %). During summer, the combination Surya x SM 385 showed maximum heterobeltiosis and standard heterosis of 66.46 and 63.63 per cent respectively. The maximum value for relative heterosis was observed in Surya x SM 366 (113.16 %).

Table 7. Estimates of heterosis of F_1 hybrids over parents during kharif season

Parent / cross	Plant height (cm)				Plant spread (cm)			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	84.00				52.00			
Swetha	67.60				36.10			
Haritha	90.50				88.80			
SM 363	85.05				58.38			
SM364	68.88				46.60			
SM366	87.75				68.90			
SM385	91.50				66.12			
Surya x SM363	96.60	13.58	6.32	14.29	76.80	31.56	-15.63	39.16
Surya x SM 364	90.05	7.20	-0.49	17.81	73.15	40.67*	-21.39	48.39*
Surya x SM 366	103.80	18.29	12.81	20.87	67.30	-2.32	-31.94	11.33
Surya x SM 385	105.50	15.30	14.22	20.23	74.90	13.27	-18.55	26.81
Swetha x SM 363	88.70	4.29	-2.03	16.21	70.70	21.11	-25.60	49.6*
Swetha x SM 364	95.05	38.00*	4.78	39.29*	60.95	30.79	-45.69	47.40*
Swethax SM 366	107.30	22.28	18.56*	38.14	73.40	6.53	-20.98	39.81
Swetha x SM 385	69.30	-24.26	-30.59	-12.88	35.00	-47.07	-153.71	-31.52
Haritha x SM 363	105.00	16.02	16.02	19.62	76.70	-13.62	-13.62	7.90
Haritha x SM 364	102.45	13.20	13.20	28.56	84.60	-4.96	-4.96	29.75
Haritha x SM 366	103.93	14.83	14.83	16.61	69.00	-22.29	-22.29	-9.63
Haritha x SM 385	102.65	12.19	13.42	12.80	80.70	-9.97	-9.97	7.65

*significant at 5% level

Table 7. Continued.

Parent / cross	No. of primary branches				Leaf length (cm)			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**	**Mean**	**HB(%)**	**SH(%)**	**RH(%)**
Surya	4.00				11.01			
Swetha	4.20				9.20			
Haritha	5.40				17.58			
SM 363	4.18				10.70			
SM 364	5.00				11.90			
SM 366	5.00				12.64			
SM 385	5.45				13.73			
Surya x SM 363	4.50	7.78	-20.00	10.09	13.01	18.17 *	-35.12	19.85
Surya x SM 364	5.95	19.00	9.24	32.22	11.63	-2.37	-51.16	1.51
Surya x SM 366	7.00	40.00	22.86	55.56	12.30	-2.65	-42.93	4.04
Surya x SM 385	6.30	15.60	14.28	33.33	13.26	-3.42	-32.58	7.19
Swetha x SM 363	4.50	7.14	-20.00	7.46	12.37	15.61	-42.12	24.32
Swetha x SM 364	7.35	47.00*	26.53*	59.78*	13.63	14.49	-28.98	29.16 *
Swethax SM 366	7.00	40.00	22.86	52.17	13.32	5.42	-31.98	22.01
Swetha x SM 385	3.90	-28.44	-38.46	-19.17	9.85	-28.26	-78.47	-14.09
Haritha x SM 363	5.90	9.26	9.26	23.24	14.88	-15.38	-15.38	5.21
Haritha x SM 364	6.00	11.11	11.11	15.38	14.84	-15.61	-15.61	0.64
Haritha x SM 366	5.50	1.85	1.85	5.77	14.61	-16.92	-16.92	-3.31
Haritha x SM 385	4.90	-10.09	-9.25	-9.68	13.92	-20.84	-20.84	-11.10

*significant at 5% level

Table 7. Continued.

Parent / cross	Days to first flowering				Days to 50 % flowering			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**	**Mean**	**HB(%)**	**SH(%)**	**RH(%)**
Surya	35.50				40.00			
Swetha	41.50				46.00			
Haritha	40.50				46.50			
SM 363	47.50				60.50			
SM364	56.50				65.50			
SM366	45.00				52.50			
SM385	48.00				59.00			
Surya x SM363	37.50	-21.05	-8.00	-9.64	43.50	-28.10	-6.89	-13.43
Surya x SM 364	51.00	-9.73	20.58	10.87	56.00	-14.50	16.96	6.16
Surya x SM 366	34.50	-23.33	-17.39 *	-14.29	40.00	-23.81	-16.25*	-13.51
Surya x SM 385	39.50	-17.71	-2.53	-5.39	44.00	-25.42	-5.68	-11.11
Swetha x SM 363	39.50	-16.84	-2.53	-11.24	45.00	-25.62	-3.33	-15.49
Swetha x SM 364	47.50	-15.93	14.73	-3.06	51.50	-21.37	9.70	-7.62
Swethax SM 366	41.00	-8.89	1.22	-5.20	46.00	-12.38	-1.08	-6.60
Swetha x SM 385	44.00	-8.33	7.95	-1.68	49.00	-16.95	5.10	-6.67
Haritha x SM 363	38.50	-18.95	-5.19	-12.50	43.50	-28.10*	-6.89	-18.69*
Haritha x SM 364	42.00	-25.66*	3.57	-13.40	47.00	-28.24*	1.06	-16.07
Haritha x SM 366	35.50	-21.11	-14.08	-16.96*	40.50	-22.86	-14.81	-18.18*
Haritha x SM 385	46.00	-4.17	11.95	3.95	51.00	-13.56	8.82	-3.32

*significant at 5% level

Table 7. Continued.

Parent / cross	Days to first harvest				Days to 50 % harvest			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	65.00				136.00			
Swetha	70.50				126.50			
Haritha	72.00				142.50			
SM 363	75.00				108.50			
SM364	92.00				135.00			
SM366	74.00				142.50			
SM385	76.50				135.00			
Surya x SM363	66.50	-11.33	-8.27	-5.00	142.50	4.78 *	0.00	16.56 *
Surya x SM 364	85.00	-7.61	15.29	8.28	129.50	-4.78	-10.03	-4.43
Surya x SM 366	67.50	-8.78	-6.66	-2.88	145.00	1.75	1.72 *	4.13
Surya x SM 385	71.00	-7.19	-1.41	0.35	137.50	1.10	-3.64	1.48
Swetha x SM 363	72.50	-3.33	0.68	-0.34	127.00	0.40	-12.20	8.099
Swetha x SM 364	80.50	-12.50	10.56	-0.92	127.50	-5.56	-11.76	-2.49
Swethax SM 366	70.00	-5.41	-2.86	-3.11	134.00	-5.96	-6.34	-0.37
Swetha x SM 385	74.00	-3.27	2.70	0.68	113.00	-16.30	-20.70	-13.58
Haritha x SM 363	68.00	-9.33	-5.88	-7.48	139.00	-2.46	-2.46	10.76
Haritha x SM 364	70.50	-23.37 *	-2.06	-14.02*	132.50	-7.02	-7.02	-4.50
Haritha x SM 366	65.00	-12.16	-10.77 *	-10.96	142.50	0.00	0.00	0.00
Haritha x SM 385	80.00	4.58	10.00	7.74	123.50	-13.33	-13.33	-10.99

*significant at 5% level

Table 7. Continued.

Parent / cross	Days to last harvest				No. of economic harvests			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	185.00				10.00			
Swetha	169.00				8.00			
Haritha	182.50				9.50			
SM 363	142.00				5.00			
SM364	175.00				4.50			
SM366	180.00				8.00			
SM385	179.50				8.00			
Surya x SM363	187.50	1.35	2.66*	16.48*	9.00	-10.00	-5.56	20.00
Surya x SM 364	169.00	-8.65	-7.99	-6.11	8.50	-15.00	-11.76	17.24
Surya x SM 366	187.50	1.35	2.66*	2.74	11.00	10.00	13.64*	22.22
Surya x SM 385	187.00	-2.70	2.41*	-1.23	10.50	5.00	9.52	16.67
Swetha x SM 363	165.50	-2.07	-10.27	6.43	6.50	-18.75	-46.15	0.00
Swetha x SM 364	166.00	-5.14	-9.94	-3.49	7.00	-12.50	-35.71	12.00
Swethax SM 366	185.00	2.78 *	1.35	6.02	11.00	37.50*	13.64*	37.50
Swetha x SM 385	148.00	-17.55	-23.31	-15.02	6.50	-18.75	-46.15	-18.75
Haritha x SM 363	181.00	-0.82	-0.82	11.56	10.00	5.00	5.00	37.93
Haritha x SM 364	175.00	-4.28	-4.28	-2.10	11.00	13.64	13.64*	59.14*
Haritha x SM 366	186.00	1.88	1.88	2.26	10.50	9.78	9.78	20.00
Haritha x SM 385	163.00	-11.96	-11.96	-9.67	9.50	0.00	0.00	8.57

*significant at 5% level

Table 7. Continued.

Parent / cross	Total no. of harvests				Fruit length (cm)			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	10.50				8.85			
Swetha	11.00				10.70			
Haritha	10.50				12.10			
SM 363	7.00				9.15			
SM364	5.50				9.35			
SM366	9.50				9.50			
SM385	9.00				9.50			
Surya x SM363	11.50	9.52	8.69	31.43	9.65	5.46	-25.38	-7.22
Surya x SM 364	11.00	4.76	4.55	37.50	9.80	4.81	-23.46	-7.69
Surya x SM 366	12.50	19.05	16.00	25.00	10.35	8.95	-16.90	-12.81
Surya x SM 385	11.00	4.76	4.55	12.82	10.10	6.32	-19.80	-10.08
Swetha x SM 363	10.00	-9.09	-5.00	11.11	11.70	9.35	-3.41	-17.88
Swetha x SM 364	9.50	-13.64	-10.52	15.15	11.05	3.27	-9.50	-10.22
Swethax SM 366	12.00	9.09	12.50	17.07	12.55	17.29 *	3.58*	19.26*
Swetha x SM 385	8.50	-22.73	-23.52	-15.00	11.90	11.21	-1.68	-17.82
Haritha x SM 363	12.00	14.29	14.29	37.14	11.85	-2.10	-2.10	-17.91
Haritha x SM 364	11.50	9.52	9.52	43.75*	11.90	-1.68	-1.68	-17.24
Haritha x SM 366	13.00	23.81*	23.81*	30.00	11.25	-7.55	-7.55	-20.74
Haritha x SM 385	11.50	9.52	9.52	17.15	11.50	-5.21	-5.21	-12.47

*significant at 5% level

Table 7. Continued.

Parent / cross	Fruit girth (cm)				Fruit weight (g)			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	16.15				68.50			
Swetha	10.80				63.20			
Haritha	13.05				78.80			
SM 363	18.90				75.40			
SM364	21.15				86.50			
SM366	18.65				79.30			
SM385	18.48				79.80			
Surya x SM363	18.35	-2.91	28.88	4.71	80.30	6.50*	1.87	11.61*
Surya x SM 364	18.00	-14.89	27.50	-3.49	68.30	-21.04	-15.37	-11.87
Surya x SM 366	17.65	-5.36	26.06	1.44	82.45	3.97	4.46*	11.57*
Surya x SM 385	18.70	1.19*	30.21*	8.00*	78.50	-1.63	-0.38	5.87
Swetha x SM 363	13.38	-29.23	2.46	-18.57	71.80	-4.77	-9.74	3.61
Swetha x SM 364	14.40	-31.91	9.38	-17.95	63.90	-26.13	-23.21	-14.63
Swethax SM 366	16.20	-13.14	19.44	-0.61	76.55	-3.47	-2.93	7.44
Swetha x SM 385	13.85	-25.05	5.77	-14.59	68.10	-14.66	-1.32	-4.76
Haritha x SM 363	14.65	-22.49	10.92	-8.29	68.60	-14.86	-14.86	-4.99
Haritha x SM 364	15.45	-26.95	15.53	-9.65	70.00	-19.08	-12.57	-9.97
Haritha x SM 366	15.65	-16.09	16.61	-1.26	79.20	-0.13	0.50	6.81
Haritha x SM 385	16.40	-11.26	20.42	4.03	70.10	-12.16	-12.41	-5.78

*significant at 5% level

Table 7. Continued.

Parent / cross	No. of fruits / plant				Yield per plant (kg)			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	14.00				0.87			
Swetha	11.50				0.71			
Haritha	13.50				0.80			
SM 363	5.50				0.41			
SM364	7.50				0.23			
SM366	6.00				0.46			
SM385	8.50				0.66			
Surya x SM363	14.00	0.00	3.57	43.59	0.98	13.29	18.36	53.73
Surya x SM 364	8.50	-39.29	-58.82	-20.93	0.73	-16.18	-9.58	32.42
Surya x SM 366	14.00	0.00	3.57	40.00	1.54	70.08*	48.05*	131.58*
Surya x SM 385	14.50	3.57	6.89*	28.89	1.28	48.55	37.50	68.52
Swetha x SM 363	10.00	-13.04	-35.00	17.65	0.46	-34.04	-73.91	-16.59
Swetha x SM 364	12.50	8.70	-8.00	31.58	0.86	21.99	6.98	83.96
Swethax SM 366	13.00	13.04*	-3.85	48.57*	1.03	46.81	22.33	76.92
Swetha x SM 385	8.50	-26.09	-39.29	-15.00	0.36	-48.94	-122.22	-47.25
Haritha x SM 363	14.00	3.70	3.70	47.37	0.91	13.04	13.04	49.79
Haritha x SM 364	12.50	-7.41	-7.41	19.05	0.73	-9.94	-9.94	40.10
Haritha x SM 366	12.00	-11.11	-11.11	23.08	1.05	29.81	29.81	64.57
Haritha x SM 385	12.50	-7.41	-7.41	13.64	0.97	20.50	20.50	32.42

*significant at 5% level

Table 7. Continued.

Parent / cross	**Yield per plot (kg)**			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**
Surya	10.46			
Swetha	8.70			
Haritha	8.75			
SM 363	4.94			
SM364	2.80			
SM366	5.59			
SM385	7.97			
Surya x SM363	11.97	14.39	26.90	55.39
Surya x SM 364	8.72	-16.63	-0.34	31.52
Surya x SM 366	18.49	76.77*	52.67*	130.48*
Surya x SM 385	15.52	48.37	43.62	68.42
Swetha x SM 363	5.15	-40.80	-69.90	-24.49
Swetha x SM 364	10.33	18.74	15.29	79.65
Swethax SM 366	12.47	43.33	29.83	74.59
Swetha x SM 385	3.94	-54.71	-122.08	-52.73
Haritha x SM 363	10.98	25.49	25.49	60.41
Haritha x SM 364	8.76	0.11	0.11	51.69
Haritha x SM 366	12.60	44.06	44.06	75.86
Haritha x SM 385	11.70	33.71	33.71	39.95

*significant at 5% level

Table 8. Estimates of heterosis of F_1 hybrids over parents during summer

Parent / cross	**Plant height (cm)**				**Plant spread (cm)**			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**	**Mean**	**HB(%)**	**SH(%)**	**RH(%)**
Surya	70.00				55.00			
Swetha	55.50				35.00			
Haritha	71.00				70.00			
SM 363	67.50				57.50			
SM364	60.00				37.50			
SM366	59.00				55.00			
SM385	80.00				66.50			
Surya x SM363	73.50	5.00	3.40	6.91	77.00	33.91	9.09	36.89
Surya x SM 364	80.50	15.00	11.72	23.85	71.50	90.67*	2.09	54.59
Surya x SM 366	97.30	39.00	27.02	50.85	67.00	21.82	-4.47	21.82
Surya x SM 385	103.00	28.75	31.00	37.33	71.00	6.77	1.41	16.87
Swetha x SM 363	77.00	14.07	7.79	25.20	67.50	17.39	-3.70	45.95
Swetha x SM 364	104.00	73.33	31.73	80.09	60.00	60.00	-16.66	65.52*
Swethax SM 366	109.00	84.75*	34.86*	90.39*	73.50	33.64	4.76	63.33
Swetha x SM 385	69.30	-13.37	-2.45	2.29	32.50	-51.13	-115.38	-35.96
Haritha x SM 363	94.30	32.82	32.82	36.17	70.50	0.71	0.71	10.59
Haritha x SM 364	99.00	39.44	39.44	51.15	82.00	14.63*	14.63*	52.56
Haritha x SM 366	103.00	45.07	45.07	58.46	68.00	-2.94	-2.94	8.00
Haritha x SM 385	98.65	23.31	28.03	30.66	77.50	9.68	9.68	13.55

*significant at 5% level

Table 8. Continued.

