PATH COEFFICIENT ANALYSIS, GENETIC VARIABILITY AND DIVERGENCE OF DIFFERENT CULTIVARS OF *SOLANUM MELONGENA* FOR SCREENING RELATIVE SUSCEPTIBILITY TO MAJOR INSECT PESTS SPECIALLY TO *LEUCINODES ORBONALIS*

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By

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Dedicated to the memory
of my
beloved mother

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SUPERVISORS' CERTIFICATE

This is to certify that Mr. Ananda Kumar Mandal, M.Sc. (Ag.), WBAS (Admn.) has worked on the topic "Path coefficient analysis, genetic variability and divergence of different cultivars of *Solanum melongena* for screening relative susceptibility to major insect pests specially to *Leucinodes orbonalis*" under our supervision and guidance, and that he has fulfilled the requirements relating to the nature and period of research. This is also to certify that the research work embodies original results based on well-planned investigation made by Mr. Mandal. The dissertation submitted herewith is for fulfilment of the degree of Doctor of Philosophy in Science (Life Sciences) of the University of North Bengal, and has not been submitted for any degree whatsoever by him or any one else. We sincerely wish Mr. Mandal and his endeavour success.

A. Mukhopadhyay
Reader in Zoology

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PREFACE

Solanum melongena L is a very popular vegetable in India and abroad, having the common name egg plant or brinjal. In the plain of North Bengal (Darjeeling Terai) this vegetable is grown in good quantity. However, the crop is subjected to insect pest attack from the very seedling stage to the ratoon and seed crop. Farmers use chemical pesticides for controlling the major and minor pests of brinjal in North Bengal. The environmental hazards arising out of indiscriminate and frequent use of pesticides warrant an alternative pest management measure. To undertake such a planning information on pest complex of brinjal and natural resistance in different cultivars against the pests is of utmost necessity for the agroclimatic region of Terai.

The present study unravels and evaluates some of the hitherto unknown facts and attributes relevant for contemplating IPM programme, specially for some of the key pests of brinjal from terai climate of North Bengal.

This thesis comprises eight conventional chapters. The result chapter-4 is having six articulated divisions. The division 4.1 reveals the screening of 41 germplasm of brinjal for their degree of susceptibility to major pests with special reference to the shoot and fruit borer, *Leucinodes orbonalis*. Division 4.2 deals with genetic variability, heritability and genetic advances for selection of suitable plant genotypes. 4.2 discusses the correlation and path analysis for vegetative, reproductive and susceptibility components to

L. orbonalis. 4.4. evaluates the 41 germplasm through genetic divergence study. 4.5. embodies the screening of agrochemicals, using degree of infestation of *L. orbonalis* as the index for their bioefficacy and their impact on plant growth, yield and economics. The combined effect of using low dosage of pesticides and resistant cultivars for controlling insect-pest complex of brinjal is also included. Finally, division 4.6, deals with the performance of hybrids obtained from diallele crosses of six screened cultivars with respect to vegetative, reproductive and some susceptibility components of brinjal. The thesis finally, offers a discussion on the above chapters followed by a summary and highlights on new information gathered out of the work. The present findings will give a first hand idea of any future possibility of introducing a new strategy of IPM and besides breeding resistant brinjal crop in Darjeeling Terai. The information obtained has an immense possibility for exploiting hybrid vigour in brinjal with respect to yield attributes and insect pest resistance.

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List Of Abbreviations

BLP	-	Banaras Long Purple
BP	-	Better Parent
BGW	-	Banaras Giant White
CD	-	Critical Difference
GA	-	Genetic Advance
GV	-	Genotypic Variance
GCV	-	Genotypic Co-effficient of Variability.
H	-	Heritability (Broad Sense)
KD	-	Kalo Dhepa
KPR	-	Krishnanagar Purple Round
KHV_{90}	-	Krishnanagar Hybrid Variety '90
MP	-	Mid Parent
PPL	-	Pusa Purple Long
PPR	-	Pusa Purple Round
PV	-	Phenotypic Variance
PCV	-	Phenotypic Co-efficient of Variability
RH	-	Relative Humidity
SE	-	Standard Error

Glossary

Analysis of variance	:	A statistical procedure that splits the total variation into different components.
Correlation	:	The ratio of appropriate covariance to the product of two standard deviations, i.e. cov xy/SDx. SDy. It is the statistics which measures the degree and direction of association between two or more variables. Its coefficient is represented by 'r'.
D^2 Statistics	:	A biometrical technique used for the study of genetic divergence in a population
Diallele Cross	:	All possible crosses among a number of genotypes. Analysis of such set of crosses is known as diallele analysis.
F_1	:	The progeny obtained by crossing two different selected genotypes. The first generation from a cross.
Genetic Advance	:	The improvement in mean genotypic value of selected plants over the parental population.
Genetic Diversity	:	Variability between different genotypes of a species.
Genetic Variation	:	The inherent variability. It consists of additive, dominance and epistatic components.

Heritability	: The ratio of genotypic variance to total or phenotypic variance (broad sense) and the ratio of additive genetic variance to phenotypic variance (narrow sense)
Heterobeltiosis	: The superiority of hybrid over its better parent.
Heterosis	: The superiority of a hybrid for one or more characters over its parents.
Overdominance	: The superiority of heterozygote (Aa) over both the homozygotes (AA and aa)
Path Analysis	: A standard partial regression coefficient into the measures of direct and indirect effects and which also measures the direct and indirect contribution of each independent variable.
Phenotypic Correlation	: Observable correlation between two variables.
Phenotypic Variation	: The total or observable variation in a population. It is the resultant of the genotypes in cooperation with the environment.
Variance	: The square of the standard deviation.
Variability	: The existence of phenotypic differences among the genotypes of a population.

1. INTRODUCTION

The Darjeeling district of West Bengal (Fig.1) is located between 26°31′ and 27°13′ North latitude and between 87°59′ and 88°53′ East longitude covering an area of 3149 sq. km. Northern part of the district has the distribution of Eastern Himalayan range and the Southern part has a stretch of alluvial plain at the base of the hills which is known as terai (Fig.2). In this exclusive agro-climatic region an experimental study on egg plant was carried out.

1.1. Introduction to *Solanum melongena* L. (brinjal or egg plant)

Solanum melongena L. is one of the 900 species of the genus *Solanum* having high economic value. Popularly the species goes by the names : egg plant (Fig.3), brinjal, Guinea squash and aubergine. It is believed to have originated in Indo-Burma. China may be the secondary centre of origin.

Among the solanaceous vegetables, brinjal is extensively grown in India and is very well appreciated vegetable among people of all social and economic strata. It is grown both in home and in market gardens. Several varieties of this crop are cultivated throughout the year. It is also popular in several other countries like, Bangladesh, Pakistan, Japan, Indonesia, Philippines, China, Bulgaria, France and Italy and to some extent in some tropical countries of Africa and America.

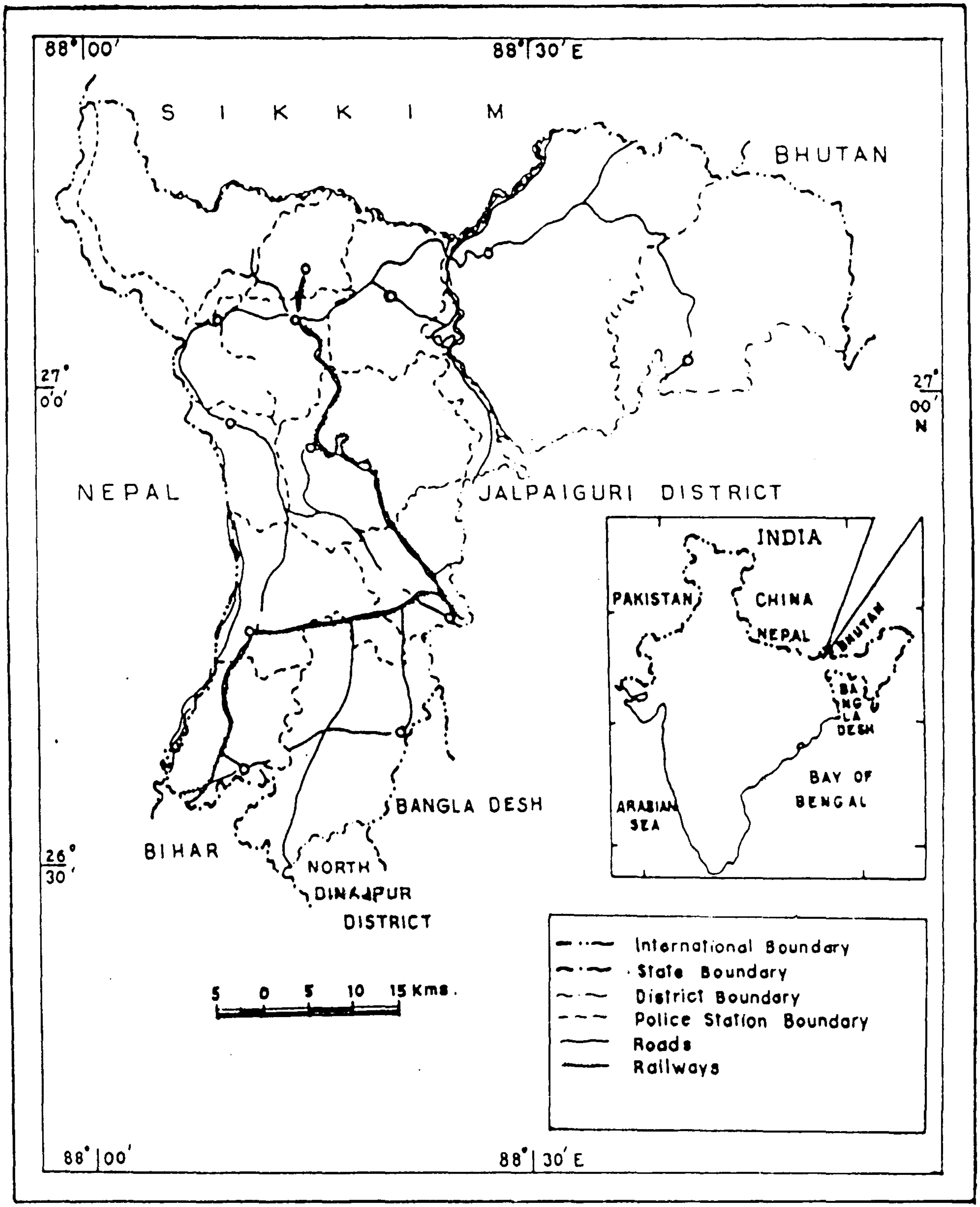


Fig.1. Map showing location of district Darjeeling

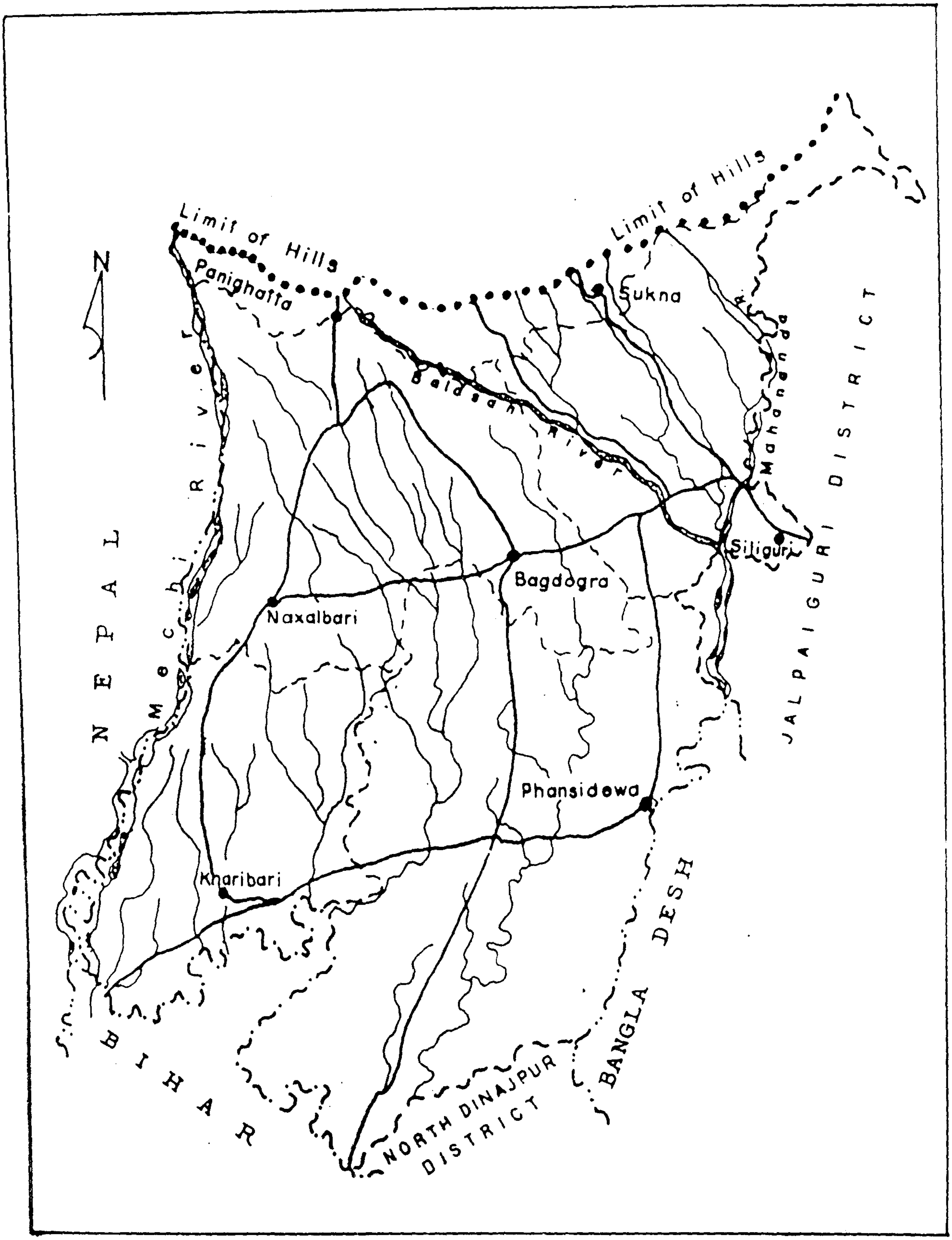


Fig.2. Map showing Darjeeling plain with roads police stations and rivers.

Brinjal is a major commercial vegetable crop and is grown all over India except at high altitudes (Wesley, 1956). It is also one of the common cash vegetables of West Bengal, in almost all the districts, and in both urban and rural areas.

It is a herbaceous annual plant with an erect and semi-spreading habit. The fruit is berry, borne singly or in clusters.

Brinjal has been a staple vegetable in our diet since ancient times. It is liked by both poor and rich. Contrary to the common belief, it is quite high in nutritive value and can be compared with tomato. The chemical composition of brinjal per 100 gm of edible portion contains 1.4g protein, 0.3g fat, 4.0g carbohydrate and 12 mg vitamin C along with vitamin B-complex and other ingredients. So, it is the proven fact that brinjal is a nutritious vegetable. The fruits are supposed to contain certain medicinal properties (Hemi, 1955).

The present market demand for vegetable particularly brinjal has increased (Fig.4) considerably leading to an increase in land area for the crop (Fig.5). With the increase in cultivation of brinjal, both during Kharif and during Rabi seasons incidences of brinjal pests have also increased considerably. Hence, insect pest attack is considered as an important factor limiting the successful cultivation of this crop. Some of the important insect pest that attack brinjal are the shoot and fruit borer, epilachna beetle, jassids, mites, leaf roller, stem borer, mealy bug, aphids, bud worm, lace wing bug etc.

Among these, the brinjal shoot and fruit borer, *L. orbonalis* Guen. (Pyralidae : Lepidoptera) is considered as the key pest of brinjal. It causes

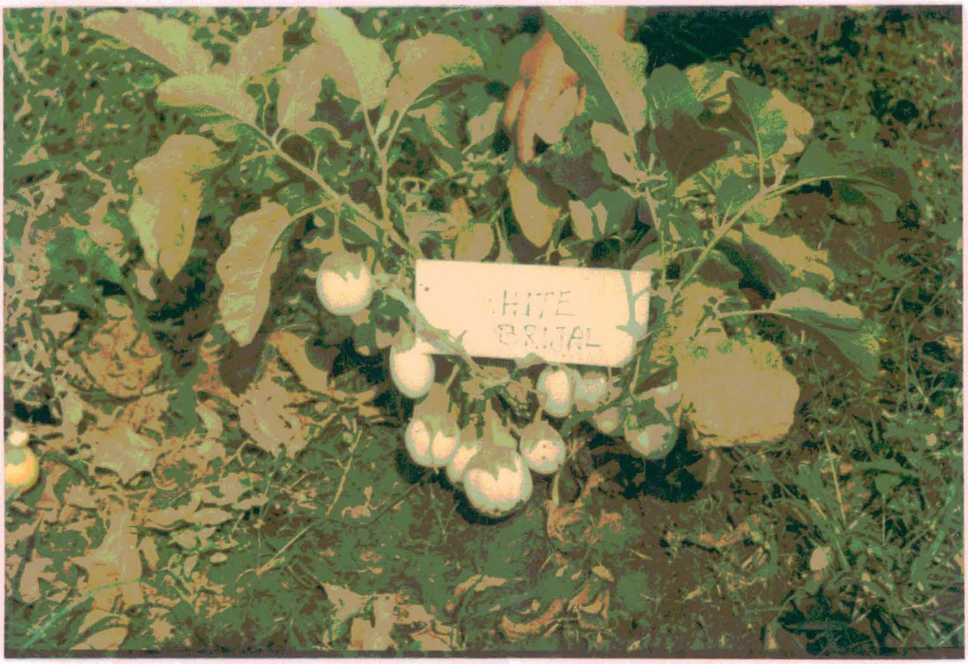


Fig. 3. An egg plant (Solanum melongena L.)

Fig. 4. A market view of North Bengal showing importance of brinjal

Fig. 5. A brinjal field of North Bengal

Fig. 6. Full grown larva of Leucinodes orbonalis (Guen.)

Fig. 7. Borer infested brinjal fruits showing exit holes

Fig. 8. Infested brinjal fruits showing tunnels due to consumption of internal tissue by the borer (Leucinodes orbonalis)

serious damage to the plant and fruit every year. Boring a fruit by a single larvae causes almost total loss of market value of the fruit though the larva itself consumes only a very little portion of it. The other major pests are the jassid, *Amrasca biguttula biguttula* (Ishida), the cotton aphid, *Aphis* gossypii (Glover), and the epilachna beetle, *Epilachna vigintioctopunctata* (Fab).

Because of high demand of brinjal in the market and because of its short supply and also for good market value, farmers, therefore, want to keep the crop pest free. Hence to get a better economic return from their produce, farmers are seeking assistance from technical personel to combat the pest and to prevent the loss in yield particularly due to attack of shoot and fruit borer.

1.2. Nature and symptoms of damage caused by four major pests of brinjal

Shoot and fruit borer :

Leucinodes orbonalis : The shoot and fruit borer, *L. orbonalis* Guen is the key pest of brinjal. This most important and destructive insect enjoys a country wide distribution. The damage is done by caterpillars which are creamy white when young, but light pink (Fig.6) when full grown. They measure about 18-23 mm in length. The moth is white but has pale brown or black spots on the dorsum of the thorax and abdomen. Its wings are white with a pinkish or bluish tinge and are ringed with small hair along the apical and anal margins. The forewings are ornamented with a number of black, pale and light brown spots. The moth measures about 20-22 mm across the spread wings (Atwal, 1986).

During their life span of 2-5 days, the moths lay 80-120 creamy white eggs, singly or in batches of 2-4 on the under surface of leaves, on green stems, flower buds or the calyces of fruits. The larva is a borer of tender shoot, leaf mid-rib, petiole and fruits and feeds on the internal tissue. A full-fed and grown larva becomes stout and pink coloured. One larva may destroy as many as 4-6 fruits. The larva grows through 5 stages and are full-fed in 9-28 days (Atwal, 1986). The mature larvae come out of their feeding tunnels and pupate in tough silken cocoons among the fallen leaves. The pupal stage lasts for 6-17 days and the life-cycle is completed in 20-43 days during active season. There are 5 overlapping generations in a year.

The pest starts attacking brinjal from a few weeks after its transplantation. When the shoot is infested by the caterpillar it droops and withers away and finally dries up. When the petioles of the leaves are bored the leaves wither and droop. The attacked fruit show holes being pluged with excreta (Fig.7).

The genus *Leucinodes* includes three species namely, *L. orbonalis* Guen., *L. diaphana* Hampson and *L. apicalis* Hampson. This pyralid pest is found to be associated with a number of host plants like potato, brinjal (Kadam and Patel, 1956) *Solanum xanthocarpum, S. indicum S. nigram,* bitter gourd and pea pods.

Brinjal suffers from damage by various pests of which *L. orbonalis* causes serious damage to the plants and fruits (Fig.8) every years, either sporadically or in epidemic form in West Bengal. According to Hemi (1955), the content of Vitamin C (Ascorbic acid) of brinjal fruits is reduced by 68% due to attack of this pest.

Fig. 7. Borer infested brinjal fruits showing exit holes

Fig. 8. Infested brinjal fruits showing tunnels due to consumption of internal tissue by the borer (Leucinodes orbonalis)

Banerjee and Basu (1956) and Srinivasan and Basheer (1961) have reported that the infestation by *L. orbonalis* on brinjal crop starts after a few week following transplantation which results in withering of leaves, fruits, buds and shoots. The infestation on brinjal can be as high as 70%. Dhankhar *et al.* (1977) also reported as high as 54% yield loss from Haryana. About 40-70% loss in production has also been reported by Panda *et al.* (1976). Mandal *et al.* (1994) and Mukhopadhyay and Mandal (1994) reported 11.76 to 52.73% yield loss in the rabi season in North Bengal Terai region of the Darjeeling foot hills.

Jassid :

Amrasca biguttula biguttula (Ishida) : This is another important pest of brinjal. Both nymphs and adults suck the sap from the lower surface of the leaves. The infested leaves curl upwards along the margins which may turn yellowish and show burnt up patches. The pest also transmits mycoplasma disease like tissue leaf and virus disease like mosaic. Fruit setting is adversely affected by the infestation.

Among the various pests of brinjal the cotton jassid *A. biguttula biguttula* is one of the most important hemipteran pest, causing serious damage by sucking cell sap.

Both adults and nympths of the jassid species suck sap from the leaves and transmit various type of viruses that cause mosaic diseases in brinjal.

Egg plant is infested by about a dozen of different species of leaf hoppers in different tropical and subtropical countries (Mahal, 1975). In India, it suffers greatly from the attack by the polyphagous jassid, *A. biguttula biguttula*.

Aphid :

Aphis gossypii Glover : It is a polyphagous species infesting a large number of plants throughout India. The aphid is small, soft, yellowish green or greenish brown and is found in colonies of hundreds on the tender shoot and the under surface of tender leaves. Both nymph and adults suck the sap of the leaves. In case of severe attack, the affected leaves curl, fade gradually and finally dry up. Black sooty mould grows on the honey dew excreted by the aphid and falling on the leaves, that adversely affects the photosynthesis resulting in the arrest of plant growth and reduction in fruit size (Bose, Some and Kabir, 1993).

The aphid, *Aphis gossypii* of the order Hemiptera is one of the most important pests causing damage to the cultivated crops. Both adults and nymphs of this pest suck sap from leaves and transmit various types of virus and mosaic diseases. Among the vegetable crops brinjal is severely affected by aphid pest particularly during pre-flowering stage.

A. gossypii is an important pest of eggplant causing extensive damage during pre-flowering stage of the crop. The preferred feeding sites were midribs, major veins, and the junction between petiole and lamina on the lower surface of young or early senescent leaves shoot apices and flower buds. (Cruz and Bernardo, 1971).

According to Chelliah (1973), damage potential of aphid in eggplant may be to the extent of 75.26% in shoot weight, 65.80% in root weight, 37.07% in shoot length and 23.68% in leaf number. Regupathy and Jayaraj (1973) noticed that occurrence of dark green form of aphids on brinjal were fewer in summer season and cold period of the year. Ueda and Takada

(1977) studied differential relative abundance of green yellow and red forms of aphids in relation to the food plant. They reported that the proportion of green yellow aphids was lowest on potato and egg plant in comparison to that of radish and cabbage.

By Epilachna beetle :

Epilachna vigintioctopunctata Fab : It is also a polyphagous insect that feeds on the leaves of potato, brinjal, tomato, etc. by scrapping, in a characteristic manner leaving the veins intact. The grubs are yellowish in colour and stout bodied with stiff hairs on their bodies. The beetle is bronze to red, small, spherical and mottled with black spots. In brinjal, the adult and grub feed voraciously on the leaves and tender parts of the plant and often cause serious damage when they appear in good numbers. As a result of feeding by both grubs and adults on green chlorophyll, characteristic skeletonized patches appear on leaves which later dry away.

The plant is severely affected by the attack of the beetle whose incidence have been found to be serious under West Bengal condition.

1.3. Screening of brinjal germplasm against major insect pests

To protect the crop from the depredation of these four insect pests, various chemical control measures have been suggested from time to time. Since, present control methods are not fully effective and are costly and ecotoxic, plant resistance may be combined as an effective measure to combat the menace caused by the pests and all the same overcoming the hazards associated with chemical control (Schalk, 1990).

The development, survival, biology etc. of a particular pest differ from place to place because of agroclimatic variations particularly with respect to temperature and humidity. Further, growth and yield potentiality of different cultivars of brinjal are influenced by argoclimatic conditions. Combined effects of the abiotic factors on the pest species and the crop plant are crucial to determine the degree of tolerance of the plant against the pest. However, no information is available on this aspect of brinjal crop in the exclusive agroenvironment of Darjeeling foothills and plain. This prompted the author to undertake an investigation on brinjal pests from this area.

Considering other control practices, breeding of brinjal cultivars for insect pest resistance appeared to be one of the economic and ecofriendly means for sustainable brinjal productivity in the argoclimatic region of Darjeeling Terai. In the present investigation 41 common cultivars and lines of brinjal collected from different parts of India were screened to identify the varieties showing better yield and acceptability and at the same time showing certain degree of resistance against major insect pests in the area of study.

1.4. Variability studies on different traits of brinjal cultivars

This has got profound importance and utility for estimating genotypic and phenotypic variances and covariances for brinjal breeding programme. Specific objectives in relation to various traits are analysed by variability studies to estimate genotypic, phenotypic and genotype-environmental interaction variances among strains to utilize the preceding estimates to predict progress expected from selection and to construct and evaluate various selection indices.

The importance of genetic variability for resistance and wider adaptibility is well known. Moreover, the efficiency of selection, in plant breeding largely depends on the extend of genetic variability present in the plant population. Thus, insight into the magnitude of genetic variability is of paramount importance to a plant breeder for starting a judicious breeding programme. Finally, biological variation present in the plant population is of three type, viz., phenotypic, genotypic and environmental. (Singh and Narayanan, 1994).

1.5. Correlation and path analysis of various traits of brinjal

In plant breeding correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield.

Correlation coefficients are of 3 types, viz. (i) simple or total, (ii) partial and (iii) multiple correlation. These are again classified as phenotypic, genotypic and environmental correlations (Singh and Narayanan, 1993).

Correlation studies provides better understanding of yield components which helps the plant breeder during selection (Robinson *et al.* 1949; Johnson *et al,* 1955). There are 3 main implications of correlations in plant breeding as discussed below.

1. A positive correlation between desirable characters is favourable to the plant breeder because it helps in simultaneous improvement of both the characters. A negative correlation, on the other hand, will hinder the simultaneous expression of both the characters with high values. In such situations some economic compromise has to be made.

2. The genetic improvement, in dependent trait can be achieved by applying strong selection to a character which is genetically correlated with the dependent character. This is called correlated response.
3. Sometimes a character has low heritability. Under such situation another character having high heritability and high correlation with the former trait is chosen to make selection more effective. Thus genetic improvement is achieved using indirect selection through component characters with high heritability.

The concept of path analysis, also known as path coefficient analysis, was originally developed by Wright in 1921, but the technique was first used for plant selection by Dewey and Lu in 1959. Path coefficient analysis is simply a standardized partial regression coefficient which splits the correlation coefficient into the measures of direct and indirect effects. It measures the direct and indirect contribution of independent variables on dependent variables.

The path coefficient analysis is of three types - (i) phenotypic, (ii) genotypic and (iii) environmental paths. The phenotypic path splits the phenotypic correlation coefficients into the measures of direct and indirect effects. While the genotypic path is estimated from genotypic correlation coefficient. The environmental path is estimated from environmental coefficients. In plant breeding experiments the first two types of paths are in common use.

It provides the basis for selection of superior genotypes from the diverse breeding population.

1.6. Genetic divergence in brinjal

The concept of D^2 statistics was originally developed by P.C. Mahalanobis in 1928. Now this technique is extensively used in plant breeding and genetics for study of genetic divergence in various breeding materials. This is one of the potent techniques of measuring genetic divergence. In plant breeding, genetic diversity plays an important role because hybrids between lines of diverse origin generally, display a greater heterosis than those between closely related parents.

D^2 statistics finds out the contribution of individual character towards total divergence and groups the different genotypes into various cluster forming cluster diagram.

1.7. Judicious use of pesticides under IPM

With the consciousness of using the chemicals judiciously to minimize the pollution hazards, the scientists recommended the pests should be controlled by integrating and manipulating the biological factors with the use of insecticides. Based on this concept Bartlett (1956), coined the term 'Integrated Pest Control' which was defined as the blending of biological control agents with chemical control measures.

In line with the above philosophy, 3 spray schedules at 15 days intervals have been tried on the relatively tolerant local variety Dhepa to minimise the pest population below the economic threshold and also to find out the economically best pesticides in the times of need as well as to assess the degree of pest infestation when judicious application of agrochemicals or pesticides was made of an expectedly resistant cultivar in the exclusive climate of Darjeeling Terai.

1.8. Performance of parents and F_1 hybrids

The superiority of hybrids has been well demonstrated in a variety of important vegetable crops. Therefore, the demand for hybrid seeds will definitely increase. The main constraints in commercialization of hybrid cultivars are availability of hybrid seeds and its comparatively higher cost. Hybrid vgetables are well known in developed countries like Japan, the Netherlands, the USA and Canada where the vegetable seed industry, in general, is well organised and highly developed. Several workers have estimated that even with the present high cost of seed it is profitable to grow F_1 hybrids.

Though the possibilities of exploiting hybrid vigour in number of vegetable crops for higher, early and total yield, uniformity, in performance, environmental adaptation, resistance to diseases and insect-pests, and nutritional and processing qualities are well known, the work on heterosis breeding in vegetables in India needs to be strengthened and properly organised. The improvement programme of brinjal is oriented to develop new varieties which have disease resistance, insect pest resistance, high yielding potentiality, wider adaptibility and better quality fruits.

In order to achieve this objective, it is necessary to evaluate a large number of parents for their combining ability. The ability of parents to combine well depends upon complex interactions among the genes. So selection of potential parents for hybridization needs to be based on their complete genetic information and combining ability and not merely the yield performance of the different genotypes. Therefore, investigation was aimed at studying the combining ability and hybrid vigour of six selected brinjal parents in the exclusive climate of Darjeeling Terai.

1.9. Principal objectives of the present investigation

1. Screening of brinjal germplasm for resistance to major insect pests and selection of suitable variety having resistance or tolerance for sustainable production without any obligation for pesticides for the following reasons :

(i) to overcome the inadequacy of direct control measures in terms of efficacy, availability, cost of chemicals etc.

(ii) to avoid the toxic effect of chemicals on plants and human beings.

(iii) to maintain a natural balance in agro-eco-system.

iv) to evaluate the performance of these lines and varieties by noticing the degree of infestation.

(v) to identify the sources of resistance for future development of varieties from the view point of acceptable quality and quantity to the farmers.

(vi) to improve the genetic make up of the crop in the process of resistant breeding.

2. Variability studies for different parameters of brinjal for selecting elite types from mixed populations after calculating phenotypic and genotypic variations, heritability and genetic advance for predicting the transmission of characters from the parents to their offspring.

3. Correlation studies among different pairs of characters which may provide information on yield components and thus helps in the selection of superior genotypes from diverse genetic populations.

4. Path analysis of different parameters for getting information on the cause and effect situation between two variables. This analysis permits the examination of various characters on yield as well as their indirect

effects via other components traits. It also provides basis for selection of superior genotypes from the diverse breeding population.

5. D^2 statistics measure the forces of differentiation at intra and inter cluster levels and determine the relative contribution of each component trait to the total divergence. The clusters which are separated by the largest statistical distance show maximum divergence. Thus, this technique helps in the selection of genetically divergent parents for their exploitation in hybridization programmes.
6. To protect the crop from the depredation by pests, effect of pesticides were studied to find out the economically and environmentally best pesticides for the resistant varieties selected through screening, following the modern concept of integrated pest management.
7. Exploitation of hybrid vigour obtained from breeding of suitable cultivars with special reference to yield and insect-pest resistance.

2. REVIEW OF LITERATURE

2.1 List of the brinjal pests occurring in India

Nair (1975) compiled from different sources a general list of pests under different orders and families that are known to attack brinjal in India. The list is tabulated below.

Scientific Name	*Common Name*	*Family*	*Order*
1. *Atractomorpha crenulata* Fab.	Hopper	Acridiidae	Orthoptera
2. *Orthacris sp.*	"	"	"
3. *Poecilocerus pictus* Fab.	"	"	"
4. *Empoasca binotata* Pruthi	Jassid	Jassidae	Hemiptera
5. *E. punjabensis* Pruthi	"	"	"
6. *E. parathea* Pruthi	"	"	"
7. *E. devastans* Dist.	"	"	"
8. *Aphis gossypii* Glover	Aphid	Aphididae	"
9. *Centrococcus insolitus* Gr.	Mealy bug	Coccidae	"
10. *Aspidiotus desturctor* Sign.	"	"	"
11. *A. orientalis* Newst.	"		"
12. *Chionaspis manni* Gr.	"	"	"
13. *Cerococcus hibisci* Gr.	"	"	"
14. *Creontiades pallidifer* Wlk.	-	Miridae	"
15. *Halticus minutus* Reut.	-	"	"
16. *Anoplocnemis phasiana* Fab.	-	Coreidae	"
17. *Spilostethus panduras* Scopoli	Seed-bug	Lygaeidae	"
18. *Spilostethus hospes* Fab.	Seed-bug	"	"
19. *Urentius echinus* Dist.	Lace-wing bug	Tingidae	"
20. *Aspongopus janus* Fab.	-	Pentatomidae	"
21. *Selenothrips indicus* Bagn.	Thrips	Thripidae	Thysanoptera

Scientific Name	Common Name	Family	Order
22. *Scirtothrips dorsalis* Hood.	Thrips	Thripidae	Thysanoptera
23. *Phthorimoea blapsigona* M.	Bud borer	Gelechiidae	Lepidoptera
24. *P. ergasima* Meyr.	"	"	"
25. *P. helipa* Lower	"	"	"
26. *P. operculella* Zell.	Bud borer	Gelechiidae	Lepidoptera
27. *Leucinodes orbonalis* Guen.	Shoot and fruit borer	Pyralidae	"
28. *Euzophera perticella* Raj.	Stem borer	"	"
29. *Nephopteryx minutella* Rag.	Leaf feeder	"	"
30. *Phycita clientella* Z.	Leaf roller	"	"
31. *Psara bipunctalis* Fab.	Leaf webber	"	"
32. *Pterophorus lienigianus* Z.	-	Pterophoridae	Lepidoptera
33. *Acherontia styx* West.	-	Sphingidae,	"
34. *Antoba(Eublemma) olivacea* Wlk.	Leaf folder	Noctuidae	"
35. *Selepa docilis* Btlr.	-	"	"
36. *Laphygma exigua* Hb.	-	"	"
37. *Prodenia litura* Fab.	-	"	"
38. *Solenopus germinata* Fab.	Household ant	Formicidae	Hymenoptera
39. *Camponotus maculatus infuscus*	-	"	"
40. *Holotrichia insularis* Bren.	Root grub	Melolonthinae	"
41. *Epilachna vigintioctopunctata* Fab.	Epilachna beetle	Coleoptera	Coccinellidae
42. *Lema praeusta* Fab.	-	Chrysomelidae	Coleoptera
43. *L. semiregularis* Jac.	-	Chrysomelidae	Coleoptera
44. *L. signatipennis* Jac.	-	Chrysomelidae	Coleoptera
45. *Myllocerus blandus* Fst.	-	Curculionidae	Coleoptera
46. *M. pretiosus* Fst.	-	Curculionidae	Coleoptera
47. *M.subfasciatus* Quen.	-	Curculionidae	Coleoptera
48. *Tetranychus telarius* Linn.	Spidermite	Tetranychidae	Acarina
49. *T. cucurbitae* Rah and Sap.	Spidermite	"	"
50. *T. cinnabarinus* Boisduval	-	-	-
51. *Aceria lycopersici* Wlff.	-	Eriophyidae	"

Mites of the super-family Tetranychoidea and Eriophyoidea comprise most of the economically important phytophagous species. The most important and abundant group is the Tetranychidae (Spider mites) which cause extensive damage to the field crops in India and abroad.

Twenty-three species of mites have so far been reported to be associated with brinjal plant from different parts of the world. The species are enlisted below :

Scientific Name	***Family***	***Part affected***	***Reference***
1. *Tetranychus tumidus*	Tetranychidae	Leaf	Weber, 1951
2. *Aceria lycopersici* K.	Eriophydae	Leaf	Lamb, 1953
3. *Tetranychus maefarlanci* Baker and Pritchard	Tetranychidae	Leaf	Moutia, 1958
4. *Tetranychus evansi* Baker and Pritchard	"	"	Moutia, 1958
5. *Tetranychus cinnabarinus* Boisd.	"	"	Prasad,1974
6. *Tetrranychus desertarum*	"	"	Nickel, 1958. Banks
7. *T. ludene* Zacher.	"	"	Meyer Rodrigos. 1566
8. *T. nescaledonicus* Andre	"	"	Pande and Jadava.1976
9. *Brevipalpus phoenicis* Geiti	Tenuipalpidae	"	Nagesh Chandra and Channna Basavanna, 1976
10. *Polyphagotarsonemus latus* Banks.	Tersonemidae	-	Dhooria and Bindra, 1977
11. *Eutetranychus bredini*	Tetranychidae	-	Gupta, 1985.
12. *Platyeteitranychus multidigituli*	"	"	Gupta, 1985.
13. *Tetranychus savedi*	"	"	Gupta, 1985.
14. *Panonychus* (T) *harti*	"	"	Gupta, 1985.
15. *Brevipalpus* californicus (Banks)Tennuipalpidae		"	"
16. *B. karachiensis*	"	"	Sadana, 1985 b.
17. *B. obovatus*	Donnadieu	-	Sadana, 1985 b.
Predatory Mites :			
18. *Amblyseius* (T) *kalimpongensis*	Phytoseiidae	Berlese	Gupta, 1985.
19. *A.* (E) *alstoniae* Gupta	"	Berlese	Gupta, 1985.
20. *A.* (T) *tetranychivorus* Gupta	-	"	"
21. *A. (P) multidentatus* Swirski and Shechter		-	"
22. *A.* (N) *ranngatensis*	"	"	"
23. *Phytoseius kapuri* Gupta	-	-	Gupta, 1985.

2.2. Effect of environmental factors on the bionomics of pest species On *Leucinodes orbonalis* Guen.

A temperature of 30°C and 30-90% r.h. were found to be more favourable for the multiplication of this pest (Atwal and Verma, 1972). The authors studied the biology and damaging potential of *L. orbonalis* on brinjal in the field and laboratory conditions of Punjab, Western India. In the field, larval population per 0.04 ha plot varied from, 1 larva in March (when the pyralid was in hibernation) to 116 larva in August and the percentage of fruit damaged by larval infestation was most abundant in the monsoon period when r.h. and temperature were high. The development of the pyralid was investigated on brinjal and potato in the laboratory at a temperature of 20-30°C and a r.h. of 30-90%. The development and the survival rate was higher at the highest temperature and humidity and it was concluded that the abundance of the pyralid in the field during monsoon was related to higher temperature and r.h..

Mall *et al.* (1992) recorded pest infestation in the 3rd week of August which attained a serious status during September when 76.66-93.33% plants were infested. Infestation of the pests on shoots did not seem to be directly influenced by either of the environmental factors. Though it was maximum at about 28°C temperature with 80% r.h.. On fruits, its infestation was positively affected by temperature and negatively by r.h.. Mehto *et al.* (1979) showed that temperature and r.h. had great bearing on the percentage of infestation on fruits. Pawer *et al.* (1986) also reported that the fruit was infested from the 3rd week of September and reached at its peak on the second week of November.

On *Amrasca biguttula biguttula* Ishida

Mall *et al.* (1992) reported that the incidence of the jassid was observed on newly transplanted crop from the 3rd week of August till the maturity of crop. The population of jassid gradually increased and remained higher from the mid-October to mid November with highest intensity 1.82 jassid/leaf. The average temperature ranged between 20-25°C and the average r.h. between 50-72% as well as dry season (no rainfall) showed a significant impact on the population build up of jassid. Sekhon and Singh (1985) also reported conduciveness of similar environmental conditions for population build up of jassid on the brinjal crop.

On *Aphis gossypii* Glover

Oliviera (1971) studied the relation between weather condition and fluctuation in population of aphids in potato fields. It was found that the size of the population was negatively correlated with the amount of rainfall and that both very high temperatures (above 30°C) and very low ones (under 12°C) were unfavourable for the aphid multiplication, the optimum range for their development being very narrow (26-27.5°C). However, no information is available on the influence of environmental factors on the incidence and abundance of aphids on brinjal in different seasons. According to Mall *et al.* (1992) incidence of aphid on brinjal crop was found from the 3rd week of August to 3rd week of December with a peak of 6.86 aphid/leaf during the first week of November. The average temperature range of 20-25°C and average r.h. range of 50-72% were more favourable for maximum activity of the pest. Singh and Kavadia (1979) observed disappearance of the pest from the brinjal crop with a fall of minimum temperature below 20°C.

On *Epilachna vigintioctopunctata* Fab.

According to Mall *et al.* (1992) spotted leaf beetle was recorded from 3rd week of August to middle of October with its maximum population of 0.22 beetle per leaf in the middle of September. When the average temperature and humidity were about 28°C and 80% respectively. The population gradually declined and disappeared probably due to fall in temperature and humidity and also due to aging of the crop.

Singh and Kavadia (1989) also found the maximum infestation of epilachna beetle in August to October on July planted crop. According to Iftakhar and Khan (1980) the pest remained active from July to November on brinjal and was more prevalent at temperature of 27-29°C and at r.h. of more than 80% during the month of August.

Grewal (1988) found that in Punjab, temperature and r.h. affected the number of coccinellid although the availability of food was also an important factor determining the number. High temperature and low r.h. had an adverse effect on egg hatchability, the viability of newly hatched larvae and fecundity, however, advanced stages of larvae and the adults were only moderately affected.

2.3 Screening of germplasm

Brinjal shoot and fruit borer is an important insect pest which acts as a hindering factor for the successful cultivation of this crop, particularly under a condition of high temperature and humidity even in case of wild species of the genus *Solanum*. While *S. incanum* showed an infestation of 8.6 percent, *S. sisymbriifolium* (Lall and Ahmad 1965; Dhankhar *et al.*; 1977), *S. integrifolium, S. xanthocarpum, S. nigram* and *S. khasianum* have earlier been found free from the damage of this insect (Lal *et al.*, 1976). In accordance with Chelliah and Srinivasan (1983) *S. integrifolium*, *S. sisymbrifolium* and *S. xanthocarpum* could be used effectively for exploitation of resistance characters. Kashyap and Kalloo (1983), in their review reported that fruits of *S. khasianum* were found to be infested with this insect at Vegetable Research Farm, Haryana Agricultural University, Hissar. (Dhankhar, personal communication).

Kashyap and Kalloo (1983) have reviewed works of different authors on insect resistance in vegetable crops. Several accessions of *S. melongena* have been screened against this insect pest and Pusa Purple Long (Singh and Sikka, 1955) H-128, H-129 and H-158 (Srinivasan and Basheer,1961), Aushey (Lall and Ahmed, 1965; Dhankhar *et al.*, 1977), Thorn Pendy, Black Pendy, H-165 and H-407 (Panda *et al.*, 1971), SM-202, Sel. 519, Sel. 520, Sel. 521. and Solan-11 (Lal *et al.*, 1976), PPC-2, IC-1885, Aushey (Dhankhar *et al.*, 1977), Dorley (Nawale and Sonone, 1979), S-4, H-4, Punjab Chamkila, PPC and PPL (Gill and Chadha, 1979) Long Purple (Frempong and Buahin, 1977), PPC 17-4 and PVR-195 (Singh, 1981) have been reported to be tolerant or resistant. Singh and Sidhu (1980) reported that the cultivars PBR 129-5 and SM 17-4 were resistant to *L. orbonalis*.

In Rahuri, Maharastra, Raut and Sonone (1980) screened several cultivars against this pest, they have reported that the cultivars H-4, Pusa Purple Long, Pusa Kranti and SM-41 exhibited tolerance to fruit as well as to shoot infestation. Similar results were also reported by Subbaratnam and Butani (1981) from New Delhi, they reported that cultivars H-4, Pusa Kranti and A-61 were moderately tolerant to shoot and fruit borer, while

Arka Kusumakar was tolerant to this insect pest. Hence they have suggested that these cultivars might be incorporated in the pest management programme. Subbaratnam *et al.* (1981) again reported that PPC, Arka Kusumakar, H-4, A-61, Annamalai and Pusa Kranti showed resistant reaction towards borer infestation. In the same year (1981) Mehto and Lall reported resistance in Long Purple cultivar confirming the findings of Frempong and Buahin 1979. Singh in the year 1981 showed PPC 17-4, PVR-195 have tolerance against *L. orbonalis*. Naithani (1983) also reported tolerance in PPC and AM-62.

At Coimbatore, Srinivasan and Basheer (1961) trialed with 22 types of brinjal and reported that none was absolutely resistant to the borer pest of brinjal. The varieties, Coimbatore and Gudiyatham (H-158) were found to display least infestation. The types Arkadu (H-165), Vadugapalayan (H-202), Kurumbur (H-336) were next best types in respect of borer incidence.

Replicated field trials were conducted for the evaluation of the response of 19 varieties of egg plants or brinjal to shoot and fruit borer damage under natural infestation from 1964 to 1966 at Bhubaneswar. The mean percentage of shoot and fruit infestation indicated that Long White, Pusa Purple Round, Pusa Purple Long, Muktakeshi and Malipada (local) were susceptible where as Thorn Pendy, Black Pendy, H-165 and H-407 were significantly resistant to borer damage. The yield as well as field tolerance of resistant lines were also significantly higher than those of susceptible groups. The mechanism of resistance to shoot attack was attributed to compact vascular bundles in thick layer with lignified cells and low pith area. The tight and semi-tight fruit calyx in resistant lines are equally important in hindering the initial borer penetration into the fruits. The hard fruit rind and seeds arranged compactly in the mesocarp of such fruits have further provided a mechanism against borer damage (Panda *et al.,* 1971).

Lal *et al.* (1976) screened 69 strains and 6 *Solanum* species under field condition in upper Kulu valley of Himachal Pradesh. Five wild species viz. *S. sisymbriifolium, S. integrifolium, S. xanthocarpum, S. nigram* and *S. khasianum* were always found free from this pest, while *S. incanum* had 5.3 to 8.6% infestation during different years. Among cultivated types, SM-202, SM-145, S-497, S-519, S-520, S-521 and Solan 11 always showed resistance while SM-202, S-519 and S-520 were the highly resistant varieties with less than 6.3% damage during 1972 and 1973. During 1974, when the infestation in general was very high, these varieties had 11.5 to 20% infestation. The damage percent on fruit weight basis was generally more than that on fruit number basis. The highly susceptible varieties were Ramy Round Purple, Nurki, Pusa Purple Round, Japanee Long Black, Arka Shirish, S-453, S-475, S-476, S-496, S-499, S-530 and Solan-17. The highly resistant varieties had tightly arranged seeds in the mesocarp of the fruit. The colour of leaves, plant and fruits or the position of leaves on plants did not show any impact on the tolerance against the borer, *L. orbonalis*.

Dhankhar *et al.* (1977) tested 39 strains of *S. melongena* at Hissar (Haryana). Considerable genetic variability was observed for all the 9 relative susceptibility characters. The wild species showed the highest degree of tolerance to shoot and fruit borer followed by the cultivated strains, PPC-2 and Aushey.

Mehto and Lall (1981), conducted field trial in Bihar with 10 varieties of brinjal and found variability of resistance in order of Long Purple > PPL > Black Beauty > Muktakeshi > Early Crowdy > Banaras Giant > Oblong Round > Kulli > White Murgia.

Out of 150 cultivars of brinjal screened for 3 years, the cultivars Sm 17-4, Pusa Purple Cluster (PPC) and PBR 129-5 were identified as most resistant, and the cultivar Punjab Chamkila as the most susceptible to the brinjal shoot and fruit borer. Intensive testing of these cultivars for two more years indicated that the cultivar SM 17-4 had upto 1:10 as the ratio of infested to the healthy fruits as compared to 1 : 5 in case of PPC and PBR 129-5 and only 1:2.4 in case of Punjab Chamkila (Singh and Sidhu, 1986).

According to Bajaj *et al.* (1989) the fruit of the cultivar SM 17-4, relatively field resistant to *L. orbonalis* had higher glycoalkaloid content and peroxidase and polyphenol oxidase activities than the susceptible cultivar, Punjab Chamkila. However, higher anthocyanin content was found in the susceptible variety. It has been suggested that glycoalkaloids in association with phenolic compounds may be conferring resistance to egg plant fruits towards this pest.

Out of 150 lines tested by Singh and Chadha (1991), Cvs. SM 17-4, PBR 129-5 and Punjab Barsati were the most resistant but Punjab Chamkila was highly susceptible cultivar. Resistance was attributed to a large number of small sized fruits/pl with shorter inter/intra cluster distances, late and longer fruiting period.

Mandal *et al.* (1994) screened 41 cultivars of egg plant from North Bengal terai, and found Nishchindipur Local, Nurki, Shyamla Dhepa, Navkiran, Kalo Dhepa, IR-8-Baramasi, Banaras Long Purple, BB_1, and Murshidabad Local as fairly resistant having crop loss from 11.76% to 19.52%. The highly susceptible varieties were R-14, Sufal, Pusa Purple Round, Pyratuni, KB-20 and KB-2. The damage percent varied from 41.17 to 52.73 and 41.36 to 51.73 on the bases of fruit weight and fruit number respectively.

Mukhopadhyay and Mandal (1994) recommended varieties having tolerance or even multiple resistance viz. Shyamla Dhepa, Kalo Dhepa, Improved Muktakeshi, Banaras Long Purple and BB_1, for incorporation in the breeding programme and integrated pest management for rabi cultivation of brinjal under the very exclusive climate of Darjeeling Terai.

According to Srivastava and Lal (1995), Shoot and fruit borer is a serious problem in brinjal particularly in round varieties as compared to long varieties. Over 50 varieties and hybrids of prominent regional brinjal germplasm collected from different sources were screened against this pest under field conditions at I.A.R.I., New Delhi during 1994 and 1995. After each picking observations were undertaken and different grades of infested fruits were made on the basis of number and on the basis of weight against borer. None of the varieties and hybrids was found resistant to the borer. The variety SM-202 showed highly resistant to borer. The variety SM-202 showed high resistance while varieties SM-17, Pusa Purple Cluster, Pant Samrat and SM-202 × PPL were found moderately resistant on number and weight basis.

Resistance source of germplasm among hybrid

Bakash and Iqbal (1949) employed crosses of *S. incanum*, *S. khasianum*, *S. macranthum* with *S. melongena*. In the cross with *S. incanum*, the F_2 hybrids showed appreciable resistance to frost as well as shoot and fruit borer. Another hybrid (selected F_4 plant) between Pusa Purple Long and *S. indica* showed field resistance to *L. orbonalis*. (Rao and Kumar 1980). These works had been mentioned by Kashyap and Kalloo (1983) in their review article on insect resistance in vegetable crops.

F_3 progenies of *Solanum melongena* with *S. incanum* showed appreciable resistance against borer pests of brinjal (Rao, 1981). Kalloo and Berch (1990) cited resistance of hybrid egg plant against pests and diseases.

2.3.1. Screening of brinjal germplasm under semi-protected condition for IPM

By growing some of the promising varieties viz. Coimbatore, H-158, IC-1855, and H-128 and by spraying D.D.T. 0.1% or endrin 0.02% 3-4 times at fortnightly interval (commencing the treatments 3-4 weeks after transplanting), the vegetable growers can eliminate the borer completely and also obtained increased yield (Srinivasan and Basheer, 1961).

Under chemically protected/semi-protected condition the cultivar PBR 129-5 having multiple resistance for the borer and jassid gave highest borer free fruit yields (158 Qtls/ha) followed by highly borer resistant but jassid susceptible variety SM 17-4 (146.6 Qtls/ha). Under protected conditions the cultivar PBR 129-5 resulted in highest yields but the borer resistant PPC and SM 17-4 gave poorer yield performance than the borer

Table 1. Source of resistance to shoot and fruit borer

Source of resistance	Reference
PPL	Singh and Sikka, 1955
H-128, H-129, H-158	Srinivasan and Basheer, 1961
S. sisymbriifolium, Aushey	Lall and Ahmad, 1965
Thorn Pendy, Black Pendy, H-165, H-407	Panda *et al.*, 1971
Ex Beckwai, IHR-191	Krishna and Vijay, 1975
S. xanthocarpum, *S. sisymbriifolium*, *S. integrifolium*, *S. nigram*, *S. khasianum*, *S. incanum*. SM-202, S-519, S-520, SM-145, Solan-11.	Lal *et al.*, 1976
IC-1885, Aushey, *S. sisymbrifolium* PPC-2,	Dhankhar *et al.*, 1977
Dorley	Nawale and Sonone, 1977b
Long Purple	Frempong and Buahin, 1981
H-4, PPL, Pusa Kranti, SM-41	Rout and Sonone, 1980
PPC, Arka Kusumakar, H-4, A-61 Annamalai, Pusa Kranti	Subbaratnam and Butani, 1981
SM-17-4, PPC, PBR 129-5	Singh and Sidhu, 1986
Banaras Giant, S-34, Arka Kusumakar, SM-215, S-258, SM-62 SM-2, S-2070, Six Seer.	Pawar *et al.*, 1987
SM 17-4, PPC	Singh and Sidhu, 1988
SM 17-4	Bajaj *et al.*, 1989
Pusa Purple Cluster	Dash and Singh, 1990
PBr 129-5, SM 17-4, ARU-2C, Punjab Barsati, Pusa Purple Round	Tewari and Krishnamoorthy, 1985, Dilbagh Singh and Sidhu, 1988, Dilbagh Singh, 1991.
Shyamla Dhepa, Navkiran, Kalo Dhepa, Banaras Long Purple, BB_1, IR 8-Baramasi, NIL, Murshidabad Local	Mukhopadhyay and Mandal, 1994 Mandal *et al.*, 1994

susceptible Punjab Chamkila because of the formers susceptibility to the jassid. The varieties PBR 129-5 and SM 17-4 can thus be adopted for cultivation with a coverage of integrated pest management programme depending upon the complexity of pest problem and type of chemical protection given to the crop (Singh and Sidhu, 1986).

2.3.2. Varietal screening for Jassid resistance

Fakuda (1952) in Tiwan reported that the brinjal varieties Indomarunasu and Malayan 12 were found to be resistant to the cotton jassid, supporting small jassid population and suffering less damage than the susceptible varieties, Shinkuro and Tokyo-Yamanasu.

Mote (1978) made a field trial with 48 egg plant cultivars. The cultivars H-4, Round Green, Dorly, Aushey, Jumblimulayam, Long Purple showed the lowest number of jassid nymphs/30 leaves.

Subbaratnam and Butani (1981) reported that the cultivars S-5, Pusa Kranti, H-4 and A-61, showed resistance to *A. biguttula biguttula* in a field trial under normal infestation among the 18 cultivars.

Mukhopadhyay and Mandal (1994) reported that KB-9, Pusa Purple Round, Pusa Purple Long, Banaras Giant White, L-13, KB-5, Improved Muktakeshi, Navkiran, BB_1 and KB-10 had less infestation of jassid and therefore, were tolerant to the pest.

Bhandari (1985) screened 55 varieties of brinjal at B.C.K.V. Kalyani, Nadia, during rainy season and found Makra had lowest mean population of jassid during crop season and the other varieties like C-37, Bardhaman White, Pusa Purple Long, C-43, C-44, C-40, PBr-7, C-19, C-39, C-23, C-14, Banaras Giant, C-32, C-25, C-17 and C-41 did not differ significantly from Makra at 5% level. Makra and C-14, only two varieties were regarded as tolerant to both jassid and aphid.

Causes of jassid resistance :

The resistant varieties harboured a small jassid population, suffered less damage, and exhibited antibiosis by way of slower nymphal development, low nymphal survival and reduced fecundity-cum-fertility. Fakuda (1952) reported that the thickness of colenchyma cells in leaves, and the length and density of hairs on the undersite of leaves of resistant varieties of brinjal, prevented the 1st instar nymphs from feeding successfully. In Okra, however, only mid-rib hair density contributed to jassid resistance (Bindra and Mahal, 1979).

Bindra and Mahal (1981) reported varietal resistance in egg plant to cotton jassid, of 29 egg plant cultivars screened in the field. Cultivars like Junagadh sel-1, Aushey, R-34, H-4 and T_3 were resistant to A. *biguttula biguttula* due to various morphological characteristics viz. long hairs and high density of hairs on the mid-rib and lamina, more erect hairs on the mid-rib and thin leaf lamina.

Mote (1982) noted average number of jassid nymphs per 5 plants at 35-105 days after transplanting. The cultivars namely, Kalyanpur, T_3, Round Green, Pusa Purple Round, Muktakeshi were reported to be attacked by lowest number of jassid nymphs. All the resistant cultivars were noted for large number of hairs on their leaf under surfaces.

Similarly, Subbaratnam *et al.* (1983) recorded infestation of *S. melongena* at weekly interval. The thickness of the leaf lamina and mid-rib were positively correlated with the infestation. The other characters, the thickness of lateral veins, density and length of mid-rib hairs did not appear to have any correlation with jassid infestation.

2.3.3. Screening for aphid resistance

Chelliah and Sambandam (1971) made an experiment on evaluation of egg plant accessions for resistance to *Aphis gossypii* Glover. They observed that out of 205 accessions only 49A showed consistant resistance. In trial with other accessions this gave high yields of good quality fruit. The accession 49A was released with the name Annamalai. Ramaswamy *et al.* (1972) also reported that the cultivar Annamalai was resistant to *A. gossypii* and produces good quality fruits.

Subbaratnam and Butani (1981) conducted a field trial taking 18 cultivars for resistance against pest complex. In their experiment, the cultivar S-5 only showed resistance to *A. gossypii.*

In an experiment made by Sambandam and Chelliah (1983) reported that the insect resistance was heritable and all the progenies of Ac. 49A were uniformly resistant.

Bhandari (1986) screened brinjal germplasm at B.C.K.V. during rainy season of 1985. Out of 55 varieties and lines screened for their reaction to aphids and jassids infestation, C-10, C-14, C-16, C-21, C-24, Green Long and Makra have consistently low level of aphid infestation and may be considered some what less susceptible than the others.

2.3.4. Screening brinjal germplasm for epilachna beetle

Sambandam *et al.* (1976) made an experiment with the egg plant accessions No.5 and No.105 (both moderately resistant) to *E. vigintioctopunctata,* No.10 (highly susceptible) and *S. torvum* (highly resistant). Preferential feeding and antibiosis were the main factors affecting resistance. The susceptible accession had the highest total and amino nitrogen, amino acids, starch, crude fibre and K-content, where as the moderately or highly resistant accessions had the higher reducing and non-reducing sugars, chlorophyl P, total and O-dihydroxyphenol contents.

Pandey and Shanker (1975) reported the effect of 10 different food plants on the development of *E. vigintioctopunctata* (F.), a pest of solanaceous and cucurbitaceous plants, and egg plant (Brinjal) was found to be the most favourable and pumpkin the least.

2.4. Variability studies

The genetics of metric trait, centres round the study of its variation. The basic idea in the study of variation is its partitioning into its components attributed to aforesaid causes. The magnitude of heritable inability and more particularly its genetic component is the most important aspect of genetic constitution of the breeding material which has a close bearing on its response to selection.

The phenotype of quantitative traits in principle is the joint product of genotype and environment. Hence, the estimates of variability and its heritable components for the yield contributing characters in the available germplasm are a pre-requisite for a breeding programme for high yield. Achieving high yield necessiates selection on the basis of characters that have high heritability values.

2.4.1. Vegetative character

Sarkar *et al.* (1990) reported that high heritability for number of primary branches/pl and thickness of the skin in pointed gourd (*Trichosanthes* *dioica* Roxb). Highly significant differences were recorded for the characters, plant height, number of branches/pl, time taken to maturity in green chilli (Kumar *et al.*, 1993).

Variability was also discussed by many other workers in vegetable crops namely Rattan *et al.* (1983) in tomato, Solanki *et al.* (1988) in pea, Ahmed and Tanki (1992) in carrot, Baruah *et al.* (1993) in sweet gourd, Radha Krishna and Korla (1994) in cauliflower.

Singh *et al.* (1974) discussed the genetic variability, heritability and genetic advance in *S. melongena* L. The author noted highly significant differences among 24 varieties for all the characters studied. A wide range of variation was found in all the characters except for the number of primary branches (6.10-9.60). In general, a major portion of the variation was contributed by genetic components while the environmental variation played minor role. The genetic coefficient of variation helps in the measurement of the range of the genetic diversity in a character and provides a means to compare the genetic variability in the quantitative characters.

Kabir and Som (1993) reported that in brinjal wide range of variation was exhibited for plant height and period needed for flowering. GCV and PCV found to be lower for vegetative characters but 70.04% heritability was found for primary branches/pl.

2.4.2. Reproductive characters

Hazra *et al.* (1989) conducted experiment to estimate coheritability values among different pod yield contributing characters of dolichos bean revealed that coheritability values of pod yield/pl with yield components namely, days to flower, 10 pod weight, breadth of pod and pod number/

pl were greater than heritability estimate of pod yield/pl itself, suggesting potential for improving pod yield of dolichos bean (*Dolichos lablab*, Roxb. L.) by simultaneous selection for pairs of characters.

Saha *et al.* (1990) found high GCV and heritability associated with high genetic advance for pod yield/plant in french bean.

Natarajan (1994) reported high heritability estimates for days to flowering and mean fruit weight in tomato.

Ahmed *et al.* (1990) found genetic variability in 64 lines of Chilli (*Capsicum annum* L.) for plant fruit and yield characters. The results indicated considerable genetic variability for fruit yield and other traits. Estimates of components of variance revealed higher genotypic variance for all the characters than environmental variance. Heritability estimates in general were found high in all the characters. Higher genetic advance and genetic gain observed for fruit / pl, average fruit weight, fruit girth, fruit yield/pl and fruit length coupled with higher heritability indicated a large scope for the improvement of these characters by selection.

Highly significant differences were recorded for the characters, plant height, number of branches/pl, time taken to maturity, fruit length, fruit girth, number of fruit/pl and ascorbic acid content in green chilli. High heritability coupled with high genetic advance were observed for characters like number of fruit/pl, number of seeds/ft, ascorbic acid content and yield/ pl indicating the predominance of additive gene action (Kumar *et al.*, 1993). High heritability with high genetic advance was also reported by Anuradha and Narayana Gowda (1994) in gladiolus for number of cormels and 10 cormel weight.

Singh *et al.* (1977) reported high amount of GCV for fruit weight (48.46) in brinjal. Fruit length and yield/pl were the other characters in order which gave high GCV. The heritability estimates were in general high for all characters except in case of fruit weight (7.59). The high value of heritability suggests that all the characters are under genotypic control. In accord to Dharmegowda *et al.* (1979), narrow sense heritability estimates were 63.48 and 67.48% for number of fruit/pl and number of seeds/ft respectively in brinjal.

In brinjal high heritability and high genetic gain have also been observed for number of flowers/cluster, number of fruits/cluster and number of fruits/pl (Kabir, 1981). High estimates of heritability were reported by Singh *et al.* (1976) for all the characters except for yield/pl.

Kabir and Som (1993) discussed the genetic variability in some of the reproductive characters. They observed 78-86% heritability for fruit diameter and 107.64% genetic gain as percent of mean for fruits/cluster.

2.4.3. Susceptibility components

While screening for 39 strains of brinjal, Dhankhar *et al.* (1977) found considerable genetic variability. The wild species showed the highest degree of tolerance to shoot and fruit borer followed by PPC-2 and Aushey as indicated by percent infested fruits/pl in normal and ratoon crop under field condition. Estimates of components of variance revealed higher genotypic than error variance for number of infested fruits, holes/pl and larvae/pl. Therefore, selection on phenotypic basis for these characters would be more useful for relative susceptibility to shoot and fruit borer.

Several workers also worked on the genetic variability and heritability in some other vegetables like pumpkin (Gopalakrishnan *et al.*, 1980), carrot (Prasad and Prasad, 1980) etc.

2.5. Correlation and path analysis

Selection of one trait invariably affects number of associated traits which evokes the need in finding out the interrelationship of various yield components both among themselves and with yield. Selection of genotypes for high yield through yield components is judged to be more rational. Measurement of phenotypic and genotypic correlations between yield and other characters have been of great importance and is necessary, if selection for a simultaneous improvement of yield and its components is to be effective.

When more variables are included in a correlation study, the indirect associations become more complex. In such a situation, the path coefficient analysis devised by Wright (1921) provide an effective means of finding out direct and indirect causes of association and allows a detailed examination of specific forces acting to produce a given correlation and measures the relative importance of each casual factor.

According to Hanchinal *et al.* (1979), seed yield showed positive significant correlations with plant height, number of branches, number of pods and dry pod yield in winter, whereas in summer, highly significant positive correlations were obtained with number of seeds and dry pod yield in cowpea *Vigna unguiculata* (L.) Walp. The variation between two seasons in respect of correlation values for differnt traits with seed yield may be attributed to the extreme environmental fluctuations. Very high positive correlation was noted between seed yield and dry pod yield for both the seasons. 100 seed weight was negatively correlated with number of pods and number of branches for both the season. Plant height, number of branches and number of seeds revealed that the number of branches should be considered as one of the important characters in increasing the yield although the apparent correlation is negative. Further, it is suggested that rather than the direct effects of number of seeds and plant height, it is the indirect effect of seeds through branches which is more important in deciding the yield.

Saha *et al.* (1990) reported that the pod yield of french bean (*Phaseolus vulgaris* L.) was positively and significantly correlated with plant height, pod number/pl and pod weight.

In brinjal, it has been reported that there is a strong association between the number of fruits and yield/pl (Srivastava and Sachan, 1973; Singh and Nandpuri, 1974; Singh and Singh, 1980; Kabir, 1981). Srivastava and Sachan (1973) also mentioned that number of fruits/pl had a direct bearing on fruit yield. Several workers showed that both fruit weight and fruit number had a high direct contributions to yield. Thus fruit yield can be improved by selecting for those two components, giving more importance to fruit weight. Data on yield and five other characters from 19 egg plant varieties showed that yield was positively correlated with length, weight and number of fruits and negatively correlated with days to flowering, plant height and fruit girth, but fruit girth showed the greatest direct effect on yield/pl followed by fruit length and fruit weight (Singh and Singh, 1981).

Correlation among different constituents showed that the total phenols had a significant negative correlation with chlorophyll, PPO/mg/protein, PPO/mg/protein/mg orthodihydroxy phenols and significant positive correlations with PO units/g., true protein and orthodihydroxy phenols on fresh weight basis. The correlation coefficient in case of orthodihydroxy phenols was negative and significant with chlorophyll and PPO/mg protein (Sidhu *et al.,* 1982).

Yield of brinjal was positively correlated with fruits/pl, plant height and branches/pl at the phenotypic and genotypic levels and with fruit length : circumference ratio at the genotypic level (Sinha, 1983). Path analysis indicated that fruits/pl and fruit length : circumference ratio had the maximum direct effect on yield combined with GCV and heritability value. Salehuzzaman and Alam (1983) registered yield in egg plant is a complex character which is a product of its components. Wheather one should select for the components on for yield itself will depend upon their heritabilities and genetic interrelationships among yield and its component.

Patil and Shinde (1984) pointed out that in 50% of the cases, heterosis in fruit yield was positively associated with the heterosis in fruit/cluster and fruits/pl.

Chadha and Paul (1984) reported that values for expected genetic advance were high for yield/pl, fruits/pl and borer infected fruits/pl. Yield/pl was positively correlated with fruit/pl, borer infected fruits/pl and plant height. According to Sharma *et al.* (1985) infested yield was directly affected by total yield and indirectly fruit diameter. Total yield was directly affected by fruit number.

According to Sharma *et al.* (1985) total yield/pl was positively correlated with fruit number at both the phenotypic and genotypic levels. Plant height and fruit length also contributed to yield, although their correlations were not consistent over the 2 years. Infested yield/pl was correlated with the percent of infested yield and fruit diameter, the latter correlation suggesting that the round fruits are most susceptible to borer attack. According to Singh *et al.* (1988) total phenols in brinjal had significantly negative correlations with anthocyanin and non-significant but negative relationship with chlorophyll. Dry matter was positively related to chlorophyll.

Mandal and Dana (1992) reported that yield/pl in brinjal had highly significant positive genotypic association with days to 50% flowering. Fruit diameter had maximum direct positive effect on fruit yield followed by number of primary branches/pl, number of fruits/pl, number of secondary branches/pl and plant height. Since fruit diameter and number of primary branches/pl had low heritability values, fruit and secondary branch numbers and plant height would be the important yield components for selection of superior genotypes.

Information on mean, range, phenotypic and genotypic variance, genetic advance, heritability and correlation coefficients is derived from data on 10 yield related traits in 14 exotic and 2 local genotypes of brinjal grown during the winter season 1987-90 at Jorhat, Assam. Fruit yield was significantly correlated with plant height and fruit diameter (Bora and Shadeque, 1993).

Correlation and path coefficient analysis were also elaborately discussed by many workers for different vegetable crops namely, Pal *et al.* (1988) in onion; Sharma *et al.* (1993) and Prasad *et al.* (1993) in bottle gourd, and Tewatia and Banerjee (1993) and Kalita *et al.* (1994) in garden pea.

Singh and Singh (1980) worked on tomato and reported significant correlation in positive and negative direction between yield and its contributing characters. Bhagchandani and Choudhury (1980) also reported correlation and path analysis in carrot.

2.6. Genetic divergence

The importance of genetic diversity in breeding for high yield has long been recognised. The use of multivariate analysis (Mahalanobis's D^2 statistic) has well been demonstrated for choosing the parents for hybridization programme. Multivariate analysis by means of Mahalanobis's D^2 statistic and canonical analysis are powerful tools in quantifying the degree of divergence between biological populations and to assess the relative contribution of different components to the total divergence both at inter and intra cluster levels.

The present study aims at analysing the genetic divergence of 41 genotypes of egg plant in the years 1991-92 and 1992-93. For this purpose, altogether 21 characters from among vegetative growth, reproductive growth and susceptibility components towards shoot and fruit borer attack were taken for analysis. The study of genetic divergence under different environmental conditions would help to identify "stable diverse genotypes" grouped in stable clusters. Genotypes included in the stable clusters with a high order of divergence will be expected to provide best breeding material.

Eighteen genotypes of okra were evaluated for genetic divergence in respect of 16 vegetative and productive characters. The 18 genotypes fell into 5 clusters. Cluster 1 with 7 genotypes was the largest followed by cluster III with 6 genotypes. Cluster II and IV had two genotypes each, while cluster V had only one. For selecting genetically divergent parent for hybridization, fruit characters should be given due consideration (Abul Vahab *et al.,* 1994).

According to Hazra *et al.* (1993) there was no close correspondence between geographical distribution and genetic divergence in cowpea (*Vigna unguiculata* (L) Walp.) genotypes belonging to 3 cultigroups, *unguiculata, biflora* and *sesquipedalis*.

Mehra and Peter (1980) reported that based on D^2 values 27 genotypes of Chilli (*Capsicum annuum* Linn) were clustered into 9 gene constellations. NP-46, Jwala, G_3, AC-46 and AC-56 were close to each other. The fruit yield/pl contributed maximum towards the genetic divergence. The canonical variate analysis and metroglyphs confirmed the genetic group as obtained through Mahalanobis D^2 statistic. In another investigation, Sundaram *et al.* (1980) observed no relationship between genetic and geographic diversity in 50 varieties of chilli (*Capsicum frutescens*). The number of branches and number of fruits/pl were the chief contributors towards genetic divergence.

In tomato, Singh and Singh (1980) studied the components of genetic divergence for yield viz. days to flower, number of fruit, fruit size, number of locules/ft, days to maturity, number of fruits/bunch, primary branches/ pl and plant length, in 30 varieties. The maximum divergence was contributed by the number of fruits/bunch, followed by fruit size and number of primary branches/pl. The 30 varieties were grouped in 8 clusters. The clustering pattern showed that genetic divergence was not parallel in geographical distribution.

Generally, the clustering pattern of varieties revealed that geographical diversity was not always related to genetic diversity as observed by Mehndiratta and Singh (1971) and Mital *et al.* (1975) in several crops and Sachan and Sharma (1971) in tomato.

2.7. Chemical Control

A synopsis of chemical control of the key pest (*L. orbonalis*) of brinjal experimented is furnished in the Table 2 highlighting the name of the pesticides, dosage, efficacy and the author(s).

2.8. Heterosis in brinjal

2.8.1. Vegetative characters

Plant height at first flowering :

According to Venkataramani (1946), F_1 hybrids were taller than the taller parent and also gave higher yield. Singh *et al.* (1978) recorded positive heterosis of 0.7 to 23.7% over better parent for plant height. But Patil and Shinde (1984) reported that plant height was negatively associated with heterosis for yield.

Plant height at first harvesting :

Mandal *et al.* (1994) reported a positive heterosis over the better parent expressed by the hybrids from crosses : PPC × 17B (53%), PPC × MK (46.42%) and MK × PPL (7.56%). The heterosis for plant height at first

Table 2. **Chemical control of shoot and fruit borer**

Name of pesticide and combinations	*Dosage and formulation*	*Efficacy*	*Author (s)*
DDT Endrine	0.1% dust 0.08% Powder	fair	Banerjee and Basu (1955)
DDT	0.1% WP	highest	Srinivasan and Gowder (1959)
Sevin	50% WP	good	Thevasagayam and Canagasingham (1961)
Carbaryl (Sevin)	0.2% WP	effective	David (1964)
Dylox (Dipterex)	0.1% WP		David (1963) Jotwani and Swarup (1963)
Endrin	0.02%	fair	Lal and Ahmed (1965)
BHC Lindane + DDT or Carbaryl	5% dust 0.05% " 0.025% "	fair	Srivastava and Khare (1968)
Dichlorovos or Endosulfan	0.05% spray	safer control	Deshmukh and Udean (1972)
Endrine Carbaryl Gama BHC Dimethoate	0.02% 0.25% - -	fair	Lal (1973)
Parathion	0.04 %	better	Roy *et al.* (1973)
Diazinone	2-2.5 kg/h	better than disulfaton and phorate	Satpathy (1973)
Diazinone/Disul fatan + Carbaryl or Endosulfan	2.5 kg/h granule + 0.15% spray	for season long protection	
Carbaryl	0.25% granule	best	Gahukar and
Carbaryl + DDT or Endrine	0.25% (2 : 1) 0.05% dust.	 good	Bagal (1976)
Carbaryl	1 kg a.i/ha	best	Krishnaiah *et al.* (1976)

Name of pesticide and combinations	*Dosage and formulation*	*Efficacy*	*Author (s)*
Carbaryl Phosphamidon Carbaryl + Phosphamidon	0.1% 0.4% 0.05% 0.2%	best	Nair and Nair (1976)
Endosulfan or Phosphamidon	0.05% spray	effective	Sinha (1976)
Trichlorphan Chlorfevinphos	0.05% 0.05%	best on shoot best on fruits	Nawala and Sonone (1977)
Phorate / Aldicarb. + Carbaryl / Quinalphos	1kg. Gra. 0.2 / 0.05%	 effective	Mote (1978)
Carbofuran	6 kg/h granule	successfully control	Nath and Chakraborty(1978)
Lindane and mixture.	-	superior	Gera and Gupta(1979)
Diazinon, Carbaryl and Parathion mixs.		"	
Endosulfan	0.07%	better.	Shah (1979)
Diphel (a prep, of *Bacillus thuringiensis* var *Kurstaki*) + Insecticides	sublethal dose	superior than insecticides alone.	Baskaran and Kumar (1980)
Fenvalerate (Sumicidin 20 EC.) Permethrin. (Permethrin 20 EC.)	0.1kg/h, EC. 0.1kg/ha., EC.	effective	Mohan *et al.*(1980)
Fenvalerate Cypermethrin	30 g a.i./ha.. 15 g a.i./ha..	highly effective	Tewari *et al.* (1984)
Fenvalerate	0.01% spray	good	Datar and Ashtaputra (1984)
Fenvalerate and Permethrin Cypermethrin Deltamethrin	0.015% 0.03% 0.002%	15 days persistance 10 days " 7 days "	Awasthi (1985)
Fenvalerate and Permethrin Deltamethrin Endosulfan	0.25 kg a.i. / ha 0.05 kg/h 0.75 kg a.i./h	superior control	Yein (1985)

Name of pesticide and combinations	*Dosage and formulation*	*Efficacy*	*Author (s)*
Cypermethrin	0.015% spray	best	Khaire *et al.*(1986)
Deltamethrin Permethrin Cypermethrin Methomyl Quinalphos Endosulfan	-	best control.	Mohan and Prasad (1986).
Triflumuron + Fenobucarb	0.0325 % 0.025 %	most effective	Srinivas *et al.* (1986)
Carbofuran + Cypermethrin	50 kg a.i/ha 0.006 %	economic control of all major pests	Power *et al.* (1987)
Flucythrinate Methamidophos Benfuracarb	0.008% 0.15% 0.02%	effective	More *et al.* (1987)
Quinalphos	-	good	Sangma *et al.*(1988)
Quinalphos	0.05%	best	Sontakke *et al.* (1990)
Cypermethrin + Carbaryl	0.01%	most effective	Agnihotri *el at.* (1990)
Endosulfan	-	superior	Islam and Quiniones (1990)
Endosulfan	25 ULV	better	Bothera and Dethe (1991)
Deltamethrin	0.005%	most effective	Thanki and Patel (1991)
Thiodicarb + Monocrotophos	0.15% 0.04%	most effective	Dhamdhere and Sharma (1991)
Cypermethrin	30 g a.i. /ha. spray	best	Srinivasan and Krishnamoorthy (1992)
Cypermethrin	55 g a.i. / ha	best	Umapathy and Baskaran (1991)

harvesting in brinjal had also been reported by Dharmegowda *et al.* (1979), Patil and Shinde (1984) and some other workers.

Number of primary branches :

According to Mandal *et al.* (1994) offsprings of the crosses 17B × PPL and PPC × 17B showed significant positive heterosis over better parent, while the other crosses showed significant negative heterosis except BD-16 × MK which had non-significant value (0.56%). This result conforms that of Singh *et al.* (1978) Singh (1980), Balamohan *et al.* (1983) and Patil and Shinde (1984).

Number of secondary branches :

According to Mandal (1989), the extent of heterosis for number of secondary branches/plant ranged from. - 44.75% (NIL × 17B) to 307.71% (PPC × 17B) over their respective mean parents and it ranged from - 164.00% (17B × MK) to 205.22% (PPC × 17B) over better parent. These views did agree with the observation made by Patil and Shinde (1984).

Number of days to flower :

Crosses with negative values were considered desirable which in turn gave an early yield. Significant negative heterosis over better parent suggested mostly non-additive gene action (Mandal *et al.*, 1994). This view did agree with Patil and Shinde (1984).

Number of days taken from transplanting to picking :

There was no early ripening of brinjal fruits among the fruits (Venkatarammani, 1946). Studies on *per se* performance and degree of heterosis carried out in eleven important characters of brinjal reveals the fact that mean of hybrid was higher than those of the parents over all the characters except days to first flowering as well as picking (Chadha *et al.*, 1990).

2.8.2. Reproductive characters

Length of fruits :

Dahiya *et al.* (1987) made crosses between 10 female forms and 4 male testers. Hybrids showed significant positive heterosis over the superior parent and best parent for fruit length, weight, number, yield and total sugar content.

Mandal *et al.* (1994) recorded maximum positive heterosis (51.57%) in 17B × PPL followed by MK × PPL (30.33%). The significant positive heterosis over better parent might be due to over-dominance which supported the results found by Singh (1980), Balamohan *et al.* (1983) and Patil and Shinde (1984).

Maximum circumference of fruit :

According to Mandal *et al.* (1994) negative heterosis of 2.23% was recorded for this relation in the cross between PPC × MK followed by 17B × MK (- 3.49%). Heterosis with respect to equatorial diameter was reported by concilio and sanguinate (1982). Significant negative heterosis over better parent indicated the presence of incomplete dominance contradicting the inference of Patil and Shinde (1984) who described that the phenomenon was due to over-dominance.

Number of fruits/plant :

The best hybrids with heterosis for yield and number of fruits/pl and total sugar content were Ludhiana Local Long × PH-4. and Ludhiana Local Long × PPL. This was recorded by Dahiya *et al.* (1987).

Randhawa and Sukhija (1973) also observed heterosis over better parents for this character in the crosses employed. Thakur *et al.* (1968) reported heterosis for number of fruits/plant upto 34.06%. Mandal *et al.* (1994) reported a significant positive heterosis over better parents for this character in nine hybrids out of 10. Maximum heterosis over better parent was observed in case of the cross BD-21 × BD-16 (96.49%) followed by NIL × 17B (92.36%). These views were also in agreement with the findings of several other workers and most of them had opined that the heterobeltiosis occurred in number of fruits/pl was due to over dominance.

Weight of fruit :

According to Mandal *et al.* (1994), hybrids obtained from majority of the crosses usually showed negative heterosis for weight of fruits. Only three crosses, namely, 17B × PPL (29.35%), PPC × BD-21 (15.54%) and PPC × MK (4.22%) showed positive heterosis. The result was not so encouraging as compared to the findings of Singh (1980) who recorded comparatively higher level of heterosis for this trait.

Yield/plant :

Experiments conducted mostly in Japan and India have shown distinct manifestation of heterosis in egg plant (*Solanum melongena* L.). Nagai and Kida (1926) were probably the first to observe hybrid vigour in crosses among some Japanese varieties. Kakizaki (1931) noted that the highest-yielding F_1 hybrids gave 14.8% increased yield.

According to Daskaloff (1937) the average increase in yield for all crosses in Bulgaria ranged from 21.7 to 27.65%. The hybrids ripended earlier, and crosses that showed promise for economic utilization possessed greater viability of seeds and general resistance to unfavourable environmental conditions, and to shedding of flowers in particular. In a later work, Daskaloff (1937) reported increased yield ranging between 10 and 44% in crosses with exotic varieties.

Venkataramani (1946) reported that the F_1 hybrids were taller than the taller parent and also gave increased yield. Pal and Singh (1946, 1949) noted that hybrids in brinjal showed 48.8 to 56.6% increased yield over the better parent.

In another cross the F_1 hybrids exceeded the mean yield of the parents owing to the production of higher number of fruits than to the increase in fruit size (Odland and Noll, 1948).

Goto (1952) recorded marked increase in yield in the F_1 generation of a series of crosses between the Japanese varieties. Peter and Singh (1973), Singh *et al.* (1978), Cheah *et al.* (1981) Viswanathan (1973) and Sindle *et al.* (1977) also reported hybrid vigour in brinjal.

According to Dharmegowda *et al.* (1979), PPC × Arka Kusumaker exhibited highest heterosis with regard to yield/pl to the extent of 94.64% which was recommended for commercial exploitation.

Ten quantitative and two qualitative characters were evaluated in crosses involving six lines and four testers by Balamohan *et al.* (1983). A total of 22 crosses exhibited heterosis for yield. SM-19 × SM-2 was the highest yielding. Heterosis for yield in this cross was attributed to increase in number of branches, fruit length and number of fruits. Similar observation with respect to yield/pl was also observed by several workers (Ram *et al.*, 1981; Concilio *et al.*, 1983; Nualsri *et al.*, 1986; Gopinath *et al.*, 1986).

On the basis of observations heterosis and combining ability for five yield components in 45 F_1, hybrids from a 10 × 10 half-diallel of egg plant, Kandasamy *et al.* (1983) reported highest yielding hybrids were Pusa Purple Long × Punjab Bahar; Pusa Purple Long × S-373 and Annamalai × S-96.

Significant heterobeltiosis was exhibited by different F_1's ranging from 16.25 (17B × BR-112) to 136.82% (PPC × 17B). The maximum increase over better parent in the cross PPC × 17B might also be due to heavy bearing in PPC (Mandal *et al.*, 1994).