Parent / cross	No. of primary branches				Leaf length (cm)			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	4.00				11.00			
Swetha	3.70				8.35			
Haritha	4.90				17.47			
SM 363	4.05				11.20			
SM 364	5.19				11.58			
SM 366	4.60				12.57			
SM 385	5.20				12.90			
Surya x SM 363	4.10	1.23	-19.51	1.86	12.15	8.48	-43.79	9.46
Surya x SM 364	5.50	5.97	10.91	19.70	11.35	-1.91	-53.92	0.53
Surya x SM 366	6.70	45.65	26.87	55.81	12.80	1.87	-36.48	8.64
Surya x SM 385	6.40	23.08	23.44	39.13	14.00	8.53	-24.78	17.15
Swetha x SM 363	4.40	8.64	-11.36	13.55	13.40	19.64*	-30.37	37.08*
Swetha x SM 364	7.75	49.33*	36.77*	74.35*	13.10	13.13	-33.55	31.46
Swethax SM 366	6.75	46.74	27.41	62.65	13.15	4.66	-32.85	25.76
Swetha x SM 385	3.00	-42.31	-63.33	-32.58	9.50	-26.36	-83.89	-10.59
Haritha x SM 363	5.50	12.24	12.24	22.91	13.50	-22.72	-22.72	-5.82
Haritha x SM 364	6.40	23.31	23.44	26.86	14.62	-16.31	-16.31	0.65
Haritha x SM 366	5.75	17.35	17.35	21.05	14.01	-19.81	-19.81	-6.71
Haritha x SM 385	5.35	2.88	8.41	5.94	14.10	-19.29	-19.29	-7.15

*significant at 5% level

Table 8. Continued...

Parent / cross	Days to first flowering				Days to 50 % flowering			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	39.00				44.00			
Swetha	40.00				47.00			
Haritha	41.00				48.00			
SM 363	47.50				56.00			
SM364	54.00				58.00			
SM366	44.50				50.50			
SM385	45.00				51.50			
Surya x SM363	32.00	-32.63	-28.13	-26.01	39.00	-30.36	-23.07	-22.00
Surya x SM 364	45.00	-16.67	8.88	-3.23	51.00	-12.07	5.88	0.00
Surya x SM 366	36.00	-19.10	-13.88	-13.77	41.00	-18.81	-17.07	-13.23
Surya x SM 385	36.50	-18.89	-12.33	-13.10	41.50	-19.42	-15.66	-13.09
Swetha x SM 363	38.50	-18.95	-6.49	-12.00	44.00	-21.43	-9.09	-14.56
Swetha x SM 364	44.00	-18.52	6.82	-6.38	49.00	-15.52	0.24	-6.67
Swethax SM 366	37.00	-16.85	-10.81	-12.43	41.50	-17.82	-15.66	-14.87
Swetha x SM 385	41.50	-7.78	1.20	-2.35	46.00	-10.68	-4.35	-6.60
Haritha x SM 363	31.50	-33.68*	-30.16*	-28.81*	37.00	-33.93*	-28.95*	-28.85*
Haritha x SM 364	40.50	-25.00	-1.23	-14.74	45.00	-22.41	-6.66	-15.09
Haritha x SM 366	33.50	-24.72	-22.38	-21.64	37.50	-25.74	-28.00	-23.86
Haritha x SM 385	47.00	-4.44	12.76	9.30	52.50	1.94	8.57	5.53

*significant at 5% level

Table 8. Continued..

Parent / cross	Days to first harvest				Days to 50 % harvest			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**	**Mean**	**HB(%)**	**SH(%)**	**RH(%)**
Surya	54.50				92.50			
Swetha	60.50				89.00			
Haritha	59.00				92.00			
SM 363	70.50				86.00			
SM364	64.50				81.00			
SM366	67.00				87.50			
SM385	67.00				93.00			
Surya x SM363	51.50	-26.95	-14.56	-17.60	97.00	4.86*	5.15*	8.68*
Surya x SM 364	63.00	-2.33	6.35	5.88	85.00	-8.11	-8.23	-2.02
Surya x SM 366	49.50	-26.12	-19.19	-18.52	96.50	4.32*	4.66*	7.22
Surya x SM 385	50.00	-25.37	-18.00	-17.70	94.00	1.08	2.13	1.35
Swetha x SM 363	56.50	-19.86	-4.42	-13.74	86.50	-2.81	-6.36	-1.14
Swetha x SM 364	62.00	-3.88	4.84	-0.80	87.00	-2.25	-5.75	2.35
Swethax SM 366	50.00	-25.37	-18.00	-21.57	92.50	3.93	0.54	4.82
Swetha x SM 385	55.00	-17.91	10.91	-13.73	83.00	-10.75	-10.84	-8.79
Haritha x SM 363	48.50	-31.21*	-21.65*	-25.10*	80.00	-13.04	-13.04	-10.77
Haritha x SM 364	54.00	-16.28	-9.26	-12.55	89.50	-2.72	-2.72	3.47
Haritha x SM 366	49.50	-26.12	-19.19	-21.43	92.00	0.00	0.00	2.51
Haritha x SM 385	60.00	-10.45	1.66	-4.76	89.00	-4.30	-0.33	-3.78

*significant at 5% level

Table 8. Continued.

Parent / cross	Days to last harvest				No. of economic harvests			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	110.50				7.50			
Swetha	117.50				5.50			
Haritha	121.00				8.00			
SM 363	102.50				4.00			
SM364	94.00				3.00			
SM366	101.00				3.50			
SM385	111.00				5.50			
Surya x SM363	118.00	0.43	-2.54	7.27	7.00	-6.67	-14.28	21.74
Surya x SM 364	105.00	-10.64	-15.24	-0.71	5.50	-26.67	-45.54	4.76
Surya x SM 366	117.50	0.00	-2.98	7.55	7.00	-6.67	-14.28	27.27
Surya x SM 385	120.00	2.13	-0.83	5.03	7.50	0.00	-6.66	15.38
Swetha x SM 363	110.50	0.00	-9.50	3.76	6.00	9.09*	-33.33	26.32
Swetha x SM 364	103.00	-6.79	-17.48	0.73	5.00	-9.09	-60.00	17.65
Swethax SM 366	121.00	9.50*	0.00	14.42*	6.50	-18.18	-23.08	44.44*
Swetha x SM 385	105.00	-5.41	-15.24	-5.19	6.00	9.09*	-33.33	9.09
Haritha x SM 363	104.00	-14.05	-14.05	-6.94	5.50	-31.25	-31.25	-8.33
Haritha x SM 364	115.00	-4.96	-4.96	6.98	7.00	-12.50	-12.50	27.27
Haritha x SM 366	111.00	-8.26	-8.26	0.00	6.00	-25.00	-25.00	4.35
Haritha x SM 385	121.00	0.00	0.00	4.31	7.00	-12.50	-12.50	3.70

*significant at 5% level

Table 8. Continued.

Parent / cross	Total no. of harvests				Fruit length (cm)			
	Mean	HB (%)	SH(%)	RH(%)	Mean	HB(%)	SH(%)	RH(%)
Surya	8.50				9.25			
Swetha	7.50				11.25			
Haritha	8.50				12.00			
SM 363	5.50				9.75			
SM364	4.50				9.65			
SM366	5.00				9.80			
SM385	7.00				8.75			
Surya x SM363	8.50	0.00	0.00	21.43	10.25	6.22	-17.07	8.47
Surya x SM 364	7.00	-17.65	-21.43	7.69	9.11	-6.56	-31.72	-4.11
Surya x SM 366	8.50	0.00	0.00	25.93	10.45	6.33	-14.83	9.71
Surya x SM 385	9.00	5.88	5.55*	16.13	10.85	17.30*	-10.59	20.56*
Swetha x SM 363	7.50	0.00	-13.33	15.38	12.75	13.33	5.88*	22.01*
Swetha x SM 364	6.50	-13.33	-30.77	8.33	10.15	-9.78	-18.23	-3.33
Swethax SM 366	9.00	20.00*	5.55*	44.00*	11.95	6.22	-0.42	13.54
Swetha x SM 385	7.00	-6.67	-21.43	-3.45	11.50	2.22	-4.35	15.00
Haritha x SM 363	7.00	-17.65	-17.65	0.00	12.50	4.00	4.00	15.47
Haritha x SM 364	8.00	-5.88	-5.88	23.08	11.90	-0.84	-0.84	9.43
Haritha x SM 366	8.00	-5.88	-5.88	18.52	11.00	-9.09	-9.09	0.92
Haritha x SM 385	9.00	5.55	5.55*	16.13	12.75	5.88	5.88*	22.89*

*significant at 5% level

Table 8. Continued.

Parent / cross	Fruit girth (cm)				Fruit weight (g)			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**	**Mean**	**HB(%)**	**SH(%)**	**RH(%)**
Surya	15.75				66.50			
Swetha	10.70				60.10			
Haritha	13.00				77.00			
SM 363	18.25				75.00			
SM 364	19.50				88.20			
SM 366	17.25				81.00			
SM 385	18.48				85.00			
Surya x SM 363	18.75	2.74*	30.66*	10.29*	78.60	4.80*	2.03	11.10*
Surya x SM 364	16.75	-14.10	22.38	-4.96	68.80	-22.00	-11.91	-11.05
Surya x SM 366	17.40	0.87	25.29	5.45	79.00	-2.47	2.53*	7.12
Surya x SM 385	18.50	0.11	29.73	8.09	77.25	-9.12	0.32	1.98
Swetha x SM 363	13.50	-26.03	3.70	-15.36	69.80	-6.93	-10.31	3.33
Swetha x SM 364	13.30	-31.79	2.26	-19.76	58.90	-33.22	-30.73	-20.57
Swetha x SM 366	15.80	-9.17	17.72	2.27	75.00	-7.41	-2.66	6.31
Swetha x SM 385	13.00	-29.65	0.00	-19.08	66.50	-21.76	-15.78	-8.34
Haritha x SM 363	14.55	-20.27	10.65	-6.88	66.70	-15.44	-15.44	-7.55
Haritha x SM 364	15.65	-19.74	16.93	-3.69	71.00	-19.50	-8.45	-9.84
Haritha x SM 366	14.50	-15.94	10.34	-4.13	75.50	-6.79	-1.98	0.47
Haritha x SM 385	15.75	-14.77	17.46	0.06	67.00	-21.18	-14.92	-13.16

*significant at 5% level

Table 8. Continued.

Parent / cross	No. of fruits / plant				Yield per plant (kg)			
	Mean	**HB (%)**	**SH(%)**	**RH(%)**	**Mean**	**HB(%)**	**SH(%)**	**RH(%)**
Surya	11.00				0.68			
Swetha	8.50				0.60			
Haritha	10.00				0.69			
SM 363	5.00				0.32			
SM364	5.50				0.37			
SM366	5.00				0.27			
SM385	8.00				0.60			
Surya x SM363	10.50	-4.55	4.76	31.25	0.75	10.37	4.00	49.75
Surya x SM 364	6.50	-40.91	-53.85	-21.21	0.51	-23.70	-35.29	-1.44
Surya x SM 366	11.00	0.00	9.09	37.50	1.01	49.63	31.68	113.76*
Surya x SM 385	14.00	27.27	28.57*	47.37	1.12	66.67*	46.42*	77.17
Swetha x SM 363	8.50	0.00	-17.65	25.93	0.41	-30.25	-68.29	-9.29
Swetha x SM 364	12.00	41.18	16.66	71.43	0.72	21.01	4.16	49.22
Swethax SM 366	12.50	47.06*	20.00	85.19*	0.78	31.93	11.53	81.50
Swetha x SM 385	7.00	-17.65	-42.86	-15.15	0.38	-35.29	-81.58	-35.29
Haritha x SM 363	11.50	15.00	15.00	53.33	0.62	-8.76	-8.76	24.38
Haritha x SM 364	12.00	20.00	20.00	54.84	0.65	-4.38	-4.38	24.17
Haritha x SM 366	13.00	30.00	30.00	73.33	0.81	18.98	18.98	70.68
Haritha x SM 385	9.50	-5.00	-5.00	5.46	0.86	24.82	24.82	33.59

*significant at 5% level

Table 8. Continued.

Parent / cross	Yield per plot (kg)			
	Mean	HB (%)	SH(%)	RH(%)
Surya	8.11			
Swetha	7.12			
Haritha	8.25			
SM 363	3.87			
SM 364	2.26			
SM 366	3.29			
SM 385	7.14			
Surya x SM363	8.90	9.80	7.30	48.73
Surya x SM 364	6.14	-24.23	-34.36	18.51
Surya x SM 366	12.15	49.82	32.09	113.16*
Surya x SM 385	13.50	66.46*	63.63*	77.11
Swetha x SM 363	5.25	-26.26	-57.14	-4.42
Swetha x SM 364	8.60	20.79	4.24	83.37
Swethax SM 366	8.90	25.00	7.30	70.99
Swetha x SM 385	4.65	-34.83	-77.41	-34.76
Haritha x SM 363	7.50	-9.09	-9.09	23.81
Haritha x SM 364	7.90	-4.24	-4.24	50.33
Haritha x SM 366	9.82	19.09	19.09	70.28
Haritha x SM 385	10.25	24.24	24.24	33.25

*significant at 5% level

4.1.2.2. *Combining Ability Analysis*

The general combining ability (gca) effects of seven brinjal genotypes and specific combining ability (sca) effects of 12 F_1 hybrids for 17 characters were estimated during the kharif and summer seasons. The gca and sca effects of parents and F_1 hybrids are presented in Table 9, 10, 11, 12.

4.1.2.2.1. *Plant height*

During kharif season highest gca effect for plant height was observed for the genotype SM 366 (7.48). This was followed by Haritha (5.98) and Surya (1.46). All the other genotypes had negative gca effects. The combination Surya x SM 385 showed the highest value for sca effect (11.56) followed by Swetha x SM 366 (9.73). In summer, the genotype SM 366 showed highest gca effect (10.72) which was followed by Haritha (6.36). In the case of sca effect the cross Surya x SM 385 exhibited maximum sca effect (16.49) during summer also. This was followed by Swetha x SM 364 (12.05).