2.8.3. Susceptibility components

The hybrids obtained from BR-103 × White Long and from BR-112 × Aushey had shown significant heterobeltiosis with respect to yield components and shoot and fruit borer (*Leucinodes orbonalis*) resistance (Dhankhar *et al.*, 1983).

3. MATERIALS AND METHODS

3.1. Major pests studied and the methods employed for pest sampling

In this investigation 4 major pests studied were-

(i) shoot and fruit borer (*Leucinodes orbonalis* Guen.)

(ii) cotton leaf hopper or jassid (*Amrasca biguttula biguttula* Ishida)

(iii) cotton aphid or aphid (*Aphis gossypii* Glover) and

(iv) spotted leaf beetle (*Epilachna vigintioctopunctata* Fab.)

Data were recorded from the time of first occurrence of pests. The populations of jassid, aphid and spotted leaf beetle were counted from 5 leaves (2 top, 2 middle and 1 bottom) from each of the 5 central plants in every subplot at 20 day intervals till the completion of harvesting. The total number of shoots damaged due to the attack of *L. orbonalis* in the central 5 plants was also recorded. The fruits were harvested at an interval of 10 days, sorted out into marketable fruits, counted and weighed for computation of final yield.

Any decision of pest management must be based on economic ratio of benefit to cost, and this largely depends on the quantitative pest density.

The sampling procedure consisted of a constant number of sample for each sampling occasion for each sampling programme, it was necessary to decide upon:

(i) the size of the sampling unit used

(ii) the number of sampling units taken and

(iii) the location (i.e.distibution) of that sampling unit

3.2. Agroclimatic features of the experimental site

Field studies were carried out during 1991 to 1996, in the vicinity of North Bengal University, Siliguri, West Bengal at Block seed farm, Salbari; CADC farm, Satbhaia, Naxalbari and farmers field of Siliguri subdivision of Darjeeling. Place is located $26^0 4'$N, $88^0 26'$E and 126m amsl. The area belongs to foothills of Darjeeling, plain topography and an average annual rainfall of 350cm with minimum temperature of 12^0C and maximum of 30^0C in general.

Soil of Siliguri sub-division of Darjeeling district is deep, light texture, high permeable porus soil with water regime fluctuating within 1 metre depth relative to river-flow level; moderate level of organic matter content without appreciable mineralisation, highly acidic, low in bases, phosphate, potash and micronutrient. Area is mostly flat with 0-1% having low height field bund. Soil P^H ranged from 5.5-6.0, acidic in nature.

The climate of the experimental site is of subtropical humid. The climatic parameters mainly monthwise average rainfall(mm) and 10 years average data (1983-1992) is presented in Table 3. Monthwise minimum and maximum relative humidity (%) and temperature (^{0}C) have been presented in Table 4.

Fig.9 depicts monthly assured rainfall showing, mean, 50%, 60% and 70% assured rainfall (mm) in Darjeeling district. Fig.10 represents the rainfall scenario of Siliguri subdivision in particular period of experimentation along with 10 years average data.

Table 3. Mean monthly rainfall (mm) of Siliguri subdivision during 1991-96

Years/Month	1991	1992	1993	1994	1995	1996	10 Yrs. Av. ('83-'92)
JAN.	24.00	16.00	17.60	48.20	1.10	43.00	15.45
FEB.	2.50	12.00	8.60	58.60	14.70	4.40	22.20
MAR.	42.50	0.00	8.80	28.60	20.50	5.00	39.00
APR.	32.00	61.00	114.70	42.20	7.20	14.40	80.77
MAY	128.00	161.00	186.30	152.20	137.70	305.60	280.65
JUNE	1358.00	369.00	495.20	314.80	1092.90	273.30	725.43
JULY	650.50	755.40	847.70	380.80	862.00	1159.20	1033.32
AUG.	749.50	366.90	500.80	446.70	582.60	623.30	624.64
SEP.	1459.50	385.10	283.90	374.47	416.90	-	678.44
OCT.	149.50	244.20	271.40	43.80	268.60	-	232.23
NOV.	0.00	0.00	44.10	3.00	83.40	-	7.10
DEC.	39.00	21.80	14.60	0.00	12.00	-	17.93
TOTAL	**4635.00**	**2392.40**	**2793.70**	**1893.47**	**3499.60**		**3807.01**

Table 4. Meteorological data for the experimental period (1991-96)

	RELATIVE HUMIDITY (%) Minimum						Maximum						TEMPERATURE (°C) Minimum						Maximum					
Year / Month	1991	1992	1993	1994	1995	1996	1991	1992	1993	1994	1995	1996	1991	1992	1993	1994	1995	1996	1991	1992	1993	1994	1995	1996
JAN.	-	64.39	65.13	55.00	51.00	55.00	-	72.84	94.19	92.00	88.00	92.00	-	10.32	9.63	9.60	6.70	7.9	-	24.40	20.59	24.30	23.40	22.9
FEB.	-	60.55	54.75	59.00	52.00	49.00	-	78.00	90.71	90.00	88.00	91.00	-	9.38	12.58	10.60	10.10	10.7	-	22.83	23.78	24.30	25.00	26.6
MAR.	-	47.44	43.10	55.29	49.00	49.00	-	75.30	83.03	81.26	85.00	86.00	-	16.35	14.16	16.43	13.80	15.3	-	30.12	26.33	28.32	29.80	30.2
APR.	-	61.47	45.90	54.00	34.00	39.00	-	76.53	78.57	75.00	65.00	68.00	-	19.69	18.96	18.70	17.90	17.4	-	33.33	31.17	31.60	33.80	33.9
MAY.	-	88.90	66.65	64.00	61.00	68.00	-	93.61	87.48	83.00	82.00	87.00	-	21.97	21.98	22.00	23.20	20.7	-	30.68	30.79	32.90	33.50	32.5
JUNE.	-	72.92	71.17	76.00	80.00	72.00	-	88.73	91.17	91.00	95.00	93.00	-	24.43	22.35	23.60	23.00	21.6	-	32.42	31.68	31.50	30.60	31.4
JULY.	-	75.77	74.23	74.00	78.00	79.00	-	91.29	93.45	91.00	96.00	96.00	-	30.56	23.88	24.00	23.10	22.5	-	31.58	31.39	33.20	30.80	30.9
AUG.	-	75.65	81.06	75.00	76.00	77.00	-	91.84	93.97	92.00	92.00	95.00	-	24.65	24.41	23.80	22.80	22.1	-	32.22	31.06	32.50	31.9	32.6
SEP.	86.73	72.73	73.87	72.00	77.00	-	92.33	92.27	91.43	90.00	92.00	-	26.62	24.15	23.33	22.70	21.9	-	80.55	31.89	31.50	32.10	30.7	-
OCT.	76.13	60.55	74.87	66.00	65.00	-	82.58	92.84	92.26	89.00	88.00	-	20.48	20.27	20.27	18.80	18.4	-	31.71	30.61	30.27	30.00	31.2	-
NOV.	62.57	43.50	55.57	54.00	52.00	-	67.00	91.73	91.47	87.00	86.00	-	12.94	13.59	15.85	12.40	14.00	-	30.78	29.31	28.28	29.10	29.5	-
DEC.	52.26	48.16	47.00	47.00	54.00	-	79.42	92.48	90.00	88.00	91.00	-	9.99	9.75	10.50	8.70	10.4	-	26.89	48.16	26.60	25.60	24.8	-

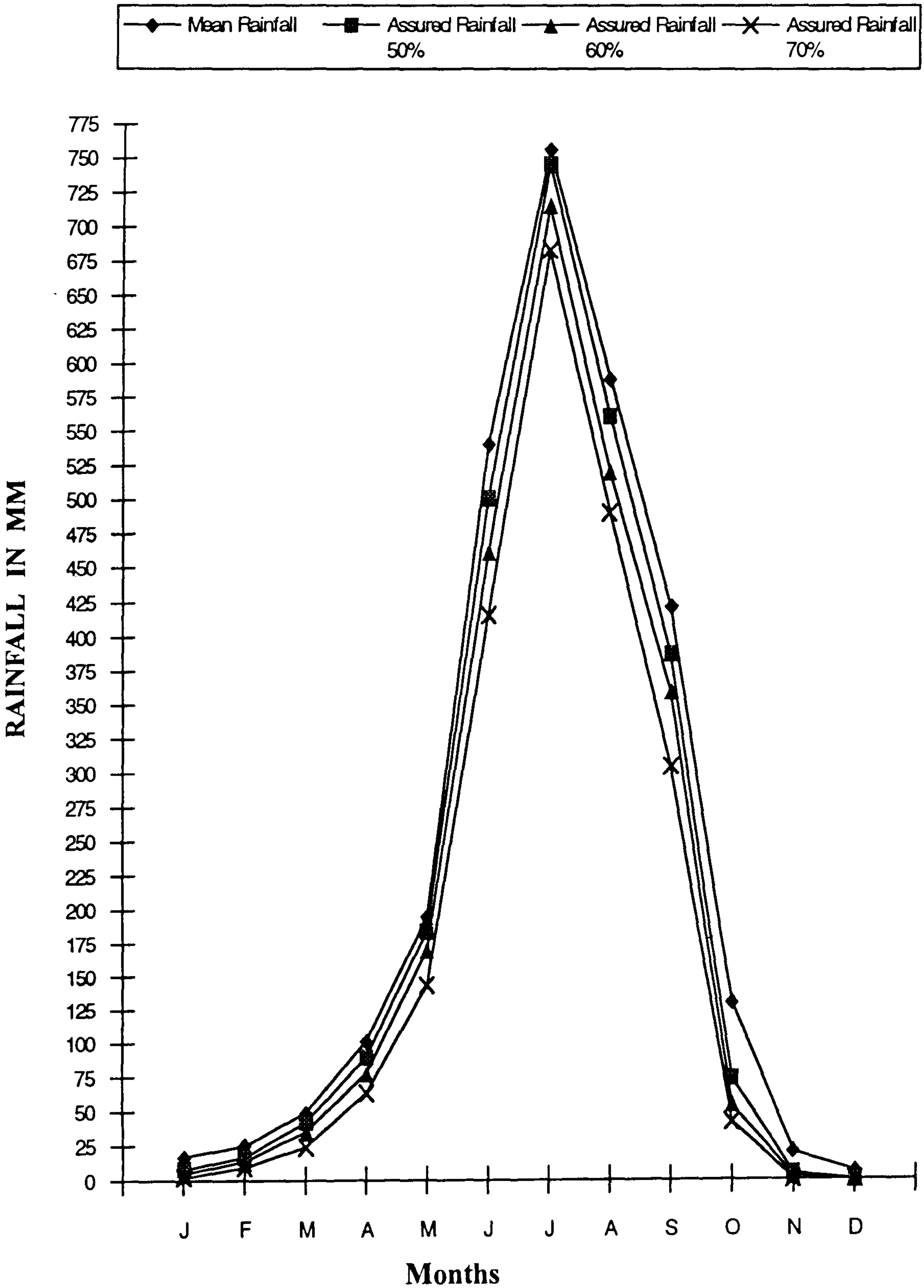


Fig. 9 : Monthly assured rainfall graph showing mean, 50%, 60%, 70% rainfall (mm) in Darjeeling district (based on 80 years data)

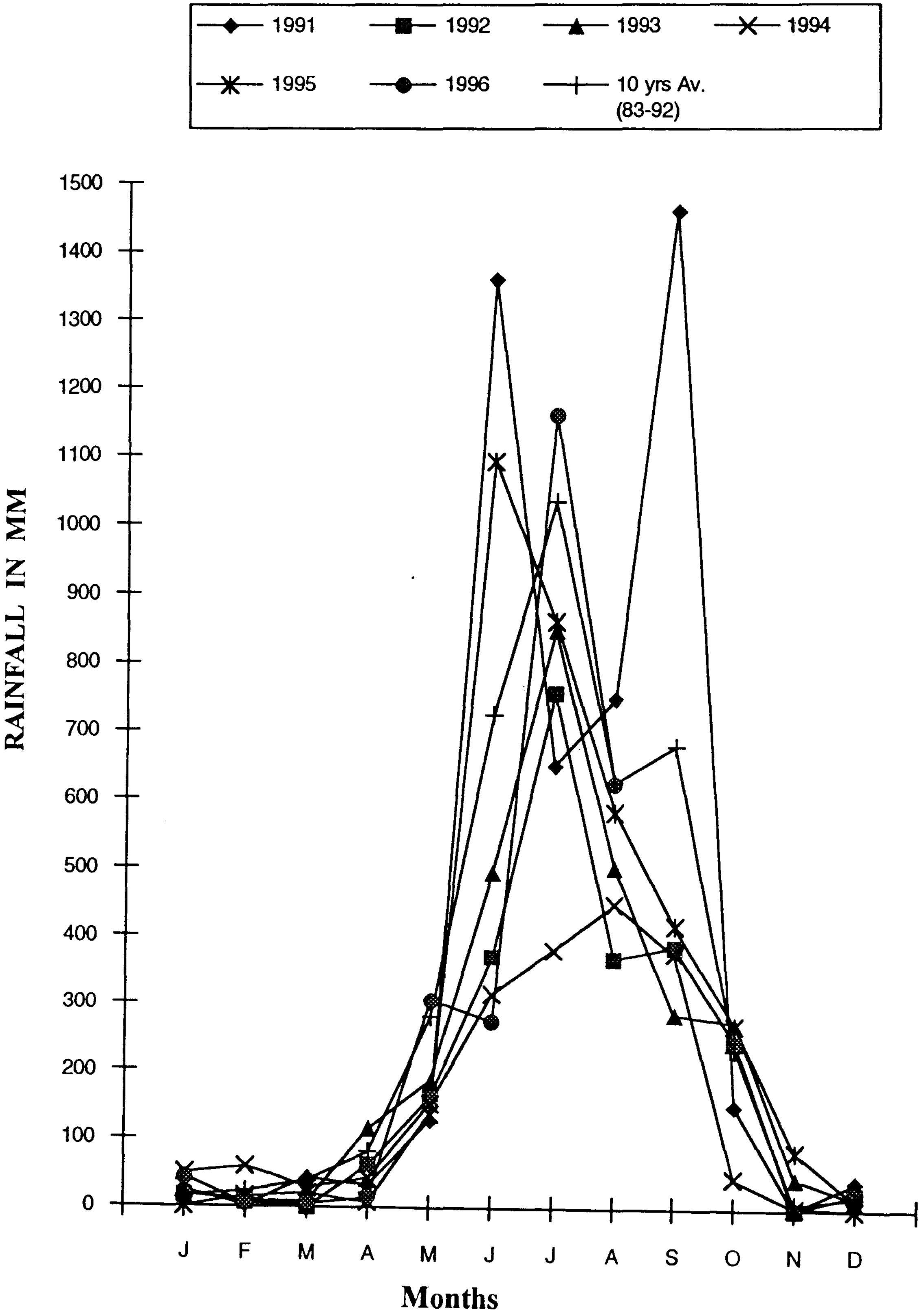


Fig.10. Monthly rainfall graph of Siliguri Subdivision during 1991-96 in mm

3.3 Source of germplasm

Investigation was carried out including 53 germplasm of brinjal collected from different corners of India. But due to failure in germination, 12 varieties were discarded and ultimately experiment was conducted with the following 41 varieties or lines of egg plant.

1. R-14, 2. Nishchindipur Local, 3. Sufal, 4. KB-9, 5. White Long Cluster, 6. Nurki, 7. Muktajhuri, 8. Shyamla Dhepa, 9. Neelam Long, 10. Pusa Purple Round, 11. Kalo Dhepa, 12. Pusa Purple Long, 13. Banaras Giant White, 14. KB-20, 15. L-13, 16. Boral, 17. Pusa Purple Cluster, 18. Banarasi, 19. KB-5, 20. Muktakeshi., 21. Krishnanagar Purple Round, 22. Navkiran, 23. Rajkrishna, 24. Pyratuni, 25. IR-8 Baramasi, 26. Banaras Long Purple, 27. Baramasi, 28. Shyamla Bhangar, 29. BB_1, 30. Murshidabad Local 31. ARM-3, 32. Krishna, 33. Krishnanagar Hybrid Variety-90, 34. KB-52, 35. KB-10, 36. Brinjal Long Green, 37. Pusa Kranti, 38. KB-2, 39. Black Prince, 40. Agora, 41. Suttons Long.

These planting material have clear variability with respect to plant growth, type, pigmentation, color-shape-size of fruit as summarised in Table 5. These are collected from different parts of the country as enumerated on the next page :

Another 12 varieties such as P-18 line from BCKV, Kalyani, W.B. Arka Shirish, Arka Sourav, collected from IIHR, Bangalore, Pusa Anmol, S-5, SM 17-4 from New Delhi (IARI) and Banamala, Krishnanagar (27 × 30), T_3, Muktakeshi, Amdanga (3), Amdanga (8), collected from Horticultural Research Station, Krishnanagar, W.B., unfortunately did not germinate in the very exclusive climate of Darjeeling foot hills and were as such could not be included in the experiments.

Name of germplasm	*Source*
Pusa Purple Long, Pusa Purple Cluster, Pusa Purple Round.	IARI, New Delhi
Navkiran	Kashmir Seed Co., Kashmir
BB_1	OUAT (Orissa University of Agriculture and Technology) Bhubaneswar.
R-14, L-13, Sufal	IAHS (Indo American Hybrid Seed Co.) Bangalore, Karnataka.
Black Beauty, Muktakeshi, Banarasi, Neelam Long	Bharat Nursery, Calcutta, W.B.
Suttons Long, Nurki	Suttons & Sons, Calcutta, W.B.
Shyamla Dhepa, Kalo Dhepa	From Farmer's field
Baramasi, IR-8 Baramasi	Siliguri, North Bengal.
KB-2, KB-5, KB-10, KB-20, KB-52.	All India Co-ordinated Vegetable Improvement Project, BCKV, Kalyani, Nadia, WB.
Banaras Giant White Banaras Long Purple	Varanasi, U.P.
Murshidabad Local	Murshidabad, W.B.
Nishchindipur Local, ARM-3	Midnapur (Mecheda), W.B.
Shyamla Bhangar	Bhangar, 24 Parganas (South), W.B.
Boral	Calcutta, W.B. (Sealdah)
Brinjal Long Green	IAHS. Co., Siliguri, Hill Cart Road, W.B.
Krishnanagar Purple Round Krishnanagar Hybrid Variety '90 Krishna, Raj Krishna.	Assitant Horticulturist, Krishnanagar Horticultural Research Station, Dept. of Agriculture, W.B.
Pyratuni, Muktajhuri, White Long Cluster	Krishnanagar, Nadia West Bengal.
Agora	Sandose Co. Seed, Collected from Siliguri, Bidhan Market.

3.4. Source of Agrochemicals

Agrochemicals used in the experiment are presented in tabular form as briefed below.

Trade Name	Chemical Name	Company source
1. Metacid 50 EC	Methyl Parathion 50 EC	Bayer (India) Ltd., Bombay.
2. Thiodan 35 EC	Endosulfan	Hoechest.
3. Basathrin 25 EC	Cypermethrin 25 EC	BASF India Ltd., Bombay.
4. Rogor 30 EC	Dimethoate	Ralis India.
5. Monocil	Monocrotophos 36%	NOCIL, Bombay.
6. Decis 2.5 EC	Decamethrin	Hoechest.
7. Demecron 85 EC	Phosphomidan 85 EC	Hindusthan Cibaca.
8. Ripcord 10%	Cypermethrin 10% EC	NOCIL, Bombay.
9. Suquin	Quinalphos 25 EC	Sudarshan Chemical Industries Ltd., Pune.
10. Malathion 50 EC	Malathion 50% EC	East Coast Pesticides, Ganjam, Orissa.
11. Neem Gold	Azadirachtin-0.3%	SPIC, Madras.
12. Vage Guard	Vage Guard	Exel Agro Industries.

3.5. Screening of *Solannum melangena* for its relative susceptibility to four major insect pests

3.5.1. Relative susceptibility to *Leucinodes orbonalis* as a fruit borer and as a shoot borer

The experiment was conducted during autumn-winter seasons of 1991-92 and 1992-93 to study the response of 41 cultivars and lines of brinjal against the damage caused by major insect pests at Siliguri. The experiment was laid out in simple randomized block design with 3 replications during both the years. The size of subplot was 3.0 m × 2.8 m, having 20 plants spaced 70 cm × 60 cm apart. The crop was left for natural infestation of pests. Data were recorded from the time of first occurrence of the pests. The total number of shoots damaged due to the attack of *L. orbonalis* in the central 5 plants was also recorded. The fruits were harvested at an interval of 10 days, sorted out into marketable and unmarketable fruits, counted and weighed for computation of final yield. The data were statistically analysed.

The resistance grade index was calculated for each variety according to the degree of infestation. According to Lal *et al.* (1976), percent fruit damage on number and weight basis were considered for gradation. These grades were deemed as immune (0%), highly resistant (1-10%), fairly resistant (11-20%), tolerant (21-30%), susceptible (31-40%) and highly susceptible (above 41% infestation).

Following the grade index of Subbaratnam and Butani(1981) the relative tolerance was estimated on the basis of incidence of number of pests/5 plants for shoot borer. But the index for fruit borer was considered on the basis of fruit damage (%).

On this basis following are the grading index :

Grade	**Shoot borer**	**Fruit borer**
Tolerant	< 2.0	< 15.0 %
Moderately Tolerant	2.1-3.0	16.0-25.0%
Susceptible	3.1-5.0	26.0-40.0%
Highly susceptible	> 5.0	> 40

3.5.2. Relative susceptibility to jassid, aphid and spotted leaf beetle

Likewise the populations of cotton leaf hopper (jassid), cotton aphid (aphid) and spotted leaf beetle were counted from 5 leaves (2 top, 2 middle and 1 bottom) from each of the 5 central plants in every subplot at 20 day intervals-starting from the first incidence till completion of harvesting and data were statistically analysed.

Following the grade index of Subbaratnam and Butani(1981) the relative tolerance was estimated on the basis of incidence of number of insect pests/5 leaves/pl for cotton leaf hopper and aphid. On this basis the grading index are :

Grade	Cotton leaf hopper	Cotton aphid
Tolerant	< 10.0	< 20.0
Moderately tolerant	11.0 - 19.0	21.0 - 30.0
Susceptible	23.0 - 30.0	31.0 - 50.0
Highly Susceptible	> 30.0	> 50.0

however, no grade index is available for spotted leaf beetle.

3.6. Variability studies

Genetic varibility or the differences among the 41 cultivars were tested for significancee by using analysis of variance technique on the basis of model proposed by Panse and Sukhatme (1989). The genotypic and phenotypic co-efficient of variation were calculated by the formula given by Burton (1952). The genotypic and phenotypic variance were calculated as per the formulae given by Burton and Devane (1953). Heritability in broad sense was estimated by using formula given by Hanson (1963). The procedure suggested by Allard (1960) was used for computation of genetic advances.

3.6.1. Genotypic and phenotypic variability for vegetative characters.

Following vegetative character were considered during investigation.

(i) **Plant height at first flowering :**

The mean of the height of 5 randomly selected plants was measured in cm at the time when plants flowered.

(ii) **Plant height at first harvesting :**

The average height of 5 randomly selected plants were measured in cm at the time when tender fruits having edible maturity were first harvested for consumption.

(iii) **Number of primary branches :**

For each randomly selected 5 numbers of individual plant, the number of primary branches were counted arising from the main stem and their average value was taken into consideration.

(iv) **Number of secondary branches :**

Mean of the randomly selected 5 plants with regards to number of secondary branches arising out from the primary branches were taken under observation.

(v) **Days to flower :**

The average days taken to flower after transplanting were calculated for each parent and hybrids of 5 randomly selected representative plants. Data of each replication mean during each time was averaged to calculate mean days.

(vi) **Days taken from transplanting to first picking :**

Number of days were recorded from date of transplanting to the first edible stage of picking.

(vii) **Marketable yield :**

The weights of the total number of fruits for each selected plant were considered to calculate the average yield/pl in kg.

3.6.2. Variability for some reproductive characters

Under this group following 5 parameters were considered.

(i) **Length of fruit :**

The mean length of the randomly selected fruits from each harvest for each selected plant were recorded in cm.

(ii) **Maximum circumference of the fruit :**

The maximum circumference in cm. was recorded for those fruits whose lengths were measured and the average value for each randomly selected plant was calculated.

(iii) **Number of fruits/plant :**

Number of fruits produced per plant were recorded and the average of each treatment was calculated from randomly selected plants.

(iv) **Weight of fruit :**

Mean weight of marketable or unmarketable fruits for this character was recorded from each picking of each variety in each replication for treatment average in kg/fruit.

(v) **Total yield/plant :**

For this character total number of marketable and unmarketable fruits and their respective yield were added together from each of the replications for treatment average.

At each picking time the number of markatable and unmarketable fruits and their respective weights were calculated. The Picking of fruits were made at an interval of 7-10 days. Then by adding all the numbers of all harvest total number of marketable and unmarketable fruits, their respective yield were calculated for each replications and averaged out and converted to total yield/pl in kg. by addition of marketable and unmarketable yield.

3.6.3. Variablility for some important susceptibility components for *L. orbonalis* attack

Susceptibility components considered are as briefed below -

(i) **Number of larvae/plant :**

Randomly selected 10 plants from each replication were taken for calculation of the number of larvae/pl. Infested fruits of the plants were also added to the shoot infestation. This is based on the number of larvae found during the investigationn and averaged out for treatment total.

(ii) **Number of larvae/fruit :**

From among the infested fruits from each lot of a replication was taken to find out the number of larvae present with in the fruits. And average value for randomly selected 10 infested fruits gives the required data.

(iii) **Number of holes/plant :**

Ten plants were randomly selected to estimate the number of holes/ pl including the holes on fruit and average out.

(iv) **Number of holes/fruit :**

Out of 10 randomly selected infested fruits number of holes were averaged out to find out the total number of holes/ft.

(v) **Number of days taken by the borer to attack on branches :**

After transplanting, number of days taken to observe first incidence of attack on the shoots by the borer pest was counted for this purpose and average out for each replication.

(vi) **Number of days taken by the borer to attack on fruits :**

Similarly, number of days taken from transplanting to observe the first incidence of the attack by the fruit borer was counted for this purpose.

(vii) **Percent infested branches/plant :**

Number of shoots affected in each plant by the shoot and fruit borer was recorded while picking was done at an interval of 10 days. Based on total number of secondary branches or shoots or twigs and number of infested shoots, percent infestation/pl was calculated from the 5 central plants from each replication.

(viii) **Percent infested fruit/plant :**

It was estimated from the total number of fruits/pl and infested fruit for same plant and their percent conversion. Average for each replication gives treatment data in percentage. This is based on number of fruits mainly.

(ix) **Percent loss in yield/plant.**

The quantity of unmarketable fruits divided by total yield (both marketable and unmarketable) when multiplied by 100 gives the estimate of percent yield loss. This is based on the weight of fruits/pl.

3.7. Correlation and path analysis

Correlation and path analysis were done for all the vegetative, reproductive and susceptibility components enumerated as in 3.6.1, 3.6.2. and 3.6.3. Correlation and path analysis was performed with 41 genotypes of brinjal but during 1995-96 only 38 brinjal lines were tested. Lay out and replications were same for all the 3 cases.

For genotypic correlations the method of Robinson *et al*. (1949) and for path analysis, the method of Dewey and Lu (1959) were followed.

3.8. Genetic divergence

The multivariate analysis based on Mahalanobis D^2 statistic is desired to be employed as a powerful tool for measuring genetic divergence in plant breeding experiments (Mital *et al.*, 1975) and the populations were grouped into cluster treating D^2 as the square of generalised distance (Rao, 1952).

3.9. Screening of 12 agrochemicals using *L. orbonalis* as shoot borer and fruit borer

3.9.1. Efficacy of 12 agrochemicals on the suppression of *L. orbonalis* infesting a local cultivar (Dhepa)

Altogether 12 agrochemicals of different nature were put into trial in this investigation as water soluble sprays. Treatments were, - methyl parathion 0.05% (metacid 50 EC), - endosulfan 0.07% (thiodan 35 EC), - cypermethrin 0.006% (basathrin 25 EC), T_4-dimethoate 0.03% (rogor 30 EC), T_5 - monocrotophos 0.03 % (monocil 36 %), T_6 - decamethrin 0.002% (decis 2.5 EC), T_7 - Phosphomidan 0.04% (dimecron 85 EC), T_8 - cypermethrin 0.005 (ripcord 10%), T_9 - quinalphos 0.05EC), T_{11} - azadirachtin 0.001% (neem gold 0.30%), T_{12} - vage guard 0.001% (vage guard) and T_{13} - Control (waterspray).

The investigation was carried out in some experimental plots in the Darjeeling Terai having a distinct agroclimatic character. The locally preferred high yielding 'Dhepa' cultivar of brinjal was the experimental plant. The plants were sprayed thrice, first on 45 days after transplantation, thereafter on 15 days interval. Seedlings of brinjal were transplanted in a plot of 3m × 5m during October to February (rabi season) of 1993-

94, consisting of 12 chemical treatments and one control as water spray. For each treatments and control 10 plants were considered randomly. The number of infested shoots or fruits, due to attack of *L. orbonalis* Guen. recorded during the course of investigation were converted into percentage infestation over the control. The data were subjected to analysis of variance following Randomised Block Design after making angular transformation.

3.9.2. Impact of 12 agrochemicals on growth and yield of local cultivar of brinjal and cost:benefit ratio

Similarly, this experiment was conducted as reported in 3.9.1. while studying efficacy of 12 agrochemicals. The observation on plant vagetative growth parameters was restricted to the number of secondary branches, plant height and the number of leaves/pl at the time of each harvesting. The yield was computed while weighing the fruits after sorting out into healthy and borer affected fruits at each harvest. The economics of the pesticides was calculated from the yield data obtained during screening efficacy of the agrochemicals.

3.9.3. Efficacy of pesticide combinations using six promising brinjal cultivars under modern concept of IPM

In order to find out the resistance response of the cultivars, at first screening work was carried out during autumn winter season of 1991-92 and 1992-93. Following Lal *et al.* (1976), out of 41 cultivars screened, 3 cultivars namely, Kalo Dhepa (KD), Banaras Long Purple (BLP) and Navkiran were identified as resistant; Banaras Giant White (BGW) and Krishna as moderately susceptible and R-14 as highly susceptible cultivar to *L. orbonalis*. The promising 6 cultivars thus obtained were further tested for two more years during 1993-94 and 1994-95 for confirmation of their resistance response to the 4 major insect pests with special emphasis to *L. orbonalis.*

In all the screening experiments varieties were transplanted in a randomized block design with 3 replications. The size of subplot (replication) was 3.0m × 2.8m having 20 plants spaced 70 cm. × 60 cm. apart.

Split plot technique was followed during 1993-94 and 1994-95 for pesticidal screening. During this period, varietal performace of brinjal towards the borer, jassid, aphid and spotted leaf beetle was tested in an unprotected crop as control. The pesticidal screening design was as under -

P_0 = Control having no treatments of water or insecticides.

P_1 = Root zone treatment with carbofuran @ 750g a.i./ha at 3 weeks stage after transplanting followed by single foliar spray of cypermethrin @ 50g a.i/ha at 70 days after transplanting.

P_2 = Carbofuran was applied as in the first one followed by single spray of endosulfan @ 525g a.i/ha at 70 days after transplanting.

P_3 = Water Spray only.

From all the experiments on varietal testing and chemical centrol, observations on the number of healthy and the cumulative mean percent fruits damage by the borer was worked out for different treatments. the population of jassid, spotted leaf beetle and aphid were recorded from 5 leaves of each of the 5 central plants in every subplot and averaged out. The observations were recorded through out the crop growth phase at 20 day interval. The yield of marketable fruits were recorded at each picking on whole plot basis and converted into total yield/pl for different treatments.

3.10. Performance of six selected parents and their 30 F_1 hybrids

Hybridization experiment was conducted at CADC Farm, Siliguri during 1994 september to 1995, April including six selected parents in a diallele fashion. Seeds are collected and another experiment was conducted during September 1995 to April, 1996 under the following sub heads.

Materials : Materials include 6 promising and widely divergent varieties as parents and their 30 F_1 hybrids produced during 1994-95. along with other two popular varieties of Malda district of North Bengal as check variety. These are as briefed below —

Parents

1. Kalo Dhepa (KD)
2. Banaras Giant White (BGW)
3. Krishna
4. R-14
5. Bararas Long Purple (BLP)
6. Navkiran.

Check variety

1. Nababganj
2. Tal

Hybridization :

The varietal seeds were sown separately in the field on 15.10.94 and raised seedings were transplanted on 25.11.94 to 30.11.94 in 2 rows with

40 plants each for each of the parents with 1m isolation distance between the varieties as parents.

Bud selection for emasculation :

Flower bud selection for hybridization is very important. According to Krisnamurti and Subramanian (1954a) there are 4 types of flower in brinjal viz. —

(i) long-styled with big size ovary

(ii) medium styled with medium size ovary

(iii) pseudoshort styled with rudimentary ovary

(iv) true short-styled with very rudimentary ovary.

Long and medium styled flower buds which were just to bloom were selected for emasculation.

Emasculation : Before emasculation was done, morphology of flower was studied. Emasculation was done by forcep method in the afternoon to avoid drying of stigmatic secretion.

Anthesis in brinjal flowers, starts from 7,30 a.m. and continues upto 11 a.m. Peak time for anthesis is 8.30 to 10.30 a.m. The pollen dehiscence starts from 9.30 to 10 a.m.

Protection of stigma : Artificial cross pollination was done in the earlier part of the next morning (between 7.30 a.m. to 8.30 a.m.). Crossing were done between parents as stated on the next page :

In each combination more than 50 flower buds has been emasculated and cross pollinated for raising. F_1 hybrid seeds during 1995, October to 1996, at Siliguri.

	Female Parent	**Male or Pollen Parent**
1)	Kalo Dhepa (KD)	Banaras Giant White (BGW)
		Krishna
		R-14
		Banaras Long Purple (BLP)
		Navkiran.
2)	BGW	KD
		Krishna
		R-14
		BLP
		Navkiran
3)	Krishna	KD
		BGW
		R-14
		BLP
		Navkiran
4)	R - 14	KD
		BGW
		Krishna
		BLP
		Navkiran
5)	BLP	KD
		BGW
		Krishna
		R-14
		Navkiran
6)	Navkiran	KD
		BGW
		Krishna
		R-14
		BLP

Harvesting of F_1 hybrid seeds :

Well ripened, mature selfed and crossed fruits were harvested separately variety wise to extract seeds by farmentation methods, dried properly, packed in seed packets and kept in desiccator. Selfed seeds of parent varieties were also kept in desiccator. On an average there were 200 seeds for each cross combination.

Raising of F_1 generation along with their parents :

Thirty F_1 hybrids along with 8 parent varieties were sown on 15.10.95 to raise seedlings and these were transplanted on 25th Nov; 95.

Layout : The experiment was laid out in a randomised block design replicted thrice in a sandy loam soil with individual plot size 3.0 m × 2.8 m having 20 plants spaced 70 cm × 60 cm. apart. The crop was left for natural infestation of pests. Data were recorded from the time of first occurrence of the pests. Six weeks old seedlings were transplanted in the experimental plots. All cultural, and agrotechniques were adopted uniformly in all treatments as required.

Observation recorded : All the vegetative, reproductive and susceptibility parameters considered during the investigation was as in case of normal 41 varieties studied during 1991-92 and 1992-93.

Qualitative characters : Qualitative Characters viz flower colour, fruit colour, fruit shape and leaf characters were recorded for each selected plants.

Agrotechniques adopted :

Land Preparation : The experimental field was prepared thoroughly by repeated ploughing and laddering to get a fine tilth.

Raising of seedling in Nursery : The seeds were treated with bavistin @ 3 gm/kg of seeds and then sown in the raised seed beds on october 5 to 15 during 1991-96 for different experiments. The seeds of different varieties were sown in seperate seed beds. The 0.45 m × 0.45 m beds were first prepared with 0.4 kg organic manure @ 20 tons FYM/ha.

Transplanting : When the age of seedlings were 35-40 days these were transplanted in the main field during November-December for different experiments conducted during 1991-96.

Manures and Fertilizer : Compost @ 10 tons/ha were applied to the field at the time of final land preparation. A fertilizer dose of 75 Kg N, 50 Kg P_20_5 and 50 Kg K_2o/ha were applied as basal dose and another 75 Kg N were applied 30 days after transplanting, considering the medium to low level of nutrient status of the experimental field.

Irrigation and interculture : Spot application of irrigation by bucket was done during establishment phase of the seedling. Irrigation and interculture was provided as and when necessary other normal recommended cultural practice was adopted for raising brinjal crop.

Plant Protection : Experimental plots were left for natural infestation by the insect pests. Only during sowing of seeds. A systemic fungicide Bavistion @ 3 gm/kg of seeds was used for checking fungal diseases. Roughing of little leaf infected plants were made when noticed in the field. Phomopsis blight infected fruits were plucked when observed. These methods were adopted for screening the germplasm during 1991-92, 1992-93 and 1995-96. Agrochemical spray were done while screening for different agrochemicals under specific experiments.

3.11. Statistical calculations and biometrical methods

Statistical Analysis :

The experimental data of the 1991-92, 1992-93, and 1995-96 for the various characters studied were subjected to the variance analysis appropriate to a simple RBD and the significance of different sources of variation were tested following standard procedure of 'F' test at probability level 0.05. The critical difference between the entries were calculated at 5% level of significance. Split Plot Technique was followed as per Panse and Sukhatme, 1989. Other biometrical analysis were done using the following procedure.

(i) Genotypic, Phenotypic and error variances

The expected mean sum of squares for error, E. (MS) i.e. $\delta^2 e$ may be considered as purely a random environmental variance. The mean sum of squares consist of variances (i) attributable to varietal differences (i.e. genotypic differences) and (ii) due to environmental variation among individuals of each genotype. Thus the expected mean sum of squares would be

$$E\,(MSv) = \delta^2 e + r\delta^2 g$$

$$E\,(MSe) = \delta^2 e$$

and therefore, $\delta^2 g = \dfrac{MS_v - MS_e}{r}$

Thus the genotypic variance being $\delta^2 g$ and the environmental variance as $\delta^2 e$, the phenotypic variance $\delta^2 p$ will be equal to $\delta^2 g + \delta^2 e$ (Singh and Chowdhury, 1985). $\delta^2 g$ and $\delta^2 p$ with regard to the different growth and yield attributing characters were worked out.

The data on phenotypic variation in various plant characters were statistically analysed. Standard errors of means and critical differences for each character were worked out by the method of analysis of variance used for randomised block design. (Panse and Sukhatme, 1989).

a) Standard error of means (S.Em $\pm$) was calculated by using formula —

S.Em $= \pm\sqrt{\frac{EMS}{r}}$, where EMS = Error Mean Square

r = Number of replication.

b) Critical difference (CD) was calculated by using following formula - SED $\times$ t at 5% or 1% level of significance.

where, standard error difference, SED $=\sqrt{\frac{2EMS}{r}}$

(ii) Genotypic and phenotypic co-efficient of variation.

$$GCV = \sqrt{\frac{\delta^2 g}{X}}$$ where X = Grand mean of treatment.

$$PCV = \sqrt{\frac{\delta^2 p}{X}}$$

(iii) Heritability (broad sense) : It is the ratio of genotypic variance to the phenotypic variance.

$$\text{Thus, } h^2 = \frac{\delta^2 g}{\delta^2 p}$$

(iv) Genetic advance : The estimation of genetic advance under selection is obtained by using the following formula.

GA = (K) (δ_p) (H). where K = 2.06 at 5% selection intensity,

$\delta^2 p$ = phenotypic variance H = Heritability.

(v) Correlation are calculated using the following formula :

$$r(x_1x_2) = \frac{Cov\ (x_1x_2)}{\sqrt{v(x_1)\ v(x_2)}}$$

where, $r(x_1x_2)$ is the correlation between x_1 and x_2 Cov. (x_1x_2) is the covariance between x_1 and x_2

$v(x_1)$ is the variance of x_1

$v(x_2)$ is the variance of x_2

(vi) **Path co-efficient analysis.**

Path co-efficient analysis was carried out at the genotypic level as suggested by Wright (1921) and discussed by Li (1954) and Dewey and Lu (1959). The simultaneous equation of path analysis was worked out by Elemination Procedure.

Statistical calculation for heterosis in brinjal :

Percentage heterosis with respect to mid parent, better parent and superior variety was calculated for different characters by using the methods of Turner (1953) and Hayes *et al.* (1955).

(i) Percentage heterosis with respect to Mid parent

$$= \frac{F_1 - MP}{MP} \times 100$$

where, F_1 = Mean of F_1 hybrid

MP = Average Mid Parental value which is

$\frac{P_1 + P_2}{2}$ (P_1 and P_2 are the mean of two parent)

Critical difference (CD) of Mid parent was calculated by using formula —

CD for MP = $\sqrt{\frac{3}{2} \times SEM} \times t$ at 5% or and at 1% level of significance where, SEM $= \frac{EMS}{r}$

(ii) Percentage heterosis with respect to better parent, i.e. heterobeltiosis can be calculated as $\frac{F_1 - BP}{BP} \times 100$

where, F_1 = Mean of F_1 hybrid

BP = Mean of better parent.

(iii) Percentage heterosis with respect to superior variety $\frac{F_1 - SV}{SV} \times 100$

where, F_1 = Mean of F_1 hybrid.

SV = Mean of Superior variety.

Critical difference (CD) of better and superior variety was calculated as -

$\sqrt{2 \times SEM} \times t$ at 5% or 1% level of significance.

where, SEM $= \frac{EMS}{r}$

EMS = Error mean squares, and

r = Number of replication.

3.12 Computer Software used

RBD, Path Analysis, D^2 statistics, GPVCA, Anand-inv., Inverse Basic, HPG, Lotus, Cw, Page Maker, Sigma Plow, Cannroot and Scientific calculater Casio 82L.

4. RESULTS

4.1. Screening of *S. melongena* for its relative susceptibility to four major insect pests

The distinctive features of the 41 varieties screened during 1991-92 and 1992-93 with respect to some qualitative characters are enumerated in the Table 5. The varieties significantly differ among themselves for the characters studied.

Photographs of the selected few germplasm of the 41 brinjal varieties screened are presented in Figures 11-27 respectively for the cultivars R-14, Banaras Long Purple (BLP), Banaras Giant White (BGW), Kalo Dhepa (KD), Krishna, Navkiran, Nababganj, Tal, Muktajhuri, IR-8-Baramasi, Shyamla Bhangar, Murshidabad Local, KB-10, ARM-3, BB_1, Krishnanagar Hybrid Variety '90 (KHV_{90}) and Shyamla Dhepa. Number of secondary branches/pl, number of fruits/pl, total yield/pl (kg) and percent yield loss for each of the varieties (Figs. 11-27) are also highlighted from among the vegetative, reproductive and susceptibility components.