4.1.2.2.2. *Plant spread*

The variety Haritha exhibited the highest gca effect for plant spread followed by SM 363 during both seasons (7.48 and 4.47 during first season and 6.33 and 3.50 during second season for Haritha and SM 363 respectively). The lowest value of gca effect was shown by the female parent, Swetha (-10.25 in kharif and -9.79 in summer). Highest sca effect was shown by the cross Swetha x SM 366 (13.75 during kharif and 13.79 in summer) which was followed by the combination Haritha x SM 385 (9.68 in kharif crop and 10.83 in summer crop) and Surya x SM 385 (8.60 and 7.21 in kharif and summer respectively).

4.1.2.2.3. *Number of primary branches*

SM 366 was the genotype with maximum general combining ability effect (0.77) in first season and SM 364 in summer season (0.92) compared to other parents. The lowest value of gca effect was shown by the genotype SM 363 (-0.77 in first and -0.97 in second seasons respectively). In the case of specific combining ability effects, Haritha x SM 363 was the cross with maximum sca effect (1.09) followed by Surya x SM 385 (1.06) and Swetha x SM 364 (0.96) during first season. But during second season, Surya x SM 385 recorded highest sca effect (1.44) followed by Swetha x SM 364 (1.36).

4.1.2.2.4. *Leaf length*

Haritha, one of the female parents exhibited the maximum gca effect for leaf length in both seasons (1.43 in kharif and 1.08 in summer season). The lowest gca effect was shown by Swetha which was estimated to be -0.84 in kharif and -0.69 in summer season. The highest sca effect was exhibited by the combination Surya x SM 385 (1.50 and 1.86 during first and second crop seasons respectively) followed by Swetha x SM 364 (1.11) in kharif season and Swetha x SM 363 (1.07) in summer season. Swetha x SM 385 recorded the highest negative sca effect during both the seasons (-1.65 and -2.35 during kharif and summer seasons respectively).

4.1.2.2.5. *Days to first flowering*

The highest negative gca effect for days to first flowering was shown by the genotype SM 366 (- 4.38), followed by SM 363 (-2.88) in kharif season. But during summer season SM 363 expressed highest negative gca value (-4.58) followed by SM 366 (-3.08). The cross Haritha x SM 364 showed highest negative sca effect (-3.96) followed by Surya x SM 385 (-2.92) during first crop season. But in summer season Surya x SM 385 showed the highest negative sca effect (-3.96) followed by Haritha x SM 364 (-2.21). The combination Surya x SM 364 exhibited highest positive sca effect for days to first flowering (4.92) in first season and Haritha x SM 385 in second season (5.79).

4.1.2.2.6. *Days to 50 per cent flowering*

The genotype SM 366 showed the highest negative gca effect (-4.25) followed by SM 363 (-2.42) in kharif crop. SM 364 was the genotype with maximum positive gca effect (5.08). But during summer season, SM 363 and SM

366 showed highest negative gca value (-3.75 each). In summer also SM 364 was observed with highest positive gca value for days to 50 per cent flowering (4.58). The F1 hybrid Haritha x SM 364 showed the highest negative sca effect (-3.58) in first crop and Surya x SM 385 in summer crop (-4.54). The highest positive sca effect was observed in the cross Surya x SM 364 (5.04) in first crop season and Haritha x SM 385 in second season (6.58).

4.1.2.2.7. ***Days to first harvest***

Highest negative gca effect was observed for SM 366 (-5.04 in kharif and -4.46 in summer) followed by SM 363 (-3.54 in kharif and -1.96 in summer). The cross which exhibited maximum negative sca effect was Haritha x SM 364 (-6.50 and -4.54 in first and second crop seasons respectively). This was followed by the hybrid Surya x SM 385 (- 3.96 in first season and -4.38 in second season).

4.1.2.2.8. ***Days to 50 per cent harvest***

Highest positive gca effects for days to 50% harvest was estimated for the genotype SM 366 (7.71 and 4.33 in first and second season respectively), which was followed by the female parent Surya (5.83 in first season and 3.79 in second season). Here, the cross Surya x SM 385 exhibited highest sca effect (7.00) followed by Swetha x SM 364 (5.08) during first crop season. But in summer season highest positive sca effect for days to 50 per cent harvest was exhibited by the cross Surya x SM 363 (5.38) followed by Haritha x SM 364 (4.04).

4.1.2.2.9. ***Days to last harvest***

The genotype SM 366 showed highest gca effect (11.67 in kharif and 3.92 in summer) for days to last harvest followed by Surya (6.50) in kharif season and SM 385 in summer season (2.75). The highest sca effect was shown by the combination Surya x SM 385 (9.67) followed by Swetha x SM 366 (7.21) in kharif season. The lowest sca effect was shown by Surya x SM 364 (- 7.50). But in summer, Swetha x SM 366 was observed with highest sca value (7.21) closely followed by Haritha x SM 364 (7.17). Swetha x SM 385 was the F_1 hybrid which exhibited lowest sca effect for days to last harvest (-7.62).

4.1.2.2.10. *Number of economic harvests*

The highest gca effect for number of economic harvests was calculated for SM 366 (1.58 in first season and 0.58 in second season). The cross which exhibited maximum sca effect was Swetha x SM 366 (1.67 and 0.92 in first and second season respectively). This was closely followed by Surya x SM 385 and Haritha x SM 364 (1.17 each) in first season and Haritha x SM 364 in second season (0.75).

4.1.2.2.11. *Total number of harvests*

SM 366 was the genotype which exhibited highest value for gca effect (1.33) followed by Haritha (0.83) in kharif season. But during summer, the genotype SM 385 recorded maximum value for general combining ability which was found to be 0.50 followed by Surya (0.42). In case of sca effect, the combination Swetha x SM 366 recorded the highest value (0.67) during kharif season. Then comes Surya x SM 385 and Haritha x SM 385 (0.33 each). In summer, highest value for sca effect was shown by Haritha x SM 364 (1.12).

4.1.2.2.12. *Fruit length*

The genotype which exhibited the highest gca effect for fruit length was Haritha (0.71 during first season and 0.77 in second season) which was followed by SM 366 in first crop and SM 363 in second crop seasons (0.57 each). The cross which showed maximum sca effect was Haritha x SM 364 (0.27 and 0.74 in first and second seasons respectively).

4.1.2.2.13. *Fruit girth*

The variety Surya showed the highest gca effect (2.21 and 2.23 in kharif and summer respectively) for girth of fruit followed by SM 366 (0.44 in kharif and 0.28 in summer season) and SM 385 (0.26 and 0.13 for kharif and summer seasons respectively). All other genotypes recorded negative gca effect. The combination which exhibited the maximum sca effect was Swetha x SM 366 (1.30 in kharif and 1.62 in summer respectively).

4.1.2.2.14. ***Fruit weight***

The genotype SM 366 exhibited the highest general combining ability effect (6.25 in first season and 5.33 in second season) followed by Surya (4.24 in first crop and 4.74 in summer crop). The lowest gca effect was observed in SM 364 (- 5.75 and -4.94 in first and second crop respectively). During both the seasons, Haritha x SM 364 showed highest value for sca effect (3.77 and 5.89 for first and second crop seasons respectively).

4.1.2.2.15. ***Number of fruits per plant***

The maximum gca effect for number of fruits per plant was observed in the genotype SM 366 for both seasons (0.83 and 1.50). This was followed by Surya and Haritha (0.58 each) in first season and Haritha in second season (0.83). The highest sca effect was estimated for the cross Swetha x SM 364 (2.50) whereas the combination Surya x SM 364 showed the lowest sca effect (-3.25) in kharif crop season. But in summer season, Surya x SM 385 was the combination with highest sca effect (4.00) followed by Swetha x SM 364 (2.50).

4.1.2.2.16. ***Yield per plant***

The genotype which exhibited the maximum gca effect for yield per plant was SM 366 (0.30 in kharif and 0.15 in summer) followed by Surya (0.22 and 0.13 during kharif and summer seasons respectively). The highest sca effect was exhibited by the combination Swetha x SM 364 (0.32 in first season and 0.23 in second season) followed by Surya x SM 385 (0.19 in first crop and 0.21 in second crop). Swetha x SM 385 showed the highest negative sca effect during both seasons.

Table 9. Estimates of gca effect of seven brinjal accessions for 17 characters during kharif season

Characters	**Surya**	**Swetha**	**Haritha**	**SM 363**	**SM364**	**SM 366**	**SM 385**
Plant height	1.46	-7.44	5.98	-0.76	-1.68	7.48	-5.04
Plant spread	2.77	-10.25	7.48	4.47	2.63	-0.37	-0.37
No. of primary branches	0.20	-0.05	-0.16	-0.77	0.70	0.77	-0.70
Leaf length	-0.59	-0.84	1.43	0.29	0.23	0.28	-0.79
Days to first flowering	-0.75	1.62	-0.88	-2.88	5.46	-4.38	1.79
Days to 50 % flowering	-0.54	1.46	-0.92	-2.42	5.08	-4.25	1.58
Days to first harvest	-0.04	1.71	-1.67	-3.54	6.12	-5.04	2.46
Days to 50 % harvest	5.83	-7.42	1.58	3.38	-2.96	7.71	-8.13
Days to last harvest	6.50	-8.38	1.88	3.50	-4.50	11.67	-10.67
No. of economic harvest	0.50	-1.50	1.00	-0.75	-0.42	1.58	-0.42
Total no. of harvests	0.33	-1.17	0.83	0.00	-0.50	1.33	-0.83
Fruit length	-1.27	0.56	0.71	-0.71	-0.32	0.57	-0.07
Fruit girth	2.21	-1.60	-0.52	-0.60	-0.11	0.44	0.26
Fruit weight	4.24	-3.06	-1.17	0.42	-5.75	6.25	-0.92
No. of fruits / plant	0.58	-1.17	0.58	0.50	-1.00	0.83	-0.33
Yield per plant	0.22	-0.23	0.00	-0.12	-0.14	0.30	-0.04
Yield per plots	2.79	-2.91	0.13	-1.52	-1.62	3.64	-0.50

Table 10. Estimates of sca effect of 12 F_1 hybrids for 17 characters during kharif crop season

F_1 hybrids	Plant height	Plant spread	No. of branches	Leaf length	Days to first flowering	Days to 50 % flowering	Days to first harvest	Days to 50 % Harvest	Days to last harvest
1	-1.63	-0.70	-0.67	0.17	-0.25	0.04	-2.46	0.50	3.00
2	-7.26	-2.52	-0.69	-1.15	4.92	5.04	6.38	-6.17	-7.50
3	-2.67	-5.37	0.30	-0.52	-1.75	-1.62	0.04	-1.33	-5.17
4	11.56	8.60	1.06	1.50	-2.92	-3.46	-3.96	7.00	9.67
5	-0.63	6.22	-0.42	-0.21	-0.62	-0.46	1.79	-1.75	-4.12
6	6.64	-1.70	0.96	1.11	-0.96	-1.46	0.12	5.08	4.38
7	9.73	13.75	0.55	0.75	2.38	2.38	0.79	0.92	7.21
8	-15.74	-18.28	-1.09	-1.65	-0.79	-0.46	-2.71	-4.25	-7.46
9	2.25	-5.52	1.09	0.03	0.88	0.42	0.67	1.25	1.12
10	0.62	4.22	0.27	0.05	-3.96	-3.58	-6.50	1.08	3.12
11	-7.06	-8.38	-0.84	-0.23	-0.62	-0.75	-0.83	0.42	-2.04
12	4.19	9.68	0.03	0.15	3.71	3.92	6.67	-2.75	-2.21

1 – Surya x SM 363 5 – Swetha x SM 363 9 –Haritha x SM 363

2 - Surya x SM 364 6 - Swetha x SM 364 10 - Haritha x SM 364

3 - Surya x SM 366 7 - Swetha x SM 366 11 - Haritha x SM 366

4 - Surya x SM 385 8 - Swetha x SM 385 12 - Haritha x SM 385

Table 10. Continued.

F_1 hybrids	No. of economic harvests	Total harvests	Fruit length	Fruit girth	Fruit weight	No. of fruits per plant	Yield per plant	Yield per plot
1	0.00	0.00	-0.15	0.77	2.50	0.75	-0.03	-0.19
2	-0.83	0.00	0.15	-0.07	-3.34	-3.25	-0.27	-3.34
3	-0.33	-0.33	-0.20	-0.97	-1.19	0.42	0.11	1.18
4	1.17	0.33	0.20	0.26	2.03	2.08	0.19	2.35
5	-0.50	0.00	0.08	-0.48	1.30	-1.50	-0.09	-1.30
6	-0.33	0.00	-0.43	0.05	-0.44	2.50	0.32	3.97
7	1.67	0.67	0.18	1.30	0.21	1.17	0.06	0.86
8	-0.83	-0.67	0.17	-0.87	-1.07	-2.17	-0.28	-3.53
9	0.50	0.00	0.07	-0.29	-3.79	0.75	0.12	1.49
10	1.17	0.00	0.27	0.02	3.77	0.75	-0.05	-0.64
11	-1.33	-0.33	0.02	-0.33	0.97	-1.58	-0.17	-2.04
12	-0.33	0.33	-0.38	0.60	-0.96	0.08	0.09	1.19

1 – Surya x SM 363 5 – Swetha x SM 363 9 –Haritha x SM 363

2 - Surya x SM 364 6 - Swetha x SM 364 10 - Haritha x SM 364

3 - Surya x SM 366 7 - Swetha x SM 366 11 - Haritha x SM 366

4 - Surya x SM 385 8 - Swetha x SM 385 12 - Haritha x SM 385

Table 11. Estimates of gca effects of seven parents for 17 characters during summer season

Characters	**Surya**	**Swetha**	**Haritha**	**SM 363**	**SM364**	**SM 366**	**SM 385**
Plant height	-3.80	-2.55	6.36	-10.78	2.12	10.72	-2.06
Plant spread	3.46	-9.79	6.33	3.50	3.00	1.33	-7.83
No. Of primary branches	0.04	-0.16	0.12	-0.97	0.92	0.77	-0.72
Leaf length	-0.40	-0.69	1.08	0.04	0.05	0.35	-0.44
Days to first flowering	-1.21	1.67	-0.46	-4.58	4.58	-3.08	3.08
Days to 50 % flowering	-0.62	1.38	-0.75	-3.75	4.58	-3.75	2.92
Days to first harvest	-0.62	1.75	-1.12	-1.96	5.54	-4.46	0.88
Days to 50 % harvest	3.79	-2.08	-1.71	-1.50	-2.17	4.33	-0.67
Days to last harvest	2.54	-2.71	0.17	-1.75	-4.92	3.92	2.75
No. Of economic harvest	0.33	-0.42	0.08	-0.25	-0.75	0.58	0.42
Total no. Of harvests	0.42	-0.46	0.04	-0.17	-0.50	0.17	0.50
Fruit length	-1.10	0.32	0.77	0.57	-0.88	-0.13	0.44
Fruit girth	2.23	-1.72	-0.51	-0.02	-0.39	0.28	0.13
Fruit weight	4.74	-3.62	-1.12	0.53	-4.94	5.33	-0.92
No. Of fruits / plant	-0.17	-0.67	0.83	-0.50	-0.50	1.50	-0.50
Yield per plant	0.13	-0.14	0.02	-0.13	-0.09	0.15	0.07
Yield per plots	1.54	-1.78	0.24	-1.41	-1.08	1.66	0.84

Table 12. Estimates of sca effect of 12 F_1 hybrids for 17 characters during summer season

F_1 hybrids	Plant height	Plant spread	No. of branches	Leaf length	Days to first flowering	Days to 50 % flowering	Days to first harvest	Days to 50 % Harvest	Days to last harvest
1	-4.30	1.88	-0.61	-0.47	-0.79	-0.38	-0.04	5.38	4.62
2	-10.20	-3.12	-1.09	-1.28	3.04	3.29	3.96	-5.96	-5.21
3	-2.00	-5.96	0.26	-0.12	1.71	1.62	0.46	-0.96	-1.54
4	16.49	7.21	1.44	1.86	-3.96	-4.54	-4.38	1.54	2.12
5	-2.05	5.62	-0.11	1.07	2.83	2.62	2.58	0.75	2.38
6	12.05	-1.38	1.36	0.76	-0.83	-0.17	0.58	1.92	-1.96
7	8.45	13.79	0.51	0.52	-0.17	0.12	-1.42	0.92	7.21
8	-18.46	-18.04	-1.76	-2.35	-1.83	-2.04	-1.75	-3.58	-7.62
9	6.34	-7.50	0.72	-0.60	-2.04	-2.25	-2.54	-6.12	-7.00
10	-1.86	4.50	-0.27	0.51	-2.21	-2.58	-4.54	4.04	7.17
11	-6.46	-7.83	-0.77	-0.39	-1.54	-1.75	0.96	0.04	-5.67
12	1.97	10.83	0.32	0.48	5.79	6.58	6.12	2.04	5.50

1 – Surya x SM 363

2 - Surya x SM 364

3 - Surya x SM 366

4 - Surya x SM 385

5 – Swetha x SM 363

6 - Swetha x SM 364

7 - Swetha x SM 366

8 - Swetha x SM 385

9 –Haritha x SM 363

10 - Haritha x SM 364

11 - Haritha x SM 366

12 - Haritha x SM 385

Table 12. Continued.