4.1.1. To *Leucinodes orbonalis* as a fruit borer and as a shoot borer

Relative susceptibility to *L. orbonalis* as a fruit borer during 1991-92 :

None of the 41 tested cultivars of egg plant was found to be totally

Table 5. Summarised table of some distinctive characters of 41 brinjal germplasm screened during 1991-92 to 1992-93

	Varieties	Leaf character	Flower colour	Fruit colour	Fruit shape
1.	R 14	Green, White vein,	Pink	Pink	Round, depression on back.
2.	NIL	Green, purple vein	Light purple	Purple	Small, medium long
3.	Sufal	Green, white vein, narrow	Black purple	Black purple	Oblong
4.	KB-9	Green, purple veinp	Light purple	Purple	Medium long
5.	WLC	Green, white vein	Light purple	Purple	Medium long
6.	Nurki	Purple vein	Light purple	Purple	Long
7.	Muktajhuri	Narrow, purple vein	Reddish purple	Redish purple	Narrow, very Long
8.	Shyamla Dhepa	Medium, purple, pigment	Light purple	Green	Round
9.	Neelam Long	Medium, purple vein	Purple	Purple	Small oblong
10.	Pusa Purple Round	Medium, purple vein	Purple	Purple	Round
11.	Kalo Dhepa	Medium green, purple vein	White purple	Purple	Medium round
12.	Pusa Purple Long	Narrow green	Purple	Purple	Long
13.	Banaras Giant White	Broad, light green, thick, white vein	Purple white	Light green	Round big.
14.	KB-20	Narrow, long white vein.	Light purple	Purple	Medium round

Table 5 contd............

	Varieties	Leaf character	Flower colour	Fruit colour	Fruit shape
15.	L-13	Vertical, narrow, white vein.	Light purple	Light purple	Long narrow.
16.	Boral	Narrow, white vein	Light purple	Pinkish purple	Medium round.
17.	PPC	Medium, purple vein,	Light purple	Purple	Small, round
18.	Banarasi	Long narrow, white vein.	Light purple	Green with purple tint	Oblong medium.
19.	KB-5	Narrow, spiny, purple vein.	Light purple	Purple	Medium long
20.	Improved Muktakeshi	Narrow, spiny	Light purple	Purple	Medium round
21.	K.P. Round	Medium, purple vein,	Purple	Purple	Round medium.
22.	Navkiran	Medium-broad, purple vein.	Purple	Purple glossy	Round medium
23.	Rajkrisna	Medium narrow, purple vein.	Purple	Purple	Round
24.	Pyratuni	Semi spreading, purple vein.	Purple	Green	Round
25.	IR-8-Baramasi	Semi errect, purple vein	Purple	Purple	Narrow long.
26.	Banarasi	Small, green, semi errect, purple vein.	Purple	Purple	Long narrow.
27.	Baramasi	Narrow, purple vein	Light Purple	Purple	Long
28.	Shyamla Bhangar	Green, long, white vein	Purple	Light green	Medium long back depressed.

Table 5 contd............

Table 5 contd............

Varieties	Leaf character	Flower colour	Fruit colour	Fruit shape
29. BB_1	Green, white vein	Light purple	Green with white shade	Round, spiny calyx.
30. Murshidabad Local	Broad, purple vein	Light purple	Light purple	Medium round
31. ARM-3	Medium, purple vein	Light purple	Light purple	Medium long
32. Krishna	Green, purple vein	Purple	Light purple	Medium long
33. KHV-90	Medium, purple vein	Purple	Purple	Medium round
34. KB-52.	Medium,	Light purple	Purple	Medium long
35. KB-10	Medium, whitish vein	Light purple	Purple	Medium long.
36. Brinjal Long Green	Small, white vein	Light purple	Green	Long
37. Pusa Kranti	Medium, purple vein	Light purple	Purple	Medium long.
38. KB-2	Narrow purple	Light purple	Purple	Medium
39. Black Prince	Medium, purple vein	Light purple	Black purple	Small thin.
40. Agora	Horizontal, purple vein	Purple	Purple glossy	Medium tapering end.
41. Suttons Long	Small, Green, white vein	Light purple	Green	Long thin.

No. of secondary br/pl	→	*12.33*
No. of fruits/pl	→	*5.50*
Total yield/pl (kg)	→	*3.42*
Percent yield loss	→	*52.73*

Fig. 11. Brinjal R-14

No. of secondary br/pl	→	*16.33*
No. of fruits/pl	→	*44.83*
Total yield/pl (kg)	→	*4.54*
Percent yield loss	→	*15.59*

Fig. 12. Brinjal Banaras Long Purple

No. of secondary br/pl → 2.33
No. of fruits/pl → 2.16
Total yield/pl (kg) → 4.70
Percent yield loss → 26.40

Fig. 13. Brinjal Banaras Giant White

No. of secondary br/pl → 14.00
No. of fruits/pl → 14.00
Total Yield/pl (kg) → 6.79
Percent yield loss → 12.85

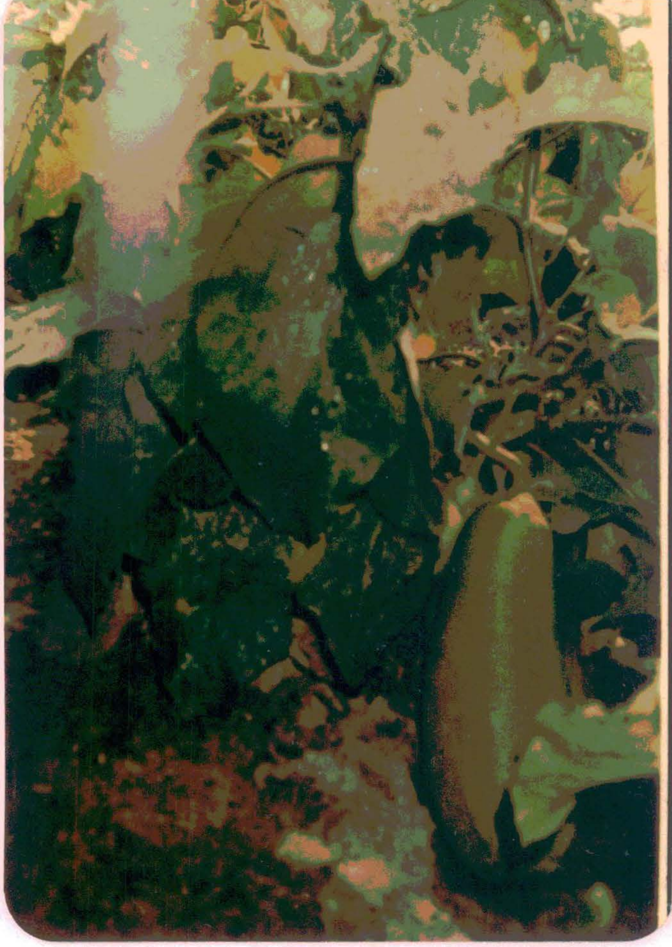
Fig. 14. Brinjal Kalo Dhepa

No. of secondary br/pl	→	*3.66*
No. of fruits/pl	→	*12.33*
Total yield/pl (kg)	→	*3.47*
Percent yield loss	→	*24.80*

Fig. 15. Brinjal Krishna

No. of secondary br/pl	→	*14.66*
No. of fruits/pl	→	*11.83*
Total yield/pl (kg)	→	*5.06*
Percent yield loss	→	*17.04*

Fig. 16. Brinjal Navkiran



No. of secondary br/pl → *12.00*
No. of fruits/pl → *5.45*
Total yield/pl (kg) → *6.10*
Percent yield loss → *20.00*

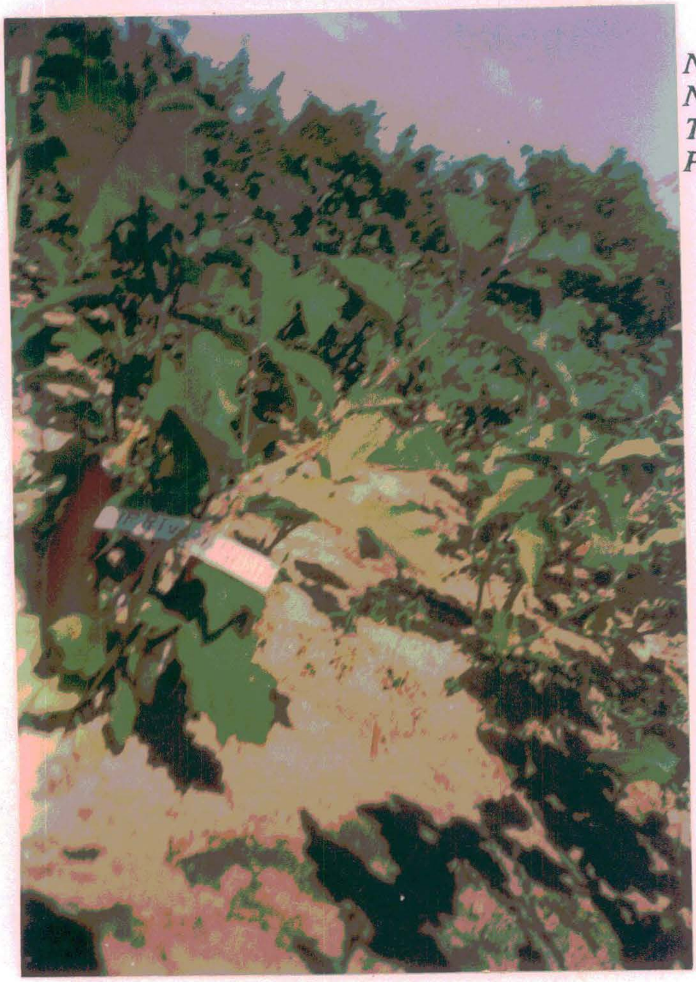
Fig. 17. Brinjal Nababganj

No. of secondary br/pl → *10.00*
No. of fruits/pl → *14.28*
Total yield/pl (kg) → *3.50*
Percent yield loss → *25.00*

Fig. 18. Brinjal Tal

No. of secondary br/pl → *8.66*
No. of fruits/pl → *39.33*
Total yield/pl (kg) → *6.71*
Percent yield loss → *22.30*

Fig. 19. Brinjal Muktajhuri



No. of secondary br/pl → *8.66*
No. of fruits/pl → *39.33*
Total yield/pl (kg) → *6.71*
Percent yield loss → *22.30*

Fig. 20. Brinjal IR-8-Baramasi

No. of secondary br/pl	→	*3.00*
No. of fruits/pl	→	*4.16*
Total yield/pl (kg)	→	*4.70*
Percent yield loss	→	*16.78*

Fig. 21. Brinjal Shyamla Bhangar

No. of secondary br/pl	→	*3.66*
No. of fruits/pl	→	*11.33*
Total yield/pl (kg)	→	*3.68*
Percent yield loss	→	*20.83*

Fig. 22. Brinjal Murshidabad Local

No. of secondary br/pl → *6.00*
No. of fruits/pl → *11.00*
Total yield/pl (kg) → *2.19*
Percent yield loss → *39.62*

Fig. 23. Brinjal KB-10

No. of secondary br/pl → *6.00*
No. of fruits/pl → *29.66*
Total yield/pl (kg) → *3.95*
Percent yield loss → *30.53*

Fig. 24. Brinjal ARM-3

No. of secondary br/pl	→	*6.33*
No. of fruits/pl	→	*9.49*
Total yield/pl (kg)	→	*2.10*
Percent yield loss	→	*15.54*

Fig. 25. Brinjal BB_1

No. of secondary br/pl	→	*5.00*
No. of fruits/pl	→	*11.83*
Total yield/pl (kg)	→	*4.32*
Percent yield loss	→	*45.73*

Fig. 26. Brinjal Krishnanagar Hybrid Variety '90

No. of secondary br/pl	→	*13.00*
No. of fruits/pl	→	*10.66*
Total yield/pl (kg)	→	*6.11*
Percent yield loss	→	*12.94*

Fig. 27. Brinjal Shyamla Dhepa

immuned or highly resistant during the first year of screening (1991-92), though Navkiran appeared as highly resistant marginally (Tables 6 and 7) as because the percentage of the damage recorded on the basis of fruit number was 10.02. However, the screening in 1992-93 qualified Navkiran as fairly resistant grade. The other varieties found fairly resistant were Nishchindipur Local (NIL), Nurki, KD, IR-8-Baramasi, BLP, BB_1 and Murshidabad Local where the percentage of damage varied from 11.95 (BB_1) to 19.52 (IR-8-Baramasi). The highly susceptible varieties were R-14, Sufal, L-13, White Long Cluster (WLC), Neelam Long, KB-20, KB-2 and Suttons Long. The percentage damage in these varieties ranged between 41.57 (Suttons Long) to 46.39 (Brinjal Long Green). In case of tolerant and susceptibility grade the range of damage on the basis of fruit number was 21.43 (Muktajhuri) to 30.84 (BGW) and 31.27 (Krishna) to 40.91 (KB-2), respectively.

Varieties screened on the weight basis (Table 7) were found to be immuned or highly resistant forms. The percentage damage ranged between 11.08 (Shyamla Bhangar) to 20.73 (Murshidabad Local) in fairly resistant types; 21.68 (KHV_{90}) to 30.89 (BGW) for tolerant grades; 31.43 (KB-52) to 40.77 (PPC) in susceptible category and 42.02 (PPL) to 56.45 (PPR) under highly susceptible grade.

Relative susceptibility to *L. orbonalis* as a fruit borer during 1992-93 :

In the second screening during 1992-93, both on number and weight basis NIL, Nurki, Shyamla Dhepa, Kalo Dhepa, IR-8-Baramasi, BLP, BB_1 and Murshidabad Local fell under fairly resistant grade. Varieties under highly susceptible grades showed 41.39% (KB-10) to 69.42% (R-14) damage on the number and 43.84% (WLC) to 73.05% (R-14) on the weight of fruits. Other grades ranged between 21.71% (Baramasi) to 25.35% (KB-5) and 31.69% (ARM-3) to 40.57% (WLC) were put under tolerant and susceptible categories respectively based on the number of infested fruits. These ranges were 21.90% (BGW) to 30.23% (ARM-3) and 31.96% (Improved Muktakeshi) to 40.40% (KB-10) under tolerant and susceptible grades respectively on the basis of fruit weight.

Resistance based on mean data of two years screening :

Two years pooled mean data revealed the fact that among the 41 cultivars tested under field screening none was found to be either immuned or highly resistant. The percentage damage ranged between 11.76 (KD) to 14.52 (IR-8-Baramasi) for fairly resistant; 21.16 (Muktajhuri) to 30.74 (Pusa Kranti) for tolerant 31.04 (KB-5) to 40.55 (WLC) for susceptible and 41.36 (Shyamla Bhangar) to 52.27 (R-14) for highly susceptible grades based on the infested fruit number. While on the basis of fruit weight the corresponding values of the same grades were 12.85 (KD) to 20.83 (Murshidabad Local), 22.30 (Muktajhuri) to 30.50 (ARM-3); 31.46 (Pusa Kranti) to 40.41 (KB-52) and 41.17 (L-13) to 59.06 (R-14).

Relative susceptibility of *S. melongena* to *L. orbonalis* as a shoot borer :

Varieties like NIL, Muktajhuri, Shyamla Dhepa, Navkiran, BLP, BB_1 and Murshidabad Local had less infestation ranging from 0.98-1.91, number of damaged shoot / 5 plants and may therefore, be considered tolerant to shoot borer (Table 9). R-14, KD, BGW, KB-20, Banarasi, IR-8-Baramasi, Shyamla Bhangar and Pusa Kranti were found moderately tolerant (ranging

Table 6. Varietal resistance in different cultivars of brinjal against shoot and fruit borer (*L. orbonalis*) on the basis of fruit number

Grades and type of resistance	1991 - 92	1992 - 93	Mean
1. Immune (0% infestation)	None	None	None
2. Highly resistant (1 to 10% infestation)	Navkiran	None	None
3. Fairly resistant (11 to 20% infestation)	Nischindipur Local (NIL), Nurki Shyamla Dhepa, IR 8-Baramasi, Banaas Long Purple, BB_1, Murshidabad Local.	NIL, Nurki, Shyamla Dhepa, Kalo Dhepa Banarasi, Navkiran, IR-8-Baramasi, Banaras Long Purple, Murshidabad Local. BB_1, Muktajhuri	NIL, Nurki, Shyamla Dhepa, Kalo Dhepa, Navkiran, IR-8-Baramasi, Banaras Long Purple, BB_1, Murshidabad Local
4. Tolerant (21% to 30% infestation)	Muktajhuri, Boral, Banarasi, Rajkrishna, Baramasi, Shymala Bhangar, KHV-90, KB-52, Pusa Kranti, B.G. White.	BGW, Pusa Purple Cluster (PPC), KB-5, Baramasi	Muktajhuri, BGW, PPC Banarasi, Baramasi, Pusa Kranti, Boral.
5. Susceptible (31 to 40% infestation)	PPC, KB-5,Improved Muktakeshi, Krishna, KPR, Pyratuni, ARM-3, Krishna, KB-10, Agora, Pusa Purple Long (PPL).	KB-9, White Long Cluster (WLC), Neelam Long, L-13, Boral, Improved Muktakeshi, KPR, ARM-3, Krishna, Pusa Kranti, Black Prince, Agora, PPL.	KB-9, WLC, Neelam Long, L-13, Improved Muktakeshi, KPR, Rajkrishna, ARM-3, Krishna, KB-52, KHV-90, KB-10, Agora, Black Prince, PPL
6. Highly susceptible (above 41% infestation)	R-14, Sufal, KB-9, WLC, Neelam Long, KB-20, L-13, KB-2, Suttons Long.	R-14, Sufal, P.P. Round, KB-20, Rajkrishna, Pyratuni, Shyamla Bhangar, KHV-90. KB-10, Brinjal Long Green (BLG), KB-2, Suttons Long.	R-14, Sufal, Pusa Purple Round, KB-20, Pyratuni, Shyamla Bhagar, BLG, KB-2, Suttons Long.

Table 7. Varietal resistance in different cultivars of brinjal against shoot and fruit borer (*L. orbonalis*) on fruit weight basis

Grades and type of resistance	1991 - 92	1992 - 93	Mean
1. Immune (0% infestation)	None	None	None
2. Highly resistant (1 to 10% infestation)	None	None	None
3. Fairly resistant (11 to 20% infestation)	NIL, Nurki, Shymala Dhepa, Kalo Dhepa, Navkiran, IR-8 Baramasi, Shyamla Bhangar, BB_1, Murshidabad Local. BLP, Krishna.	NIL, Nurki, Shyamla Dhepa, Kalo Dhepa, Navkiran, IR-8-Baramasi, Shyamla Bhangar, BB_1, Murshidabad Local, BLP, Krishna.	NIL, Nurki, Shyamla Dhepa, Kalo Dhepa, Navkiran, IR-8 Baramasi, BLP, Shyamla Dhepa, BB_1, Murshidabad Local.
4. Tolerant (21% to 30% infestation)	Muktajhuri, BGW, Baramasi, ARM-3, Krishna, KHV-90, Brinjal Long Green, Pusa Kranti,	Muktajhuri, Pusa Purple Long, BGW, KB-5, Baramasi, Pusa Purple Cluster, Banarasi, Shyamla Bhangar, ARM-3, Brinjal Long Green.	Muktajhuri, BGW, Baramasi, KB-5, Banarasi, ARM-3, Krishna, Brinjal Long Green.
5. Susceptible (31 to 40% infestation)	Boral, Pusa Purple Cluster, Banarasi, KB-5, Improved Muktakeshi, KPR, Rajkrishna Pyratuni, KB-52, KB-10, Black Prince, Agora, Suttons Long.	KB-9, Boral, Improved Muktakeshi, KB-10, Pusa Kranti Black Prince, Agora, Suttons Long. KPR.	Pusa Purple Long, Boral, Pusa Purple Cluster, Improved Muktakeshi, Rajkrishna, KB-52, Pusa Kranti, Black Prince, Agora, Suttons Long. KB-10.
6. Highly susceptible (above 41% infestation)	R-14, Sufal, KB-9, White Long Cluster, Neelam Long, Pusa Purple Round, Pusa Purple Long, KB-20, L-13, KB-2.	R-14, Sufal, White Long Cluster, Neelam Long, Pusa Purple Round, Rajkrishna, Pyratuni, KB-20, KHV-90, L-13, KB-2.	R-14, Sufal, KB-9, White Long Cluster, Neelam Long, Pusa Purple Round, KB-20, L-13, KPR, Pyratuni, KHV-90, KB-2.

from 2.17 to 2.80 damaged shoots / 5 plants). Sufal, L-13, KB-9, WLC, Nurki, Neelam Long, Pusa Purple Round (PPR), Pusa Purple Long (PPL), PPC, Boral, KB-5, Improved Muktakeshi, KPR, Rajkrishna, Pyratuni, Baramasi, ARM-3, Krishna, KB-10, KB-2, Black Prince and Suttons Long ranging from 3.10 to 4.51 damaged shoots / 5 plants were found susceptible, where as Brinjal Long Green (5.02 damaged shoots / 5 plants) as highly susceptible.

Analysis of variance (Tables 10, 13 and 16) revealed significant differences among the tested cultivars in respect of 21 test characters studied. Performance of 41 brinjal cultivars for some vegetative characters during 1991-92 is presented in Table 11 and that of the following year 1992-93 in Table 12. Regarding reproductive characters the performance during 1991-92 and 1992-93 are also presented in Tables 14 and 15. Data related to the susceptibility components are tabulated in Tables 17 and 18. Genetic potentiality of various cultivars with respect to yield components and the extent of relative susceptibility are presented in Figures 28-34.

The KD variety was least susceptible as indicated by percent infested fruits (10.02). However, KD, Shyamla Dhepa, Navkiran could be statistically clustered under the same susceptibility group. These cultivars could be fairly graded as tolerant to the pest. Among the 41 genotypes of egg plant, Baramasi proved to be the best yielder (6.91 kg/pl) followed by Kalo Dhepa (6.79 kg/pl).

Table 8. **Analysis of variance for relative susceptibility to major insect pests of 41 brinjal cultivars**

Character	Mean sum of squares			CD
	Treatments (df = 40)	Replications (df = 2)	Errors (df = 80)	(P = 0.05)
Mean shoots damaged / 5 plants	3.48**	0.03	0.09	0.47
	3.17**	0.13	0.12	0.55
No. of fruits damaged (%)	287.86**	15.18	23.59	7.76
	490.68**	9.46	32.33	9.06
Weight of fruits damaged (%)	515.30**	40.82	28.26	8.51
	531.15**	103.45	50.81	11.39
Cotton leaf hoppers / 5 leaves	265.29**	3.96	2.56	2.54
	259.83**	9.50	13.32	5.82
Cotton aphids/5 leaves	4743.68**	106.03	29.04	8.60
	5003.41**	4.31	5.28	3.67
Spotted leaf beetles / 5 leaves	1.22**	0.03	0.04	0.31
	5.83**	0.06	0.03	0.27

 # For each character the first row represents the value for 1991-92 and second for 1992-93. **P=0.01

Table 9. Relative susceptibility of different varieties of brinjal to insect pests on (pooled mean data of 2 years)

Variety	Shoots damaged/5 plants	Pest(no.)/5 leaves		
		Cotton leaf hopper	Cotton aphid	Spotted leaf beelte
R-14	2.17 M	30.70 H	141.00 H	2.17
Nishchindipur Local	1.66 T	21.15 M	79.50 H	1.63
Sufal	4.51 S	44.40 H	19.00 T	0.45
KB-9	4.21 S	3.55 T	153.00 H	0.42
White Long Cluster	4.35 S	11.00 M	83.50 H	1.31
Nurki	4.26 S	17.95 M	65.50 H	0.81
Muktajhuri	1.91 T	24.90 S	137.00 H	0.59
Shyamla Dhepa	1.55 T	18.20 M	80.50 H	1.04
Neelam Long	3.21 S	15.35 M	86.50 H	1.22
Pusa Purple Long	4.35 S	9.60 T	64.50 H	0.46
Kalo Dhepa	2.40 M	15.80 M	59.50 H	1.25
Pusa Purple Long	3.16 S	9.80 T	52.95 H	11.13
Banaras Giant White	2.35 M	9.05 T	78.80 H	0.42
KB-20	2.68 M	23.80 S	23.15 M	1.56
L-13	4.50 S	9.95 T	93.00 H	0.28
Boral	3.48 S	18.90 M	75.00 H	0.33
Pusa Purple Cluster	3.12 S	15.20 M	84.00 M	0.70
Banarasi	2.71 M	23.40 S	28.00 M	1.70
KB-5	3.47 S	6.40 T	47.00 S	0.63
Improved Muktakeshi	3.62 S	8.40 T	77.80 H	0.36
KP Round	3.31 S	18.20 M	112.50 H	0.46
Navkiran	0.98 T	6.75 T	14.45 T	0.35
Rajkrishna	3.11 S	20.15 M	130.50 H	0.28
Pyratuni	3.82 S	13.45 M	163.00 H	0.32
IR-8-Baramasi	2.80 M	41.45 H	40.50 S	1.30
Banaras Long Purple	1.35 T	15.20 M	33.85 S	2.84
Baramasi	3.18 S	18.95 M	33.55 S	1.45
Shyamla Bhangar	2.72 M	18.83 M	96.10 H	0.09
BB_1	1.45 T	6.55 T	32.50 S	0.27
Murshidabad Local	1..57 T	26.60 S	52.50 H	0.43
ARM-3	3.10 S	18.65 M	13.50 T	0.55
Krishna	3.14 S	15.90 M	16.50 T	0.45
Krishnanagar Hybrid Variety '90	2.26 M	18.40 M	22.95 M	1.77
KB-52	2.71 M	32.75 H	42.80 S	0.98
KB-10	3.56 S	6.45 T	775.50 H	1.12
Brinjal Long Green	5.02 H	11.75 M	16.65 T	1.61
Pusa Kranti	2.37 M	11.50 M	95.00 H	0.78
KB-2	3.93 S	27.15 S	37.00 S	1.08
Black Prince	3.67 S	11.55 M	65.00 H	1.27
Agora	3.21 S	12.25 M	32.05 S	2.03
Suttons Long	4.10 S	36.45 H	17.50 T	0.98

T = tolerant; M = moderately tolerant; S = susceptible; H= highly susceptible

Table 10. Analysis of variance for vegetative parameters in 41 cultivars of brinjal

Character	Mean sum of squares			CD
	Treatments (df=40)	Replications (df=2)	Errors (df=80)	(P=0.05)
1. Plant height at first flowering	308.66**	13.63	4.54	4.47
	183.18**	63.51	63.36	12.75
2. Plant height at first harvesting	260.80**	1.49	68.10	17.31
	320.41**	8.72	1.98	2.94
3. No. of primary branches/pl	4.51**	0.11	0.54	1.55
	2.25**	0.25	1.29	1.81
4. No. of Secondary branches/pl	48.25**	0.29	0.67	1.71
	34.20**	2.98	7.41	4.34
5. Days to flowering	516.82**	2.50	2.18	2.36
	206.83**	14.89	89.73	15.16
6. Days taken from transplanting to 1st picking	429.61**	19.54*	111.32	16.83
	560.22**	33.23**	6.71	4.16
7. Marketable yield/pl (Kg/pl)	714.88**	27.47*	8.05	0.28
	6.22**	0.02	0.03	0.36

** Significant at 0.01 level

For each characters the first row represent the value for 1991-92 and second row for 1992-93

Table 11. Performance of 41 brinjal cultivar for some vegetative characters for 1991-92

Varieties	Pl. ht. at first flowering	Pl. ht. at first harvesting	No. of primary branches	No. of secondary branches	Days to flowering	Days taken from transplanting to 1st picking	Total yield (kg/pl)
1. R-14	50.00	62.00	3.66	12.33	70.66	98.66	1.73
2. Nishchindipur Local	60.00	69.00	2.53	13.66	52.33	82.33	4.00
3. Sufal	52.00	66.00	1.33	3.66	70.66	97.33	3.57
4. KB-9	70.00	85.00	2.33	4.00	59.33	89.33	1.83
5. White Long Cluster	70.00	80.00	2.66	7.66	59.33	91.00	1.29
6. Nurki	15.00	77.00	3.33	8.00	55.00	85.00	3.60
7. Muktajhuri	80.00	89.00	7.33	8.66	63.66	92.00	5.10
8. Shyamla Dhepa	80.00	91.00	2.00	13.00	71.00	92.33	4.58
9. Neelam Long	70.00	82.00	2.33	3.66	63.66	93.66	1.57
10. Pusa Purple Round	55.00	66.00	2.66	3.66	69.33	122.66	1.75
11. Kalo Dhepa	70.00	82.00	2.33	14.00	67.66	93.33	5.10
12. Pusa Purple Long	55.00	70.00	1.00	3.66	43.66	73.66	0.58
13. Banaras Giant White	75.00	95.00	1.00	3.66	43.66	73.66	0.58
14. KB-20	60.00	69.00	2.33	3.66	60.33	108.33	1.06
15. L-13	63.00	78.00	1.33	6.33	45.00	92.33	2.93
16. Boral	55.00	65.00	1.00	2.66	67.00	104.66	0.46
17. Pusa Purple Cluster	80.00	91.00	2.66	5.33	106.00	140.60	2.48
18. Banarasi	60.00	71.00	1.66	3.66	69.33	102.00	0.68
19. KB-5	75.00	91.00	2.00	3.66	54.33	102.00	0.68
20. Improved Muktakeshi	85.00	95.00	2.66	9.66	53.66	85.33	3.37
21. K.P. Round	70.00	82.00	1.66	3.33	101.00	142.33	2.57
22. Navkiran	85.00	97.00	6.00	14.66	68.66	99.33	5.33
23. Rajkrishna	70.00	80.00	2.66	6.66	61.00	92.33	1.84
24. Pyratuni	60.00	72.00	1.66	3.66	56.00	86.00	1.39
25. IR-8-Baramasi	77.66	85.66	1.33	12.66	61.00	91.66	4.80
26. Banaras Long Purple	70.00	79.00	2.66	16.33	49.00	79.00	3.35
27. Baramasi	69.00	81.00	1.33	14.00	63.00	91.00	4.77
28. Shyamla Bhangar	60.00	69.00	1.33	3.00	68.66	98.66	4.97
29. BB_1	55.00	65.00	2.33	6.33	69.33	104.66	1.70
30. M. Local	85.00	96.00	1.00	3.66	60.00	93.66	4.28
31. ARM-3	70.00	90.00	3.00	6.00	54.33	93.66	2.45
32. Krishna	90.00	100.00	1.00	3.66	64.66	99.33	1.36
33. KHV-90	70.00	90.00	4.33	5.00	57.00	84.66	1.76
34. KB-52	65.00	91.00	2.00	5.53	63.33	96.00	1.39
35. KB-10	75.00	92.00	3.33	6.00	59.66	90.00	1.12
36. Brinjal Long Green	61.00	71.66	1.66	3.33	91.00	87.00	0.99
37. Pusa Kranti	90.00	105.00	3.33	5.00	48.66	74.33	0.87
38. KB-2	65.00	75.00	2.00	6.66	61.00	108.00	1.61
39. Black Prince	60.00	85.00	1.00	3.00	50.00	91.00	0.40
40. Agora	60.00	70.00	2.00	5.00	62.00	91.00	1.10
41. Sottons Long	58.33	65.33	1.00	3.00	39.66	68.00	1.10
CD at 5%	3.40	13.15	1.17	1.31	2.36	16.83	0.36

Table 12. Performance of 41 brinjal cultivar for some vegetative characters for 1992-93.

Varieties	Pl. ht. at first flowering	Pl. ht. at first harvesting	No. of primary branches	No. of secondary branches	Days to flowering	Days taken from transplanting to 1st picking	Total yield (kg/pl)
1. R-14	44.00	61.33	4.00	11.66	80.66	103.00	1.07
2. Nishchindipur Local	62.00	64.33	2.66	12.66	62.33	85.66	4.80
3. Sufal	50.00	67.00	1.33	3.66	70.66	91.00	1.46
4. KB-9	72.00	85.00	2.33	3.66	59.33	90.00	1.10
5. White Long Cluster	69.00	80.00	2.66	7.00	69.33	91.00	1.40
6. Nurki	65.00	75.66	3.66	7.66	65.00	86.00	3.83
7. Muktajhuri	80.00	87.00	6.00	8.66	63.66	91.00	4.46
8. Shyamla Dhepa	80.00	91.00	2.00	12.00	71.00	92.33	4.58
9. Neelam Long	69.00	78.00	2.33	3.33	63.00	92.00	1.47
10. Pusa Purple Round	55.00	67.00	2.66	3.33	70.00	123.00	1.76
11. Kalo Dhepa	70.00	82.00	2.33	14.00	67.66	93.33	5.78
12. Pusa Purple Long	53.00	68.33	1.00	4.00	53.66	73.00	1.72
13. Banaras Giant White	77.00	85.33	1.00	2.66	70.66	103.00	2.54
14. KB-20	59.00	70.00	2.33	4.33	65.66	110.66	1.18
15. L-13	63.00	65.00	1.33	7.00	45.66	79.00	3.37
16. Boral	60.00	64..66	1.00	3.00	64.66	105.00	0.50
17. Pusa Purple Cluster	70.00	90.00	2.66	5.66	85.66	131.00	3.21
18. Banarasi	70.00	74.33	1.66	3.33	69.33	101.33	0.79
19. KB-5	74.00	90.00	2.00	3.33	53.33	97.66	1.89
20. Improved Muktakeshi	73.00	96.00	2.66	9.66	69.00	84.00	3.22
21. K.P. Round	71.00	80.00	1.66	4.00	101.00	135.66	1.45
22. Navkiran	83.66	99.00	5.33	15.00	69.00	84.00	3.22
23. Rajkrishna	71.00	80.66	2.33	7.00	64.00	91.00	0.97
24. Pyratuni	58.33	71.00	1.66	3.33	58.66	81.33	1.16
25. IR-8-Baramasi	77.66	85.66	1.33	16.00	61.00	91.66	4.76
26. Banaras Long Purple	59.33	71.66	2.33	15.33	49.00	77.00	3.98
27. Baramasi	69.00	82.00	1.33	14.00	63.00	91.00	4.36
28. Shyamla Bhangar	61.00	71.33	1.66	3.00	66.00	95.00	4.98
29. BB_1	56.33	66.00	2.00	6.33	70.00	104.00	1.16
30. M. Local	85.00	84.33	1.00	3.33	60.33	92.66	1.81
31. ARM-3	64.00	73.66	3.33	6.00	60.33	93.00	1.40
32. Krishna	91.66	101.66	1.00	4.00	68.00	96.00	1.46
33. KHV-90	75.33	84.33	4.33	5.66	52.66	86.00	1.47
34. KB-52	64.00	81.66	2.33	4.33	66.66	96.00	1.44
35. KB-10	71.00	81.33	3.33	6.33	52.66	87.00	1.03
36. Brinjal Long Green	61.00	71.66	1.66	5.00	91.00	87.00	0.94
37. Pusa Kranti	88.33	89.66	3.33	5.33	54.00	93.00	1.20
38. KB-2	65.00	74.00	2.33	6.33	66.66	87.00	1.84
39. Black Prince	58.00	68.66	1.00	3.00	52.00	83.66	0.32
40. Agora	60.00	70.00	2.00	4.00	62.00	91.00	0.80
41. Sottons Long	58.33	65.33	1.00	3.00	39.33	68.00	0.90
CD at 5%	12.75	2.24	1.81	4.34	15.16	4.16	0.28

Table 13. Analysis of variance for some reproductive characters in 41 cultivars of brinjal

Character	Mean sum of squares			CD
	Treatments (df = 40)	Replications (df = 2)	Errors (df = 80)	(P = 0.05)
1. Fruit length	50.71**	1.08	8.71	4.70
	67.41**	10.76	18.66	6.81
2. Fruit circumferance	260.00**	0.61	21.93	7.46
	262.50**	1.27	1.95	2.23
3. No. of marketable fruits/pl.	261.13**	25.81	18.07	2.85
	463.66**	6.02	3.17	2.85
4. Average wt. of fruit (kg)	0.11**	0.01	0.01	0.16
	0.06**	0.00	0.01	0.16
5. Marketable yield (kg/pl)	714.88**	27.47*	8.05	0.28
	6.22**	0.02	0.03	0.26
6. Total yield (kg/pl)	442.08**	0.06	9.14	0.54
	444.36**	0.06	8.63	0.90

For each characters the first row represent the value for 1991-92 and second row for 1992-93. ** P = 0.01

Table 14. Performance of 41 brinjal cultivar for some reproductive yield components during 1991-92

Varieties	Fruit length (cm)	Fruit circumference (cm)	Total no. of marketable fruits	Av. wt. of fruit (kg)	Total yield (kg/pl)
1. R-14	19.33	39.33	7.00	0.21	3.76
2. Nishchindipur Local	9.33	24.33	45.00	0.10	5.23
3. Sufal	17.00	27.33	12.33	0.41	7.770
4. KB-9	15.00	28.66	11.00	0.19	3.65
5. White Long Cluster	17.33	20.33	12.66	0.13	2.74
6. Nurki	11.66	11.00	31.33	0.11	4.47
7. Muktajhuri	29.33	15.33	40.00	0.13	7.10
8. Shyamla Dhepa	17.00	30.00	10.66	0.36	6.28
9. Neelam Long	19.33	30.33	11.33	0.15	2.98
10. Pusa Purple Round	18.33	15.00	11.66	0.17	3.78
11. Kalo Dhepa	15.00	31.66	14.00	0.36	6.42
12. Pusa Purple Long	23.00	13.00	31.33	0.05	1.20
13. Banaras Giant White	15.33	44.00	2.00	1.20	5.60
14. KB-20	12.00	24.00	10.00	0.10	2.51
15. L-13	22.33	15.66	29.00	0.11	6.02
16. Boral	10.33	15.33	3.66	0.12	0.95
17. Pusa Purple Cluster	11.00	10.00	30.33	0.10	2.75
18. Banarasi	14.66	28.00	5.00	0.14	1.21
19. KB-5	19.66	36.33	14.33	0.12	3.20
20. Improved Muktakeshi	17.66	25.00	15.33	0.19	5.94
21. K.P. Round	10.66	48.00	12.00	0.23	4.39
22. Navkiran	18.00	31.33	14.66	0.50	6.36
23. Rajkrishna	19.00	20.00	11.00	0.15	3.60
24. Pyratuni	20.33	11.66	10.66	0.13	2.97
25. 1R-8-Baramasi	21.66	15.66	31.00	0.13	6.16
26. Banaras Long Purple	23.00	10.66	44.00	0.08	4.18
27. Baramasi	21.66	14.00	31.00	0.15	6.95
28. Shyamla Bhangar	12.33	24.33	4.66	0.26	6.24
29. BB_1	10.33	26.33	11.33	0.15	2.16
30. M. Local	12.66	31.00	12.00	0.15	4.74
31. ARM-3	17.33	14.00	30.66	0.08	3.93
32. Krishna	29.33	13.00	12.33	0.11	2.50
33. KKV-90	15.33	30.00	12.00	0.14	4.53
34. KB-52	19..33	18.33	13.66	0.11	2.45
35. KB-10	15.33	23.33	12.00	0.10	2.39
36. Brinjal Long Green	14.00	8.33	6.33	0.05	1.25
37. Pusa Kranti	17.33	23.33	7.66	0.12	1.46
38. KB-2	16.33	29.00	10.00	0.177	2.98
39. Black Prince	10.33	11.33	3.00	0.10	0.87
40. Agora	16.00	17.00	4.00	0.20	2.06
41. Sottons Long	19.00	12.00	14.66	0.05	1.66
CD at 5%	4.70	7.46	9.33	0.16	0.75

Table 15. Performance of 41 brinjal cultivar for some reproductive yield components during 1992-93

Varieties	Fruit length (cm)	Fruit circumference (cm)	Total no. of marketable fruits	Av. wt. of fruit (kg)	Total yield (kg/pl)
1. R-14	18.00	40.66	4.00	0.27	3.08
2. Nishchindipur Local	8.66	19.00	53.00	0.10	5.95
3. Sufal	14.66	26.00	5.00	0.36	4.95
4. KB-9	15.33	28.66	10.00	0.11	2.12
5. White Long Cluster	18.33	21.00	12.00	0.13	2.76
6. Nurki	11.66	11.33	31.00	0.11	4.22
7. Muktajhuri	26.00	14.00	38..66	0.13	6.32
8. Shyamla Dhepa	18.00	32.66	10.66	0.46	5.94
9. Neelam Long	20.00	30.00	10.00	0.15	3.20
10. Pusa Purple Round	18.33	15.00	11.60	0.17	3.26
11. Kalo Dhepa	15.00	32.00	14.00	0.46	7.16
12. Pusa Purple Long	16.66	12.33	29.66	0.07	2.38
13. Banaras Giant White	16.00	40.00	2.33	0.83	3.80
14. KB-20	12.33	26.00	11.33	0.10	2.28
15. L-13	18.66	15.66	33.33	0.11	6.01
16. Boral	10.37	15.33	3.66	0.12	1.001
17. Pusa Purple Cluster	11.66	37.33	30.33	0.11	4.73
18. Banarasi	16.00	28.33	6.00	0.13	1.28
19. KB-5	17.00	25.33	14.00	0.12	3.66
20. Improved Muktakeshi	17.00	40.33	16.33	0.19	5.36
21. K.P. Round	11.00	33.33	12.00	0.23	2.95
22. Navkiran	17.00	36.60	9.00	0.42	4.90
23. Rajkrishna	20.33	11.66	9.00	0.12	2.45
24. Pyratuni	23.00	15.60	31.00	0.13	6.09
25. 1R-8-Baramasi	21.00	11.33	45.66	0.10	4.89
26. Banaras Long Purple	20.00	14.00	31.00	0.16	6.86
27. Baramasi	20.00	14.00	31.00	0.16	6.86
28. Shyamla Bhangar	12.00	25.00	3.66	0.28	3.11
29. BB_1	10.33	27.33	7.66	0.15	2..03
30. M. Local	13.33	31.00	10.66	0.18	2.61
31. ARM-3	18.33	15.00	28.66	0.08	3.97
32. Krishna	29.00	15.33	12.33	0.12	2.43
33. KHV-90	15.66	29.33	11.66	0.114	4.22
34. KB-52	18.66	18.66	12.33	0.12	2.67
35. KB-10	15.33	16.00	10.00	0.10	1.99
36. Brinjal Long Green	13.00	7.00	6.33	0.05	1.23
37. Pusa Kranti	17.33	18.00	7.66	0.15	2.10
38. KB-2	19.00	17.33	9.00	0.19	3.77
39. Black Prince	11.00	12.00	5.33	0..11	0.99
40. Agora	15.00	16.66	4.00	0.20	1.78
41. Sottons Long	18.00	11.33	14.66	0.05	1.47
CD at 5%	6.81	2.23	2.85	0.16	0.72

Table 16. **Analysis of variance for some susceptibility components during 1991-92 and 1992-93 for 41 varieties of brinjal**

	Mean sum of squares			CD
	Treatments (df = 40)	Replications (df = 2)	Errors (df = 80)	(P = 0.05)
1. Larvae/pl	1.78**	0.01	0.01	0.17
	1.75**	0.01	0.02	0.22
2. Larvae/ft	0.05**	0.01	0.01	0.17
	0.05**	0.01	0.01	0.17
3. Holes/pl	17.49**	0.16	0.12	0.55
	14.70**	0.17	1.65	2.05
4. Holes/ft	196.64**	0.00	9.09	4.81
	0.46**	0.01	0.05	0.36
5. Days to borer on branches	340.52**	33.33	48.83	11.14
	340.98**	3.42	6.11	3.95
6. Days to borer on fruit	344.87**	3.81	14.06	5.97
	316.12**	79.73	36.00	9.56
7. Infested br/pl	0.52**	0.00	0.01	0.17
	174.13**	1.61	13.52	5.86
8. Infested ft./pl	287.86**	15.18	23.59	7.74
	490.68**	9.46	32.33	9.06
9. Total yield (kg/pl)	515.30**	40.82	28.26	8.48
	531.15**	103.45	50.81	11.39

 # First row for each characters represent value for 1991-92 and second row for 1992-93.

 # ** Significant at 1% level

Table 17. **Mean performance of different cultivars for some relative susceptibility components of brinjal to *L. orbonalis* during 1991-92 and 1992-93**

Varieties	Loss of yield / pl (%)		Infestation / pl (%) Fruits		Infestation / pl (%) Branches		Yield / pl (Kg.)	
	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93
	1	2	3	4	5	6	7	8
1. R-14	45.07	60.39	45.12	58.33	3.33	3.58	3.76	3.08
2. Nishchindipur Local	19.12	16.89	17.44	16.42	2.19	2.32	5.23	5.95
3. Sufal	53.25	48.35	40.55	62.42	23.64	24.97	7.76	4.95
4. KB-9	45.97	36.65	42.86	37.26	20.25	23.31	3.65	2.22
5. White Long Cluster	47.45	43.84	40.54	40.57	11.84	12.76	2.74	2.76
6. Nurki	16.29	19.24	16.54	18.79	10.68	11.42	4.47	4.22
7. Muktajhuri	21.97	22.63	21.43	20.88	4.93	5.18	7.10	6.32
8. Shyamla Dhepa	12.94	12.94	12.22	12.22	2.37	1.90	6.28	5.94
9. Neelam Long	48.86	44.94	42.27	38.70	22.50	25.25	2.98	3.20
10. Pusa Purple Round	56.45	55.52	46.23	42.11	25.00	18.61	3.73	3.26
11. Kalo Dhepa	12.85	12.85	11.76	11.76	2.97	3.45	6.42	7.16
12. Pusa Purple Long	45.02	29.91	34.22	33.72	9.25	8.42	1.20	2.38
13. Banaras Giant White	30.89	21.90	30.84	25.00	27.29	23.33	5.60	3.90
14. KB-20	52.07	45.18	49.26	46.26	12.77	10.57	2.50	2.28
15. L-13	45.68	36.67	42.14	33.33	13.77	12.83	6.02	6.01
16. Boral	37.89	35.64	28.57	37.50	20.11	20.17	0.95	1.01
17. Pusa Purple Cluster	40.77	24.79	35.98	24.07	13.04	12.18	2.75	4.73
18. Banarasi	32.23	17.05	26.12	17.90	11.36	14.28	1.21	1.28
19. KB-5	36.05	23.68	36.73	25.35	19.44	19.08	3.20	3.66
20. Improved Muktakeshi	35.19	31.96	38.38	32.93	6.67	7.64	5.94	5.36
21. K.P. Round	34.47	50.00	32.22	32.75	18.67	15.83	4.39	2.95
22. Navkiran	13.21	20.87	10.02	19.42	1.43	1.34	6.36	4.90
23. Rajkrishna	31.94	46.86	33.35	45.89	9.20	9.22	3.60	2.37
24. Pyratuni	40.40	44.44	39.59	43.54	19.95	23.31	2.97	2.45
25. IR-8 Baramasi	18.00	17.73	19.52	19.52	4.11	3.53	6.16	6.09
26. Banaras Long Purple	16.80	14.37	14.37	12.57	1.88	2.04	4.18	4.89
27. Baramasi	24.72	27.04	21.71	21.71	3.73	4.57	6.95	6.86
28. Shyamla Bhangar	11.08	22.47	21.61	55.12	17.66	17.89	6.29	3.11
29. BB_1	11.63	19.45	11.65	20.68	5.49	5.60	2.16	2.03
30. M. Local	20.73	20.93	17.04	20.51	8.61	8.83	4.74	2.61
31. ARM-3	30.77	20.23	30.40	31.69	10.44	10.57	3.93	3.97
32. Krishna	29.20	20.39	31.27	34.43	17.39	15.75	2.50	2.43
33. KHV-90	22.18	69.28	22.58	44.93	9.25	8.18	4.53	4.12
34. KB-52	31.43	49.38	27.27	41.67	10.39	12.43	2.45	2.67
35. KB-10	38.83	40.40	35.29	41.39	12.00	11.43	2.39	1.99
36. Brinjal Long Green	26.89	26.89	46.34	46.34	30.55	20.64	1.25	1.23
37. Pusa Kranti	24.83	38.10	22.49	38.99	8.89	8.67	1.46	2.10
38. KB-2	51.52	50.53	40.91	48.38	10.55	11.17	2.98	3.77
39. Black Prince	34.88	35.11	37.50	32.15	24.00	24.00	0.67	0.99
40. Agora	33.90	33.90	36.01	36.01	12.63	16.00	2.06	1.78
41. Suttons Long	36.05	36.05	41.57	41.57	29.25	29.78	1.66	1.47
CD at 5%	4.86	5.62	4.64	5.02	0.67	4.04	1.21	0.88

Table 18. Mean performance of different cultivars for some relative susceptibility components of brinjal to *L. orbonalis* during 1991-92 and 1992-93

Varieties	Days to borer attack in plants				Number of holes per				Number of larvae per			
	Fruits		Branches		Fruit		Plant		Fruit		Plant	
	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93
	1	2	3	4	5	6	7	8	9	10	11	12
1. R-14	129.33	130.67	108.67	110.00	2.73	2.80	11.60	11.60	0.57	0.57	2.70	2.80
2. Nishchindipur Local	114.67	118.00	91.00	90.67	1.57	1.57	6.00	6.00	0.20	0.23	0.23	0.23
3. Sufal	122.00	124.67	101.00	101.00	2.73	2.73	13.03	9.73	0.43	0.47	0.50	2.57
4. KB-9	116.33	116.67	106.33	101.00	1.83	1.77	2.80	2.77	0.40	0.37	1.93	1.93
5. White Long Cluster	119.00	116.67	99.67	99.67	1.73	1.73	3.93	4.00	0.47	0.47	1.03	1.03
6. Nurki	114.33	113.67	93.67	94.00	1.37	1.30	2.57	2.77	0.40	0.37	1.90	1.83
7. Muktajhuri	117.00	117.33	99.00	100.33	1.40	1.40	4.17	4.40	0.54	0.50	2.03	2.03
8. Shyamla Dhepa	118.00	119.67	100.00	99.33	1.20	1.17	3.33	3.37	0.17	0.13	0.40	0.40
9. Neelam Long	125.67	126.33	105.67	106.33	1.90	1.93	4.90	4.90	0.37	0.37	1.70	1.67
10. Pusa Purple Round	131.67	133.67	107.00	102.67	2.07	2.06	7.90	7.90	0.47	0.43	2.20	2.20
11. Kalo Dhepa	123.00	125.17	99.67	100.00	1.17	1.10	4.17	4.17	0.27	0.27	0.73	0.73
12. Pusa Purple Long	81.00	80.67	68.33	70.67	1.57	1.53	11.17	11.13	0.40	0.40	0.57	0.67
13. Banaras Giant White	104.00	107.67	93.33	96.33	1.50	1.50	1.80	1.80	0.37	0.37	1.20	1.20
14. KB-20	125.00	130.67	100.33	100.00	1.73	1.73	5.53	5.53	0.43	0.43	2.40	2.40
15. L-13	108.67	112.67	75.00	75.00	2.20	2.27	8.47	8.53	8.53	0.57	2.57	2.53
16. Boral	132.33	127.33	101.00	102.33	2.00	3.00	3.93	3.97	0.27	0.27	0.93	1.07
17. Pusa Purple Cluster	131.33	131.00	103.00	102.67	1.60	1.70	3.53	3.67	0.17	0.13	0.50	0.47
18. Banarasi	128.33	130.33	102.00	102.00	1.23	1.27	4.23	4.23	0.33	0.33	1.03	1.13
19. KB-5	125.33	126.00	100.33	100.33	1.30	1.43	3.00	5.67	0.43	0.40	2.23	2.37
20. Improved Muktakeshi	120.00	121.00	95.00	95.00	1.60	1.53	4.67	4.57	0.23	0.23	1.87	1.87

Table 18 contd...............

Table 18 contd................

Varieties	Days to borer attack in plants				Number of holes per				Number of larvae per			
	Fruits		Branches		Fruit		Plant		Fruit		Plant	
	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93
	1	2	3	4	5	6	7	8	9	10	11	12
21. K.P. Round	136.00	136.33	108.33	108.33	1.60	1.60	4.60	4.50	0.40	0.37	0.27	0.27
22. Navkiran	122.33	125.67	97.00	96.67	1.30	1.33	3.43	3.50	0.17	0.13	0.47	0.40
23. Rajkrishna	122.33	121.00	111.00	84.00	1.87	1.93	9.20	9.43	0.43	0.47	1.53	1.53
24. Pyratuni	120.36	122.33	100.67	102.33	1.57	1.67	4.73	4.73	0.47	0.33	2.10	2.20
25. IR-8 Baramasi	118.67	121.00	101.00	101.00	1.80	1.80	4.37	4.37	0.33	0.33	0.60	0.57
26. Banaras Long Purple	108.67	108.00	78.33	78.00	1.23	1.23	3.23	3.23	0.17	0.13	0.43	0.43
27. Baramasi	118.33	122.00	101.67	102.00	1.47	1.43	4.17	4.50	0.47	0.47	1.20	1.20
28. Shyamla Bhangar	125.00	125.00	96.67	96.67	2.20	2.10	6.17	6.13	0.17	0.33	0.87	0.90
29. BB_1	129.33	133.00	112.00	112.33	1.67	1.77	4.53	4.77	0.23	0.23	0.67	0.57
30. M. Local	120.67	122.67	103.67	106.67	1.47	1.43	3.50	3.50	0.20	0.17	1.10	1.10
31. ARM-3	122.33	123.00	101.00	100.00	1.77	2.10	7.33	7.17	0.60	0.60	2.23	2.23
32. Krishna	127.33	126.00	102.67	102.67	1.77	1.80	4.60	4.80	0.50	0.90	2.63	2.63
33. KHV-90	126.00	126.33	97.33	98.00	1.53	1.93	8.03	8.03	0.43	0.40	2.17	2.17
34. KB-52	125.00	126.00	102.67	102.67	1.73	2.10	7.87	7.63	0.53	0.50	1.77	1.77
35. KB-10	121.67	127.33	101.67	101.67	2.33	2.47	8.40	8.57	0.47	0.43	1.80	1.80
36. Brinjal Long Green	426.00	426.33	73.00	73.00	2.60	2.60	3.70	3.70	0.57	0.57	2.13	2.17
37. Pusa Kranti	103.33	103.67	97.00	97.00	2.10	2.17	8.33	8.47	0.33	0.33	0.87	0.87
38. KB-2	106.33	107.00	100.33	100.47	2.53	2.50	2.47	3.50	0.53	0.53	1.33	1.43
39. Black Prince	124.00	123.67	98.33	97.67	1.67	1.60	2.33	2.27	0.27	0.20	0.60	0.60
40. Agora	121.00	120.67	101.00	100.47	1.30	1.30	4.53	5.47	0.47	0.47	2.30	2.20
41. Suttons Long	89.00	88.33	67.00	67.00	2.00	2.00	7.10	7.10	0.50	0.50	2.03	2.03
CD at 5%	4.08	5.16	5.57	3.31	3.66	1.00	1.24	2.39	0.67	0.67	0.67	0.79

4.1.2. Screening for relative susceptibility to jassid, aphid and spotted leaf beetle

***A. biguttula biguttula* (Jassid) :**

Brinjal suffered greatly from the jassid attack. KB-9, PPR, PPL, BGW, L-13, KB-5, Improved Muktakeshi, Navkiran, BB_1 and KB-10 showed less infestation of jassid and were, therefore, regarded as tolerant to the pest (Table 9). The varieties NIL. WLC, Nurki, Shyamla Dhepa, Boral, PPC, KPR, Rajkrishna, Pyratuni, BLP, Baramasi and Shyamla Bhangar were considered moderately tolerant ranging from 11.50 to 21.15 jassids / 5 leaves. The susceptible varieties were Muktajhuri, KB-20, Banarasi, Murshidabad Local and KB-2 where 23.40 to 27.15 jassids / 5 leaves were recorded, whereas R-14, Sufal, KB-52 and IR-8 Baramasi were found to be highly susceptible showing 30.70 to 41.45 jassids / 5 leaves.

***A. gossypii* (Aphid) :**

Sufal, Navkiran, ARM-3, Krishna, Brinjal Long Green and Suttons Long suffered from relatively less infestation of aphids ranging from 13.50 to 19.00 / 5 leaves and were regarded as tolerant (Table 9). KB-20, Banarasi and KHV_{90} were found moderately tolerant showing 22.95 to 28.00 number of aphids / 5 leaves whereas the rest of the varieties came under susceptible (32.05-47.00) and highly susceptible categories (52.50-163.00).

***E. vigintioctopunctata* (Spotted leaf beetle) :**

Spotted leaf beetle population was found in low keys ranging from 0.09 individuals/5 leaves for relatively tolerant Shyamla Bhangar to 2.84 / 5 leaves for highly susceptible BLP. R-14 and Agora showed 2.17 and 2.03 numbers of the beetles / 5 leaves respectively which, therefore, was considered as susceptible. The rest of the cultivars were moderately tolerant, registering 0.43-1.77 pest incidence / 5 leaves.

4.2 Variability studies

4.2.1. Variability of *S. melongena* for some vegetative characters

Analysis of variance revealed significant differences for all the vegetative characters studied during 1991-92 and 1992-93 (Table 10). Wide range of variation was exhibited for days to flowering, plant height both at flowering and harvesting and days taken from transplanting to first picking. Genotypic co-efficient of variability (GCV) was highest for the secondary branches/pl followed by primary branches/pl and their corresponding phenotypic coefficient of variability (PCV) which also showed higher value (Table 19). Moderate GCV and PCV were estimated for the days to flowering while it was very low for the characters like plant height at first flowering, plant height at first harvesting and days taken from transplanting to first picking during both the years of observation indicating their limited scope for improvement.

Narrow differences between phenotypic and genotypic coefficients of variation were noticed for plant height at first flowering, number of secondary branches/pl, days to flowering and marketable yield/pl during 1991-92. During 1992-93 it was for the characters like plant height at first harvesting, days taken from transplanting to first picking and marketable yield/pl (Table19).

The estimates of heritability during 1991-92 were found to be high for almost all the characters ranging from 64.83% for primary branches/pl to 98.33% for days to flowering. Genetic advance for all the characters

Table 19. **Mean, standard error (SE±), co-efficient of variability, heritability (broad sense) and genetic advance for some vegetative characters in 41 cultivars of brinjal (*Solanum melongena* L.)**

Characters	Range	Mean and SE±	Variance		Coefficient of variation		Heritability	Genetic advance as % of Mean
			Phenotypic	Genotypic	Phenotypic(%)	Genotypic(%)		
	1	2	3	4	5	6	7	8
1. Plant height at first flowering	50.00-90.00	69.19±1.23	80.57	76.03	13.24	12.86	94.36	25.74
	44.00-91.66	87.41±4.60	93.32	29.96	14.17	8.03	32.10	9.37
2. Plant height at first harvesting	62.00-105.00	80.87±4.76	116.27	48.18	13.35	8.59	41.43	11.40
	61.33-101.66	77.89±0.81	81.59	79.61	11.68	11.53	97.57	23.47
3. Number of primary branches	1.00-7.00	2.31±0.42	1.53	0.99	53.81	43.32	64.83	71.86
	1.00-5.33	2.29±0.66	1.53	0.24	52.69	20.80	15.59	16.92
4. Number of secondary branches	3.00-16.33	6.57±0.47	12.56	11.89	53.82	52.37	94.69	104.98
	2.66-16.00	6.61±1.57	14.11	6.70	57.39	39.54	47.48	56.12
5. Days taken for flowering	39.66-106.00	62.93±0.85	130.84	128.66	18.18	18.03	98.33	36.83
	39.33-101.00	64.47±5.47	119.00	29.27	16.86	8.36	24.60	8.54
6. Days taken from transplanting to first picking	68.00-142.33	95.27±6.09	196.89	79.57	14.56	9.40	41.68	12.50
	68.00-131.00	92.23±1.50	145.09	138.38	12.87	12.57	95.37	25.29
7. Marketable yield per plant (Kg)	0.40-5.78	2.36±1.64	184.76	176.71	51.21	50.08	95.64	100.89
	0.32-5.78	2.22±0.10	1.58	1.55	57.71	57.16	98.11	116.63

For each character the first row represent the value for 1991-92 and second row for 1992-93

studied were noted to be highly variable which varied from 12.50% for days taken from transplanting to first picking to 104.98% for number of secondary branches/pl for the year 1991-92. Value of genetic advance (GA) was relatively high for secondary branches/pl (56.12%) during 1992-93 but highest for marketable yield/pl (116.63).

For the character marketable yield/pl, GCV and PCV were very high. The values were 50.08 and 51.21 for 1991-92 and 57.16 and 57.71 for 1992-93. Heritability and GA were also very high ranging from 95.64-98.11 and 100.89 to 116.63 respectively for the two years of study.

4.2.2. Variability for some reproductive characters

The differences among 41 varieties were highly significant for all the characters studied (Table 13). A wide range of variation was noticed in all the characters except for the average weight of fruit. In general, a major portion of the variation was contributed by genotypic component. While the environmental variation played minor role. The genetic co-efficient of variation helps in the measurement of the range of genetic diversity of a character and provides a means to compare the genetic variability of the quantitative characters. High amount of genetic coefficient of variability was exhibited by fruit weight for both the years of study, (82.01 and 62.98) respectively. Number of marketable fruits/pl and total yield/pl were the other characters in order which gave high genetic co-efficient of variation (Table 20). Variability among some of the parent varieties with respect to fruit characters are depicted in Fig. 35.

The heritability estimates were in general high for all characters except in case of fruit length during 1992-93 and number of fruits/pl during 1991-

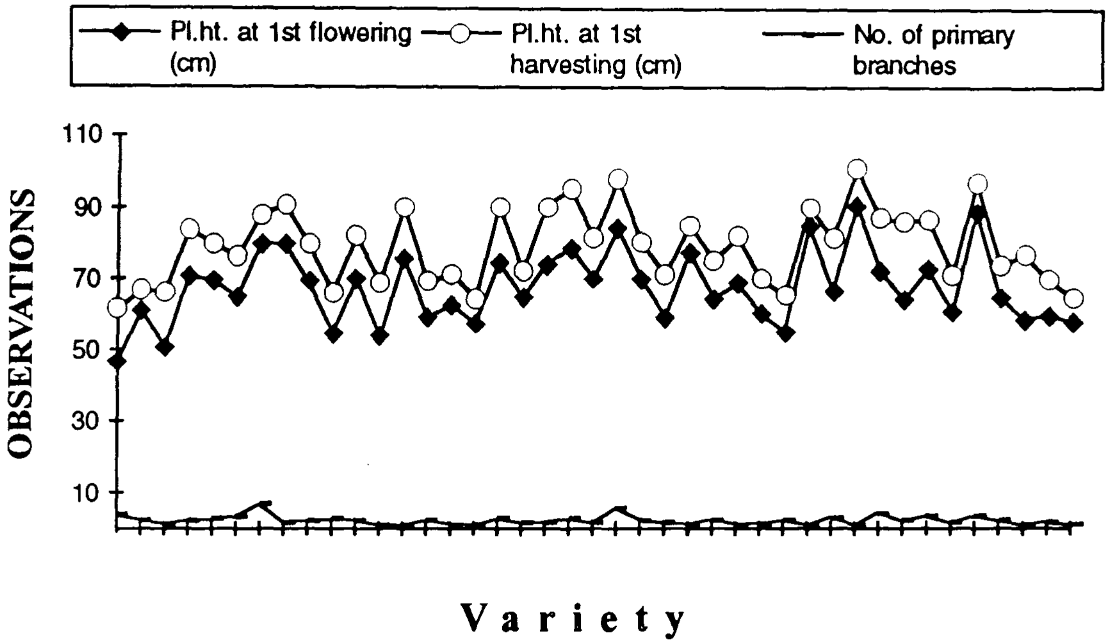


Fig. 28. **Mean performance of 41 egg plant with respect to some vegetative characters**

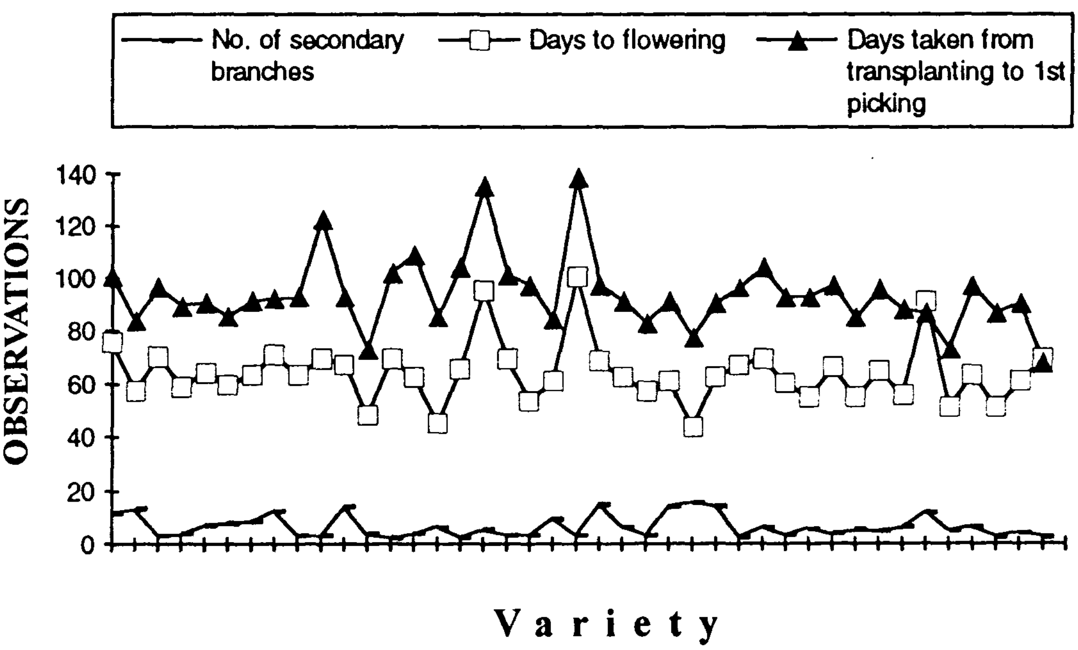


Fig. 29. **Mean performance of 41 egg plant with respect to some vegetative characters**

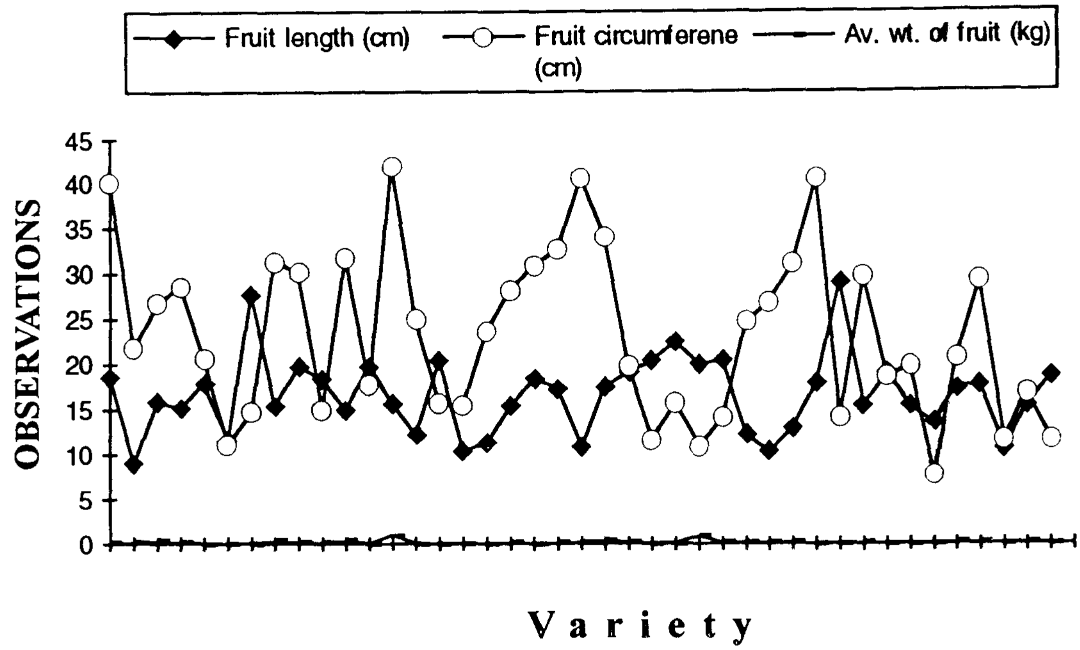


Fig. 30. **Mean performance of 41 egg plant with respect to some reproductive characters**

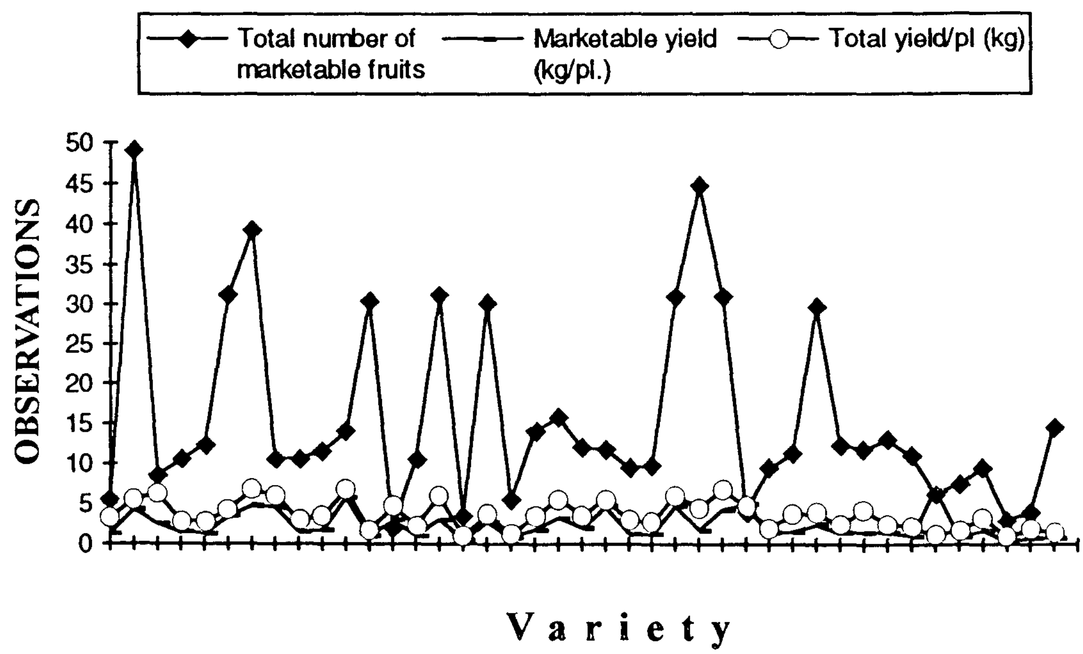


Fig. 31. **Mean performance of 41 egg plant with respect to some reproductive characters**

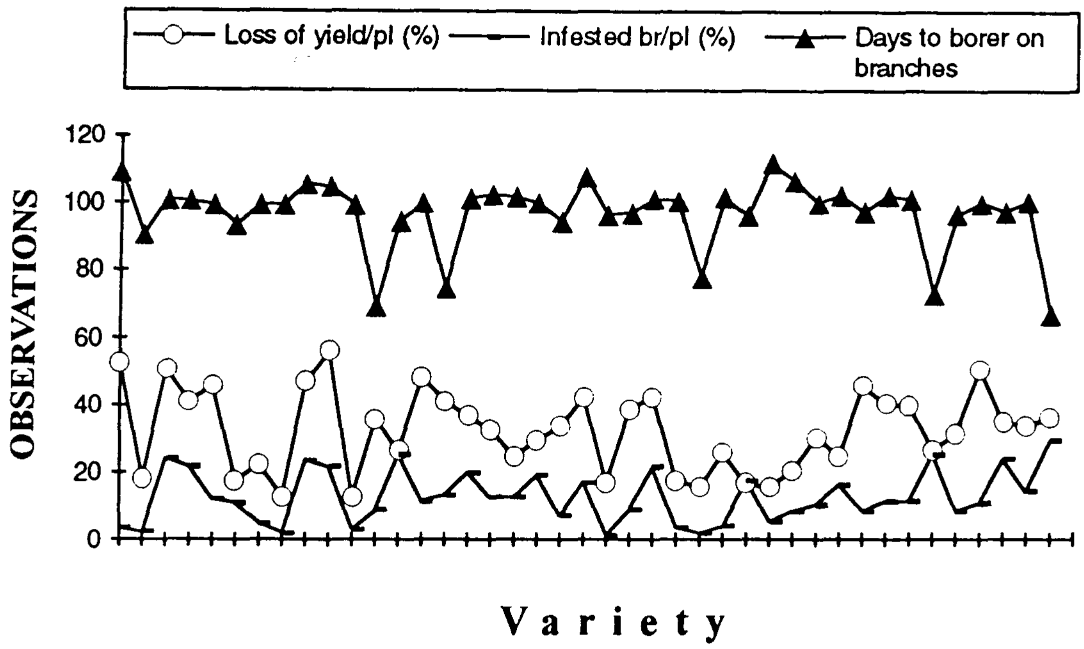


Fig. 32. **Mean performance of 41 egg plant with respect to some susceptibility components**

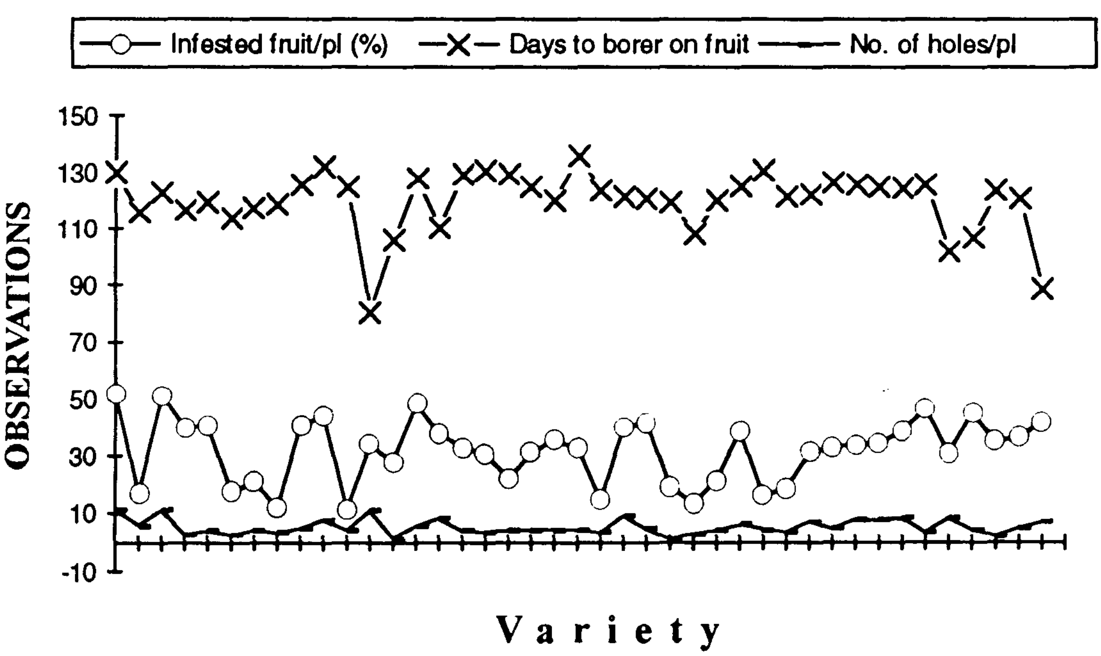


Fig. 33. **Mean performance of 41 egg plant with respect to some susceptibility components**

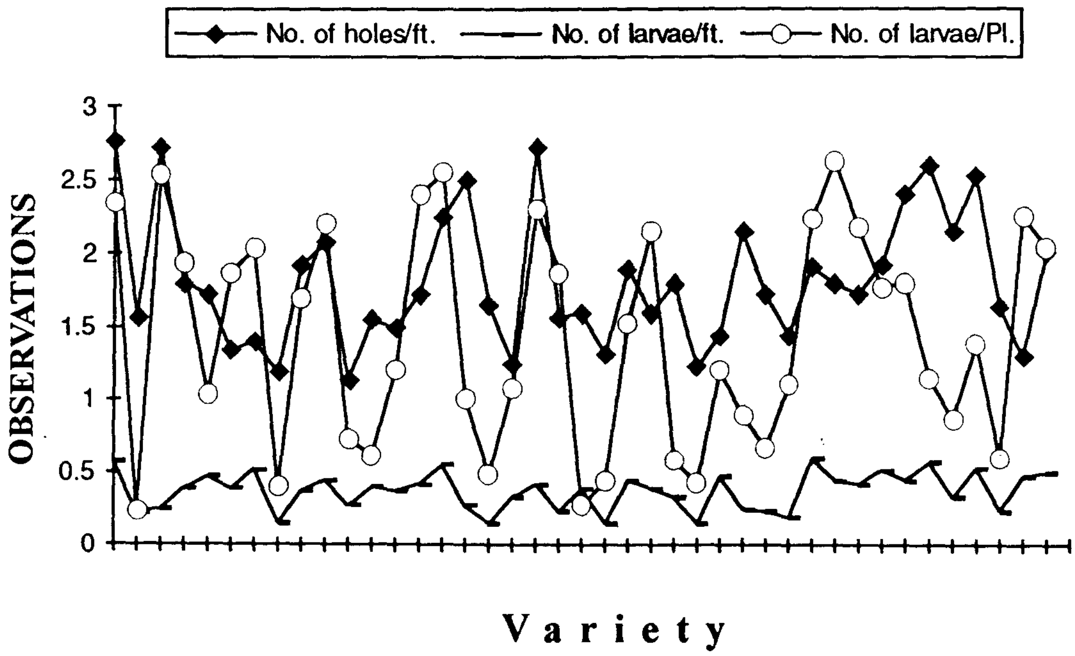


Fig. 34. **Mean performance of 41 egg plant with respect to some susceptibility components**

92. High genetic advance as percent of mean was obtained for all the characters except fruit length (Table 20).

4.2.3. Susceptibility components for the attack by *L. orbonalis*

Considerable amount of variability was exhibited by various plant parameters of relative susceptibility (Table 16). Highest phenotypic variance of 150.02 and genotypic variance of 121.76 were recorded for loss of yield/ pl for the year 1991-92. Whereas, these values were 170.90 and 120.08 for phenotypic variance (PV) and genotypic variance (GV) respectively for the year 1992-93. Number of larvae/ft exhibited lowest PV (0.02) and GV (0.01) for both the years.

Number of holes/ft not only had high GCV but also showed highest GA (99.99) with 83.75% heritability as estimated for 1991-92 record, although in 1992-93 highest heritability (95.12) and GA (89.91) were exhibited by the test character, number of larvae/pl (Table 21).

4.3. Correlation and path co-efficient analysis

4.3.1. Three levels of correlations and path analysis for vegetative characters with marketable yield

Correlation values at genotypic, phenotypic and environmental levels are presented in Tables 22 and 23 respectively for 1991-92 and 1992-93. The genotypic correlations in general, were higher than the corresponding, phenotypic and environmental correlations. Plant height at first flowering was found to be highly significant even at 1% levels of significance with plant height at first harvesting. Days to flowering appeared to be significant at 1% level with days taken from transplanting to first picking. Marketable yield was significantly correlated with number of secondary branches/pl.

Fig. 35. Phenotypic variability in shape, size and colour of the fruits of some of the brinjal cultivars screened during 1991-92 and 1992-93

1st Column	*2nd Column*	*3rd Column*
BGW	Navkiran	Shyamla Bhangar
KB-2	White brinjal	Krishna
NIL	KHV_{90}	ARM-3
KB-5	R-14	Sufal
M. Local	WLC	Nurki
Banarasi	BLP	

Table 20. **Mean, standard error (SE±), co-efficient of variability, heritability (broad sense) and genetic advance for 5 reproductive characters in 41 cultivars of brinjal (*Solanum melongena* L.)**

Characters	Range	Mean and SE±	Variance		Coefficient of variation		Heritability	Genetic advance as % of Mean
			Phenotypic	Genotypic	Phenotypic(%)	Genotypic(%)		
	1	2	3	4	5	6	7	8
1. Fruit Length (cm)	9.33-29.33	16.92±2.70	19.21	10.50	25.79	19.07	54.67	29.05
	8.66-29.00	16.51±2.49	30.85	12.19	32.91	21.68	39.50	29.05
2. Fruit circumference (cm)	10.00-44.00	22.57±2.70	81.47	59.54	40.94	35.00	73.08	61.63
	7.00-40.66	22.27±0.81	67.09	65.14	36.82	36.28	97.09	73.65
3. No. of marketable fruits	2.00-45.00	16.01±4.76	116.34	48.26	66.94	43.11	41.49	57.21
	2.33-53.00	15.53±1.03	118.30	115.12	69,90	68.95	97.32	140.12
4. Average weight of fruit (Kg)	0.05-1.20	0.19±0.06	0.03	0.03	94.52	82.01	75.28	146.58
	0.05-0.83	0.18±0.06	0.02	0.01	75.76	62.98	69.11	187.85
5. Total yield/pl (Kg)	0.87-7.70	3.84±0.27	2.85	2.73	44.17	43.28	95.99	87.34
	0.99-7.16	3.52±0.26	3.77	3.66	50.68	49.95	50.68	87.09

For each character the first row represent the value for 1991-92 and second row for 1992-93

Table 21. **Mean, standard error (SE±), co-efficient of variability, heritability (broad sense) and genetic advance for 9 characters of susceptibility to *L. orbonalis* in 41 cultivars of brinjal (*Solanum melongena* L.)**

Characters	Range	Mean and SE±	Variance		Coefficient of variation		Heritability	Genetic advance as % of Mean
			Phenotypic	Genotypic	Phenotypic(%)	Genotypic(%)		
	1	2	3	4	5	6	7	8
Loss of yield/pl (%)	11.08-56.45	32.11±3.07	150.02	121.76	37.93	34.17	81.16	63.41
	12.85-60.39	38.06±4.12	170.90	120.08	40.29	33.77	70.27	58.32
Infested fruit./pl (%)	10.02-49.93	30.55±2.80	89.66	66.07	9.69	8.32	73.69	14.71
	11.76-62.42	33.29±3.28	146.92	114.59	36.54	32.27	77.99	58.71
Infested br./pl (%)	1.43-30.55	12.91±0.06	0.94	0.13	21.04	20.14	91.68	39.73
	1.34-29.78	12.73±2.12	93.68	40.15	57.51	49.74	74.80	88.62
Days to borer on fruit	81.00-136.00	119.58±2.16	96.76	82.70	8.22	7.60	85.47	14.47
	80.67-136.33	120.69±3.46	106.03	70.03	8.52	6.92	66.05	11.59
Days to borer on branches	67.00-108.67	94.96±4.03	121.75	72.92	35.63	27.57	59.90	43.96
	67.00-108.67	97.05±1.43	89.83	83.72	9.68	9.35	96.20	18.59
Holes/ft	1.20-2.73	1.75±0.74	55.98	46.89	57.95	53.04	83.75	99.99
	1.10-3.00	1.81±0.13	0.16	0.10	22.25	17.94	65.06	29.82
Holes/pl	1.80-13.63	5.52±0.20	4.46	4.34	38.29	37.76	97.22	76.69
	1.80-11.60	5.51±0.74	4.92	3.26	39.91	32.51	66.34	54.55
Larvae/ft	0.17-0.60	0.33±0.06	0.02	0.01	31.94	26.14	67.00	45.08
	0.13-0.60	0.37±0.06	0.02	0.01	35.50	26.22	54.54	39.89
Larvae/pl	0.43-2.70	1.45±0.06	0.45	0.44	46.03	45.53	97.83	92.77
	0.23-2.80	1.47±0.08	0.45	0.43	45.88	44.75	95.12	89.91

For each character the first row represent the value for 1991-92 and second row for 1992-93

Table 22. Correlation matrix of some vegetative characters of 41 cultivars of brinjal with marketable yield during 1991-92

Characters		Pl.ht at 1st flowering	Pl.ht at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Marketable yield (kg/pl)
Pl. ht. at 1st flowering	g	–	0.920[a]	0.311	0.201	0.078	0.012	0.319
	p	–	0.891[a]	0.282	0.199	0.074	0.012	0.304
	e	–	0.106	-0.035	0.161	-0.073	0.023	-0.107
Pl. ht at 1st harvesting	g	–	–	0.272	0.107	-0.066	-0.031	0.215
	p	–	–	0.247	0.100	-0.061	-0.030	0.203
	e	–	–	-0.037	-0.072	0.020	-0.016	-0.144
Primary br. / pl.	g	–	–	–	0.387	0.035	-0.023	0.262
	p	–	–	–	0.357	0.031	-0.019	0.249
	e	–	–	–	0.040	-0.038	0.032	0.124
Secondary br. / pl.	g	–	–	–	–	-.093	-0.206	0.635[a]
	p	–	–	–	–	-.093	0.294	0.616[b]
	e	–	–	–	–	-.107	0.156	0.114
Days to flowering	g	–	–	–	–	–	0.805[a]	0.019
	p	–	–	–	–	–	0.790[a]	0.016
	e	–	–	–	–	–	0.167	-0.114
Days from transplanting to picking	g	–	–	–	–	–	–	-0.056
	p	–	–	–	–	–	–	-0.056
	e	–	–	–	–	–	–	-0.051

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = significant at 1% level
b = significant at 5% level.