F_1 hybrids	No. of economic harvests	Total harvests	Fruit length	Fruit girth	Fruit weight	No. of fruits per plant	Yield per plant	Yield per plot
1	0.50	0.42	-6.49	0.92	2.16	0.50	0.02	0.14
2	-0.50	-0.75	-0.18	-0.71	-2.16	-3.50	-0.24	-2.95
3	-0.33	0.08	0.41	-0.73	-2.24	-1.00	0.01	0.31
4	0.33	0.25	0.25	0.52	2.26	4.00	0.21	2.49
5	0.25	0.29	0.59	-0.38	1.72	-1.00	-0.04	-0.19
6	-0.25	-0.38	-0.56	-0.21	-3.71	2.50	0.23	2.83
7	0.92	0.46	0.49	1.62	2.12	1.00	0.06	0.39
8	-0.92	-0.38	-0.52	-1.03	-0.13	-2.50	-0.26	-3.04
9	-0.75	-0.71	-0.11	-0.54	-3.88	0.50	0.01	0.04
10	0.75	1.12	0.74	0.93	5.89	1.00	0.01	0.11
11	-0.58	-0.54	-0.91	-0.89	0.12	0.00	-0.07	-0.70
12	0.58	0.12	0.28	0.51	-2.13	-1.50	0.05	0.55

1 – Surya x SM 363 5 – Swetha x SM 363 9 –Haritha x SM 363

2 - Surya x SM 364 6 - Swetha x SM 364 10 - Haritha x SM 364

3 - Surya x SM 366 7 - Swetha x SM 366 11 - Haritha x SM 366

4 - Surya x SM 385 8 - Swetha x SM 385 12 - Haritha x SM 385

4.1.2.2.17. *Yield per plot*

Highest gca effect in yield per plot was observed in SM 366 (3.64 and 1.66 in kharif and summer crop respectively), which was followed by Surya (2.79 in kharif and 1.54 in summer). The combination Swetha x SM 364 was observed as the F_1 hybrid with maximum sca effect (3.97 and 2.83 for first and second crop respectively) followed by Surya x SM 385 (2.35 and 2.49). The highest negative sca effect was exhibited by the cross Swetha x SM 385 closely followed by Surya x SM 364 during both seasons (-3.53 and -3.04 for Swetha x SM 385 and -3.34 and -2.95 for Surya x SM 364 during kharif and summer seasons respectively).

4.2. SCREENING FOR JASSID RESISTANCE

During the first crop season, due to continuous rains, jassid count was too low to cause any symptom and hence effective screening could not be carried out. During the summer season, brinjal hybrids and parents were subjected to an intensive screening against jassid infestation. The nymphal count recorded at different stages starting from the stage of infestation is given in the Table 13. The statistical analysis of data revealed significant variation among the accessions. Observations were recorded from 20 days after transplanting (DAT) to 80 DAT when there was a significant reduction in jassid count.

At 20 DAT, the F_1 hybrid Haritha x SM 363 was observed with highest number of jassid nymphs (1.09 nymphs per leaf). Jassids were absent on SM 363 and SM 364 at this stage.

Observations at 28 DAT showed highest nymphal population on Haritha x SM 363 itself (2.21) followed by SM 366 (1.66). At this stage also SM 363 and SM 364 recorded significantly lower number of jassids (0.23 and 0.29) than all other accessions. This was followed by Surya, SM 385, Swetha x SM 363 and Swetha x SM 364.

Table 13. Number of jassid nymphs / leaf observed at different stages of crop (Summer, 2011)

Accessions	**20 DAT**	**28 DAT**	**36 DAT**	**44 DAT**
Surya	0.54	0.36^{c}	1.46^{abcd}	0.76^{c}
Swetha	0.16	0.46^{c}	0.79^{cde}	1.46^{abc}
Haritha	0.23	0.45^{c}	1.85^{abc}	2.73^{a}
SM 363	0.00	0.23^{c}	0.25^{e}	1.26^{bc}
SM 364	0.00	0.29^{c}	0.32^{e}	1.16^{bc}
SM 366	0.21	1.66^{ab}	1.93^{ab}	2.50^{ab}
SM 385	0.33	0.36^{c}	1.81^{abc}	0.76^{c}
Surya x SM 363	0.09	0.86^{bc}	0.99^{bcde}	1.46^{abc}
Surya x SM 364	0.49	0.75^{bc}	1.00^{bcde}	0.93^{c}
Surya x SM 366	0.47	0.93^{bc}	1.71^{abc}	1.46^{abc}
Surya x SM 385	0.10	1.00^{bc}	1.09^{bcde}	1.91^{abc}
Swetha x SM 363	0.42	0.46^{c}	0.86^{bcde}	1.59^{abc}
Swetha x SM 364	0.38	0.54^{c}	0.53^{de}	1.23^{bc}
Swetha x SM 366	0.34	1.09^{bc}	1.26^{bcde}	1.59^{abc}
Swetha x SM 385	0.22	1.56^{ab}	1.56^{abcd}	1.26^{bc}
Haritha x SM 363	1.09	2.21^{a}	2.53^{a}	2.63^{ab}
Haritha x SM 364	0.24	1.03^{bc}	1.53^{abcd}	1.36^{abc}
Haritha x SM 366	0.16	0.79^{bc}	1.86^{abc}	1.56^{abc}
Haritha x SM 385	0.39	1.03^{bc}	1.23^{bcde}	1.59^{abc}

Table 13. Continued.

Accessions	**52 DAT**	**60 DAT**	**68 DAT**	**80 DAT**
Surya	1.76^{bcde}	3.36^{bcdef}	2.98^{ab}	2.20^{abcde}
Swetha	2.65^{abc}	3.56^{bcdef}	2.99^{ab}	1.96^{bcde}
Haritha	2.89^{ab}	5.50^{ab}	2.95^{abc}	2.95^{a}
SM 363	1.30^{de}	2.23^{cdef}	2.10^{abcd}	1.96^{bcde}
SM 364	0.63^{e}	1.86^{ef}	1.20^{d}	1.28^{def}
SM 366	2.33^{abcd}	3.06^{cdef}	1.96^{abcd}	1.56^{def}
SM 385	1.36^{cde}	3.33^{bcdef}	2.60^{abcd}	1.63^{def}
Surya x SM 363	2.90^{ab}	3.94^{abcde}	2.23^{abcd}	2.76^{ab}
Surya x SM 364	1.26^{de}	1.89^{def}	2.49^{abcd}	2.20^{abcd}
Surya x SM 366	1.90^{abcde}	2.40^{cdef}	2.13^{abcd}	1.36^{def}
Surya x SM 385	1.96^{abcd}	1.40^{f}	1.60^{bcd}	1.53^{def}
Swetha x SM 363	0.99^{de}	4.43^{abc}	1.50^{cd}	2.04^{abcde}
Swetha x SM 364	1.13^{de}	4.06^{abcde}	1.15^{d}	1.13^{ef}
Swetha x SM 366	3.06^{ab}	4.26^{abcd}	1.97^{abcd}	1.63^{def}
Swetha x SM 385	2.17^{abcd}	5.93^{a}	2.39^{abcd}	2.03^{abcde}
Haritha x SM 363	3.16^{a}	3.88^{abcde}	3.30^{a}	2.70^{abc}
Haritha x SM 364	1.43^{cde}	2.71^{cdef}	2.36^{abcd}	0.72^{f}
Haritha x SM 366	1.20^{de}	3.81^{abcde}	2.16^{abcd}	1.29^{def}
Haritha x SM 385	1.49^{cde}	4.00^{abcde}	2.23^{abcd}	1.76^{cde}

Peak infestation of jassids was at 52 – 60 DAT. Observations recorded on 60 DAT revealed a jassid infestation rate as high as 5.93 nymphs per leaf in Swetha x SM 385 which was followed by 5.50 nymphs per leaf (Haritha) and 4.43 nymphs per leaf (Swetha x SM 363). Surya x SM 385, SM 364, Surya x SM 364 and SM 363 were the accessions which recorded comparatively lower nymphal count at peak infestation stage (1.40, 1.86, 1.89 and 2.23 respectively).

A drastic reduction in the jassid population was noticed from 68 DAT. Observations at 68 DAT revealed a range of 1.15 – 3.30 nymphs per leaf. At this stage Swetha x SM 364 recorded the lowest jassid count (1.15 nymphs per leaf) followed by SM 364 (1.20 nymphs per leaf). Highest jassid count was in the F_1 hybrid Haritha x SM 363 (3.30 nymphs per leaf).

Last observation on nymphal count was taken at 80 DAT. The F_1 hybrids Haritha x SM 364, Swetha x SM 364 and the parent SM 364 recorded comparatively lower values for nymphal count per leaf (0.72, 1.13 and 1.28 respectively). Higher number of jassid nymphs were observed in Haritha, Surya x SM 363 and Haritha x SM 363 (2.95, 2.76 and 2.70 nymphs per leaf respectively).

4.2.1. Categorization of Brinjal Accessions Based on Per Cent Intensity of Jassid Infestation.

The brinjal hybrids and parents were categorized into resistant / susceptible classes based on intensity of hopper burn symptoms (Table 14.).

Out of the 19 accessions (7 parents and 12 F_1 hybrids), only two genotypes *viz.,* SM 363 and SM 366 were categorized as highly resistant with 5.55 and 8.35 per cent intensity respectively. There were nine brinjal accessions with moderate resistance to jassid infestation which included three parents (Surya, SM 364 and SM 385) and six F_1 hybrids (Surya x SM 364, Surya x SM 366, Surya x SM 385, Swetha x SM 363, Haritha x SM 364 and Haritha x SM 366). Out of these nine

Table 14. Categorization of brinjal accessions based on per cent intensity of jassid infestation in the field during summer, 2011.

Accessions	**Per cent intensity**	**Category**
Surya	18.95	MR
Swetha	49.48	MS
Haritha	50.34	HS
SM 363	5.55	HR
SM 364	14.30	MR
SM 366	8.32	HR
SM 385	19.87	MR
Surya x SM 363	31.01	MS
Surya x SM 364	20.80	MR
Surya x SM 366	18.97	MR
Surya x SM 385	16.66	MR
Swetha x SM 363	23.14	MR
Swetha x SM 364	25.89	MS
Swetha x SM 366	30.97	MS
Swetha x SM 385	37.48	MS
Haritha x SM 363	40.88	MS
Haritha x SM 364	20.48	MR
Haritha x SM 366	20.36	MR
Haritha x SM 385	30.52	MS

moderately resistant accessions, SM 364 showed lowest per cent of hopper burn intensity (14.30 %) followed by the cross Surya x SM 385 (16.66 %). The rest of the six F_1 hybrids *viz.* Surya x SM 363, Swetha x SM 364, Swetha x SM 366, Swetha x SM 385, Haritha x SM 363 and Haritha x SM 385 were categorized into moderately susceptible with a percentage intensity of 31.01, 25.89, 30.9, 37.48, 40.88 and 30.52 respectively. The released variety Swetha was also grouped into moderately susceptible category with a high per cent intensity of 48.48. Haritha was highly susceptible to jassid attack with an intensity value of 50.34 per cent.

4.2.2. Confirmation Screening of Jassid Tolerance / Susceptibility by Artificial Infestation of Plants Under Cages

Eleven *Solanum melongena* accessions (two highly resistant and nine moderately resistant) *viz.,* SM 363, SM 366, Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 366, Surya x SM 385, Swetha x SM 363, Haritha x SM 364 and Haritha x SM 366 were further subjected to confirmation test under protected environment. Moderately susceptible hybrid Swetha x SM 385 was also kept under protected cages for the susceptibility evaluation. In order to assess the resistance or the susceptibility of the accessions to infestation by specified population levels of jassid, 20 jassid nymphs of medium size were released on each caged plant at 8 – 10 leaf stage. The observations were recorded on 4, 10, and 16 days after release are given in Table 15.

The nymphal counts at four days after release were 15 and 16 on the highly resistant accessions SM 363 and SM 366 respectively and 20 on the susceptible accession Swetha x SM 385. The moderately resistant accessions *viz.,* Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 366, Surya x SM 385, Swetha x SM 363, Haritha x SM 364 and Haritha x SM 366 were observed with nymphal counts of 17, 20, 20,15,20,18,20,20 and 17 respectively. On the tenth day of release the number of surviving nymphs was found to be less on resistant and moderately resistant lines (10, 10, 11, 11, 12, 12 and 12 on SM 363, SM 366, SM 385, Haritha x SM 364, SM 364, Swetha x SM 363 and Haritha x SM 366

Table 15. Count of jassids at different intervals during cage tests of resistant accessions

Accessions	**Number of nymphs in cages**	**Count of jassids on whole plant under cages**		
		After 4 days	**After 10 days** (Adult + surviving nymphs)	**After 16 days** (Adult + emerged nymphs)
Surya	20	17 nymphs	5 adults + 12 nymphs	9 adults + 8 nymphs
SM 363	20	15 nymphs	4 adults + 10 nymphs	5 adults +4 nymphs
SM364	20	20 nymphs	7 adults +12 nymph	5 adults +5 nymphs
SM366	20	16 nymphs	6 adults +10 nymphs	6 adults +4 nymphs
SM 385	20	20 nymphs	7 adults +11 nymphs	10 adults +7 nymphs
Surya x SM 364	20	15 nymphs	4 adults +11 nymphs	10 adults +8 nymphs
Surya x SM 366	20	20 nymphs	5 adults +14 nymphs	10 adults+8 nymphs
Surya x SM 385	20	18 nymphs	5 adults +13 nymphs	8 adults+ 4 nymphs
Swetha x SM 363	20	20 nymphs	8 adults +12 nymphs	10 adults +10 nymphs
Haritha x SM 364	20	20 nymphs	7 adults +11 nymphs	9 adults + 6 nymphs
Haritha x SM 366	20	17 nymphs	5 adults +12 nymphs	8 adults + 7 nymphs
Swetha x SM 385	20	20 nymphs	5 adults +15 nymphs	14 adults +10 nymphs

Plate 10. Jassid resistant brinjal accessions after 30 days release of insects in cages

SM 363

SM 364

Surya x SM 364

Surya x SM 385

Haritha x SM 364

Haritha x SM 366

respectively) compared to the susceptible accession Swetha x SM 385 (15). After 16 days of release the number of surviving adults and newly emerged nymphs was recorded on each plant. The highly resistant accessions like SM 363 and SM 366 retained only 5 and 6 adults respectively per plant and on moderately resistant accessions number of survived adults were 9, 5, 10, 10, 8, 9 and 8 (Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 385, Haritha x SM 364 and Haritha x SM 366). On susceptible cross Swetha x SM 385 comparatively higher adult survival was observed (14 adults per plant). The number of newly emerged nymphs was 4 each on highly resistant accessions SM 363 and SM 366 and 8, 5, 7, 8, 4, 6 and 7 on moderately resistant accessions (Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 385, Haritha x SM 364 and Haritha x SM 366 respectively). Ten emerged nymphs were observed in the susceptible cross Swetha x SM 385.

In Surya x SM 366 and Swetha x SM 363, which were rated as moderately resistant in the field trials, the intensity of hopper burn symptom was more and hence they were grouped into moderately susceptible category (27.77 and 33.33 per cent intensity respectively).

4.2.3. Screening for Jassid Resistance in F_2 Generation

Twelve F_2 generations were screened in summer for jassid infestation along with their F_1 hybrids and parents and the range for intensity of hopper burn symptom and level of resistance is given in Table 16.

Most of the F_2 generations showed a range of moderate resistance to moderate susceptibility except Surya x SM 385, Swetha x SM 385 and Haritha x SM 366. The F_2 segregants of the above three crosses recorded a wide range in jassid reaction, that was ranging between moderate resistance to high susceptibility. Among these twelve F_2 population, the segregants from the cross Surya x SM 366 exhibited lowest range for intensity of jassid infestation (13.88 – 33.33 per cent).

Table 16. Range for percentage intensity of jassid infestation for 12 F_2 generations.

F_2 accessions	Range for intensity	Range for resistance
Surya x SM 363	16.66 – 38.88	MR - MS
Surya x SM 364	19.44 – 41.66	MR - MS
Surya x SM 366	13.88 – 33.33	MR - MS
Surya x SM 385	19.44 – 52.77	MR - HS
Swetha x SM 363	22.22 – 38.88	MR - MS
Swetha x SM 364	16.66 – 44.44	MR - MS
Swetha x SM 366	16.66 – 38.88	MR - MS
Swetha x SM 385	25.00 – 52.77	MR - HS
Haritha x SM 363	16.66 – 41.66	MR - MS
Haritha x SM 364	16.66 – 38.88	MR - MS
Haritha x SM 366	16.66 – 55.55	MR - HS
Haritha x SM 385	25.00 – 44.44	MR - MS

4.3. SCREENING FOR BACTERIAL WILT RESISTANCE

Screening was done for bacterial wilt resistance during both crop seasons. During the first season (June – November, 2010), plants from the accessions SM 366, F_1 hybrids Swetha x SM 363 and Haritha x SM 385 had wilted while others appeared healthy (Table 17).

Among 19 accessions of brinjal evaluated, 40 per cent plants of SM 366 and the hybrid Haritha x SM 385 had wilted and so they were categorized as moderately resistant. The cross Swetha x SM 363 was another hybrid with moderate resistance to bacterial wilt in which only 20 per cent plants wilted. All other accessions appeared to be free from the infection of bacterial wilt and hence categorized as resistant. But in the summer season crop, all 31 accessions screened for bacterial wilt resistance which included the parents, F_1 hybrids and the F_2 generation were categorized as highly resistant to bacterial wilt with zero per cent wilting.

4.4. MORPHOLOGICAL CHARACTERS CONFIRMING RESISTANCE IN BRINJAL AGAINST JASSIDS

The observations on leaf thickness, midrib thickness and density of midrib hairs of 19 accessions of brinjal (parents and hybrids) during summer season are given in the Table 18.

4.4.1. Leaf Thickness (mm)

Brinjal accessions showed no significant difference in leaf thickness. The mean value for leaf thickness ranged between 0.38 mm and 0.54 mm. The genotype SM 363 was observed with thickest leaves (0.54 mm) followed by Swetha x SM 364 (0.49 mm), Surya x SM 385 (0.48 mm) and Surya (0.47 mm). The lowest value for leaf thickness was observed in the accessions Swetha and Swetha x SM 385 (0.38 mm each).

Table 17. Categorization of accessions based on percentage of wilting due to bacterial wilt in the field

Accessions	Percentage of wilting	Category
Surya	0	Resistant
Swetha	0	Resistant
Haritha	0	Resistant
SM 363	0	Resistant
SM 364	0	Resistant
SM 366	40	Moderately resistant
SM 385	0	Resistant
Surya x SM 363	0	Resistant
Surya x SM 364	0	Resistant
Surya x SM 366	0	Resistant
Surya x SM 385	0	Resistant
Swetha x SM 363	20	Moderately resistant
Swetha x SM 364	0	Resistant
Swetha x SM 366	0	Resistant
Swetha x SM 385	0	Resistant
Haritha x SM 363	0	Resistant
Haritha x SM 364	0	Resistant
Haritha x SM 366	0	Resistant
Haritha x SM 385	40	Moderately resistant

4.4.2. Midrib Thickness (mm)

There was no significant difference among the accessions for midrib thickness. The range for midrib thickness was from 1.72 mm (Swetha x SM 385) to 2.46 mm (Surya x SM 363). The other accessions with higher midrib thickness were Surya x SM 366, Swetha x SM 364 (2.28 mm each) and Haritha (2.25 mm).

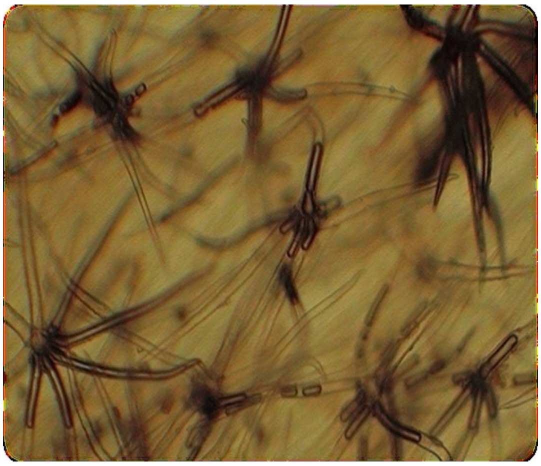
4.4.3. Density of Midrib Hairs

Midrib hair density varied significantly from 4.16 hairs per 25 mm^2 (Swetha x SM 385) to 19.13 hairs per 25 mm^2 (SM 366). One of the male parents SM 366 showed significantly higher density of midrib hairs (19.13 hairs per 25 mm^2). This was on par with SM 363 and SM 364 (17.75 and 17.70 hairs per 25 mm^2 respectively). The least value for midrib hair density was recorded in Swetha x SM 385 (4.17 hairs per 25 mm^2 respectively) followed by Haritha (4.50 hairs per 25 mm^2 respectively).

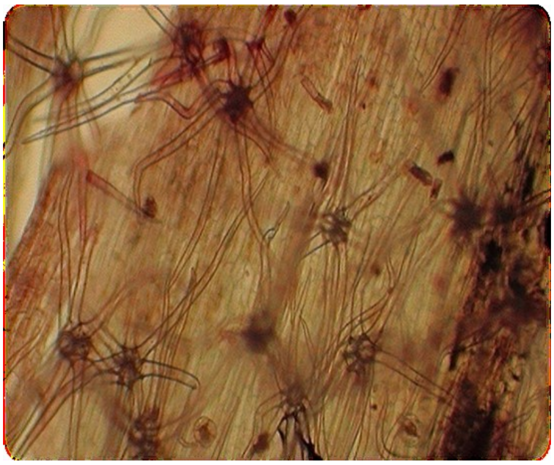
Table 18. Morphological characters observed for jassid resistance in brinjal accessions.

Accessions	**Leaf thickness(mm)**	**Midrib thickness(mm)**	**Hair density(/ 25mm^2)**
Surya	0.47	1.98	7.37 **fghi**
Swetha	0.38	2.04	5.72 **ghi**
Haritha	0.44	2.25	4.50 **i**
SM 363	0.53	2.10	17.75 **ab**
SM 364	0.42	2.13	17.70 **ab**
SM 366	0.43	1.82	19.12 **a**
SM 385	0.43	2.14	14.23 **bc**
Surya x SM 363	0.45	2.46	4.91 **ghi**
Surya x SM 364	0.46	2.13	12.91 **cd**
Surya x SM 366	0.42	2.28	6.80 **fghi**
Surya x SM 385	0.48	2.02	8.75 **efgh**
Swetha x SM 363	0.43	1.99	9.00 **defg**
Swetha x SM 364	0.49	2.28	10.16 **def**
Swetha x SM 366	0.43	2.03	4.75 **hi**
Swetha x SM 385	0.38	1.72	4.16 **i**
Haritha x SM 363	0.41	2.22	5.91 **ghi**
Haritha x SM 364	0.43	1.96	15.00 **bc**
Haritha x SM 366	0.43	1.99	12.16 **cde**
Haritha x SM 385	0.44	2.23	7.00 **fghi**

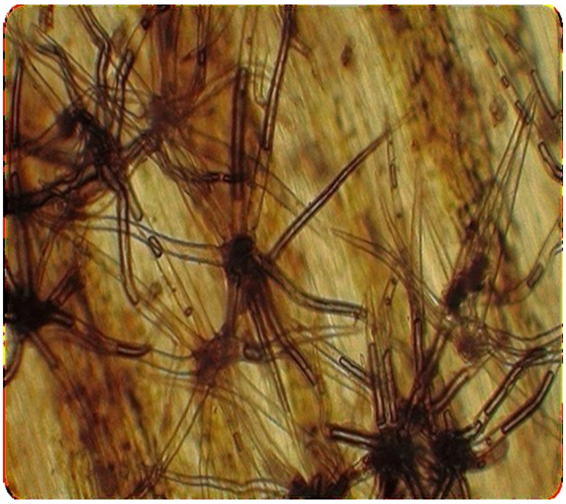
Plate 11. Midrib hair density of resistant and susceptible accessions.



SM 363 (highly resistant)



SM 366 (highly resistant)



Surya x SM 364 (moderately resistant)

Haritha (highly susceptible)

Discussion

5. DISCUSSION

Brinjal or egg plant (*Solanum melongena* L.) is an important vegetable crop of Indian sub continent. It is grown in all the states and a wide range of variation is observed in the country. The crop is being cultivated in India in an area of 6.12 lakh hectares producing 105.63 lakh tonnes with an average productivity of 17.26 tonnes per hectare (NHB database, 2010).

Preference of this vegetable depends on size, shape, colour and spineness of fruits which also varies with location and with individuals. Brinjal fruits are rich in minerals like calicium, magnesium, potassium etc. and also possess medicinal properties. A variety of food preparations can be made out of this vegetable.

Brinjal is mainly cultivated in rainy season during May to December in Kerala. In summer the cultivation of this vegetable is limited mainly due to the severe incidence of jassids *Amrasca biguttula bigutula*. The pale green nymphs and the adults feed on the underside of the leaves and cause characteristic hopper burn symptoms. The chemical control of this pest is practically ineffective since the hoppers are highly mobile and occur in large number. Hence developing resistant or tolerant varieties is the only viable strategy for the management of jassids. Varieties currently available in the state do not possess resistance to this pest. Hence the present investigation was carried out to study the feasibility of transferring the jassid resistance present in some of the identified brinjal genotypes to our cultivated bacterial wilt resistant and high yielding varieties through hybridization.

An effort was also taken to estimate the genetic parameters of brinjal hybrids like heritability, heterosis and combining ability for yield and other quantitative characters. In addition, attempt was also made to study the morphological features associated with jassid resistance.

5.1. EVALUATION OF BRINJAL ACCESSIONS FOR HORTICULTURAL AND GENETIC PARAMETERS

The experimental material consisted of 19 brinjal accessions (parents and hybrids) during both seasons. The performance of the crop with respect to vegetative characters and productivity was better during first season (June – November, 2010).

5.1.1 Horicultural Parameters in Brinjal

The horticultural parameters included both qualitative and quantitative characters. Brinjal accessions were evaluated for six qualitative characters and 17 quantitative characters. The brinjal parents and hybrids were varying greatly in their morphological traits. Varghese (1991) and Varma (1995) also reported high variability for most of the characters studied in brinjal accessions.

It was observed that out of the seven parents only Swetha had upright growth habit, while the other six parents were with intermediate growth habit. Among the 12 F_1 hybrids evaluated, eight were with intermediate growth habit and other four hybrids which included the four F_1 hybrids of Swetha (Swetha x SM 363, Swetha x SM 364, Swetha x SM 366 and Swethax SM 385) had upright growth habit. This suggests the need for varying spacing for different hybrids and parents in accordance with their growth habit.

According to Ananthakrishnan (1992) foliage colour possesses an important role in species characterization and insect resistance. Out of the seven parents and F_1 hybrids, only one accession (Haritha) was having entirely green foliage and the remaining accessions had green coloured lamina with purple tinged venation. Presence of prickles on stem, leaf and calyx is considered as a wild character in brinjal which hinder intercultural operations and harvesting. Out of the seven parents four male parents were having prickles on their calyx and out of the twelve hybrids, except the four hybrids of Surya; all others were with prickleless calyx.

In the case of flower colour also, Haritha was the only accession with white coloured flowers while all other accessions including parents and hybrids, were having violet coloured flowers. The colour and shape of the fruits determine the market preference of brinjal in different localities. Among the 12 F_1 hybrids, eight hybrids (hybrids of Swetha and Haritha) were with striated fruits and other four hybrids of Surya were with purple fruits. In the case of fruit shape, eight hybrids were observed with elongated fruits, two hybrids with oblong shaped fruits and the remaining two hybrids with oval fruits.

5.1.1.1 *General Analysis of Variance for Quantitative Characters*

General analysis of variance showed significant differences among parents and F_1 hybrids for majority of characters which revealed considerable variation existing for these characters indicating scope for further improvement of population. In the first season significant difference was exhibited by the accessions for plant spread, leaf length, days to first flowering, days to 50 per cent flowering, days to first harvest, number of economic harvests, total number of harvests, fruit length, fruit girth, fruit weight, number of fruits per plant, yield per plant and yield per plot. During the second season, all the 17 characters studied differed significantly among the 19 brinjal accessions.

When we go through the analysis of variance for vegetative characters we can see that during both seasons, Swetha x SM 366 was the tallest plant (107.30 cm and 109.00 cm in first and second season respectively) and Haritha x SM 364 was the most spreading plant (84.60 cm in first season and 82.00 cm in second season). Maximum number of primary branches was observed in Swetha x SM 364 (7.35 and 7.75 in kharif and summer season respectively) and Haritha was the variety with longest leaves (17.58 cm and 17.47cm during first and second seasons respectively).