Table 23. **Correlation matrix of some vegetative characters of 41 cultivars of brinjal with marketable yield during 1992-93**

Characters		Pl.ht at 1st flowering	Pl.ht at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Marketable yield/pl.
Pl. ht.at 1st flowering	g	–	0.786[a]	0.221	0.191	-0.002	-0.020	0.299
	p	–	0.770[a]	0.198	0.188	-0.003	-0.019	0.296
	e	–	0.036	-0.012	0.123	-0.003	0.010	-0.176
Pl. ht at 1st harvesting	g	–	–	0.325	0.240	0.147	0.076	0.332
	p	–	–	0.292	0.229	0.141	0.078	0.321
	e	–	–	0.006	-0.058	-0.114	0.167	-0.302
Primary br./pl	g	–	–	–	0.313	0.049	0.012	0.254
	p	–	–	–	0.289	0.046	0.025	0.246
	e	–	–	–	0.123	0.026	0.184	0.298
Secondary br./pl	g	–	–	–	–	.154	-0.008	0.775[a]
	p	–	–	–	–	.147	-0.002	0.742[b]
	e	–	–	–	–	.008	0.119	-0.143
Days to flowering	g	–	–	–	–	–	0.737[a]	-0.013
	p	–	–	–	–	–	0.714[a]	-0.012
	e	–	–	–	–	–	0.024	0.018
Days taken from trans-planting to picking	g	–	–	–	–	–	–	-0.076
	p	–	–	–	–	–	–	-0.074
	e	–	–	–	–	–	–	0.024

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = significant at 1% level
b = significant at 5% level.

These finding were true for both phenotypic and genotypic corelations and for both the years of study.

The results of genotypic, phenotypic and environmental path analysis for 1991-92 are presented in Tables 24, 26 and 28 respectively and in the Tables 25, 27 and 29 for 1992-93. The character secondary branches/pl showed highest direct effect with marketable yield during both the years of study. Value for genotypic correlation during 1991-92 was 0.604 and during 1992-93 it was 0.775. The residual effects were respectively 0.739 and 0.591 for 1991-92 and 1992-93. The character days from transplanting to picking had high negative direct effect at phenotypic level followed by high positive direct effect of days to flowering (1.839) and secondary branches/pl (1.583). Residual effect was 0.241, during 1991-92. But during 1992-93 at phenotypic level secondary branches/pl had high direct positive effect with marketable yield. Residual effect being 0.635, the secondary branches also showed very high positive correlation (0.742) with marketable yield.

Very low direct effect was expressed by almost all the characters during both the years of study. Residual effect was 0.981 for 1991-92 and 0.353 for 1992-93.

4.3.2. Three levels of correlation and path analysis for some important reproductive components with total yield

Correlation co-efficients between different characters are shown in Tables 30 and 31 during 1991-92 and 1992-93 respectively. The fruit circumference had high positive correlation with fruit weight. Fruit weight showed highest correlation value with the total yield/pl both at phenotypic and genotypic level during 1991-92 (Table 30). During 1992-93 fruit circumference showed high positive correlation (0.606) with fruit weight followed by fruit numbers with total yield/pl (0.606) at genotypic level. At the phenotypic level, fruit number/pl showed significant ($p = 0.01$) correlation with total yield (0.592) followed by fruit circumference with fruit weight (0.516).

Of the three categories of correlations, environmental correlation values were the lowest excepting in respect of fruit length with fruit circumference while the value was highest when compared with the phenotypic and genotypic correlation values. However, in no case the fruit length and circumference were significantly correlated with the environment.

Direct and indirect effects of some reproductive yield components are presented in the Tables 32 to 37. The number of fruits/pl had very high positive direct effect (0.686) on total yield followed by fruit circumference (0.427) and fruit weight (0.399), and the residual effect was 0.635 during 1991-92 (Table 32). With slight variation during 1992-93 these values were highest for the number of fruits for (0.772) followed by fruit weight (0.495) and fruit circumference (0.185). Residual effect was 0.509 (Table 33).

Phenotypic path analysis revealed that fruit number/pl had very high positive direct effect followed by fruit weight for both the years of study (Tables 33 and 34). The residual effect were 0.707 for 1991-92 and 0.571 for 1992-93.

Environmental paths showed comparatively lower values during 1991-92 and 1992-93, residual effects being 0.903 and 0.979 (Tables 35 and 36) respectively.

4.3.3. Three levels of correlation and path analysis for some important susceptibility components in respect of attack by *L. orbonalis* with loss of yield

Correlation co-efficient for different pairs of susceptibility components are presented in Tables 38 and 39 for 1991-92 and 1992-93 respectively. During 1991-92 a significant positive correlation was recorded for the character larvae/pl with larvae/ft both at genotypic and phenotypic levels. Similarly, days to borer attack on branches had a correlation with days to borer on fruit. Infested branches/pl also showed high positive correlation (0.681) at genotypic level with yield loss (0.681) and infested fruit/pl (0.681). Infested fruit/pl also significantly correlated at 5% level of significance with larvae/ft (0.603) and holes/ft (0.603). Percent yield loss showed a significant positive correlation with infested fruit/pl (0.681), infested branches/pl (0.681), holes/ft (0.603), larvae/ft (0.603) and larvae/ pl (0.601) at genotypic level.

During 1992-93, larvae/pl was highly significant at 1% level of significance with larvae/ft at genotypic level while significantly positive at 5% level for phenotypic correlation. Days to borer attack on branches showed highly significant correlation both at genotypic and phenotypic levels with the character days to borer attack on fruit. The character infested fruit/pl had also high correlation with the larvae/ft at genotypic level (0.629) and holes/ft both at genotypic (0.860) and phenotypic (0.768) levels, and with infested fruit/pl both at genotypic and phenotypic levels and with holes/ ft at genotypic level.

Path co-efficient analysis for susceptibility components with percent

Table 24. Direct and indirect effect of some vegetative characters on marketable yield of 41 cultivars of egg plant during 1991-92 at genotypic level

Characters	Pl.ht at 1st flowering	Pl.ht at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Genotypic Correlation with yield
Pl. ht. at 1st flowering	*0.415*	-0.203	-0.012	0.121	-0.003	0.001	0.319
Pl. ht. at 1st harvesting	0.381	*-0.221*	-0.010	0.065	0.003	-0.003	0.215
Primary branches	0.129	-0.060	*-0.037*	0.234	-0.001	-0.002	0.262
Secondary branches	0.083	-0.024	-0.014	*0.604*	0.004	-0.018	*0.635*
Days taken for flowering	0.032	0.015	-0.001	-0.057	*-0.042*	0.072	0.019
Days taken from transplanting to picking	0.005	0.007	0.001	-0.124	-0.034	*0.089*	-0.056
Marketable yield (kg/pl)	0.132	-0.047	-0.010	0.384	-0.001	-0.005	

Italicized (diagonal) values represent direct effect
Residual effect = 0.739

Table 25. **Direct and indirect effect of some vegetative characters on marketable yield of 41 cultivars of egg plant during 1992-93 at genotypic level**

Characters	Pl. ht. at 1st flowering	Pl. ht at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Genotypic Correlation with yield
Pl. ht. at 1st flowering	*0.043*	0.117	-0.008	0.148	0.000	-0.001	0.294
Pl. ht. at 1st harvesting	0.034	*0.148*	-0.012	0.186	-0.030	0.005	0.332
Primary branches	0.010	-0.048	*-0.037*	0.242	-0.010	0.001	0.254
Secondary branches	0.008	0.036	-0.012	*0.775*	-0.031	-0.001	*0.775*
Days taken for flowering	-0.000	0.022	-0.002	0.114	*-0.205*	0.052	-0.013
Days taken from trans-planting to picking	-0.001	0.001	-0.000	-0.006	-0.151	*0.071*	-0.076
Marketable yield	0.013	-0.049	-0.009	0.600	0.003	-0.003	

* Italicized (diagonal) values represent direct effect

* Residual effect = 0.591

Table 26. **Direct and indirect effect of vegetative yield component on marketable yield of 41 cultivars of egg plant during 1991-92 at phenotypic level**

Characters	Pl. ht. at 1st flowering	Pl. ht. at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Phenotypic Correlation with yield
Pl. ht. at 1st flowering	*-0.906*	0.896	-0.114	0.315	0.136	-0.023	0.304
Pl. ht. at 1st harvesting	-0.807	*1.005*	-0.099	0.158	-0.112	0.058	0.203
Primary branches	-0.255	0.248	*-0.403*	0.565	0.057	0.037	0.249
Secondary branches	-0.180	0.101	-0.144	*1.583*	-0.173	-0.571	*0.616*
Days taken for flowering	-0.067	-0.061	-0.012	-0.149	*1.839*	*-1.533*	0.016
Days taken from trans-planting to picking	-0.011	-0.030	0.008	0.465	1.453	*-1.941*	-0.056
Marketable yield	-0.275	0.204	-0.100	0.975	0.029	0.109	

* Italicized (diagonal) values represent direct effect
* Residual effect = 0.241

Table 27. **Direct and indirect effect of vegetative yield component on marketable yield of 41 cultivars of egg plant during 1992-93 at phenotypic level**

Characters	Pl. ht. at 1st flowering	Pl. ht. at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Phenotypic Correlation with yield
Pl. ht. at 1st flowering	*0.061*	0.100	-0.001	0.137	0.000	-0.001	0.296
Pl. ht. at 1st harvesting	0.047	*0.130*	-0.002	0.166	-0.023	0.003	0.321
Primary branches	0.012	-0.038	*-0.007*	0.210	-0.007	0.001	0.246
Secondary branches	0.011	0.030	-0.002	*0.727*	-0.024	-0.000	0.742
Days taken for flowering	-0.000	0.018	-0.000	0.107	*-0.160*	0.024	-0.012
Days taken from transplanting to picking	0.001	0.010	-0.000	-0.001	-0.114	*0.033*	-0.074
Marketable yield	0.018	0.042	-0.002	0.539	0.002	-0.002	

* Italicized (diagonal) values represent direct effect

* Residual effect = 0.635

Table 28. **Direct and indirect effect of vegetative yield component on marketable yield of 41 cultivars of egg plant during 1991-92 at environmental level**

Characters	Pl.ht at 1st flowering	Pl.ht at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Environmental Correlation with yield
Pl. ht. at 1st flowering	*-0.115*	-0.013	-0.004	0.019	0.007	-0.001	-0.107
Pl. ht. at 1st harvesting	-0.012	*-0.118*	-0.004	-0.009	-0.002	0.001	-0.144
Primary branches	0.004	0.004	*0.109*	0.005	0.004	-0.002	0.124
Secondary branches	-0.019	0.009	0.004	*0.118*	0.010	-0.009	0.114
Days to flowering	0.008	-0.002	-0.004	-0.013	*-0.094*	-0.009	-0.114
Days from trans-planting to to picking	-0.003	0.002	0.003	0.018	-0.016	*-0.057*	-0.051
Marketable yield	0.012	0.017	0.014	0.014	0.011	0.003	

* Italicized (diagonal) values represent direct effect
* Residual effect = 0.981

Table 29. **Direct and indirect effect of vegetative yield component on marketable yield of 41 cultivars of egg plant during 1992-93 at environmental level**

Characters	Pl. ht. at 1st flowering	Pl. ht. at 1st harvesting	Primary branches	Secondary branches	Days to flowering	Days from transplanting to picking	Environmental Correlation with yield
Pl. ht. at 1st flowering	*0.220*	-0.012	-0.004	-0.029	0.000	0.001	0.176
Pl. ht. at 1st harvesting	0.008	*-0.336*	0.002	0.014	0.003	0.008	-0.302
Primary branches	-0.003	-0.002	*-0.324*	-0.029	-0.001	0.009	0.298
Secondary branches	0.027	0.020	0.040	*-0.235*	-0.000	0.006	-0.143
Days to flowering	-0.001	0.038	0.008	-0002	*-0.027*	0.001	0.018
Days taken from trans-planting to picking	0.002	-0.056	0.060	-0.028	-0.001	*0.047*	0.024
Marketable yield (kg/pl)	0.039	0.102	0.096	0.034	-0.000	-0.001	

* Italicized (diagonal) values represent direct effect

* Residual effect = 0.853

Table 30. **Correlation matrix of some reproductive characters with total yield of 41 cultivars of brinjal during 1991-92**

Characters		Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Total yield (kg/pl)
Fruit length (cm)	g	–	0.235	0.334	-0.088	0.212
	p	–	-0.193	0.315	-0.080	0.210
	e	–	0.230	0.012	0.057	0.180
Fruit circumference (cm)	g	–	–	-0.402	0.591[a]	0.359
	p	–	–	-0.362	0.575[a]	0.333
	e	–	–	0.046	0.456	0.030
Fruit numbers	g	–	–	–	-0.319	0.364
	p	–	–	–	-0.305	0.350
	e	–	–	–	-0.040	0.023
Fruit weight (kg)	g	–	–	–	–	0.422
	p	–	–	–	–	0.419
	e	–	–	–	–	0.348

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = significant at 1% level
b = significant at 5% level

Table 31. Correlation matrix of some reproductive characters with total yield of 41 cultivars of brinjal during 1992-93

Characters		Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Total yield (kg/pl)
Fruit length (cm)	g	–	0.222	0.176	-0.032	0.263
	p	–	-0.207	0.160	-0.011	0.253
	e	–	0.090	-0.145	0.106	0.083
Fruit circumference (cm)	g	–	–	-0.310	0.606[a]	0.205
	p	–	–	-0.304	0.516[b]	0.203
	e	–	–	0.058	-0.082	0.059
Fruit numbers	g	–	–	–	-0.288	0.604[a]
	p	–	–	–	-0.260	0.592[a]
	e	–	–	–	-0.198	-0.162
Fruit weight (kg)	g	–	–	–	–	0379
	p	–	–	–	–	0.332
	e	–	–	–	–	0.116

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = significant at 1% level
b = significant at 5% level

Table 32. Direct (diagonal) and indirect effect of reproductive characters on total yield of 41 cultivars of brinjal during 1991-92 (at genotypic level)

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Genotypic correlation with total yield (kg/pl.)
Fruit length (cm)	*0.118*	-0.100	0.229	-0.035	-0.212
Fruit circumference (cm)	-0.028	*0.427*	-0.276	0.236	0.359
Fruit numbers	-0.023	-0.172	*0.686*	-127	0.364
Fruit weight (kg)	0.010	0.252	-0.219	*0.399*	0.422
Total yield (kg/pl.)	0.025	0.153	0.250	0.168	

Italicized (diagonal) values are direct effect
Residual effect = 0.635

Table 33. Direct (diagonal) and indirect effect of reproductive characters on total yield of 41 cultivars of brinjal during 1992-93 (at genotypic level)

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Genotypic correlation with total yield (kg/pl.)
Fruit length (cm)	*0.184*	-0.041	0.136	-0.016	0.263
Fruit circumference (cm)	-0.041	*0.185*	-0.239	0.300	0.205
Fruit numbers	-0.032	-0.057	*0.772*	-0.143	0.604
Fruit weight (kg)	-0.006	0.112	-0.222	*0.495*	0.379
Total yield (kg/pl.)	0.048	0.038	0.466	0.188	

Italicized (diagonal) values represent direct effect
Residual effect = 0.509

Table 34. **Direct (diagonal) and indirect effect of some reproductive characters on total yield of 41 cultivars of brinjal during 1991-92 (at phenotypic level)**

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Phenotypic correlation with total yield (kg/pl.)
Fruit length (cm)	*0.131*	-0.062	0.173	-0.033	0.210
Fruit circumference (cm)	-0.025	*0.320*	-0.199	0.238	0.333
Fruit numbers	0.041	0.116	*0.551*	-0.126	0.350
Fruit weight (kg)	-0.011	0.184	-0.168	*0.413*	0.419
Total yield (kg/pl.)	0.028	0.107	0.193	0.173	

Italicized (diagonal) values are for direct effect
Residual effect = 0.707

Table 35. **Direct (diagonal) and indirect effect of some reproductive growth characters on total yield of 41 cultivars of brinjal during 1992-93 (at phenotypic level)**

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Phenotypic correlation with total yield (kg/pl.)
Fruit length (cm)	*0.194*	-0.056	0.119	-0.004	0.253
Fruit circumference (cm)	-0.040	*0.269*	-0.226	0.201	0.203
Fruit numbers	-0.031	-0.082	*0.744*	-0.101	0.592
Fruit weight (kg)	-0.002	0.139	-0.193	*0.389*	0.379
Total yield (kg/pl.)	0.049	0.055	0.440	0.129	

Italicized (diagonal) values are direct effect
Residual effect = 0.571

Table 36. **Direct (diagonal) and indirect effect of some reproductive characters on total yield of 41 cultivars of brinjal during 1991-92 (at environmental level)**

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Environmental correlation with total yield (kg/pl.)
Fruit length (cm)	*0.205*	-0.050	0.001	0.025	0.180
Fruit circumference (cm)	0.047	*0.219*	0.002	0.200	0.030
Fruit numbers	0.002	-0.010	*0.048*	-0.018	0.023
Fruit weight (kg)	0.012	-0.100	-0.002	*0.438*	0.348
Total yield (kg/pl.)	0.037	-0.007	0.4001	0.152	

\# Italicized (diagonal) values represent direct effects
\# Residual effect = 0.903

Table 37. **Direct (diagonal) and indirect effect of some reproductive characters on total yield of 41 cultivars of brinjal during 1992-93 (at environmental level)**

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Environmental correlation with total yield (kg/pl.)
Fruit length (cm)	*0.047*	0.006	0.021	0.009	0.083
Fruit circumference (cm)	0.004	*0.070*	-0.008	-0.007	0.059
Fruit numbers	-0.007	0.004	*0.142*	-0.018	-0.162
Fruit weight (kg)	0.005	-0.006	0.028	*0.089*	0.116
Total yield (kg/pl.)	0.004	0.004	0.023	0.010	

Italicized (diagonal) values are direct effect
Residual effect = 0.979

Table 38. Correlation matrix for some susceptibility components on percent yield loss in 41 cultivars of brinjal during 1991-92

Characters		Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borrer on fruit	Infested br/pl	Infested ft./pl	Yield loss (%)
Larvae/pl	g	—	0.775[a]	0.371	0.427	-0.006	0.091	0.362	0.601[b]	0.601[b]
	p	—	0.687[a]	0.365	0.407	-0.005	0.089	0.345	0.539	0.010
	e	—	-0.072	0.027	-0.059	0.051	0.041	0.174	0.157	0.122
Larvae/ft	g		—	0.469	0.518	-0.102	-0.084	0.339	0.603	0.603[b]
	p		—	0.424	0.455	-0.069	-0.073	0.289	0.468	0.101
	e		—	0.167	0.078	0.262	-0.003	0.036	-0.041	0.062
Holes/pl	g			—	0.563	-0.096	-0.197	-0.057	0.343	0.343
	p			—	0.537	-0.091	-0.192	-0.058	0.296	-0.033
	e			—	-0.042	0.119	-0.237	-0.113	-0.088	-0.042
Holes/ft	g				—	-0.059	0.030	0.388	0.603[b]	0.603[b]
	p				—	-0.056	0.026	0.362	0.529	-0.029
	e				—	0.003	-0.050	0.101	0.088	-0.033
Days to borer on branches	g					—	0.722[a]	-0.206	-0.111	-0.111
	p					—	0.700[a]	-0.124	-0.102	0.045
	e					—	0.091	0.120	-0.068	-0.069
Days to borer on fruit	g						—	0.017	-0.031	-0.031
	p						—	0.0118	-0.018	-0.108
	e						—	0.037	0.090	0.108
Infested br/pl	g							—	0.681[a]	0.681[a]
	p							—	0.578	-0.068
	e							—	0.032	0.010
Infested fruit/pl	g								—	0.681[a]
	p								—	-0.038
	e								—	-0.068

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = Significant at 1% level
b = Significant at 5% level

Table 39. Correlation matrix for some susceptibility components on percent yield loss in 41 cultivars of brinjal during 1992-93

Characters		Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Yield loss (%)
Larvae/pl	g	—	0.752[a]	0.398	0.476	-0.005	0.103	0.388	0.590	0.487
	p	—	0.652[b]	0.383	0.451	-0.004	-0.093	0.354	0.539	0.459
	e	—	-0.085	-0.244	-0.064	0.008	-0.088	0.162	-0.087	-0.081
Larvae/ft	g		—	0.529	0.581	-0.118	-0.117	0.280	0.629[b]	0.561
	p		—	0.460	0.494	-0.073	-0.071	0.239	0.530	0.455
	e		—	0.082	0.51	0.238	0.189	0.099	0.128	-0.096
Holes/pl	g			—	0.545	-0.069	-0.156	-0.071	0.564	0.524
	p			—	0.524	-0.062	-0.142	-0.069	0.522	0.511
	e			—	0.125	0.124	0.136	-0.088	0.061	-0.330
Holes/ft	g				—	-0.014	0.068	0.334	0.860[a]	0.632[b]
	p				—	-0.014	0.069	0.305	0.768[a]	0.591
	e				—	-0.010	0.086	0.142	-0.047	-0.068
Days to borer on branches	g					—	0.699[a]	-0.112	0.073	0.222
	p					—	0.665[a]	-0.136	0.065	0.211
	e					—	0.186	-0.379	-0.012	0.054
Days to borer on fruit	g						—	-0.036	0.069	0.142
	p						—	-0.061	0.061	0.129
	e						—	-0.247	-0.004	-0.030
Infested br/pl	g							—	0.526	0.311
	p							—	0.407	0.267
	e							—	-0.191	0.002
Infested fruit/pl	g								—	0.800[a]
	p								—	0.742[a]
	e								—	0.255

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = Significant at 1% level
b = Significant at 5% level

Table 40. Direct (diagonal) and indirect effect of some susceptibility components on yield loss in 41 cultivars of brinjal during 1991-92 (at genotypic level)

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Genotypic Corre. with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	*0.226*	0.084	-0.049	0.088	-0.001	-0.011	0.202	-0.036	0.601
2. Larvae/ft	0.775	*0.108*	0.062	0.107	-0.013	0.010	0.189	-0.037	0.603
3. Holes/pl	0.084	0.051	*0.132*	0.116	-0.012	0.024	-0.032	-0.021	0.343
4. Holes/ft	0.097	0.056	0.074	*0.207*	-0.007	-0.004	0.217	-0.0377	0.603
5. Days to borer on branches	-0.001	-0.011	-0.013	-0.012	*0.124*	-0.089	-0.115	0.007	-0.111
6. Days to borer on fruit	0.021	-0.009	-0.026	0.006	0.089	*-0.123*	0.009	0.002	-0.031
7. Infested br./pl	0.082	0.037	-0.008	0.080	-0.025	-0.002	*0.559*	-0.041	0.681
8. Infested ft./pl	0.136	0.065	0.045	0.125	-0.014	0.004	0.380	*-0.061*	0.681
9. Yield loss (%)	0.136	0.065	0.045	0.125	-0.014	0.004	0.380	-0.041	

* Italicized diagonal values represent direct effect

* Residual effect = 0.547

Table 41. **Direct (diagonal) and indirect effect of some susceptibility components on yield loss in 41 cultivars of brinjal during 1992-93 (at genotypic level)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Genotypic Corre. with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	***-0.086***	0.141	0.025	-0.134	-0.001	0.004	-0.043	0.581	0.487
2. Larvae/ft	-0.065	***0.187***	0.034	-0.163	-0.016	-0.004	-0.031	0.620	0.561
3. Holes/pl	-0.034	0.099	***0.064***	-0.153	-0.009	-0.006	0.008	0.556	0.524
4. Holes/ft	-0.041 632	0.109	0.035	***-0.281***	-0.002	0.002	-0.037	0.847	0.632
5. Days to borer on branches	0.000	-0.022	-0.004	0.004	***0.135***	0.025	0.012	0.072	0.222
6. Days to borer on fruit	-0.009	-0.022	-0.010	-0.019	0.094	***0.036***	0.004	0.068	0.142
7. Infested br./pl	-0.033	0.052	-0.005	-0.094	-0.015	-0.001	***-0.111***	0.518	0.3111
8. Infested ft./pl	-0.051	0.118	0.036	-0.242	0.010	0.002	-0.059	***0.985***	0.800
9. Yield loss (%)	-0.042	0.105	0.034	-0.178	0.030	0.005	-0.035	0.788	

* Italicized diagonal values represent direct effect
* Residual effect = 0.541

Table 42. Direct (diagonal) and indirect effect of some susceptibility components on yield loss in 41 cultivars of brinjal during 1991-92 (at phenotypic level)

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Phenotypic Corre. with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	*-0.053*	0.152	-0.042	0.002	-0.000	-0.005	-0.033	-0.011	0.010
2. Larvae/ft	-0.036	*0.222*	-0.048	0.002	-0.005	0.004	-0.028	-0.009	0.101
3. Holes/pl	-0.019	0.094	*-0.114*	0.002	-0.006	0.011	0.006	-0.006	-0.033
4. Holes/ft	-0.021	0.101	-0.061	*0.004*	-0.004	-0.002	-0.035	-0.010	-0.029
5. Days to borer on branches	0.000	-0.015	0.010	-0.000	*0.071*	-0.041	0.018	0.002	0.045
6. Days to borer on fruit	-0.005	-0.016	0.022	0.000	0.050	*-0.059*	-0.002	0.000	-0.009
7. Infested br./pl	-0.018	0.064	0.007	0.001	-0.013	-0.001	*-0.096*	-0.011	-0.068
8. Infested ft./pl	-0.028	0.104	-0.034	0.002	-0.007	0.001	-0.056	*-0.020*	-0.038
9. Yield loss (%)	-0.001	0.022	0.004	-0.000	0.003	0.001	0.007	0.001	

* Italicized diagonal values represent direct effect

* Residual effect = 0.964

Table 43. **Direct (diagonal) and indirect effect of some susceptibility components on yield loss in 41 cultivars of brinjal during 1992-93 (at phenotypic level)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Phenotypic Corre. with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	*0.032*	0.029	0.76	0.006	-0.001	-0.001	0.020	0.297	0.459
2. Larvae/ft	0.021	*0.044*	0.092	0.007	-0.015	0.001	0.014	0.292	0.455
3. Holes/pl	0.012	0.020	*0.199*	0.007	-0.013	0.002	-0.004	0.287	0.511
4. Holes/ft	0.015	0.022	0.104	*0.013*	-0..003	-0.001	0.018	0.423	0.591
5. Days to borer on branches	-0.000	-0.003	-0.012	-0.000	*0.206*	-0.007	-0.008	0.036	0.211
6. Days to borer on fruit	0.003	-0.003	-0.028	0.001	0.137	*-0.011*	-0.004	0.034	0..129
7. Infested br./pl	0.011	0.011	-0.014	0.004	-0.028	0.001	*0.058*	0.224	0.267
8. Infested ft./pl	0.017	0.024	0.104	0.010	0.013	-0.001	0.024	*0.551*	0.742
9. Yield loss (%)	0.015	0.020	0.102	0.008	0.043	-0.001	0.005	0.409	

* Italicized diagonal values represent direct effect
* Residual effect = 0.623

Table 44. **Direct (diagonal) and indirect effect of some susceptibility components on yield loss in 41 cultivars of brinjal during 1991-92 (at environmental level)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Environ. Corre. with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	*0.132*	0.003	-0.001	0.001	-0.002	-0.004	-0.004	-0.015	0.122
2. Larvae/ft	0.009	*0.047*	-0.008	-0.001	-0.011	-0.000	-0.001	0.004	0.062
3. Holes/pl	0.004	0.008	*-0.048*	0.001	0.005	-0.023	0.003	0.008	-0.042
4. Holes/ft	-0.008	0.004	0.002	*-0.015*	0.000	-0.005	-0.002	-0.008	-0.033
5. Days to borer on branches	0.007	0.012	-0.006	-0.000	*0.043*	0.009	-0.003	0.006	0.069
6. Days to borer on fruit	0.005	-0.000	0.011	0.001	0.004	*0.096*	-0.001	-0.009	0.108
7. Infested br./pl	0.023	0.002	0.005	-0.002	0.005	0.004	*-0.024*	-0.003	0.010
8. Infested ft./pl	0.21	-0.002	0.004	-0.001	-0.003	0.009	-0.001	*-0.095*	-0.068
9. Yield loss (%)	0.016	0.003	0.002	0.001	0.003	0.010	-0.000	0.006	

* Italicized diagonal values represent direct effect

* Residual effect = 0.979

Table 45. **Direct (diagonal) and indirect effect of some susceptibility components on yield loss in 41 cultivars of brinjal during 1992-93 (at environmental level)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested br/pl	Infested ft./pl	Environ. Corre. with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	*0.018*	-0.017	-0.080	-0.02	0.001	0.002	0.022	-0.025	-0.081
2. Larvae/ft	0.002	*-0.202*	0.027	0.002	0.029	0.005	0.014	0.037	-0.096
3. Holes/pl	-0.004	-0.017	*0.329*	0.004	0.015	-0.003	-0.012	0.018	0.330
4. Holes/ft	-0.001	-0.010	0.041	*0.036*	-0.001	-0.002	0.020	-0.014	0.068
5. Days to borer on branches	0.000	-0.048	0.041	-0.000	*0.122*	-0.005	-0.053	-0.004	0.054
6. Days to borer on fruit	-0.002	-0.038	0.045	0.003	0.023	*-0.025*	-0.034	-0.001	-0.030
7. Infested br./pl	0.003	-0.020	-0.029	0.005	-0.046	0.006	*0.139*	-0.056	0.002
8. Infested ft./pl	-0.002	-0.026	0.020	-0.002	-0.001	0.000	-0.026	*0.292*	0.255
9. Yield loss (%)	-0.001	0.014	0.109	0.002	'0.002	0.001	0.000	0.074	

* Italicized diagonal values represent direct effect

* Residual effect = 0.888

yield loss is furnished in Tables 40 to 45. Infested branches/pl showed highest positive direct effect (0.559) for percent yield loss followed by larvae/ft (0.226) at genotypic level during 1991-92 while infested fruit/pl showed highest positive direct effect (0.985) on percent yield loss during 1992-93 (Tables 40 and 41).

Phenotypic path analysis showed that larvae/ft (0.222) and holes/pl (0.004) had direct positive effect while other characters showed a negative direct relation with the percent yield loss during 1991-92. Residual effect appeared to be 0.964. But during 1992-93, a positive direct effect was shown by the test characters infested fruit/pl (0.551) days to borer on branches (0.206), holes/pl (0.199), larvae/ft (0.044) and larvae/pl (0.032). The days to borer on fruit had negative (-0.011) effect on percent yield loss. Residual effects were 0.964 and 0.623 during 1991-92 and 1992-93 respectively (Tables 42 and 43).

Environmental path co-efficient analysis showed very lower value for direct effects during both the years of study and as such residual effect was very high 0.979 for 1991-92 followed by 0.888 during 1992-93. (Tables 44 and 45).

4.4. Genetic divergence

Analysis of variance showed significant differences among the 41 genotypes for 21 characters. The 41 genotypes were grouped into 4 clusters which differed slightly as appeared from the investigation covering two years (Tables 46 and 49).

During 1991-92 cluster I formed with 11 genotypes, cluster II with smallest number of 7 genotypes, highest was the cluster III consisting of

13 genotypes followed by cluster IV with 10 genotypes (Table 46).

During 1992-93, similar pattern of grouping among the genotypes was recorded with slight variation. Cluster IV formed the largest having 12 genotypes followed by cluster I with 11 and the remaining II and III consisting of only 9 genotypes each. (Table 49).

The intracluster distance during 1991-92 (Table 47) was the highest in cluster I (80.38) followed by cluster III (79.07) and cluster II (74.94). Intercluster distance was maximum between I and IV (97.86) followed by I and II (95.49), II and III (90.06) and I and III (82.07). The minimum genetic distance was between cluster II and IV (35.78).

The intracluster distance during 1992-93 (Table 50) was high in cluster I (50.34), closely followed by cluster II (50.25) and cluster III (49.38). The least intracluster distance was recorded in the cluster IV (35.75). Intercluster distance was maximum between I and IV (56.07) followed by I and III (53.62). The minimum genetic distance was between cluster III and IV (40.50).

Examination of the character means for 21 traits showed that during 1991-92 (Table 48) and 1992-93 (Table 51), geographical distribution and spatial distribution of clusters were not necessarily related.

Table 48 revealed that during 1991-92 the cluster I included genotypes with average or grand mean values for plant height at first flowering, plant height at first harvesting, number of primary branches/pl, days to flowering among the vegetative characters studied; length of fruit, maximum circumference of fruit, weight of fruit and total yield from among the reproductive components and also the number of larvae/ft, number of holes/ft and days

Table 46. **Distribution of 41 genotypes of egg plants among four clusters (1991-92)**

Cluster	No. of genotypes	Genotypes
I.	11	NIL, Nurki, Shyamla Dhepa, KD, Navkiran, IR-8-Baramasi, Shyamla Bhangar, BB_1, Murshidabad Local, BLP, Krishna.
II.	7	Muktajhuri, BGW, Baramasi, ARM-3, KHV-90, Brinjal Long Green, Pusa Kranti.
III.	13	Boral, PPC, Banarasi, KB-5, Improved Muktakeshi, KPR, Rajkrishna, Pyratuni, KB-52, KB-10, Black Prince, Agora, Suttons Long.
IV.	10	R-14, Sufal, KB-9, WLC, Neelam Long, PPR, PPL, KB-20, L-13, KB-2.

Table 47. Average intra and inter cluster distances during 1991-92

Cluster	I	II	III	IV
I	80.38	95.49	82.07	97.86
II		74.94	90.06	35.78
III			79.07	56.96
IV				28.96

Table 48. Cluster means for 21 characters in egg plant during 1991-92

Characters	Clusters				Grand Mean ± S.D.
	I	II	III	IV	
1. Pl. ht. at 1st flowering	72.51	69.28	66.02	61.20	68.19 ± 3.40
2. Pl. ht. at 1st harvesting	81.96	88.95	78.41	73.30	80.87 ± 13.15
3. No. of primary branches/pl	2.39	3.28	1.92	1.89	2.31 ± 1.17
4. No. of secondary branches/pl	9.54	6.80	5.15	5.21	6.57 ± 1.31
5. Days to flowering	62.48	65.33	64.84	60.29	62.93 ± 2.36
6. Days taken from transplanting to picking	83.72	89.28	98.71	86.89	95.27 ± 16.83
7. Marketable yield (kg/pl)	3.91	2.89	1.41	1.78	2.36 ± 0.28
8. Length of fruit (cm)	15.45	15.75	15.63	17.69	16.92 ± 4.70
9. Max. circumference of fruit (cm)	21.75	21.28	24.14	24.26	22.37 ± 7.46
10. No. of fruit/pl	21.06	18.71	11.84	14.23	16.01 ± 9.33
11. Weight of fruit	0.21	0.26	0.14	0.16	0.19 ± 0.16
12. Total yield/pl	4.42	10.62	2.64	3.72	3.84 ± 0.75
13. No. of larvae/pl	0.91	1.69	5.44	1.86	1.45 ± 0.75
14. No. of larvae/ft	0.25	0.54	0.37	0.45	0.33 ± 0.17
15. No. of holes/pl	4.55	5.36	5.24	1.36	5.52 ± 0.55
16. No. of holes/ft	1.52	2.06	1.55	2.10	1.75 ± 0.94
17. Days to borer on branches	98.15	108.47	98.76	96.53	94.96 ± 11.14
18. Days to borer on fruits	119.82	116.71	122.81	116.50	119.58 ± 5.97
19. Infested branches/pl	3.15	13.58	15.12	15.30	12.91 ± 0.17
20. Infested fruit/pl	13.34	25.40	34.50	42.47	30.55 ± 7.74
21. Yield loss (%)	15.69	26.03	35.46	48.80	32.11 ± 8.48

Table 49. Distribution of 41 genotypes of egg plants among four clusters (1992-93)

Cluster	No. of genotypes	Genotypes
I.	11	NIL, Nurki, Shyamla Dhepa, KD, Banarasi, Navkiran, IR-8-Baramasi, BB_1, Murshidabad Local, Banaras Long Purple, Krishna.
II.	9	Muktajhuri, Pusa Purple Long, BGW, PPC, KB-5, Baramasi, Shyamla Bhangar, ARM-3, Brinjal Long Green
III.	9	KB-9, Boral, Improved Muktakeshi, KB-10, Pusa Kranti, Black Prince, Agora, Suttons Long Krishnanagar Purple Round
IV.	12	R-14, Sufal, KB-9, White Long Cluster, Neelam Long, Pusa Purple Round, Rajkrishna, Pyratuni, KB-52, KB-2, Krishnanagar Hybrid Variety '90, L-13, KB-20.

Table 50. Average intra and inter cluster distances during 1992-93

Cluster	I	II	III	IV
I	50.34	52.79	53.62	56.07
II		50.25	50.81	52.72
III			49.38	40.50
IV				25.75

Table 51. Cluster means for 21 characters in egg plant during 1992-93

Characters	Clusters I	II	III	IV	Grand Mean ± S.D.
1. Pl. ht. at 1st flowering	73.54	83.44	68.92	63.13	67.41 ± 12.75
2. Pl. ht. at 1st harvesting	79.51	59.94	72.07	73.33	77.89 ± 2.44
3. No. of primary branches/pl	2.11	2.29	2.03	2.46	2.29 ±1.81
4. No. of secondary branches/pl	9.99	6.55	5.40	5.21	6.61 ± 4.34
5. Days to flowering	53.97	83.28	61.59	64.38	64.47 ± 15.56
6. Days taken from transplanting to picking	89.60	105.62	98.37	94.64	92.23 ± 4.16
7. Marketable yield (kg/pl)	3.05	2.56	1.16	1.47	2.22 ± 0.28
8. Length of fruit (cm)	16.63	15.63	14.48	16.08	16.51 ± 6.81
9. Max. circumference of fruit (cm)	23.69	19.99	21.29	22.55	22.27 ± 2.23
10. No. of fruit/pl	21.72	20.96	9.07	11.44	15.53 ± 2.85
11. Weight of fruit	0.184	0.247	0.137	0.158	0.18 ± 0.16
12. Total yield/pl	4.290	4.006	2.148	3.811	3.52 ± 0.72
13. No. of larvae/pl	1.08	1.47	1.40	1.94	1.47 ± 0.22
14. No. of larvae/ft	0.25	0.42	0.35	0.46	0.37 ± 0.17
15. No. of holes/pl	0.75	4.78	5.29	7.12	5.51 ± 2.05
16. No. of holes/ft	1.43	1.60	1.94	2.11	1.81 ± 0.36
17. Days to borer on branches	98.48	93.59	96.74	98.55	97.05 ± 3.95
18. Days to borer on fruits	112.29	106.55	118.33	123.42	120.69 ± 9.56
19. Infested branches/pl	6.49	13.54	17.42	5.35	12.73 ± 5.86
20. Infested fruit/pl	17.66	31.43	36.70	45.51	33.29 ± 9.06
21. Yield loss (%)	17.51	25.47	37.53	48.78	36.06 ± 11.39

taken by the borer to attack fruit, irrespective of source/origin. However cluster II had seven genotypes of different sources having average plant height at first flowering and number of secondary branches/pl among the vegetative characters; length of fruit, maximum circumferance of fruit and number and weight of fruits, among the reproductive characters and also in respect of number of larvae/pl, number of holes/pl and infested branches/pl. The 11 genotypes in cluster III, however, showed a closeness with the average values of the characters considered except the number of primary branches, days taken from transplanting to picking, marketale yield, number of fruits/pl, and number of larvae/pl. The cluster IV was quite unique in being the smallest with ten genotypes. All the tested characters had shortest genetic distance. But exceeds the average value with respect to length of fruit, maximum circumference of fruit, number of larvae/ft and plant, number of holes/ft, days to borer attack on branches, infested branches/pl and infested fruit/pl and also percent yield loss.

Almost a similar pattern of cluster means was recorded during 1992-93 (Table 51).

Contribution towards divergence :

During 1991-92 the character, marketable yield had maximum contribution towards divergence (70.6%) and frequency of ranking was 579.1 followed by fruit weight (28.1%) and frequency being 231, primary branches/pl (1.09%), frequency being only 9 and larvae/ft (0.12%) frequency of ranking being only 1. The contributions are presented in pie-chart (Fig. 36).