A perusal of performance of the varieties and hybrids showed that the hybrids Surya x SM 366 (took 34.50 and days from transplanting in first season), Haritha x SM 363 (took 31.50 days in summer), Surya x SM 363 (32.00 days from transplanting in summer) were some of the earliest accessions with lesser number days to first flowering. These accessions were also observed to reach 50 per cent flowering earlier than other accessions. But for days to first harvest, the variety Surya and F_1 hybrid Haritha x SM 366 were the earliest in first season (65.00 days each from transplanting). In summer season, days to first harvest was less as compared to first season and was observed in the F_1 hybrid Surya x SM 366 (49.50 days from transplanting). Varietal difference in earliness was reported earlier by many workers namely Kandaswamy *et al*. (1983), Salehuzzaman (1981) and Varghese (1991). Maximum fruiting period was observed in the cross Surya x SM 363 and Surya x SM 366 (187 .00 days each) in first season and in summer season Haritha, Swetha x SM 366 and Haritha x SM 385 (121.00 days each) were observed with longest fruiting period.

More number of economic harvests was recorded in Surya x SM 366, Swetha x SM 366 and Haritha x SM 364 (11.00 each) during first season and in Haritha during summer season (8.00). Number of harvests was highest for Haritha x SM 366 (13.00) in first season and for Haritha x SM 385, Surya x SM 385, Swetha x SM 366 (9.00 each) in summer season. Fruit length was maximum for Swetha x SM 366 and Haritha x SM 366 (12.55 cm each) in first season and in summer Haritha x SM 385 and Swetha x SM 363 recorded longer fruits (12.75 cm each). In the case of fruit girth and fruit weight also significant difference was observed. SM 364 recorded maximum value for fruit girth during both seasons (21.15 cm and 19 .50 cm for first and second season respectively). Similarly for fruit weight also SM 364 recorded heaviest fruits (86.50 g in first season and 88.20 g in summer season). Lightest fruits were observed in Swetha during kharif (63.23 g) and for Swetha x SM 364 (58.90 g) during summer.

During kharif season, maximum number of fruits was recorded in Surya x SM 385 (14.50) followed by Surya, Surya x SM 363, Surya x SM 366 and Haritha x SM 363. During summer also Surya x SM 385 recorded maximum number of fruits (14.00) as compared to all other accessions. In the case of yield per plant and yield per plot the F_1 hybrid Surya x SM 366 recorded maximum yield (1.54

kg and 18.49 kg) in kharif season which was significantly higher than all other accessions. But during summer, Surya x SM 385 was the hybrid which produced maximum yield (1.13 kg and 15.52 kg for yield per plant and yield per plot respectively). So from these results we can infer that Surya x SM 366 and Surya x SM 385 were the high yielding hybrids followed by Haritha x SM 366 and Swetha x SM 366.

Duration of the crop was more in first season (190 days) than summer season (135 days). Receipt of continuous rain and low incidence of pest complex (sucking insects) may be the reasons for longer duration in kharif season.

In the pot culture experiment also, Surya x SM 385, Surya x SM 366, Haritha x SM 366 and Swetha x SM 366 were the promising hybrids with good yield and yield contributing characters.

5.1.2. Estimation of genetic parameters

Studies on genetic parameters of a crop are the basic requirement for its further genetic improvement. Magnitude of genotypic coeffient of variation (GCV) and phenotypic coeffient of variation (PCV), heritability, genetic advance and genetic gain of different characters and their association with yield are important prerequisites for formulating effective breeding strategies. Further, the effectiveness of selection depends on whether variability is heritable or non heritable in nature and this is more so in a crop like brinjal where high degree of divergence is known to exist among different genotypes (Kalloo, 1988).

5.1.2.1. *Variability and Heritability Parameters in Brinjal*

Information on variability helps the plant breeder to continue with effective selection for further crop improvement. In the present study significant difference was observed for almost all characters among the accessions (parents and hybrids). PCV values were found to be more than GCV values for both seasons as reported by Kumar *et al*. (2000). It indicated the rate of environmental influence on the exploitation of varietal characters. The characters like yield per plot and yield per plant recorded comparatively high GCV than all other characters. The existence of high variability for these characters indicated a scope for further improvement through selection from F_2 generations and parents. Varma (1995) and, Singh and Gopalakrishnan (1999) recorded a high GCV for fruit yield per plant. Earlier workers like Sharma and Swarup (2000), Daliya (2001) and Kamani and Monpara (2007) also reported high genotypic variability in brinjal for yield and yield contributing characters. The results of the present study are in accordance with earlier findings. GCV values were moderate for number of fruits per plant, number of harvests and number of primary branches and low GCV values were observed for characters like days to last harvest, fruit weight, fruit length, fruit girth and plant height. This result was in accordance with the reports of Mohanty and Prusti (2002), Kamani and Monpara (2007) and Sao and Mehta (2009).

During first season, high heritability values were observed in eleven characters namely yield per plant, yield per plot, days to first harvest and number of fruits per plant. But in summer 14 characters were observed with high heritability values. A high heritability coupled with high GCV as in the case of yield per palne and yield per plot would indicate less environmental influence on these characters and high transmission index. Heritability is not always an indication of high genetic advance. Heritability estimates along with genetic advance would be more accurate than heritability alone in predicting the consequential effects of selection to choose the best individual (Johnson *et al*., 1955). During first season none of the accessions were observed with high heritability coupled with genetic advance but in summer plant height and plant spread were having high heritability coupled with high genetic advance. So selection from segregating generations is a good breeding strategy for these two characters.

High heritability coupled with high genetic gain was observed for characters like plant height, plant spread, leaf length, days to first flowering, number of economic harvests, total number of harvests, fruit girth, fruit weight, number of fruits per plant, yield per plant and yield per plot indicating that these characters are least affected by environment. High heritability with moderate genetic gain was recorded for days to first harvest. Low genetic gain was for number of primary branches and days to 50 per cent harvests. This was earlier reported by Peter and Singh (1974) for number of branches per plant.

5.1.2.2. ***Heterosis in Brinjal***

Heterosis breeding is one of the important breeding strategies extensively explored to boost up yield and other yield contributing characters in brinjal and other economically important crops. Exploitation of heterosis presents immense potential for the improvement of this crop. In the present study, seven parents and twelve F_1 hybrids were evaluated in a field trial for 17 characters for two seasons. Heterosis was observed for all the 17 characters studied.

Venkataramani (1946) reported that hybrid egg plants were taller, spread more, flowered earlier than the early parent and yielded more than either parent. Here Swetha x SM 364 and Swetha x SM 366 were the crosses which exhibited significant heterotic values for heterobeltiosis, standard heterosis and relative heterosis for plant height during two seasons. Standard heterosis was extended upto 18.56 per cent during kharif and 34.86 per cent during summer for Swetha x SM 366 from the standard variety Haritha which is a high yielding and popular variety among farmers. Pal and Singh (1946) reported that majority of the hybrids exhibited heterosis with respect to seed germination, plant height, plant spread, number of branches, early flowering, number of fruits per plant, fruit size and fruit yield. Paikra *et al*. (2003), Paikra and Lavatre (2005) Prabhu *et al*. (2005), Bavege *et al*. (2005), Vaddoria *et al*. (2007) and Roy *et al.*(2009) reported hybrid vigour for plant height in brinjal.

Surya x SM 364 was the hybrid which exhibited significant heterobeltiosis for plant spread during both the seasons. Haritha x SM 364 recorded highest standard heterosis and Swetha x SM 363 and Surya x SM 364 had recorded significant relative heterosis for plant spread. In the case of number of primary branches, Swetha x SM 364 was observed in first position which exhibited maximum value for heterobeltiosis, standard heterosis and relative heterosis in both seasons. In the case of leaf length, standard heterosis was not observed from the female parent Haritha by any of the F_1 hybrids. Surya x SM 363 and Swetha x SM 363 were noticed with significant heterobeltiosis and Swetha x SM 364 and Swetha x SM 363 with significant relative heterosis in first and second seasons respectively.

When we go through the results of flowering characters *viz*. days to first flowering, days to 50 per cent flowering and days to first harvest we can notice that the hybrids like Haritha x SM 363 and Haritha x SM 364 were having significant heterobeltiosis. Standard heterosis and relative heterosis were found to be significant in Surya x SM 366, Haritha x SM 366 and Haritha x SM 363. This result can be correlated with the results obtained by Venkataramani (1946) and Pal and Singh (1946) who reported that majority of the hybrids exhibited heterosis with respect to early flowering and harvest. Gopalakrishnan and Singh (2000), Ashwani and Khandelwal (2003) and Bavege *et al*. (2005) also reported heterosis (from better parent, standard variety and relative parent) for these three characters.

In the case of characters like days to 50 per cent harvests and days to last harvest positive heterosis was recorded as best, since the prolonged fruiting period was one of the desirable characters to increase yield. Surya x SM 363 and Surya x SM 366 were having significant and positive heterotic values. Coming to the number of economic harvests, Swetha x SM 366 and Swetha x SM 363 were the best hybrids for heterobeltiosis. Surya x SM 366, Swetha x SM 366 and Haritha x SM 364 were recorded significant standard heterosis and Haritha x SM 364 and Swetha x SM 366 were having significant relative heterosis for this character. In the case of heterosis for total number of harvests also the F_1 hybrid Haritha x SM 364 was observed as good with significant heterobeltiosis, standard heterosis and relative heterosis. Other hybrids with significant heterosis for this character was Swetha x SM 366 and Surya x SM 385.

Among the fruit characters, Swetha x SM 366 was noticed with positive and significant heterobeltiosis, standard heterosis and relative heterosis for fruit length. Other F_1 hybrids like Surya x SM 385, Swetha x SM 363 and Haritha x SM 385 were also observed with positive and significant heterobeltiosis, standard heterosis and relative heterosis respectively. For fruit girth, Surya x SM 385 and Surya x SM 363 recorded significant value for all the three types of heterosis. Surya x SM 363 and Surya x SM 366 were the best hybrids in the case of fruit weight since they were observed with significant heterotic values for fruit weight. The present result was in accordance with the results obtained by earlier workers like Ashwani and Khandelwal (2003), Paikra *et al*. (2003), Kumar and Pathania (2004), Panda *et al.* (2005), Paikra and Lavatre (2005) who reported significant heterotic values for the fruit characters like fruit length, fruit diameter and fruit weight.

Swetha x SM 366 was the cross which exhibited significant heterobeltiosis and relative heterosis for number of fruits per plant. For standard heterosis for this character Surya x SM 385 was noticed with significant value. So for number of fruits per plant Surya x SM 385 was the best hybrid compared to standard variety Haritha. In the case of yield per plant and yield per plot the combination Surya x SM 366 was rated as best with significant heterobeltiosis, standard heterosis and relative heterosis. Surya x SM 385 was also observed with significant and positive heterobeltiosis and standard heterosis for yield per plant and yield per plot. This result is supported by the findings of Shafeeq (2006), Vaddoria *et al*. (2007), Roy *et al.* (2009), Patil *et al.* (2010) and many other earlier works in which heterosis was reported for the characters like yield per plant and yield per plot.

5.1.2.3. ***Combining Ability***

In a heterosis breeding programme, the selection of parents is a very important step for getting good results. The selection of parents based on per se performance need not necessarily lead to production of best F_1 hybrids. Therefore the parents will have to be identified based on complete genetic information and knowledge of their combining abilities.

The combining ability analysis gives an indication of the variance due to the general combining ability (gca) and specific combining ability (sca) which represent a relative measure of additive and non additive gene actions respectively. It is an established fact that dominance is a component of non additive genetic variance. Breeders use these variance components to infer the gene action and to assess the genetic potentialities of the parents in hybrid combination.

The combining ability concept was first proposed by Spargue and Tatum (1942) in corn. According to them, gca is the comparative ability of the mean performance of all the crosses involving a parent from all over mean. Similarly sca was defined as the deviation in the performance of specific cross from the performance expected on the basis of general combing ability effects of parents involved in the crosses. A positive gca indicates a parent that produced above average progeny whereas parent with negative gca produces progeny that performs below average of the population. Specific combining ability can be positive or negative and it always refers to specific cross and never to particular parent by itself.

In the present study seven parents (three female parents and four male parents) were crossed without reciprocals to obtain 12 F_1 hybrids. The F_1 hybrids along with their parents were evaluated to obtain information on combining ability and heterosis. Out of the 17 characters studied in two seasons, nine characters showed non additive gene action, four showed additive gene action and the rest four characters (number of primary branches, days to 50 % harvest, days to last harvest and number of fruits per plant) showed both additive and non additive gene action. The values of gca and sca variances are given in Table 19.

Among the vegetative characters, plant height, plant spread and leaf length showed only non additive gene effect (dominance effect). It implies that for these

Table 19. Gene action for 17 quantitative characters under study

Characters	First season		Second season		Gene action
	gca variance	**sca variance**	**gca variance**	**sca variance**	
Plant height(cm)	30.05	92.29	7.40	517.92	Non additive
Plant spread(cm)	65.40	418.67	44.89	481.11	Non additive
No. of primary branches	0.03	-0.03	-0.25	4.22	Additive and non additive
Leaf length(cm)	2.39	3.40	-0.39	7.00	Non additive
Days to first flowering	24.97	34.74	23.66	46.42	Non additive
Days to 50% flowering	18.89	33.51	16.38	59.49	Non additive
Days to first harvest	22.36	92.11	15.48	60.82	Non additive
Days to 50% harvest	159.75	-70.35	12.32	80.02	Additive and non additive
Days to last harvest	227.31	-62.44	-19.87	126.07	Additive and non additive
No. of economic harvests	4.14	5.09	0.16	0.74	Non additive
Total harvests	3.78	-0.72	0.10	-0.57	Additive
Fruit length (cm)	2.92	-0.43	2.33	0.84	Additive
Fruit girth (cm)	7.80	-0.67	7.93	2.56	Additive
Fruit weight (g)	63.87	-4.24	54.82	15.07	Additive
No. of fruits/plant	2.94	-19.59	-6.00	30.88	Additive and non additive
Yield/ plant (kg)	0.12	0.22	0.03	0.14	Non additive
Yield/ plot (kg)	18.26	34.51	3.87	20.33	Non additive

characters heterosis breeding is best for further improvement. The present finding was supported by Suneetha *et al*. (2005) who reported preponderance of non additive gene action for yield and yield contributing characters and plant height was one of the yield contributing characters (Chadha and Sidhu, 1982). SM 366 was the best general combiner for plant height with positive and significant gca effect and the cross Swetha x SM 366 was one of the crosses which exhibited a positive significant sca effect in which one of the parents is SM 366. The similar result was observed by Bavege (2000) for two crosses. Another finding which supports the present study was by Vinodkumar and Pathania in 2003 who observed highly significant sca effect for plant height for a brinjal hybrid Arka Keshav x Pusa Purple Cluster. Patil (1998), Anuroopa (2000) and Bulgundi (2000) noticed lines and testers with positive and significant gca effect for plant height and spread.

In the present study number of primary branches had exhibited both additive and non additive gene effects. For the first season gca variance was found to be higher than sca variance and so additive gene action is predominant but in second season higher sca variance was observed for that character. Hence we can adopt biparental approach and recurrent selection to exploit both gene actions simultaneously. For this character also positive and significant gca and sca effects were observed which is similar to the results of Patil (1998), Balgundi (2000), Bavege (2000) and Bisht *et al*. (2006).