Fig. 36. **Genetic divergence for 1991-92**
Contribution of characters

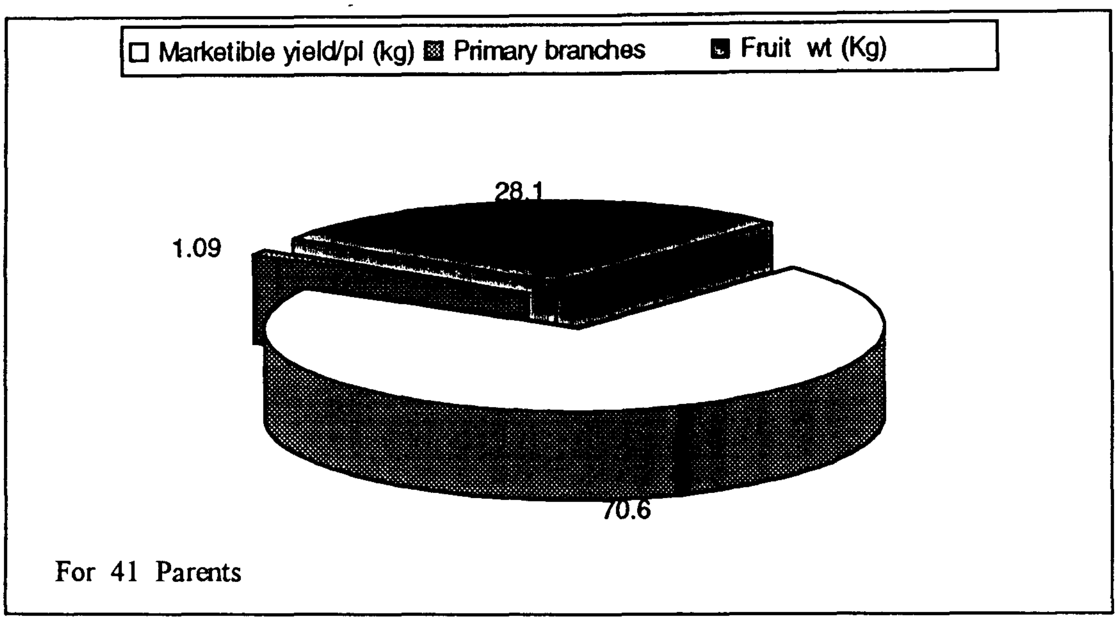
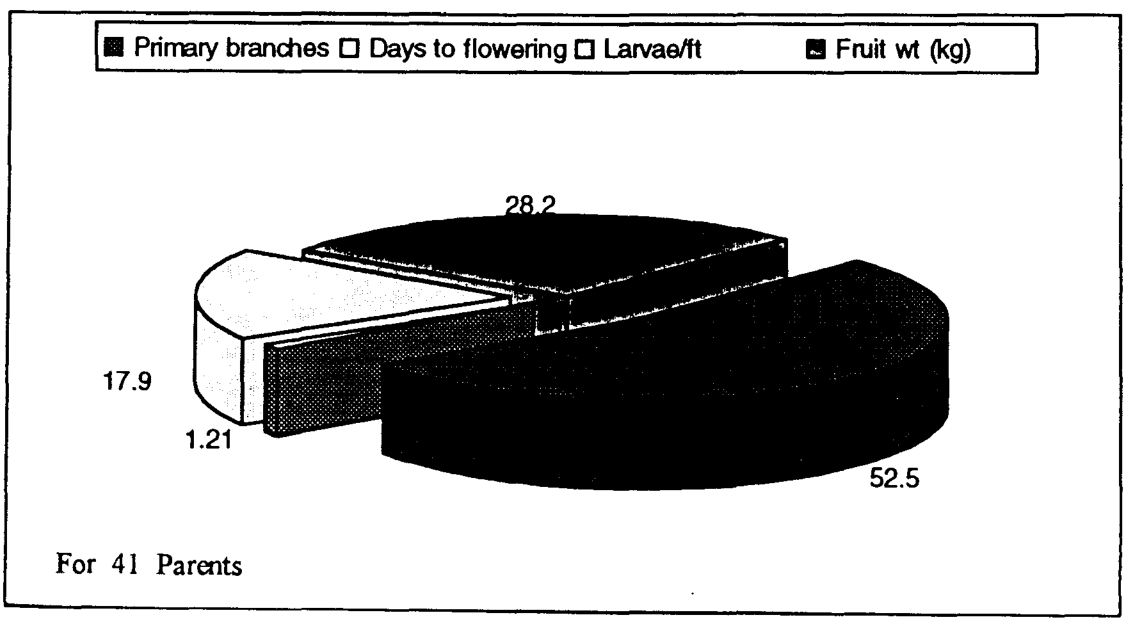


Fig. 37. **Genetic divergence for 1992-93**
Contribution of characters



During 1992-93, primary branches/pl contributed maximum of 52.5% (431 frequency) followed by fruit weight 28.2%(232 frequency), larvae/ft. 17.9% (frequency 147) and days to flower 1.21% (frequency 10). Contribution by different characters has been presented in the pie-chart (Fig. 37).

4.5. Screening of 12 agrochemicals using *L. orbonalis* as a shoot borer and as a fruit borer

4.5.1 Efficacy of 12 agrochemicals on the suppression of *L.orbonalis* infestation

As shoot borer :

The results are presented in the Table 52. After the 1st spray, endosulfan proved most effective followed by cypermethrin 25 EC. After the 2nd spray, cypermethrin 10 EC followed by cypermethrin 25 EC and decamethrin proved to be much better upto 7 days of 2nd spray. But just after 10 days of 2nd spray both synthetic pyrethroides and endosulfan appeared to be efficacious. After the 3rd spray, and in contrary to the 1st and 2nd applications methyl parathion proved best and statistically was at par with endosulfan and cypermethrin. Although, all the treatments against shoot borer proved superior over untreated control the contact poisons endosulfan, methyl parathion and synthetic pyrethroides proved more effective than the others.

As fruit borer :

On the 7th day after the 1st spray of methyl parathion, a very minimum infestation of fruits was observed. The percent damage of fruits ranged from 2.73 to 39.73 and 13.18 to 38.19 respectively on number and weight basis (Table 53). Compared with all the treatments one fascinating observation was the highest infestation after azadirachtin application up to even the 2nd spray and the 4th harvest. The infestation was even greater than the values obtained from control plots though the differences were insignificant. Interestingly, at the 6th harvest the bioinsecticide proved most efficacious because of least infestation of fruits. Statistically, even this efficacy differed significantly with all the treatments except that of cypermethrin 0.006%. The best efficacy at the final phase may be due to higher accumulation of active ingredients of the chemicals used i.e., cypermethrin 0.006%.

4.5.2 Impact of 12 agrochemicals on growth and yield of brinjal and the cost : benefit ratio

A significant differences were recorded in the number of secondary branches/pl, plant height and number of leaves/pl. However the maximum response was observed with cypermethrin 25 EC for all the growth parameters studied. The percent increase over control was ranged from 8.60 to 112.91, -2.35 to 50.00 and 5.88 to 79.41 for number of secondary branches, plant height and number of leaves/pl respectively (Table 54).

Data presented in Table 55 indicate an increase in fruit weight due to spraying of agrochemicals with some exceptions of azadirachtin, quinalphos and phosphomidan. The range of percent increase in fruit weight was found to be -4.92 to 31.41 leading to cypermethrin 25 EC as most effective pesticide (Table 55). However, in case of unmarketable fruit maximum increase was recorded for systemic insecticides phosphomidan (23.38%) followed by methyl parathion (22.78%).

The pesticide cypermethrin 10 EC (ripcord 10%) showed best response for increasing marketable yield (Table 55) which was statistically at par with the results obtained from monocrotophos, dimethoate and endosulfan. The range of percent increase over control was 28.47 to 115.33.

On the whole, the secondary branches, leaf number and plant height showed a significant positive correlation (0.096) with the total yield.

Calculated cost : benefit ratio revealed that the expense of 1 additional rupee for the pesticides, farmers may earn even as maximun as Rs. 44 by using cypermethrin 10 EC followed by dimethoate (Rs. 41) from 1 hectare cultivation of brinjal. All the agrochemicals used for this purpose proved their efficacy over control for increasing net income per hectare (Table 55).

4.5.3 Screening of pesticide combinations using six promising brinjal cultivars following modern concept of IPM

Varietal performance :

Against shoot and fruit borer :

Results (Table 56) indicated that in case of unprotected natural infestation, the ranges of fruit damage due to borer only were 10.02 to 19.42% in KD, BLP, and Navkiran; 25.00 to 34.43% in moderately susceptible varieties like BGW, and Krishna and 45.12 to 58.35% for susceptible R-14 thereby manifesting their relative resistance. The mean fruit damage in case of 3 former cultivars was 11.64 to 15.18% as against 50.64% for susceptible variety R-14. Under insecticidal semiprotection KD showed maximum resistance to fruit borer (Tables 57 and 58) during 1993-94 and 1994-95 with 1 : 7.27 as the ratio of infested to the healthy fruits

Table 52. **Bioefficacy of some agrochemicals against *Leucinodes orbonalis* (Guen.) as shoot borer**

Treatment	Mean % of shoot damage after 1st spray (day)						After 2nd Spray (day)						After 3rd spray (day)					
	1	3	5	7	10	15	1	3	5	7	10	15	1	3	5	7	10	15
Methyl Parathion 0.5% (Metacid 50 EC)	10.50	10.01	9.49	10.12	9.49	13.60	15.35	11.80	6.34	6.72	5.23	5.23	0.00	0.00	5.23	7.43	8.99	7.29
Endosulfan 0.07% (Thiodan 35 EC)	5.74	5.77	7.45	0.00	4.70	2.69	14.69	7.96	5.50	5.85	0.00	2.69	0.00	0.00	0.00	0.00	0.00	0.00
Cypermethrin 0.006% (Basathrin 25 EC)	1.42	8.72	7.24	7.34	7.34	5.13	5.13	0.00	0.00	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dimethoate 0.03% (Rogor 30 EC)	11.42	12.16	6.29	5.23	5.23	5.16	8.57	8.21	11.75	11.70	0.01	7.56	4.00	6.92	8.25	8.43	9.74	9.89
Monocrotophos 0.03% (Monocil 36%)	10.42	9.37	8.70	7.90	9.75	8.07	11.54	8.41	9.99	8.49	7.08	10.06	8.76	7.15	7.15	7.38	6.96	6.94
Decamethrin 0.002% (Decis 2.5 EC)	12.22	1,06	10.86	8.67	8.67	7.82	7.60	5.23	5.23	0.00	0.00	0.00	3.72	0.00	5.10	8.15	0.00	0.00
Phosphomidan 0.04% (Dimecron 85 EC)	12.52	11.75	13.26	13.26	13.27	13.86	15.23	12.48	10.81	10.88	5.82	11.58	12.16	10.51	8.84	8.57	8.17	5.68
Cypermethrin 0.005% (Ripcord 10%)	13.58	9.24	11.23	12.27	12.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quinalphos 0.05% (Suquin 25 EC)	12.26	8.09	11.23	14.25	11.75	10.16	10.16	8.13	8.13	8.13	10.02	11.81	10.21	11.81	10.11	8.25	4.29	7.62
Malathion 0.10% (Malathion 50 EC)	13.21	10.78	12.51	13.06	13.06	19.65	19.65	11.70	9.53	13.54	17.00	13.92	13.69	14.09	13.75	12.04	11.49	11.49
Azadirachtin 0.001% (Neem Gold 0.30%)	11.42	9.26	11.75	12.15	12.15	17.30	15.92	14.92	13.13	11.18	11.49	11.20	11.64	11.64	13.17	9.01	11.85	11.42
Vage Guard 0.001% (Vage Guard)	9.72	7.73	12.05	11.07	10.19	14.23	13.01	11.81	11.52	11.58	13.68	15.16	13.53	13.75	11.70	114.05	14.44	12.99
Control (Water Spray)	13.86	14.17	14.42	14.07	14.07	20.47	19.82	18.03	16.59	13.30	18.46	15.80	15.09	15.56	16.15	32.36	19.32	17.02
CD (P = 0.05)	2.37	2.30	2.78	3.93	3.97	1.97	2.71	3.61	3.94	5.57	2.39	4.43	2.78	3.62	2.02	3.58	3.37	1.82

* Figures are Arc - sine transformed values

Table 53. **Bioefficacy of some agrochemicals against *Leucinodes orbonalis* (Guen). as fruit borer**

Treatment	% damage on the basis of number of fruits (at harvest)						%damage on the basis of fruit weight (at harvest)					
	1st	2nd	3rd	4th	5th	6th	1st	2nd	3rd	4th	5th	6th
Methyl Parathion 0.5% (Metacid 50 EC)	2.73	25.70	26.31	23.88	17.49	25.99	13.18	25.64	26.57	23.28	18.12	25.23
Endosulfan 0.07% (Thiodan 35 EC)	28.76	34.38	25.47	21.79	14.31	22.74	27.97	34.40	26.13	22.10	15.24	23.05
Cypermethrin 0.006% (Basathrin 25 EC)	24.85	27.65	29.18	21.07	20.89	20.38	22.00	28.57	28.90	21.72	21.95	20.79
Dimethoate 0.03% (Rogor 30 EC)	21.51	24.10	24.80	21.52	23.77	26.28	21.51	24.68	25.30	22.35	24.04	26.75
Monocrotophos 0.03% (Monocil 36%)	21.96	22.44	28.69	26.36	25.90	27.45	22.95	33.61	25.97	26.71	26.46	27.75
Decamethrin 0.002% (Decis 2.5 EC)	21.82	38.79	38.90	19.98	32.56	32.60	22.37	38.33	38.74	20.58	33.13	32.95
Phosphomidan 0.04% (Dimecron 85 EC)	24.94	36.03	28.54	21.77	18.56	29.96	24.77	36.25	28.91	22.36	19.50	30.15
Cypermethrin 0.005% (Ripcord 10%)	21.69	26.55	25.83	25.30	28.54	30.59	22.08	26.86	26.91	25.52	28.73	31.38
Quinalphos 0.05% (Suquin 25 EC)	20.63	42.76	37.16	21.51	26.39	34.20	21.44	43.03	39.69	22.59	26.61	34.31
Malathion 0.10% (Malathion 50 EC)	31.39	45.02	27.99	32.04	27.08	32.16	31.40	42.33	27.60	32.54	27.39	32.34
Azadirachtin 0.001% (Neem Gold 0.30%)	39.73	43.96	37.56	35.96	23.48	19.10	38.17	39.16	33.53	37.20	23.90	20.03
Vage Guard 0.001% (Vage Guard)	29.87	36.03	30.59	25.27	22.86	30.91	30.00	36.07	29.87	23.53	23.15	30.91
Control	33.18	50.32	36.14	32.38	32.12	38.10	33.70	50.65	37.29	32.61	32.42	30.64
CD (P = 0.05)	9.25	8.20	2.75	2.85	5.57	2.44	8.48	6.73	2.79	2.08	1.88	2.37

* Figures are Arc - sine transformed values

Table 54. Effect of some agrochemicals on vegetative growth parameters of brinjal *(Solanum melongena L.)*

Treatment	Secondary branches/pl		Plant height (cm)		Number of leaves / pl	
	Mean	% increase	Mean	% increase	Mean	% increase
T_1	12.67	65.19	123.33	45.09	80.00	41.17
T_2	13.00	69.49	120.67	41.96	66.00	16.46
T_3	16.33	112.91	127.67	50.00	101.67	79.41
T_4	14.33	86.83	123.33	45.09	62.33	9.99
T_5	14.00	82.53	111.67	31.38	70.00	23.52
T_6	14.33	86.83	103.00	21.18	59.33	4.69
T_7	10.67	39.11	116.00	36.47	66.67	17.65
T_8	12.00	56.45	104.00	22.35	76.67	35.29
T_9	12.00	8.60	101.33	19.21	74.33	31.16
T_{10}	8.33	17.34	95.00	11.76	60.00	5.88
T_{11}	9.00	8.60	83.00	-2.35	72.67	28.23
T_{12}	8.33	17.34	83.67	-1.56	70.00	23.52
T_{13}	7.67	—	85.00	—	56.67	—
CD ($P=0.05$)	4.09		13.28		30.43	

Table 55. Effect of some agrochemicals on fruit weight, marketable yield and cost benefit ratio of brinjal *(Solanum melongena L.)*

Tr.	Marketable fruit wt (g)		Unmarketable ft. wt. (g)		Marketable yield (kg/pl)		Cost : benefit ratio/ha
	Mean	% inc.	Mean	% inc.	Mean	% inc.	
T_1	193.08	27.29	158.33	20.78	1.97	43.80	1 : 11
T_2	172.02	13.41	152.08	15.87	2.65	93.43	1 : 15
T_3	199.33	31.41	151.25	15.24	2.25	64.23	1 : 28
T_4	177.20	16.82	135.42	3.18	2.69	96.35	1 : 41
T_5	173.60	14.45	130.83	-0.32	2.86	108.76	1 : 30
T_6	172.67	13.84	141.25	7.62	2.04	35.70	1 : 11
T_7	150.46	-0.80	160.42	22.38	2.27	65.69	1 : 26
T_8	161.62	6.55	127.53	-2.83	2.95	115.33	1 : 44
T_9	144.21	-4.92	170.21	29.68	2.13	40.49	1 : 10
T_{10}	178.98	18.00	154.27	17.54	2.41	75.91	1 : 19
T_{11}	147.68	-2.60	145.37	10.76	1.89	37.96	1 : 31
T_{12}	163.75	7.96	152.08	15.87	1.76	28.47	1 : 11
T_{13}	151.68	—	131.25	—	1.37	—	—
CD (P=0.05)	2.04		0.98		0.43		

(Table 60). BLP and KD suffered nearly equal damage, the ratio was being 1 : 5.68 and 1 : 4.93 respectively. R-14, appeared most susceptible with a ratio of 1 : 0.85, though the damage was reduced to 21.00%.

Against jassid, beetle and aphid :

Among the 6 varieties studied Navkiran showed multiple resistance against jassids, spotted leaf beetle and aphid whereas R-14 showed relatively susceptible reaction to all these insect pests (Table 59)

Yield performance :

Mean values of healthy and infested fruits of 4 trials during 1991-92 to 1994-95 revealed the fact that maximum mean marketable yield was produced by the cultivar KD (5.54 kg / pl) followed by Navkiran (4.81 kg / pl). Considering the ratio of infested to healthy fruit yield (Table 60) KD, BLP, and Navkiran may be recommended for cultivation without any obligation to pesticidal spray. Under semiprotected condition (Tables 57 and 58) all the relatively resistant cultivars namely KD, BLP and Navkiran showed less infestation of borer and thereby better yield of healthy fruits.

Efficacy of insecticide combinations :

Bioefficacy of the two combinations of pesticides revealed a superiority of cypermethrin over endosulfan in combination with carbofuran although both the combinations statistically were almost at par (Tables 57 and 58)

During 1993-94, fairly resistant KD performed best against the borer pest when treated with carbofuran and cypermethrin combinations. Carbofuran and endosulfan combination with this variety was statistically at par. It was then followed by Navkiran and BLP treated with carbofuran and cypermethrin

Table 56. **Performance of 6 cultivars of brinjal against shoot and fruit borer, *Leucinodes orbonalis* under unprotected condition (% infested fruit by number during different years)**

Variety — Year	KD	BGW	Krishna	R-14	BLP	Navkiran	Mean
1991-92	11.76	30.84	31.27	45.12	14.37	10.02	23.90
1992-93	11.76	25.00	34.43	58.35	12.57	19.42	25.43
1993-94	11.50	29.83	28.07	53.33	16.20	13.65	25.43
1994-95	11.55	29.20	30.44	45.76	12.99	17.65	24.60
Mean	11.64	28.72	31.05	50.64	14.03	15.18	

	Variety (V)	Years (Y)	V x Y	V x Y*
$SE_{(m)}$	0.09	0.47	3.52	1.88
$CD_{(p = 0.05)}$	2.93	1.30	10.25	5.20

* Within same main plot

Table 57. Screening of pesticides with 6 promising cultivars in brinjal against, *Leucinodes orbonalis* during 1993-94 (% infested fruit by number)

Variety —— Treatments	KD	BGW	Krishna	R-14	BLP	Navkiran	Mean
P_0	13.00	28.00	31.00	49.33	15.00	16.00	25.39
P_1	2.15	9.40	12.63	22.33	6.80	5.50	10.29
P_2	3.04	12.20	14.97	25.33	8.62	6.94	11.79
P_3	14.00	27.67	28.00	25.00	16.00	23.97	2.44
Mean	8.05	19.32	21.65	30.50	11.51	13.10	

	Variety(V)	Treatments(P)	V x P	V x P*
$SE_{(m)}$	0.43	0.26	0.98	0.62
$CD_{(p = 0.05)}$	1.35	0.72	2.85	2.49

* Within same main plot

Table 58. **Screening of pesticides with 6 promising cultivars of brinjal against, *Leucinodes orbonalis* during 1994-95 (% infested fruit by number)**

Variety — Treatments	KD	BGW	Krishna	R-14	BLP	Navkiran	Mean
P_0	12.62	28.83	31.17	47.13	16.80	18.11	25.78
P_1	4.00	10.10	12.56	21.65	21.12	7.66	12.86
P_2	3.32	13.63	11.53	21.12	23.00	9.00	13.93
P_3	13.67	31.67	30.37	26.38	17.66	22.11	23.64
Mean	8.40	21.06	21.41	29.57	19.65	14.22	

	Variety(V)	Treatment(P)	V x P	V x P*
$SE_{(m)}$	0.68	0.28	1.62	0.97
$CD_{(p = 0.05)}$	3.18	1.13	4.82	2.68

* Within same main plot

Table 59. **Mean population of jassid, aphid and beetle / 5 leaves on 6 promising cultivars for 4 successive years under unprotected condition**

Varieties	Jassid	Aphid	Beetle
Kalo Dhepa	15.66	52.25	1.70
BGW	9.03	74.40	0.58
Krishna	17.78	17.50	0.44
R-14	28.88	137.50	2.37
BLP	14.35	34.68	2.83
Navkiran	8.35	13.98	0.37

Table 60. **Mean yield of 6 promising cultivars of brinjal over 4 successive years with respect to healthy (H) and borer infested (I) fruits**

Varieties	On fruit weight (kg/pl)			On fruit number		
	H	I	Ratio (I:H)	H	I	Ratio (I:H)
KD	5.54	1.09	1 : 5.08	15.34	2.11	1 : 7.27
BGW	2.83	1.47	1 : 1.93	2.75	1.28	1 : 2.15
Krishna	1.44	0.91	1 : 1.58	13.08	7.75	1 : 1.69
R-14	1.34	1.77	1 : 0.76	6.33	7.49	1 : 0.85
BLP	3.55	0.73	1 : 4.86	43.00	7.57	1 : 5.68
Navkiran	4.81	0.96	1 : 5.01	11.92	2.42	1 : 4.93

combinations. Navkiran showed a very good response with carbofuran and endosulfan combinations and ranked next. Interestingly, water spray alone appeared to reduce pest menace when compared with control plants in respect of relatively susceptible cultivars like R-14, Krishna and BGW but not in case of the fairly resistant KD, BLP and Navkiran cultivars.

During 1994-95 the combination of carbofuran with endosulfan was a bit superior to the other combination when applied to the relatively resistant KD cultivar and was statistically at par with carbofuran and cypermethrin combination. Next treatment showed superiority was Navkiran variety combined with pesticidal treatment at root zone of the crop with carbofuran @ 750 g a.i./ha at 3 weeks stage after transplanting followed by single foliar spray of cypermethrin @ 50 g a.i./ha at 70 days after transplanting. This was followed by the interaction effect of the cultivar Navkiran and pesticidal treatment of carbofuran @ 750 g a.i./ha at 3 weeks stage after transplanting followed by single spray of endosulfan @ 525 g a.i./ha at 70 days after transplanting.

4.6 Performance of six selected parents and their 30 F_1 hybrids

The distinctive features of six selected parents along with two check varieties and 30 F_1 hybrids with respect to some qualitative characters are summarised in Table 61. The varieties significantly differred among themselves for the characters studied. With regard to leaf characters, among the parents KD, Krishna, BLP and Navkiran showed purple veins on the leaf lamina while the others showed light white pigmentation on the veins. Amongst the crossess, KD × BGW, BGW × R-14 and Navkiran × BGW showed white coloured veins on the lamina while others showed almost

Table 61. Summarised table of some distinctive characters of parents and hybrids

	Parents/hybrids	Leaf character	Flower colour	Fruit colour	Fruit shape
1.	KD	Medium, green purple vein	Whitish purple	Purple	Round medium
2.	BGW	Broad, light green, white vein	Purple white	Light green	Big round
3.	Krishna	Green, medium, errect, purple vein	Purple	Light purple	Medium long
4.	R-14	Green, white vein	Pink	Pink	Round
5.	BLP	Small green, semi errect, purple vein	Purple	Purple	Narrow long
6.	Navkiran	Medium broad, purple vein, green	Purple	Purple glossy	Medium
*	Nababganj	Long, green, purple vein	Purple	Light green	Medium long, thick
*	Tal	Narrow, green, spiny, whitish vein	Purple	Green	Round
7.	KD × Krishna	Medium, purple vein	Purple	Purple	Medium long
8.	KD × Krishna	Medium, narrow, purple vein, spiny	Purple	Purple	Medium long
9.	KD × R-14	Medium, whitish vein,	Pinkish white	Light purple	Round
10.	KD × BLP	Green, purple vein, spiny	Purple	Purple glossy	Long small
11.	KD × Navkiran	Broad, semierrect, green	Purple glossy	Deep purple	Round

Table 61 contd.....

Table 61 contd.....

	Parents/hybrids	Leaf character	Flower colour	Fruit colour	Fruit shape
12.	BGW × KD	Broad thick leaf.	White purple	Light green stripped	Round small.
13.	BGW × Krishna	Medium, errect	White	Light green,	Medium long
14.	BGW × R-14	Green, white vein.	Pinkish	Pinkish	Round
15.	BGW × BLP	Green, purple vein	Purple	Green	Long small
16.	BGW × Navkiran	Medium, green, purple vein.	Purple white	Green	Roundish oblong
17.	Krishna × KD	Green, purple vein with spine	Light purple	Purple	Medium long
18.	Krishna × BGW	Medium, green	White purple	Light green	Medium long
19.	Krishna × KD	Green, pinkish vein	Purple	Pinkish	Medium long
20.	Krishna × KD	Small green, Purple vein.	Purple white	Purple	Long
21.	Krishna × Navkiran	Green, purple vein	Purple	Purple glossy	Round
22.	R-14 × KD	Medium, green	Pinkish white	Pink	Round
23.	R-14 × BGW	Thick, green.	Whitish pink	Light pink	Round
24.	R-14 × Krishna	Green, purple vein	Purple	Purple	Medium long

Table 61 contd.....

Table 61 contd.....

	Parents/hybrids	Leaf character	Flower colour	Fruit colour	Fruit shape
25.	R-14 × BLP	Small, purple vein	Purple	Deep Purple	Small Round
26.	R-14 × Navkiran	Medium, spiny.	Pinkish Purple	Purple glossy	Big round
27.	BLP × KD	Small, spiny	Purple	Deep purple	Long
28.	BLP × BGW	Medium, green. spiny	Purple White	Light green	Round
29.	BLP × Krishna	Small, purple vein	Light Purple	Light purple	Medium long
30.	BLP × R-14	Pinkish vein	Pinkish White	Pinkish purple	Round
31.	BLP × Navkiran	Medium, purple vein.	Purple	Purple glossy	Roundish oblong
32.	Navkiran × KD	Medium, green pink vein	Purple	Purple glossy	Round
33.	Navkiran × BGW	Broad, white vein	Purple White	Light purple	Big round
34.	Navkiran × Krishna	Medium, spiny, purple vein,	Purple	Purple glossy	Medium long
35.	Navkiran × R-14	Broad, thick spiny	Pink	Pinkish purple	Round
36.	Navkiran × BLP	Small, green, purple vein.	Light Purple	Purple	Long

light purple colour. Among the qualitative morphological characters studied, the flower and berry colour were of different grades of purple for all the parents and crossess excepting the BGW and BLP × BGW which had light green colour. Fruit shape and size of almost all the parents and hybrids showed medium to longer size but BGW and KD, R-14 × Navkiran, Navkiran × BGW produce big round fruits. Characteristic pink coloured medium round fruits were observed in R-14 and R-14 × KD hybrid.

Results (Tables 62-64) for analysis of variance indicated that the varieties as well as their 30 F_1 hybrids varied significantly amongst themselves for all the quantitative traits studied.

4.6.1. Heterosis for vegetative characters

Plant height at first flowering :

The parents as well as F_1 hybrids showed significant differences for plant height at first flowering (Table 65). Out of 30 F_1s, though 27 were found taller than their respective tall parents, only 24 were significantly taller. The hybrids between Navkiran × BGW, R-14 × BLP, and between Navkiran × KD showed 7.14, 1.56 and 1.19% heterobeltiosis respectively. The extent of heterosis over tall parent (better parent) ranged from -33.33% (Krishna × R-14) to 7.14% (Navkiran × BGW). Similarly, for heterosis over mid-parental value R-14 × BLP attained much higher value (16.07%).

Plant height at first harvesting :

For plant height at first harvesting hybrids were identified as significantly superior over their mid-parental values (Table 66). The magnitude of heterosis in respect of this character ranged from - 14.11% (BLP × BGW) to 32.35% (R-14 × BLP) over their mid-parental values.

Table 62. **Analysis of variance for vegetative characters during 1995-96 for 38 parents and hybrids**

Characters	Mean sum of squares: Treatments df = 37	Replications df = 2	Errors df = 74	$CD_{P=0.05}$
2. Plant ht. at 1st flowering	432.15 **	18.65	4.38	3.35
2. Plant ht. at 1st harvesting	429.88 **	4.09	5.32	3.69
3. No. of primary branches/pl	9.68 **	0.24	0.16	0.64
4. No. of secondary branches/pl	70.27 **	2.52	1.03	1.62
5. Days to flowering	403.80 **	49.92	38.32	9.91
6. Days taken from transplanting to picking	387.58 **	14.21	3.95	3.18
7. Marketable yield (kg/pl)	9.47 **	0.16	0.02	0.23

** Significant at 1% level of significance

Table 63. **Analysis of variance for reproductive characters during 1995-96 for 38 parents and hybrids**

Characters	Mean sum of squares			$CD_{P=0.05}$
	Treatments df = 37	Replications df = 2	Errors df = 74	
1. Fruit length (cm)	81.07 **	0.47	1.11	1.69
2. Fruit circumference (cm)	280.33 **	16.62	3.10	2.82
3. Fruit number/pl	425.48 **	1.12	1.51	1.96
4. Fruit weight (kg)	0.183 **	0.01	2.90	2.73
5. Total yield (kg/pl)	8.23 **	0.231	0.07	0.42

** Significant at 1% level of significance

Table 64. Analysis of variance for some susceptibility components during 1995-96 for 38 parents and hybrids

Characters	Mean sum of squares			$CD_{P=0.05}$
	Treatments df = 37	Replication df = 2	Errors df = 74	
1. Larvae/pl	2.21 **	1.68	0.002	0.07
2. Larvae/ft	0.70 **	0.0002	0.003	0.03
3. Holes/pl	16.38 **	0.09	0.05	0.36
4. Holes/ft	1.47 **	0.68	0.003	0.09
5. Days to borer on branches	208.11 **	12.92	4.33	3.33
6. Days to borer on fruit	325.66 **	12.37	8.49	4.66
7. Infested br/pl	187.216 **	2.75	0.75	1.39
8. Infested ft/pl	371.80 **	5.25	3.30	2.91
9. Yield loss (%)	485.89 **	0.36	1.82	2.16

** Significant at 1% level of significance

Positive heterosis over better parent was shown by Navkiran × BGW (7.14%) followed by Navkiran × KD (2.04%) and KD × BGW (1.12%) of which first one cross showed significant heterosis over better parent both at 1% and 5% level of significance.

Number of days to flowering :

Most of the hybrids were significantly earlier in flowering than that of both the parents. The magnitude of heterosis over mid parent ranged from -22.10% (KD × Navkiran) to 60.71% (BLP × Navkiran) and range of heterosis over better parent was -53.00% in case of BLP × KD and 38.46% in BLP × Navkiran hybrid. Among the 30 F_1 s only 9 were significant over midparent and 12 were significant over their respective better parent (Table 69).

Days taken from transplanting to first picking :

Heterosis in respect of this character has been presented in Table 70. The magnitude of heterosis over mid parent ranged from -25.39% (Navkiran × Krishna) to 27.91% (BLP × Navkiran) and the range of heterobeltiosis was -50.00% in the cross KD × R-14 and 15.79% in BLP × Navkiran.

Marketable yield / plant :

Performance of six parents and their 30 F_1 s are presented in Table 71. With respect to mid-parent value most of the hybrids showed either positive or negative heterosis significantly excepting the cross BGW × BLP and Krishna × BLP which recorded 0.00% heterosis. The magnitude of heterosis over mid parent ranged from -22.42% (R-14 × Krishna) to 133.33% (Navkiran × BGW) and the range of heterosis over better parent showed -33.07% for BGW × KD hybrid and 83.82% for BLP × Krishna.

Table 65. Heterosis in respect to plant height at first flowering in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Plant height at first flowering: Percent heterosis over Mid Parent	Plant height at first flowering: Percent heterosis over Better Parent
1. KD	72	—	—
2. BGW	75	—	—
3. Krishna	90	—	—
4. R14	48	—	—
5. BLP	64	—	—
6. Navkiran	84	—	—
* Tal (Ch.Var-1)	90	—	—
* Nababganj (Ch.Var.2)	95	—	—
7. KD × BGW	75	2.04	0.00
8. KD × Krishna	80	-1.23	-11.11 **
9. KD × R-14	66	10.00 **	-8.33 **
10. KD × BLP	67	-1.47	-6.94 **
11. KD × Navkiran	84	7.69 **	0.00
12. BGW × KD	75	2.04	0.00
13. BGW × Krishna	80	-3.03	-11.11 **
14. BGW × R-14	60	-2.44	-20.00 **
15. BGW × BLP	65	0.78	-13.33 **
16. BGW × Navkiran	75	-5.66 **	-10.71 **
17. Krishna × KD	80	-1.23	-11.11 **
18. Krishna × BGW	75	-9.09 **	-16.67 **
19. Krishna × R-14	60	-13.04 **	-33.33 **
20. Krishna × BLP	64	-16.88 **	-28.89 **
21. Krishna × Navkiran	85	-2.30	-1.19
22. R-14 × KD	50	-16.67 **	-30.56 **
23. R-14 × BGW	50	-18.70 **	-33.33 **
24. R-14 × Krishna	60	-13.04 **	-33.33 **
25. R-14 × BLP	65	16.07 **	1.56
26. R-14 × Navkiran	67	1.52	-20.24 **
27. BLP × KD	64	-5.88 **	-11.11 **
28. BLP × BGW	60	11.76 **	-20.00 **
29. BLP × Krishna	60	-22.08 **	-33.33 **
30. BLP × R14	60	7.14 **	-6.25 **
31. BLP × Navkiran	70	-5.41 **	-16.67 **
32. Navkiran × KD	85	8.97 **	1.19
33. Navkiran × BGW	90	13.21 **	7.14 **
34. Navkiran × Krishna	80	0.63	-11.11 **
35. Navkiran × R-14	70	6.06 **	-16.67 **
36. Navkiran × BLP	60	-40.00 **	-28.57 **
CD (P=0.05)	3.35	2.90	3.35
CD (P=0.01)	4.41	3.82	4.41

** Significant at 1% level

Table 66. Heterosis in respect to plant height at first harvesting in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Plant height at first flowering	
		Percent heterosis over	
		Mid Parent	Better Parent
1. KD	82	—	—
2. BGW	89	—	—
3. Krishna	99	—	—
4. R-14	62	—	—
5. BLP	74	—	—
6. Navkiran	98	—	—
* Tal (Ch.Var-1)	100	—	—
* Nababganj (Ch.Var-2)	110	—	—
7. KD × BGW	90	5.26 **	1.12
8. KD × Krishna	90	-0.55	-9.09 **
9. KD × R-14	76	5.56 **	-7.32 **
10. KD × BLP	80	28.57 **	-2.44
11. KD × Navkiran	96	6.67 **	2.04
12. BGW × KD	90	5.23 **	1.12
13. BGW × Krishna	100	6.38 **	1.01
14. BGW × R-14	70	-7.28 **	-21.35 **
15. BGW × BLP	85	4.29 **	-4.49
16. BGW × Navkiran	90	-3.74	-8.16 **
17. Krishna × KD	100	10.50 **	-8.59 **
18. Krishna × BGW	96	-4.26 **	-9.09 **
19. Krishna × R-14	75	-6.43 **	-24.24 **
20. Krishna × BLP	79	-8.67 **	-20.20 **
21. Krishna × Navkiran	95	-3.55	-4.04
22. R-14 × KD	70	-2.78	-14.63 **
23. R-14 × BGW	70	-7.28 **	-21.35 **
24. R-14 × Krishna	70	-13.04 **	-29.29 **
25. R-14 × BLP	90	32.35 **	21.62 **
26. R-14 × Navkiran	77	-3.775	-21.43 **
27. BLP × KD	74	-5.13 **	-9.76 **
28. BLP × BGW	70	-14.11 **	-21.35 **
29. BLP × Krishna	80	-7.51 **	-19.19 **
30. BLP × R-14	73	7.35 **	-1.96 **
31. BLP × Navkiran	85	-1.16	-13.27 **
32. Navkiran × BGW	100	11.11 **	2.04
33. Navkiran × BGW	105	12.30 **	7.14 **
34. Navkiran × Krishna	95	-3.55	-3.06
35. Navkiran × R-14	90	12.50 **	-8.16 **
36. Navkiran × BLP	96	11.63 **	-2.04
CD (P=0.05)	3.69	3.20	3.69
CD (P=0.01)	4.86	4.21	4.86

** Significant at 1% level

Table 67. Heterosis in respect to primary branches/pl in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	No. of primary branches/pl Percent heterosis over Mid Parent	 Better Parent
1. KD	2.43	—	—
2. BGW	1.00	—	—
3. Krishna	1.00	—	—
4. R-14	3.82	—	—
5. BLP	2.46	—	—
6. Navkiran	5.64	—	—
* Tal (Ch.Var-1)	2.00	—	—
* Nababganj (Ch.Var-2)	1.00	—	—
7. KD × BGW	3.00	74.42 **	23.46 **
8. KD × R-14	2.00	16.28 **	-17.70 **
9. KD × BLP	3.00	-4.15 **	-21.47 **
10. KD × Nrishna	2.00	-18.377 **	-18.70 **
11. KD × Navkiran	7.00	73.27 **	24.11 **
12. BGW × KD	2.00	16.28 **	-17.70 **
13. BGW × Krishna	1.00	0.00	0.00
14. BGW × R-14	2.00	-17.01 **	-47.64 **
15. BGW × BLP	2.00	15.61 **	-0.19
16. BGW × Navkiran	5.00	50.60 **	-11.35 **
17. Krishna × KD	3.00	74.42 **	-23.46 **
18. Krishna × BGW	1.00	0.00	0.00
19. Krishna × R-14	2.00	-17.01 **	-47.64 **
20. Krishna × BLP	3.00	73.41 **	21.95 **
21. Krishna × Navkiran	5.00	50.60 **	-11.36 **
22. R-14 × KD	3.00	-4.15 **	-21.47 **
23. R-14 × BGW	3.00	24.48 **	-21.47 **
24. R-14 × Krishna	3.00	24.48 **	-21.47 **
25. R-14 × BLP	4.00	27.39 **	4.71 **
26. R-14 × Navkiran	6.00	26.85 **	6.38 **
27. BLP × KD	2.00	-18.75 **	-18.70 **
28. BLP × BGW	2.00	15.61 **	-18.70 **
29. BLP × Krishna	1.00	-42.20 **	-59.36 **
30. BLP × R-14	4.00	27.39 **	4.71 **
31. BLP × Navkiran	6.00	48.15 **	6.38 **
32. Navkiran × BGW	8.00	98.02 **	41.84 **
33. Navkiran × BGW	5.00	50.60 **	-111.35 **
34. Navkiran × Krishna	5.00	50.60 **	-11.35 **
35. Navkiran × R-14	4.00	-15.43 **	-29..08 **
36. Navkiran × BLP	3.00	-25.93 **	-46.81 **
CD (P=0.05)	0.64	0.55	0.64
CD (P=0.01)	0.84	0.73	0.84

** Significant at 1% level

Table 68. Heterosis in respect to number of secondary branches/pl in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	No. of secondary branches/pl Percent heterosis over Mid Parent	Better Parent
1. KD	13.00	—	—
2. BGW	3.00	—	—
3. Krishna	3.80	—	—
4. R-14	10.90	—	—
5. BLP	15.00	—	—
6. Navkiran	14.00	—	—
* Tal (Ch.Var-1)	10.00	—	—
* Nababganj (Ch.Var-2)	12.00	—	—
7. KD × BGW	8.00	0.00	-38.46 **
8. KD × Krishna	9.00	7.14 **	-30.77 **
9. KD × R-14	12.00	0.42	-7.69 **
10. KD × BLP	15.00	7.14 **	15.38 **
11. KD × Navkiran	16.00	18.52 **	14.29 **
12. BGW × KD	8.00	0.00	-38.46 **
13. BGW × Krishna	3.00	-11.76 **	-21.05 **
14. BGW × R-14	6.00	-13.67 **	-44.95 **
15. BGW × BLP	15.00	66.67 **	0.00
16. BGW × Navkiran	14.00	64.71 **	0.00
17. Krishna × KD	8.00	-4.76 **	-38.46 **
18. Krishna × BGW	3.80	11.76 **	0.00
19. Krishna × R-14	6.00	-18.37 **	-44.95 **
20. Krishna × BLP	10.00	6.38 **	-33.33 **
21. Krishna × Navkiran	10.00	44.93 **	-28.57 **
22. R-14 × KD	15.00	25.52 **	-15.38 **
23. R-14 × BGW	3.80	-45.32 **	-65.14 **
24. R-14 × Krishna	7.00	-4.76 **	35.78 **
25. R-14 × BLP	8.00	-38.22 **	-46.67 **
26. R-14 × Navkiran	15.00	20.48 **	7.14 **
27. BLP × KD	8.00	-42.86 **	-46.67 **
28. BLP × BGW	3.00	-66.67 **	-80.00 **
29. BLP × Krishna	16.00	70.21 **	6.67 **
30. BLP × R-14	10.00	-22.78 **	-33.33 **
31. BLP × Navkiran	25.00	72.41 **	66.67 **
32. Navkiran × KD	15.00	11.11 **	-7.14 **
33. Navkiran × BGW	10.00	17.65 **	-28.57 **
34. Navkiran × Krishna	9.00	-4.26 **	-35.71 **
35. Navkiran × R-14	12.00	-3.61 **	-14.29 **
36. Navkiran × BLP	16.00	10.34 **	6.67 **
CD (P=0.05)	1.62	1.41	1.62
CD (P=0.01)	2.41	1.85	2.41

** Significant at 1% level

Table 69. Heterosis in respect to Days to flowering within parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Days to flowering: Percent heterosis over Mid Parent	Days to flowering: Percent heterosis over Better Parent
1. KD	66	—	—
2. BGW	68	—	—
3. Krishna	65	—	—
4. R-14	76	—	—
5. BLP	47	—	—
6. Navkiran	65	—	—
* Tal (Ch.Var-1)	80	—	—
* Nababganj (Ch.Var-2)	90	—	—
7. KD × BGW	60	11.670 **	-11.76
8. KD × Krishna	65	0.77	-1.52
9. KD × R-14	70	1.43	-7.89
10. KD × BLP	50	0.12	-2.40
11. KD × Navkiran	80	-22.10 **	23.00 **
12. BGW × KD	60	-10.45	-11.76
13. BGW × Krishna	65	-2.26	-4.41
14. BGW × R-14	70	-1.41	-7.89
15. BGW × BLP	50	-13.04 **	-15.44 **
16. BGW × Navkiran	80	20.30 **	17.65 **
17. Krishna × KD	60	-9.16	-9.09
18. Krishna × BGW	60	-9.77	-11.76
19. Krishna × R-14	65	7.80	-35.00 **
20. Krishna × BLP	50	-10.71	-23.08 **
21. Krishna × Navkiran	70	7.69	7.69
22. R-14 × KD	76	7.04	0.00
23. R-14 × BGW	70	-2.78	-7.89
24. R-14 × Krishna	75	-6.38	1.32
25. R-14 × BLP	59	-4.07	-22.37 **
26. R-14 × Navkiran	69	-2.13	-9.21
27. BLP × KD	47	-16.81 **	-53.00 **
28. BLP × BGW	50	13.04 **	-26.47 **
29. BLP × Krishna	62	10.71	-4.62
30. BLP × R-14	50	18.70 **	-34.21 **
31. BLP × Navkiran	90	60.71 **	38.46 **
32. Navkiran × KD	70	-5.26	6.06
33. Navkiran × BGW	60	9.77	-11.76
34. Navkiran × Krishna	58	10.77	-10.77
35. Navkiran × R-14	60	-14.89 **	21.05 **
36. Navkiran × BLP	52	-11.11	-20.00 **
CD (P=0.05)	9.91	8.58	9.91
CD (P=0.01)	13.04	11.29	13.04

** Significant at 1% level

Table 70. Heterosis in respect to days taken from transplanting to first picking in parents and hybrids of brinjal during 1995-96

Parents/hybrids		Mean	Days taken from transplanting to first picking	
			Percent heterosis over	
			Mid Parent	Better Parent
1.	KD	92	—	—
2.	BGW	100	—	—
3.	Krishna	98	—	—
4.	R-14	100	—	—
5.	BLP	77	—	—
6.	Navkiran	95	—	—
*	Tal (Ch.Var-1)	100	—	—
*	Nababganj (Ch.Var-2)	115	—	—
7.	KD × BGW	80	-16.67 **	-20.00 **
8.	KD × Krishna	90	-5.26 **	-8.16 **
9.	KD × R-14	95	1.04	-50.00 **
10.	KD × BLP	70	-17.16 **	-23.91 **
11.	KD × Navkiran	95	1.60	0.00
12.	BGW × KD	80	-16.67 **	-20.00 **
13.	BGW × Krishna	85	-14.14 **	-15.00 **
14.	BGW × R-14	90	-10.00 **	-0.10
15.	BGW × BLP	72	-18.64 **	-28.00 **
16.	BGW × Navkiran	93	-4.62 **	-7.00 **
17.	Krishna × KD	85	-10.53 **	-13.27 **
18.	Krishna × BGW	82	-17.17 **	-18.00 **
19.	Krishna × R-14	85	-14.14 **	-15.00 **
20.	Krishna × BLP	72	-17.71 **	-26.53 **
21.	Krishna × Navkiran	90	-6.74 **	-8.16 **
22.	R-14 × KD	96	0.00	-4.00
23.	R-14 × BGW	90	-10.00 **	-10.00 **
24.	R-14 × Krishna	95	-4.04 **	-5.00 **
25.	R-14 × BLP	80	-9.60 **	-20.00 **
26.	R-14 × Navkiran	90	-7.69 **	-10.00
27.	BLP × KD	70	17.16 **	-23.91 **
28.	BLP × BGW	73	-17.51 **	-27.00 **
29.	BLP × Krishna	85	2.86	13.27 **
30.	BLP × R-14	69	-22.03 **	-31.00 **
31.	BLP × Navkiran	110	-27.91 **	15.79 **
32.	Navkiran × KD	90	3.74 **	-5.26 **
33.	Navkiran × BGW	80	-17.95 **	-20.00 **
34.	Navkiran × Krishna	72	-25.39 **	-26.53 **
35.	Navkiran × R-14	82	-15.90 **	-18.00 **
36.	Navkiran × BLP	72	-16.28 **	-24.21 **
	CD (P=0.05)	3.18	2.75	3.18
	CD (P=0.01)	4.18	3.63	4.18

** Significant at 1% level

Table 71. Heterosis with respect to marketable yield in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Marketable yield/pl Percent heterosis over Mid Parent	Better Parent
1. KD	5.20	—	—
2. BGW	3.30	—	—
3. Krishna	2.60	—	—
4. R-14	1.86	—	—
5. BLP	3.40	—	—
6. Navkiran	5.60	—	—
* Tal (Ch.Var-1)	5.00	—	—
* Nababganj (Ch.Var-2)	6.00	—	—
7. KD × BGW	6.00	41.18 **	15.38 **
8. KD × Krishna	4.20	7.69 **	-19.23 **
9. KD × R-14	5.06	43.34 **	-2.77 **
10. KD × BLP	5.50	27.90 **	5.45 **
11. KD × Navkiran	7.65	29.41 **	36.60 **
12. BGW × KD	3.48	-18.11 **	-53.0 **
13. BGW × Krishna	3.26	10.50 **	-1.21 **
14. BGW × R-14	3.22	24.80 **	2.42 **
15. BGW × BLP	3.35	0.00	-1.47 **
16. BGW × Navkiran	5.00	12.35 **	10.77 **
17. Krishna × KD	3.95	1.28 **	24.03 **
18. Krishna × BGW	3.25	10.16 **	-1.51 **
19. Krishna × R-14	2.50	12.10 **	3.84 **
20. Krishna × BLP	3.00	0.00	-11.76 **
21. Krishna × Navkiran	4.00	-2.43 **	-28.57 **
22. R-14 × KD	5.00	41.64 **	-3.84 **
23. R-14 × BGW	2.65	2.71 **	-19.69 **
24. R-14 × Krishna	1.73	-22.42 **	-33.46 **
25. R-14 × BLP	3.30	25.47 **	-2.94 **
26. R-14 × Navkiran	5.33	42.89 **	-4.82 **
27. BLP × KD	4.50	4.65 **	-13.46 **
28. BLP × BGW	3.00	-10.44 **	-11.76 **
29. BLP × Krishna	6.25	108.33 **	83.82 **
30. BLP × R-14	2.50	-4.94 **	-26.47 **
31. BLP × Navkiran	9.00	100.00 **	60.71 **
32. Navkiran × KD	8.32	54.07 **	48.57 **
33. Navkiran × BGW	6.58	133.33 **	17.50 **
34. Navkiran × Krishna	6.40	56.09 **	14.28 **
35. Navkiran × R-14	6.00	60.25 **	7.14 **
36. Navkiran × BLP	6.50	44.44 **	16.07 *
CD (P=0.05)	0.23	0.20	0.23
CD (P=0.01)	0.31	0.26	0.31

** Significant at 1% level

Heterobeltiosis recorded highly significant value for all the 30 F_1 s studied.