Among the five flowering and fruiting characters, days to first flowering, days to 50 per cent flowering and days to first harvest were having high values for sca variance compared to gca variance. So they are having non additive or dominance gene effect. Hence for the further improvement of these characters heterosis breeding programme can be used. Similar finding was reported by Suneetha (2005) and Timmapur (2007). For these three characters also significant sca effects and gca effects were observed like the findings of Patil and Bavege in 1998 and 2002 respectively. In the case of remaining fruiting characters like days to 50 per cent harvest and days to last harvest, both additive and non additive gene actions were observed which indicated that for exploiting these characters biparental mating and recurrent selection are to be used. SM 366 (tester) was the best combiner for both characters with significant gca effect followed by Surya (line). For both these characters positive and significant sca effect was shown by the crosses like Surya x SM 385, Surya x SM 363 and Swetha x SM 366 in which one of the parents is a good general combiner.

The characters like total number of harvests, fruit length, fruit girth and fruit weight were found with more gca variance than sca variance. So it can be assumed that these characters are governed by additive gene action. Hence selection from the segregating generations can be followed for their improvement. This result is in accordance with the results of Kumar *et al.* (1996) which explained additive gene effects for the character fruit weight. Patil (1998) reported the predominance of additive gene action for all the characters studied. For fruit length maximum positive and significant gca effect was seen in the female parent Haritha and its cross Haritha x SM 364 recorded highest and significant sca effect. Similar was the trend observed for fruit girth which means the line or tester with significant gca produced hybrid with significant sca effect. This finding could be supported by the salient finding of Patil (1998), Balgundi (2000), Bavege (2002), Karaganni (2003) and Vinodkumar and Pathania (2003) which explained the occurance of gca and sca effect for these characters.

Number of economic harvests can be improved by heterosis breeding since it showed dominance gene action. Its value for gca variance is less compared to sca variance. This character also possessed significant gca and sca effects for parents and F_1 crosses respectively. But the number of fruits per plant is governed by both additive and non additive gene action. Hence the breeding approaches like recurrent selection or biparental mating can be applied for exploiting this character. This result was confirmed by the work of Thimmapur (2007) in which he reported that number of fruits per plant was controlled by both additive and non additive gene effects.

Yield per plant and yield per plot are the two characters in which the magnitude of sca variances are higher than gca variance. That means, dominance gene action is predominant for these two characters and hence heterosis breeding is good for improving yield per plant and yield per plot. This was supported by the findings of Singh *et al*. (2003) that explained the presence of dominance gene action for yield per plant and findings of Suneetha (2005) in which predominance of non additive gene action was explained for yield. Significant gca and sca values were observed in good general combiners and specific combiners for yield per plant and yield per plot. Similar results were noticed by Patil (1998), Karaganni (2003), Bavege (2002) and Shanmugapriya *et al*. (2009).

5.2. SCREENING FOR JASSID RESISTANCE

Brinjal is one of the popular vegetable crops cultivated during rainy season in Kerala. But cultivation of this crop during summer is limited in the state due to the severe incidence of jassids (Singh, 1996). Jassids, *Amrasca biguttula biguttula* can cause deleterious effects even at early stage of the crop growth. The infestation of this pest can lead to disruption of transportation through conducting vessels especially phloem vessels and apparently introduces a toxin that impairs photosynthesis in proportion to the amount of feeding (Sharma and Chander, 1998). The feeding results in characteristic yellowing, cupping and drying of leaves starting from the margin. In severe infestation, stunting of plants was reported which again leads to poor yield. According to Rawat and Sahu (1973) the extent of jassid damage in brinjal could approach 54 per cent.

During kharif season, the jassid count was too low to cause hopper burn symptom and there was no significant difference for jassid count among the different brinjal accessions. So effective screening could not be carried out in first season. The main reason for this was the prevalence of continuous rain throughout the season, and hence the survival of the jassid population was hindered. This result can be correlated with the research findings of Shukla (1989) which explained that the population of jassid showed a negative correlation with rain fall

Another study which supported the present result is by Singh and Sekhon (1998), in which they mentioned that relative humidity tended to decline the leaf hopper population.

During summer season, seven parents, 12 F_1 hybrids and 12 F_2 generations were subjected to an intensive screening against jassid infestation by exposing them to natural infestation. Nursery stage was free of jassid attack. Recording of nymphal count was started from 20 days after transplanting (DAT) and continued at weekly intervals upto 80 DAT when a sharp decrease of jassid count was observed. During the initial stage of infestation an average of one jassid nymph per leaf was observed. Thereafter population increased gradually and peak infestation was recorded at 55 – 60 DAT. At peak infestation stage the accessions like Swetha x SM 385, Haritha and Swetha x SM 363 were observed with high nymphal count (4.5 – 6). Jassids were more on middle leaves compared to lower or younger leaves and were concentrated on the sides of midrib as reported by Subbaratnam *et al*. (1983).

The infestation started with more population density on Haritha x SM 363 which was continued with more population upto 52 DAT followed by Haritha and Swetha x SM 366. During peak infestation stage Swetha x SM 385 was observed with highest population density (5.93 nymphs per leaf) followed by Haritha (5.50 nymphs per leaf). During the gradual decrease of nymphal population also, Haritha x SM 363 and Haritha were having more number of nymphs per leaf which indicated that concentration of high nymphal population was on some accessions only which were rated as highly susceptible (Haritha) and moderately susceptible (Haritha x SM 363).

The accessions were categorized into resistant or susceptible group according to their relative resistance or susceptibility to jassid infestation. The classification was based on the degree of hopper burn symptom exhibited by the accessions. The visual assumption of hopper burn intensity was converted into

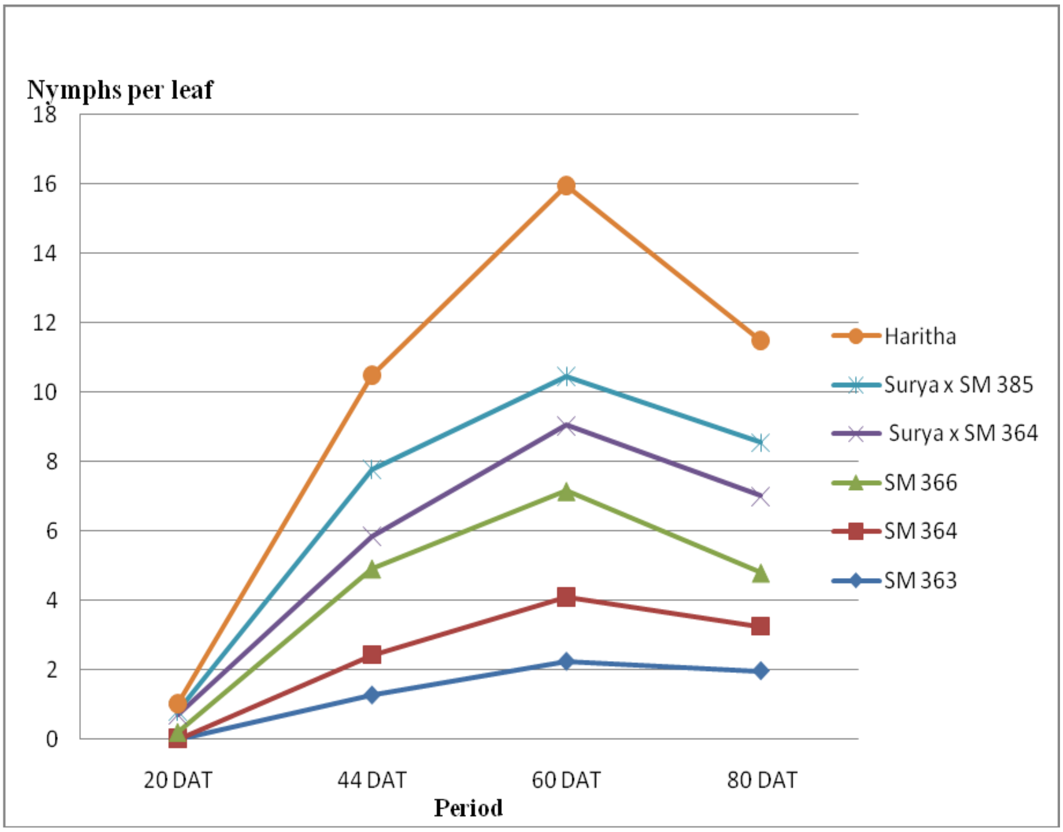


Figure 7. Weekly observation on number of nymphs per leaf on jassid resistant and susceptible accessions.

numerical terms by calculating the per cent intensity which made the classification and comparison much easier.

Thus out of 19 brinjal accessions (7 parents and 12 hybrids) screened against jassid infestation, none of them rated as immune which was against the result of Malini (2005) who grouped seven *Solanum melongena* genotypes as immune including the male parents used for the present study namely, SM 363, SM 364, SM 366 and SM 385. But after the field screening of present study, the genotypes *viz*., SM 363 and SM 366 were categorized as highly resistant with a per cent intensity of 5.55 and 8.35 per cent respectively. Nine accessions were grouped into moderately resistant (Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 366, Surya x SM 385, Swetha x SM 363, Haritha x SM 364 and Haritha x SM 366). Swetha, Surya x SM 363, Swetha x SM 364, Swetha x SM 366, Swetha x SM 385, Haritha x SM 363 and Haritha x SM 385 were moderately susceptible. Haritha was rated as highly susceptible with 50.34 per cent intensity of infestation which is in accordance with the result of Malini (2005) who obtained 51.10 per cent intensity of hopper burn symptom for Haritha. A simple correlation was worked out between intensity of hopper burn symptom and number of jassid nymphs on leaves. The correlation coeffient of 0.68 revealed that a significant and positive association was existing between number of jassid nymphs and per cent intensity of hopper burn symptom.

When we go through the range of intensity of infestation of F_2 population, we can infer that the segregating generations possessed high variability (moderate resistance to high susceptibility) with respect to their relative resistance / susceptibility to jassid attack.

Jassid infestation was substantially higher during summer months compared to first season as reported by Malini (2005) and significant difference in jassid count was observed among brinjal accessions. Dhamdhere *et al*. (1995), Singh (1996) and Mahmood *et al*. (2002) also reported that summer was the most favourable condition for the build up of leaf hopper population on brinjal. The high level of jassid infestation during summer months may be due to high temperature, more sunshine hours and low relative humidity prevailed in summer months. Several studies conducted earlier by Shukla (1989), Prasad and Logeswaran (1997), Ratnapara *et al.*(1994), Bernice (2000) and Mahmood *et al.* (2002) reported that the population build up of jassid was positively correlated with daily temperature and sunshine hours. The present study also revealed the same relation existing between jassid population dynamics and weather parameters.

The brinjal accessions which were rated as highly resistant and moderately resistant to jassid attack during field evaluation in summer were further proceeded for confirmation test under protected environment. In order to assess the susceptibility or resistance of the accession, a specified population of jassids (20 nymphs) was released on each caged and potted plant. The observation taken at 16^{th} day after release revealed substantial reduction in jassid number on resistant plants (from 20 to 10 and from 20 to 4 in susceptible and highly resistant accessions respectively). In moderately resistant accession also reduction in jassid population was noticed but it was in between highly resistant and susceptible accession.

After intensive screening under cages, accessions were confirmed as resistant or susceptible according to the hopper burn symptom produced by them. All the accessions were confirmed as highly resistant or moderately resistant as they were grouped after field evaluation except Surya x SM 366 and Swetha x SM 363. These two hybrids had to be shifted to moderately susceptible category from moderately resistant category as they have shown 27.77 and 33.33 per cent intensity of infestation respectively. On these accessions the nymphal survival and reproduction were in similar way as that of other moderately susceptible accessions. It seems that these accessions might have a chance escape from jassid attack during field evaluation. In cages the survival ability of jassids might have improved due to mechanical exclusion from natural enemies and the unavailability of other susceptible accessions. Hence based on the studies in cages also the accessions SM 363 and SM 366 can be categorized as highly resistant and accessions *viz*., Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 385, Haritha x SM 364 and Haritha x SM 366 as moderately resistant.

5.3. SCREENING FOR BACTERIAL WILT RESISTANCE

In the present study an attempt was made to screen the accessions for bacterial wilt resistance and to study the inheritance of resistance. Resistance and susceptibility to the disease are reactions with defined metabolic, environmental and genetic conditions. Screening for bacterial wilt resistance during summer season revealed that none of the parents, F_1 hybrids and F_2 generations showed wilt symptom and hence they were categorized as highly resistant to bacterial wilt. But in the first season, three of the 19 accessions like SM 366, Swetha x SM 363 and Haritha x SM 385 showed wilt symptom (40 % intensity for each), so they were rated as moderately resistant and others as highly resistant.

When we go through the results during summer season we can see that all the accession were resistant to bacterial wilt. Female parents namely Surya, Swetha and Haritha had already been released as bacterial wilt resistant varieties from Kerala Agricultural University. Other parents which were used as male parents *viz*., SM 363, SM 364, SM 366 and SM 385 were also been categorized as highly resistant to wilt disease. All the 12 F_1 hybrids were healthy and did not produce any wilt symptom during summer and hence they were grouped into highly resistant category. This result was in contradiction to the research findings of Dutta and Kishun (1982) and Manjunath and Dutta (1989) in which they reported the recessive nature of bacterial wilt resistance. At the same time the resistance showed by the F_1 hybrids were supported by the research works of Gopimony (1983), Narayan (1984) and Gopinath and Madalageri (1986) who reported that inheritance of bacterial wilt resistance was controlled by dominance gene action in brinjal. Kuch (1968) opined that disease resistance is not an absolute or static condition and depends on many factors like temperature, moisture, day length, nature of tissue, stage of development etc. As per Bell

(1981) long photoperiod and temperature may be the reason for high level of resistance during summer season. Similarly, the high moisture level in soil prevailing in rainy season may have affected the disease by favouring survival of bacteria in soil and thereby increasing capacity for infection as reported by Gallely and walker (1949) and Kelman (1953).

5.4. MORPHOLOGICAL CHARACTERS ASSOCIATED WITH JASSID RESISTANCE IN BRINJAL

Morphological features present on the plants like trichomes, surface waxes, silication or sclerotization of tissues can act as physical barriers and they interfere with locomotor mechanism specifically with mechanism of host selection, feeding, mating and oviposition of insects. Allomones which may occur in trichomes can also affect the behaviour and metabolic processes of insects (Ananthakrishnan, 1992).

In the present study, morphological characters like leaf thickness, midrib thickness and density of midrib hairs were studied since they were assumed as possible traits associated with jassid resistance in brinjal. Leaf thickness, a measure of leaf succulence would be a favouarable factor for the infestation of sucking insects like jassids since they feed on plant sap. So the leaf thickness is positively correlated with the jassid infestation. The oviposition of jassids is along the midrib of the brinjal and hence a thicker midrib can be a hindrance to jassids during egg laying. A positive correlation of jassid infestation with leaf and midrib thickness was reported by Subbaratnam *et al*. (1983), Gaikwad *et al*. (1991) and Sharma and Singh (2002). But during the present study, significant variation was not observed for these two morphological characters among the parents and F_1 hybrids eventhough they were different in their reaction to the pest infestation. The result of leaf thickness showed that the highly resistant line SM 363 and moderately resistant lines like Surya x SM 385, Surya and Surya x SM 364 were observed with thicker leaves and moderately susceptible accessions like Swetha x SM 385 and Swetha were having thinner leaves. At the same time the moderately resistant accessions like SM 364 and Surya x SM 366 had thinner leaves and highly susceptible accession Haritha had thicker leaves and it is in agreement with the earlier reports. In the case of midrib thickness moderately susceptible accessions like Surya x SM 363, Surya x SM 366 and Swetha x SM 364 and highly susceptible accession Haritha were having thicker midrib than other accessions. Some of the moderately resistant lines like Surya and Haritha x SM 364 and highly resistant line SM 366 had thin midrib which is in accordance with the result of Malini (2005) and other earlier workers. But the thinnest midrib was observed in the susceptible accession Swetha x SM 385. These results revealed that a generalization on the relation of jassid infestation with leaf lamina thickness and midrib thickness is not possible in a crop like brinjal as reported by Malini (2005).

Another morphological character which was assumed to be in association with jassid resistance was density of midrib hairs (trichomes). Arnold (1986) opined that the trichomes present on the leaves can secrete some substances which can act as a barrier to herbivors like jassids. According to him resin secretions from the clavate hairs of solanaceous plants will be retained as a droplet on plant surface and such secretion will provide defence against herbivores. Also the high midrib hair density offer substantial hindrance to egg laying. So the study of density of midrib hairs possesses a significant role in studying the mechanism of resistance to jassids.

Number of midrib hairs present in 25 mm^2 area on ventral surface of the leaf was observed for the accessions (parents and hybrids). The results of density of midrib hairs showed that there was significant difference among resistant and susceptible accessions for density of midrib hairs. The maximum trichome density was recorded for the highly resistant lines like SM 366 and SM 363 and the moderately susceptible accession Swetha x SM 385 and highly susceptible accession Haritha recorded lowest values for midrib density. Most of the moderately susceptible accessions were having significantly low density of midrib hairs compared to moderately resistant lines. For most of them the hair density was below 10 per 25 mm^2 area. Thus the present study revealed that leaf trichomes had a major role in determining jassid resistance. A simple correlation was worked out between nymphal populations on plants with the number of midrib hairs present in 25 mm^2 area on ventral surface of leaf. The correlation coefficient of -0.61 revealed a significant and positive association of jassid resistance with leaf pubescence. It is evident that the gravid females preferred substrates with sparsely distribute trichomes for oviposition. Higher trichome density in the lower surfaces of the leaves and midribs would thus confer resistance against ovipositing females. This result can be correlated with the result obtained by Malini (2005) who got a significant and positive correlation between jassid resistance and leaf pubescence. Earlier works done by Lit (1989), Lit and Bernado (1990) and Gaikwad *et al*. (1991) support the results of present study which revealed a significant and negative linear association of midrib hair density with adult oviposition and nymphal feeding of leaf hoppers in brinjal.

Thus based on the detailed discussion of the results, we can conclude that Surya x SM 385 and Haritha x SM 366 were the two promising F_1 hybrids with combined resistance to jassid and bacterial wilt and with good yield characters (29 t / ha and 23 t/ ha respectively under moderate conditions). The study also revealed that density of midrib hairs had a significant role in conferring resistance to jassids in these resistant brinjal lines.

In furure, the study would be extended to the segregating generations so that good brinjal varieties with combined resistance to jassids and bacterial wilt and with good yield characters can be developed.

Plate 12. Promising F_1 hybrids with combined resistance to jassid and bacterial wilt.

Surya x SM 385

Haritha x SM 366

Summary

6. SUMMARY

The present study on ‘Incorporation of jassid, *Amrasca biguttula biguttula* (Ishida) resistance in a bacterial wilt resistant background in brinjal’ was conducted in the Department of Olericulture, College of Horticulture, Vellanikkara from October, 2009 to June, 2011. The study was conducted to investigate the performance of F_1 hybrids in brinjal and also the feasibility of transferring jassid resistance from known sources to bacterial wilt resistant varieties, Surya, Swetha and Haritha; testing the level of jassid resistance and bacterial wilt resistance in the F_1 hybrids in brinjal.

The salient findings of the study are summarized below:

1. The parents and F_1 hybrids showed variation in growth pattern ranging from intermediate to upright stature. Accessions also varied in their leaf colour, petiole colour, flower colour and fruit colour. Flower colour was varying from white to violet and fruit colour from purple to white with a range in intensity of these colours. There were non prickly as well as prickly types with spines on calyx. Fruits of different accessions varied in size, shape and colour.

2. The 19 accessions (7 parents and 12 F_1 hybrids) showed significant variation in vegetative and fruit characteristics. Among the brinjal parents and F_1 hybrids, Swetha x SM 366 was the tallest and Haritha x SM 364 was the most spreading accession. Haritha was the variety with largest leaves. Longest fruits were seen in the hybrids Swetha x SM 366 and Haritha x SM 366. SM 364 produced largest fruits with maximum fruit girth and fruit weight. In the case of yield characteristics like number of fruits per plant, yield per plant and yield per plot the F_1 hybrids *viz.* Surya x SM 366, Surya x SM 385, Haritha x SM 366 were identified as better hybrids.

3. Surya x SM 366, Haritha x SM 366 and Surya were the earliest accessions with minimum days for flowering, fruit set and first harvest. Accessions Surya x SM 363, Surya x SM 366, Surya x 385, Swetha x SM 366, Surya and Haritha had longer crop duration compared to other accessions.

4. The genetic parameters like GCV, PCV, heritability, genetic advance and genetic gain were estimated for 17 characters. During both seasons, yield per plot recorded highest GCV and PCV values followed by yield per plant. Plant height, plant spread, number of primary branches, number of fruits per plant, number of economic harvests and total number of harvests were the traits having moderate GCV and PCV values. The characters like plant height, plant spread, leaf length, days to first flowering, days to 50 % flowering, days to first harvest, days to 50 % harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, yield per plant and yield per plot were observed with high heritability values. Plant height and plant spread were observed with high genetic advance along with high heritability. Yield per plot was estimated with highest genetic gain followed by yield per plant.

5. The heterosis study revealed that among the F_1 hybrids, Surya x SM 366 and Haritha x SM 366 were having high and significant standard heterosis for earliness to flowering and fruiting over the standard variety Haritha. For yield characteristics, Surya x SM 366 and Surya x SM 385 were found to be best hybrids with maximum and significant heterosis over better parent, standard variety and mid parent.

6. The estimates of combining ability analysis revealed that the male parent SM 366 was the best general combiner for most of the characters like plant height, days to first flowering, days to first harvest, number of economic harvests, yield per plant and yield per plot. In the case of specific combining ability, Swetha x SM 364 was found to be good specific combiner for yield characteristics.

7. During the summer season, brinjal hybrids and parents were subjected to an intensive screening against jassid infestation. Field evaluation of jassid resistance revealed that nursery stage was free of jassid attack. The infestation started from 20 days after transplanting (DAT) with an average of one jassid nymph per leaf, then increased gradually and peaked at 60 DAT with a jassid count range of 1.40 – 5.93 nymphs per leaf and then started declining. The accessions *viz*. SM 363,

SM 364, Surya x SM 364 and Surya x SM 385 showed lesser jassid infestation with an average jassid count of 2.23, 1.86, 1.89 and 1.40 per leaf respectively.

8. Based on the intensity of hopper burn symptom, two brinjal accessions namely SM 363 and SM 366 were grouped under highly resistant class (<10 % intensity). There were nine brinjal accessions with moderate resistance (10 -25 % intensity) to jassid infestation *viz*. Surya, SM 364, SM 385, Surya x SM 364, Surya x SM 366, Surya x SM 385, Swetha x SM 363, Haritha x SM 364 and Haritha x SM 366. Swetha, Surya x SM 363, Swetha x SM 364, Swetha x SM 366, Swetha x SM 385, Haritha x SM 363 and Haritha x SM 385 were categorized into moderately susceptible (25 – 50 % intensity) category and Haritha was highly susceptible (>50 % intensity). The correlation study between intensity of infestation and number of jassid nymphs per leaf revealed that there was a positive correlation existing between the intensity of infestation and number of jassid nymphs with a positive and significant correlation coeffient of 0.68.

9. The evaluation of resistant accessions in insect proof cages revealed that the survival ability of jassids decreased on the resistant accessions namely SM 363, SM 364, SM 366, Surya x SM 364, Surya x SM 385 and Haritha x SM 366 as compared to the susceptible ones. The resistance reaction of all the accessions was confirmed except Surya x SM 366 and Swetha x SM 363 in which hopper burn symptoms were prominent under artificial inoculation and hence these two hybrids were categorized under moderately susceptible group.

10. Screening for bacterial wilt resistance was also carried out to find out the hybrids with combined resistance to jassid and bacterial wilt. The accessions were categorized into either highly resistant (<20 % wilting) or moderately resistant (20- 40 % wilting) category after the field screening for bacterial wilt resistance. SM 366, Swetha x SM 363 and Haritha x SM 385 were the accessions which were categorized as moderately resistant.

11. Morphological characters like leaf thickness, midrib thickness and density of midrib hairs were studied since they were assumed as possible traits associated

with jassid resistance in brinjal. But during the present study, significant variation was not observed for leaf thickness and midrib thickness among the parents and F_1 hybrids, eventhough they were different in their reaction to the pest infestation. The results revealed that a generalization on the relation of jassid infestation with leaf lamina thickness and midrib thickness is not possible in a crop like brinjal. But density of midrib hairs had a significant role in conferring resistance to jassids in brinjal. The maximum midrib hair density was recorded for the highly resistant lines like SM 366 and SM 363. The moderately susceptible accession Swetha x SM 385 and highly susceptible accession Haritha recorded lowest values for midrib hair density. The correlation coefficient of -0.61 between jassid intensity and trichome density revealed that a significant and positive association of jassid resistance with leaf pubescence exists in brinjal.

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Appendices

APPENDIX I

Weather data during kharif season crop (June- November, 2010)

Standard week	Max temp ^{0}C	Min Temp ^{0}C	RH (Morning) %	RH (Noon) %	Rainfall (mm)
26	30.2	23.1	96	76	28.6
27	28.6	22.8	96	81	26.6
28	31.2	24	95	72	33.2
29	27.8	30	97	84	23.9
30	29.6	22.3	95	81	14.8
31	28.6	22.3	96	74	19.2
32	30.6	24.1	95	73	4.4
33	29.5	23	94	79	6.2
34	28.7	23.3	94	83	1.9
35	28.6	22.8	95	76	9.1
36	29.9	23.1	94	73	5.6
37	29.8	23.2	96	72	21.2
38	30.2	23	95	72	8.1
39	31.9	23	92	68	10.8
40	30.6	22.7	95	78	41.4
41	29.5	23.3	74	70	5.1
42	28.3	21.9	95	78	18.6
43	29.3	27.3	94	76	13.4
44	30.6	22.2	95	71	22
45	30.4	22.3	96	73	17
46	31.3	22.5	92	67	8.5
47	30.8	22.5	91	71	8.7
48	28.1	22.8	83	71	1.2
49	31	21.3	89	59	0.3
50	31.4	21.5	91	59	0.4

APPENDIX II

Weather data during January –April, 2011

Std week	Max temp ^0C	Min Temp ^0C	RH (M) %	RH (N) %	Rainfall (mm)
1	31.9	22.3	84	51	0
2	33.2	22.3	89	45	0
3	32.9	20.9	73	36	0
4	32.2	22.9	67	38	0
5	33.4	22.9	61	29	0
6	34.2	21	68	27	0
7	33.9	21.2	75	35	0
8	33.5	22.7	90	52	0
9	33.7	23	73	36	0
10	33.8	23	67	38	0
11	33.9	22.9	61	29	0
12	34.1	22.6	68	27	0
13	33.4	23.1	75	35	0
14	33.5	22.8	73	36	0
15	33.7	22.5	67	38	0
16	33.1	22.2	61	29	3.4

INCORPORATION OF JASSID, *Amrasca biguttula biguttula* (Ishida) RESISTANCE IN A BACTERIAL WILT RESISTANT BACKGROUND IN BRINJAL

By

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ABSTRACT OF THE THESIS

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ABSTRACT

Brinjal or egg plant (*Solanum melongena* L.) is one of the most important vegetable crops of India for which the country occupies second position in production. In the country crop is grown in an area of 6.12 lakh hectares producing 105.63 lakh tonnes with an average productivity of 17.26 tonnes per hectare (NHB database, 2010).

During summer, the cultivation of brinjal is limited in Kerala due to the severe incidence of sucking insects, especially jassids (*Amrasca biguttula biguttula*) which are causing severe yield reduction in brinjal. Malini (2005) screened 36 accessions of brinjal to identify the sources of resistance to jassid attack and she reported seven brinjal genotypes with jassid resistance. The proposed study was conducted to transfer this jassid resistance from four identified sources (SM 363, SM 364, SM 366, and SM 385) into the bacterial wilt resistant commercial varieties like Surya, Swetha and Haritha through hybridization. These seven parents were raised in the pots and the bacterial wilt resistant varieties were crossed directly with jassid resistant accessions to develop 12 F_1hybrids.

The resulting 12 F_1 hybrids along with seven parents were raised in the field as well as in sterilized pots. The crop was raised in the field in randomized block design with two replications. The plot size was 5.4 m^2 with 12 plants in each replication planted at a distance of 0.75 x 0.60 m. The performance of the accessions was studied and they were screened for jassid and bacterial wilt resistance. The experiments were conducted during kharif (2010) and summer (2011). The biometrical characters were recorded and genetic parameters of 19 brinjal accessions were estimated.

The results showed that all accessions had significant difference for most of the characters studied among which Surya x SM 366 and Surya x SM 385 were found to have good yield characters. In the case of earliness, Surya x SM 366 and Haritha x SM 366 were found to be better hybrids.

The heterotic study revealed that among the F_1 hybrids, Surya x SM 366 and Haritha x SM 366 were having high and significant standard heterosis for earliness to flowering and fruiting from the standard variety Haritha. For yield characteristics, Surya x SM 366 was found to be best hybrid with maximum and significant heterosis from better parent, standard variety and mid parent.

The estimates of combining ability analysis revealed that the male parent SM 366 was the best general combiner for most of the characters like plant height, days to first flowering, days to first harvest, number of economic harvests, yield per plant and yield per plot. In the case of specific combining ability, Swetha x SM 364 was found to be good specific combiner for yield characteristics.

After the field screening and cage study for jassid resistance, two brinjal accessions *viz*. SM 363 and SM 366 were identified as highly resistant. Among the 12 F_1 hybrids, Surya x SM 364, Surya x SM 385, Haritha x SM 364 and Haritha x SM 366 were moderately resistant. All other hybrids and the parents like Swetha and Haritha were grouped into susceptible category after the screening for jassid resistance.

Screening for bacterial wilt resistance was also carried out to find out the hybrids with combined resistance to jassid and bacterial wilt. The accessions were categorized into either highly resistant or moderately resistant category after the field screening for bacterial wilt resistance. The F_1 hybrids like Surya x SM 385 and Haritha x SM 366 were identified as better hybrids with combined resistance to jassids and bacterial wilt and with good yield characteristics.

The study of leaf morphology of parents and F_1 hybrids to unravel the mechanism of jassid resistance revealed that density of midrib hairs had a significant role in conferring resistance to jassids in brinjal whereas the leaf thickness and midrib thickness did not show any significant difference among resistant and susceptible accessions.