4.6.2. Heterosis for reproductive characters

Length of fruits :

The parents and F_1 s showed significant variation amongst themselves for length of the fruit (Table 72). All the crossess except BGW × Krishna and BGW × Navkiran exhibited significant heterosis over their mid parents and the magnitude of signifgicant heterosis ranged from -28.57% (KD × R-14 and BLP × R-14) to 32.98% (BLP × KD). The significant negative heterosis over mid parental value was found in the 15 crossess and positive heterosis was shown for rest of the 8 hybrids. The extent of heterobeltiosis was found to range from -46.67% (R-14 × Krishna) to 8.70% (BLP × KD).

Maximum circumference of fruits :

The results are presented in the Table 73. All the hybrids showed depression in the maximum circumference of fruits in comparison to their better parents, and in more than 50% of the crosses, in comparison to of their mid parents. Almost all the hybrids were trailing behind the better parents and the extent of significant heterosis ranged from -60.00% (BLP × BGW) to 25.00% (BLP × Krishna) over their better parent, and over mid-parental value, it was between -38.46% (BLP × BGW) to 65.33% (BLP × Navkiran). The significant positive heterosis over mid parent was found in the 5 crossess.

Number of fruits / plant :

All the hybrids significantly outstripped the mid-parental values, some in positive and some in negative directions, all significantly (Table 74).

The magnitude of positive heterosis over better parent ranged between 2.74% (KD × BGW) and 217.23% (R-14 × Navkiran). Significant positive heterosis over mid-parent ranged between 4.17% (Krishna × BGW) and 246.63% (R-14 × Navkiran). Although there were 30 significant hybrids only 11 were positively significant with regards to number of fruits/pl.

Weight of fruit :

All the hybrids significantly outstripped the mid-parental values (Table 75). The increase in weight over mid parent ranged from -172.66% (KD × R-14) to 95.24% (BLP × Krishna). Significant heterobeltiosis were exhibited by the different F_1 s ranged from -85.00% (BLP × BGW) to 108.33% (BLP × Krishna).

Total yield / plant :

Out of 30 F_1 s the number of hybrids surpassed markedly the mean of the respective parents, and their better parents, the numbers being 22 and 9 respectively, all in the positive direction (Table 76). The increase in yield/ pl over mid-parent ranged from -25.56% (BLP × R-14) to 92.75% (BLP × Krishna). Significant heterobeltiosis were exhibited by the different F_1 s ranged from -43.48% (Navkiran × BLP) to 52.33% (BLP × Krishna). Regarding the total yield/pl, BLP × Navkiran hybrid showed the best performance, recording the yield of 9.80 kg/pl.

Table 72. Heterosis in fruit length of brinjal in parents and hybrids during 1995-96

Parents/hybrids	Mean	Fruit length — Percent heterosis over: Mid Parent	Better Parent
1. KD	14.60	—	—
2. BGW	15.30	—	—
3. Krishna	30.00	—	—
4. R-14	19.00	—	—
5. BLP	23.00	—	—
6. Navkiran	19.00	—	—
* Tal (Ch.Var-1)	14.00	—	—
* Nababganj (Ch.Var-2)	35.00	—	—
7. KD × BGW	14.6	-2.34 **	-4.79 **
8. KD × Krishna	25.00	10.80 **	-16.67 **
9. KD × R-14	12.00	-28.57 **	-36.84 **
10. KD × BLP	23.00	22.34 **	0.00
11. KD × Navkiran	20.00	19.05 **	5.26 **
12. BGW × KD	15.64	4.62 **	2.22 **
13. BGW × Krishna	23.00	1.55 **	-23.33 **
14. BGW × R-14	16.00	-6.71 **	-15.79 **
15. BGW × BLP	15.00	-21.67 **	-34.78 **
16. BGW × Navkiran	15.00	-0.99 **	-21.05 **
17. Krishna × KD	20.00	-10.31 **	33.33 **
18. Krishna × BGW	23.00	-13.21 **	-23.33 **
19. Krishna × R-14	26.00	-7.14 **	13.33 **
20. Krishna × BLP	25.00	-9.09 **	-16.67 **
21. Krishna × Navkiran	28.00	14.29 **	-6.67 **
22. R-14 × KD	11.00	-4.76 **	-15.79 **
23. R-14 × BGW	19.00	10.79 **	0.00
24. R-14 × Krishna	16.00	-34.69 **	-46.67 **
25. R-14 × BLP	20.00	-4.76 **	-13.04 **
26. R-14 × Navkiran	18.00	5.26 **	5.26 **
27. BLP × KD	25.00	32.98 **	8.70 **
28. BLP × BGW	20.00	-6.98 **	-13.04 **
29. BLP × Krishna	30.00	13.21 **	0.00
30. BLP × R-14	15.00	-28.57 **	-34.78 **
31. BLP × Navkiran	20.00	-4.76 **	-13.04 **
32. Navkiran × KD	18.00	7.14 **	-5.26 **
33. Navkiran × BGW	19.00	10.79 **	0.00
34. Navkiran × Krishna	25.00	2.04 **	-16.67 **
35. Navkiran × R-14	20.00	5.26 **	5.26 **
36. Navkiran × BLP	23.00	9.52 **	0.00
CD (P=0.05)	1.69	1.46	1.69
CD (P=0.01)	2.22	1.92	2.22

** Significant at 1% level

Table 73. Heterosis in respect to maximum circumference of the fruits in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Max. circumference of fruits: Percent heterosis over Mid Parent	Max. circumference of fruits: Percent heterosis over Better Parent
1. KD	32.00	—	—
2. BGW	40.00	—	—
3. Krishna	16.00	—	—
4. R-14	38.00	—	—
5. BLP	12.00	—	—
6. Navkiran	30.33	—	—
* Tal (Ch.Var-1)	45.00	—	—
* Nababganj (Ch.Var-2)	45.00	—	—
7. KD × BGW	30.00	-16.67 **	-25.00 **
8. KD × Krishna	15.00	-37.50 **	-53.13 **
9. KD × R-14	31.00	-11.43 **	-18.42 **
10. KD × BLP	15.00	31.82 **	-53.13 **
11. KD × Navkiran	35.00	12.29 **	-9.38 **
12. BGW × KD	40.00	11.11 **	0.00
13. BGW × Krishna	34.00	21.43 **	-15.00 **
14. BGW × R-14	42.00	7.69 **	5.00 **
15. BGW × BLP	36.00	38.46 **	-10.00 **
16. BGW × Navkiran	31.00	-11.86 **	-22.50 **
17. Krishna × KD	16.00	-33.33 **	-50.00 **
18. Krishna × BGW	30.00	7.14 **	-25.00 **
19. Krishna × R-14	30.00	11.11 **	-21.05 **
20. Krishna × BLP	10.66	-23.86 **	-33.38 **
21. Krishna × Navkiran	25.00	7.90 **	-17.57 **
22. R-14 × KD	30.00	14.29 **	-21.05 **
23. R-14 × BGW	40.00	-2.56 **	0.00
24. R-14 × Krishna	39.00	44.44 **	2.63
25. R-14 × BLP	16.00	36.00 **	-57.89 **
26. R-14 × Navkiran	30.33	-11.24 **	-20.18 **
27. BLP × KD	15.00	-31.82 **	-53.13 **
28. BLP × BGW	16.00	-38.46 **	-60.00 **
29. BLP × Krishna	20.00	42.86 **	25.00 **
30. BLP × R-14	30.00	20.00 **	21.05 **
31. BLP × Navkiran	35.00	65.33 **	15.40 **
32. Navkiran × KD	30.00	-3.75 **	6.25 **
33. Navkiran × BGW	25.00	-28.92 **	-37.50 **
34. Navkiran × Krishna	26.00	12.21 **	-14.28 **
35. Navkiran × R-14	40.00	17.06 **	5.26 **
36. Navkiran × BLP	20.00	-5.53 **	-34.06 **
CD (P=0.05)	2.82	2.44	2.82
CD (P=0.01)	3.71	3.71	3.71

** Significant at 1% level

Table 74. Heterosis in respect to the number of fruits/pl in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Number of fruits/pl — Percent heterosis over: Mid Parent	Better Parent
1. KD	14.60	—	—
2. BGW	3.30	—	—
3. Krishna	21.66	—	—
4. R14	9.30	—	—
5. BLP	37.77	—	—
6. Navkiran	11.20	—	—
* Tal (Ch.Var-1)	14.28	—	—
* Nababganj (Ch.Var-2)	5.45	—	—
7. KD × BGW	15.00	67.60 **	2.74 **
8. KD × Krishna	14.00	-22.78 **	-35.36 **
9. KD × R-14	22.00	84.10 **	50.68 **
10. KD × BLP	50.60	93.20 **	33.97 **
11. KD × Navkiran	12.00	-6.98 **	-17.81 **
12. BGW × KD	6.40	-28.49 **	43.85 **
13. BGW × Krishna	5.06	-59.00 **	-76.64 **
14. BGW × R-14	9.61	52.54 **	3.33 **
15. BGW × BLP	9.38	-54.33 **	-75.17 **
16. BGW × Navkiran	21.55	197.24 **	10.35 **
17. Krishna × KD	19.45	7.28 **	-10.20 **
18. Krishna × BGW	13.00	4.17 **	-39.98 **
19. Krishna × R-14	25.00	61.50 **	15.42 **
20. Krishna × BLP	8.00	-73.08 **	-78.82 **
21. Krishna × Navkiran	11.42	-30.49 **	-47.28 **
22. R-14 × KD	10.00	-16.32 **	-31.51 **
23. R-14 × BGW	8.83	40.16 **	-5.05 **
24. R-14 × Krishna	9.61	-37.92 **	-55.63 **
25. R-14 × BLP	55.00	133.64 **	45.62 **
26. R-14 × Navkiran	35.53	246.63 **	217.23 **
27. BLP × KD	30.00	14.55 **	-20.57 **
28. BLP × BGW	12.00	-41.58 **	-68.23 **
29. BLP × Krishna	25.00	-15.88 **	-33.81 **
30. BLP × R-14	6.94	-70.52 **	-81.63 **
31. BLP × Navkiran	17.30	-29.36 **	-54.20 **
32. Navkiran × KD	17.70	37.21 **	21.23 **
33. Navkiran × BGW	16.45	126.98 **	46.88 **
34. Navkiran × Krishna	16.00	-2.62 **	-26.13 **
35. Navkiran × R-14	24.00	134.15 **	114.29 **
36. Navkiran × BLP	26.00	6.17 **	-31.16 **
CD (P = 0.05)	1.96	1.70	1.96
CD (P = 0.01)	2.58	2.24	2.58

** Significant at 1% level

Table 75. Heterosis in respect to fruit weight in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Fruit weight: Percent heterosis over Mid Parent	Better Parent
1. KD	0.356	—	—
2. BGW	1.000	—	—
3. Krishna	0.120	—	—
4. R-14	0.200	—	—
5. BLP	0.090	—	—
6. Navkiran	0.500	—	—
* Tal (Ch.Var-1)	0.350	—	—
* Nababganj (Ch.Var-2)	1.100	—	—
7. KD × BGW	0.400	-41.18 **	-60.00 **
8. KD × Krishna	0.300	26.05 **	-15.73 **
9. KD × R-14	0.230	-172.66 **	-35.39 **
10. KD × BLP	0.100	-55.16 **	-71.91 **
11. KD × Navkiran	0.510	19.16 **	2.00
12. BGW × KD	1.160	71.09 **	16.00 **
13. BGW × Krishna	0.543	-1.70	-45.70 **
14. BGW × R-14	0.644	7.33 **	-35.60 **
15. BGW × BLP	0.335	-38.53 **	-66.50 **
16. BGW × Navkiran	0.357	-52.40 **	-64.30 **
17. Krishna × KD	0.232	-0.00	-34.83 **
18. Krishna × BGW	0.203	-63.75 **	-79.70 **
19. Krishna × R-14	0.250	56.25 **	25.00 **
20. Krishna × BLP	0.100	-4.76 **	-16.67 **
21. Krishna × Navkiran	0.375	20.97 **	-25.00 **
22. R-14 × KD	0.350	25.90 **	-1.69
23. R-14 × BGW	0.500	-16.67 **	-50.00 **
24. R-14 × Krishna	0.300	85.50 **	50.00 **
25. R-14 × BLP	0.180	24.14 **	-10.00 **
26. R-14 × Navkiran	0.600	71.47 **	20.00 **
27. BLP × KD	0.150	-32.74 **	-57.87 **
28. BLP × BGW	0.150	-72.48 **	-85.00 **
29. BLP × Krishna	0.250	95.24 **	108.33 **
30. BLP × R-14	0.250	72.41 **	25.00 **
31. BLP × Navkiran	0.360	22.03 **	-28.00 **
32. Navkiran × KD	0.520	21.50 **	4.00 **
33. Navkiran × BGW	0.470	-37.33 **	-53.00 **
34. Navkiran × Krishna	0.400	29.03 **	-20.00 **
35. Navkiran × R-14	0.250	-28.57 **	-50.00 **
36. Navkiran × BLP	0.250	-4.50 **	-50.00 **
CD (P = 0.05)	2.73	2.36 **	2.73 **
CD (P = 0.01)	3.59	3.11 **	3.59 **

** Significant at 1% level.

Table 76. Heterosis in respect to total yield/pl in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Total yield/plant Percent heterosis over Mid Parent	Better Parent
1. KD	6.42	—	—
2. BGW	5.60	—	—
3. Krishna	2.60	—	—
4. R-14	3.76	—	—
5. BLP	4.30	—	—
6. Navkiran	6.90	—	—
* Tal (Ch.Var-1)	3.50	—	—
* Nababganj (Ch.Var-2)	6.10	—	—
7. KD × BGW	6.72	11..81 **	4.64 **
8. KD × Krishna	4.60	2.00 **	-28.35 **
9. KD × R-14	5.96	17.09 **	-7.17 **
10. KD × BLP	5.88	9.70 **	-8.41 **
11. KD × Navkiran	7.26	9.01 **	5.07 **
12. BGW × KD	5.00	-16.81 **	-22.12 **
13. BGW × Krishna	4.50	9.76 **	-19.64 **
14. BGW × R-14	5.60	19.66 **	0.00
15. BGW × BLP	5.00	1.01 **	-10.71 **
16. BGW × Navkiran	7.00	12.00 **	1.45 **
17. Krishna × KD	4.50	-0.22	-29.91 **
18. Krishna × BGW	5.60	36.59 **	0.00
19. Krishna × R-14	3.00	-5.66 **	-20.21 **
20. Krishna × BLP	3.90	11.95 **	-9.30 **
21. Krishna × Navkiran	6.00	26.32 **	-13.04 **
22. R-14 × KD	6.30	23.77 **	-1.87 **
23. R-14 × BGW	4.00	-14.53 **	-28.57 **
24. R-14 × Krishna	3.86	21.38 **	2.66 **
25. R-14 × BLP	4.00	-0.74 **	-6.98 **
26. R-14 × Navkiran	6.73	26.27 **	-2.46 **
27. BLP × KD	4.90	-8.58 **	-23.68 **
28. BLP × BGW	3.90	-21.21 **	-30.36 **
29. BLP × Krishna	6.65	92.75 **	52.33 **
30. BLP × R-14	3.00	-25.56 **	-30.23 **
31. BLP × Navkiran	9.80	75.00 **	42.03 **
32. Navkiran × KD	3.80	32.13 **	27.50 **
33. Navkiran × BGW	7.00	12.00 **	1.45 **
34. Navkiran × Krishna	6.85	44.21 **	-5.00 **
35. Navkiran × R-14	9.00	68.86 **	30.43 **
36. Navkiran × BLP	6.60	17.86 **	-43.48 **
CD (P = 0.05)	0.42	0.37	0.42
CD (P = 0.01)	0.56	0.49	0.56

** Significant at 1% level

4.6.3. Heterosis for some susceptibility components

Number of larvae/plant :

The parents and F_1 s showed significant variation amongst themselves for the character larvae/pl (Table 77). All the cross exhibited significant heterosis over their mid-parents and the magnitude of significant heterosis ranged from - 69.28% (R-14 × Navkiran) to 169.84% (KD × BLP). The significant negative heterosis over mid-parental values were found in 18 crosses and a significant positive heterosis in case of remaining 12 crosses. The extent of heterobeltiosis was found to range from -32.00% (Krishna × R-14) to 655.96% (R-14 × BLP).

Number of larvae/fruit :

In case of 6 hybrids the number of larvae/ft was lowered with comparison to their better parent and more than 40% of the crossess over their mid-parent (Table 78). All the hybrids excepting 6 were found to be trailling behind the better parent and the extent of significant heterosis ranged from -105.26% (KD × Navkiran) to 233.33% (BGW × Krishna, R-14 × BLP, BLP × Krishna and BLP × Navkiran) over their better parent; and over the mid-parental values, it was between - 58.97% (Krishna × Navkiran) and 215.79% (BLP × Navkiran).

The significant positive heterosis over mid-parent was found in 15 crossess and another 15 crossess showed significant negative heterosis which was very much desirable for insect resistant breeding.

Number of holes/plant :

The data presented in Table 79 indicated that all the hybrids showed significant heterosis over the respective parents, and their better parents, except in the crossess BGW × R-14 and Krishna × KD. The magnitude of heterosis over better parent ranged from - 119.47% (KD × BGW) to 457.89% (R-14 × BGW).

Number of holes/fruit :

Table 80 reveals that all the hybrids had significant heterosis with relation to both of the parents. The magnitude of heterosis over mid-parent ranged from - 76.74% (BLP × Navkiran) to 75.00% (Navkiran × R-14) and range of heterobeltiosis was - 75.61% in cross BLP × Navkiran and 159.26% in Navkiran × R-14.

Days taken to borer attack on branches :

Heterosis values with respect to days taken to borer attack on branches are presented in Table 81. The magnitude of heterosis over the mid-parents ranged from - 12.62% (Krishna × R-14) to 26.44% (R-14 × BLP) and range of heterobeltiosis was - 21.57% in cross (Krishna × BLP) to 13.46% (Krishna × R-14).

Days taken for borer attack on fruit :

Table 82 embodies the heterosis values with respect to days taken for borer attack on fruit. The values ranged from - 46.61% (R-14 × Krishna) to 17.65% (BLP × BGW) over mid-parents and range of heterobeltiosis was - 29.13% in the cross Krishna × BLP and 16.67% in Navkiran × Krishna hybrid.

Percent infested branches/plant :

Heterosis values with respect to this character are presented in Table 83. The magnitude of heterosis over mid parent ranged from - 82.68% (Krishna × Navkiran) to 270.37% (BLP × Navkiran) and range of heterobeltiosis was - 102.80% in the cross Navkiran × KD and 650.75% in BGW × R-14.

Percent infested fruit/plant :

The data presented in Table 84 indicate that the hybrids surpassed markedly the mean of the respective parents and their better parents in the crosses between Navkiran × BGW (-79.00%) followed by R-14 × KD (-77.57%). The magnitude of heterosis over better parent ranged from - 79.00% (Navkiran × BGW) to 180.37% (BGW × KD).

Percent yield loss :

The data presented in Table 85 revealed that the magnitude of heterosis over mid-parent ranged from - 89.09% (KD × R-14) to 59.26% (Navkiran × R-14). Heterosis over better parent ranged from - 78.82% (KD × BLP) to 215.79% (Navkiran × R-14).

The range, mean values in parents and hybrids and heterosis over better parent (superior parent) are given in the Table 86 for the vegetative characters and marketable yield. Krishna was the most desirable parent with respect to plant height at first flowering and first harvesting. Among the parents the highest number of primary branches/pl was recorded in Navkiran while BLP appeared as top parent with respect to the number of secondary branches/pl, days to flowering and days taken from transplanting to picking. Navkiran out yielded all the parents in respect to marketable yield/pl (6.90 kg/pl).

Respective F_1 hybrid which might be considered best were Navkiran × BGW for plant height at first flowering (90.00 cm) and plant height at first harvesting (99.00 cm). The F_1 hybrids that could be considered

Table 77. Heterosis in respect to number of larvae/pl in the parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Larvae/pl	
		Percent heterosis over	
		Mid Parent	Better Parent
1. KD	0.79	—	—
2. BGW	1.47	—	—
3. Krishna	2.50	—	—
4. R-14	2.56	—	—
5. BLP	0.47	—	—
6. Navkiran	0.49	—	—
* Tal (Ch.Var-1)	1.36	—	—
* Nababganj (Ch.Var-2)	3.10	—	—
7. KD × BGW	0.76	-32.74 **	-3.80 **
8. KD × Krishna	0.70	-57.58 **	-11.39 **
9. KD × R-14	2.30	36.90 **	191.14 **
10. KD × BLP	1.70	169.84 **	261.70 **
11. KD × Navkiran	0.47	-26.56 **	-4.08 **
12. BGW × KD	1.10	-2.65 **	39.24 **
13. BGW × Krishna	2.00	50.25 **	36.05 **
14. BGW × R-14	1.20	-40.59 **	-18.37 **
15. BGW × BLP	0.43	-55.67 **	-8.51 **
16. BGW × Navkiran	0.47	52.04 **	-4.08 **
17. Krishna × KD	0.75	-54.55 **	-5.06 **
18. Krishna × BGW	2.00	0.50 **	36.05 **
19. Krishna × R-14	1.70	-32.81 **	-42.00 **
20. Krishna × BLP	0.97	-34.90 **	106.38 **
21. Krishna × Navkiran	0.47	-68.67 **	-4.08 **
22. R-14 × KD	0.78	-53.57 **	-1.27 **
23. R-14 × BGW	2.70	33.66 **	83.67 **
24. R-14 × Krishna	2.60	2.77 **	4.00 **
25. R-14 × BLP	3.60	136.84 **	665.96 **
26. R-14 × Navkiran	0.47	-69.28 **	-4.08 **
27. BLP × KD	0.73	15.87 **	55.32 **
28. BLP × BGW	0.82	-15.46 **	74.47 **
29. BLP × Krishna	0.92	-38.26 **	95.74 **
30. BLP × R-14	2.00	31.58 **	325.53 **
31. BLP × Navkiran	0.73	65.91 **	55.32 **
32. Navkiran × KD	0.70	9.38 **	42.86 **
33. Navkiran × BGW	0.79	-19.39 **	61.22 **
34. Navkiran × Krishna	0.86	-42.67 **	75.51 **
35. Navkiran × R-14	2.00	30.72 **	308.16 **
36. Navkiran × BLP	0.47	-2.08 **	-4.08 **
CD (P = 0.05)	0.07	0.06	0.07
CD (P = 0.01)	0.09	0.08	0.09

** Significant at 1% level

Table 78. Heterosis in respect to larvae/ft in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Larvae/ft: Percent heterosis over Mid Parent	Larvae/ft: Percent heterosis over Better Parent
1. KD	0.29	—	—
2. BGW	0.39	—	—
3. Krishna	0.58	—	—
4. R-14	0.56	—	—
5. BLP	0.18	—	—
6. Navkiran	0.19	—	—
* Tal (Ch.Var-1)	0.36	—	—
* Nababganj (Ch.Var-2)	0.10	—	—
7. KD × BGW	0.30	-11.76 **	3.45 **
8. KD × Krishna	0.21	-52.27 **	-277.59 **
9. KD × R-14	0.25	-41.86 **	-13.79 **
10. KD × BLP	0.50	108.33 **	177.78 **
11. KD × Navkiran	0.17	-29.17 **	-105.26 **
12. BGW × KD	0.52	52.94 **	79.31 **
13. BGW × Krishna	1.30	165.31 **	233.33 **
14. BGW × R-14	0.35	-27.08 **	10.26 **
15. BGW × BLP	0.15	-48.28 **	-16.67 **
16. BGW × Navkiran	0.17	-41.38 **	-10.53 **
17. Krishna × KD	0.36	-18.18 **	24.14 **
18. Krishna × BGW	0.50	2.04 **	28.21 **
19. Krishna × R-14	0.57	0.00	1.79 **
20. Krishna × BLP	0.36	-5.26 **	100.00 **
21. Krishna × Navkiran	0.16	-58.97 **	-15.79 **
22. R-14 × KD	0.37	13.95 **	27.59 **
23. R-14 × BGW	0.67	39.58 **	71.79 **
24. R-14 × Krishna	0.60	5.26 **	7.14 **
25. R-14 × BLP	0.60	62.16 **	233.33 **
26. R-14 × Navkiran	0.19	-50.00 **	0.00
27. BLP × KD	0.26	8.33 **	44.44 **
28. BLP × BGW	0.27	6.90 **	50.00 **
29. BLP × Krishna	0.60	57.89 **	233.33 **
30. BLP × R-14	0.90	143.24 **	400.00 **
31. BLP × Navkiran	0.60	215.79 **	233.33 **
32. Navkiran × KD	0.27	12.50 **	42.11 **
33. Navkiran × BGW	0.30	3.45 **	57.89 **
34. Navkiran × Krishna	0.37	-5.13 **	94.74 **
35. Navkiran × R-14	1.00	163.16 **	78.57 **
36. Navkiran × BLP	0.21	10.53 **	16.67 **
CD (P = 0.05)		0.02	0.03
CD (P = 0.01)		0.03	0.03

** Significant at 1% level

Table 79. Heterosis in respect to number of holes/pl in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	No. of holes/pl Percent heterosis over Mid Parent	Better Parent
1. KD	4.20	—	—
2. BGW	1.90	—	—
3. Krishna	4.60	—	—
4. R-14	11.70	—	—
5. BLP	3.20	—	—
6. Navkiran	3.42	—	—
* Tal (Ch.Var-1)	10.43	—	—
* Nababganj (Ch.Var-2)	7.00	—	—
7. KD × BGW	4.17	36.72 **	-119.47 **
8. KD × Krishna	3.00	-31.82 **	-28.57 **
9. KD × R-14	3.00	-62.26 **	-28.57 **
10. KD × BLP	2.00	-45.95 **	-37.50 **
11. KD × Navkiran	2.00	-47.51 **	-41.52 **
12. BGW × KD	1.80	-40.98 **	-5.56 **
13. BGW × Krishna	2.00	-38.46 **	-5.26 **
14. BGW × R-14	1.90	-72.06 **	0.00
15. BGW × BLP	3.00	17.65 **	57.89 **
16. BGW × Navkiran	3.00	4.81 **	57.89 **
17. Krishna × KD	4.20	-4.55 **	0.00
18. Krishna × BGW	3.60	10.77 **	-89.47 **
19. Krishna × R-14	5.00	-38.65 **	8.70 **
20. Krishna × BLP	4.00	2.56 **	25.00 **
21. Krishna × Navkiran	3.40	-15.21 **	-0.58 **
22. R-14 × KD	4.27	-46.29 **	1.67 **
23. R-14 × BGW	10.60	55.88 **	457.89 **
24. R-14 × Krishna	5.90	-27.61 **	28.26
25. R-14 × BLP	5.00	-32.89 **	56.25 **
26. R-14 × Navkiran	3.40	-55.03 **	-0.58 **
27. BLP × KD	3.00	-18.92 **	-6.25 **
28. BLP × BGW	3.96	55.29 **	108.42 **
29. BLP × Krishna	2.00	-48.72 **	-37.50 **
30. BLP × R-14	3.00	-59.73 **	-6.25 **
31. BLP × Navkiran	2.00	-39.58 **	-37.50 **
32. Navkiran × KD	4.17	9.45 **	21.93 **
33. Navkiran × BGW	5.10	91.73 **	168.42 **
34. Navkiran × Krishna	3.10	-22.69 **	-9.36 **
35. Navkiran × R-14	3.30	-56.35 **	-3.51 **
36. Navkiran × BLP	3.43	3.63 **	7.19 **
CD (P = 0.05)	0.36	0.31	0.36
CD (P = 0.01)	0.47	0.41	0.47

** Significant at 1% level

Table 80. Heterosis in respect to number of holes/ft in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Number of holes/ft — Percent heterosis over Mid Parent	Better Parent
1. KD	1.27	—	—
2. BGW	1.60	—	—
3. Krishna	1.77	—	—
4. R-14	2.93	—	—
5. BLP	1.23	—	—
6. Navkiran	1.35	—	—
* Tal (Ch.Var-1)	3.00	—	—
* Nababganj (Ch.Var-2)	2.00	—	—
7. KD × BGW	1.12	-22.22 **	-11.81 **
8. KD × Krishna	1.10	-27.63 **	-13.39 **
9. KD × R-14	1.27	-39.52 **	0.00
10. KD × BLP	1.00	-20.00 **	-18.70 **
11. KD × Navkiran	1.30	-0.76 **	-0.77 **
12. BGW × KD	1.50	4.17 **	18.11 **
13. BGW × Krishna	1.00	-40.83 **	-37.50 **
14. BGW × R-14	1.40	-38.33 **	-12.50 **
15. BGW × BLP	1.00	-29.58 **	-18.70 **
16. BGW × Navkiran	1.30	-12.16 **	-3.70 **
17. Krishna × KD	1.20	-21.05 **	-5.51 **
18. Krishna × BGW	1.70	0.59 **	6.25 **
19. Krishna × R-14	2.00	-14.89 **	12.99 **
20. Krishna × BLP	2.00	33.33 **	62.60 **
21. Krishna × Navkiran	1.30	-16.67 **	-3.70 **
22. R-14 × KD	1.28	-39.05 **	0.79 **
23. R-14 × BGW	2.73	20.26 **	70.63 **
24. R-14 × Krishna	2.10	-10.64 **	19.41 **
25. R-14 × BLP	2.30	10.58 **	86.99 **
26. R-14 × Navkiran	1.30	14.04 **	-3.70 **
27. BLP × KD	1.12	-10.40 **	-8.94 **
28. BLP × BGW	2.20	54.93 **	78.86 **
29. BLP × Krishna	0.90	-40.00 **	-26.83 **
30. BLP × R-14	3.00	7.14 **	143.90 **
31. BLP × Navkiran	0.30	-76.74 **	-75.61 **
32. Navkiran × KD	1.17	-10.69 **	-13.33 **
33. Navkiran × BGW	1.37	-7.43 **	1.48 **
34. Navkiran × Krishna	2.20	41.03 **	62.96 **
35. Navkiran × R-14	3.50	75.00 **	159.26 **
36. Navkiran × BLP	1.03	-20.16 **	-16.26 **
CD (P=0.05)	0.09	0.08	0.09
CD (P=0.01)	0.12	0.10	0.12

Significant at 1% level

Table 81. Heterosis in respect to days to borer attack on branches in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Days to borer attack on branches: Percent heterosis over Mid Parent	Better Parent
1. KD	90.00	—	—
2. BGW	90.00	—	—
3. Krishna	102.00	—	—
4. R-14	104.00	—	—
5. BLP	70.00	—	—
6. Navkiran	90.00	—	—
* Tal (Ch.Var-1)	90.00	—	—
* Nababganj (Ch.Var-2)	95.00	—	—
7. KD × BGW	90.00	0.00	0.00
8. KD × Krishna	100.00	4.17 **	-1.96
9. KD × R-14	108.00	11.34 **	3.85
10. KD × BLP	80.00	0.00	-11.11 **
11. KD × Navkiran	90.00	0.00	0.00
12. BGW × KD	90.00	0.00	0.00
13. BGW × Krishna	95.00	-1.04	-6.86 **
14. BGW × R-14	96.00	-1.03	-7.69 **
15. BGW × BLP	80.00	0.00	11.11 **
16. BGW × Navkiran	90.00	0.00	0.00
17. Krishna × KD	100.00	4.17 **	-1.96
18. Krishna × BGW	100.00	4.17 **	-1.96
19. Krishna × R-14	90.00	-12.62 **	13.46 **
20. Krishna × BLP	80.00	-6.98 **	-21.57 **
21. Krishna × Navkiran	90.00	-6.25 **	-11.76 **
22. R-14 × KD	90.00	-7.22 **	-13.46 **
23. R-14 × BGW	100.00	3.09	-13.46 **
24. R-14 × Krishna	110.00	6.80 **	5.77 **
25. R-14 × BLP	110.00	26.44 **	5.77 **
26. R-14 × Navkiran	98.00	1.03	-5.77 **
27. BLP × KD	92.00	15.00 **	2.22
28. BLP × BGW	88.00	10.00 **	-2.22
29. BLP × Krishna	95.00	10.47 **	-6.86 **
30. BLP × R-14	98.00	12.64 **	-5.77 **
31. BLP × Navkiran	100.00	25.00 **	11.11 **
32. Navkiran × KD	99.00	10.00 **	10.00 **
33. Navkiran × BGW	100.00	11.11 **	-11.11 **
34. Navkiran × Krishna	90.00	-6.25 **	-11.76 **
35. Navkiran × R-14	94.00	-3.09	-9.62 **
36. Navkiran × BLP	100.00	25.00 **	11.11 **
CD (P = 0.05)	3.33	2.88	3.33
CD (P = 0.01)	4.38	3.79	4.38

** Significant at 1% level

Table 82. Heterosis in respect to days to borer attack on fruit in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Days to borer attack on fruit: Percent heterosis over Mid Parent	Days to borer attack on fruit: Percent heterosis over Better Parent
1. KD	120.00	—	—
2. BGW	100.00	—	—
3. Krishna	127.00	—	—
4. R-14	130.00	—	—
5. BLP	90.00	—	—
6. Navkiran	120.00	—	—
* Tal (Ch.Var-1)	125.00	—	—
* Nababganj (Ch.Var-2)	110.00	—	—
7. KD × BGW	100.00	-9.09 **	-16.67 **
8. KD × Krishna	110.00	-10.93 **	-13.39 **
9. KD × R-14	120.00	-4.00	-7.69 **
10. KD × BLP	90.00	-14.29 **	-25.00 **
11. KD × Navkiran	120.00	0.00	0.00
12. BGW × KD	105.00	-4.55	-12.50 **
13. BGW × Krishna	106.00	-6.61 **	-16.54 **
14. BGW × R-14	104.00	-9.57 **	-20.00 **
15. BGW × BLP	100.00	5.26	0.00
16. BGW × Navkiran	120.00	0.09 **	0.00
17. Krishna × KD	120.00	-2.83	-5.51 **
18. Krishna × BGW	120.00	5.73 **	-5.51 **
19. Krishna × R-14	110.00	-14.40 **	-15.38 **
20. Krishna × BLP	90.00	-17.05 **	-29.13 **
21. Krishna × Navkiran	120.00	-2.83	-25.93 **
22. R-14 × KD	120.00	-4.00	-7.69 **
23. R-14 × BGW	120.00	4.35	-7.69 **
24. R-14 × Krishna	122.00	-46.61 **	-6.15 **
25. R-14 × BLP	120.00	0.09	-7.69 **
26. R-14 × Navkiran	120.00	-4.00	-7.69 **
27. BLP × KD	109.00	3.81	-9.17 **
28. BLP × BGW	100.00	17.65 **	-16.67 **
29. BLP × Krishna	110.00	1.38	-8.33 **
30. BLP × R-14	110.00	0.00	-15.38 **
31. BLP × Navkiran	110.00	4.76	-8.33 **
32. Navkiran × KD	120.00	0.00	0.00
33. Navkiran × BGW	112.00	1.82	-6.67 **
34. Navkiran × Krishna	100.00	-26.32 **	16.67 **
35. Navkiran × R-14	115.00	-8.00 **	-4.17
36. Navkiran × BLP	115.00	9.54 **	-4.15
CD (P=0.05)	4.66	4.04	4.66
CD (P=0.01)	6.14	5.29	6.14

** Significant at 1% level

Table 83. Heterosis in respect to percent infested branches in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Percent infested branches: Percent heterosis over Mid Parent	Better Parent
1. KD	6.00	—	—
2. BGW	28.00	—	—
3. Krishna	17.39	—	—
4. R-14	3.33	—	—
5. BLP	1.80	—	—
6. Navkiran	1.43	—	—
* Tal (Ch.Var-1)	5.00	—	—
* Nababganj (Ch.Var-2)	1.25	—	—
7. KD × BGW	3.00	-82.35 **	-80.00 **
8. KD × Krishna	12.00	2.56 **	-100.00 **
9. KD × R-14	3.33	-28.67 **	0.00
10. KD × BLP	2.88	-26.15 **	60.00 **
11. KD × Navkiran	1.43	-61.56 **	0.00
12. BGW × KD	27.00	58.82 **	350.00 **
13. BGW × Krishna	25.00	10.13 **	43.76 **
14. BGW × R-14	25.00	59.54 **	650.75 **
15. BGW × BLP	14.00	-6.04 **	677.78 **
16. BGW × Navkiran	1.43	90.29 **	0.00 **
17. Krishna × KD	17.00	45.30 **	183.33 **
18. Krishna × BGW	15.00	-33.92 **	-13.74 **
19. Krishna × R-14	3.60	-65.25 **	8.11 **
20. Krishna × BLP	3.60	-62.50 **	100.00 **
21. Krishna × Navkiran	1.63	-82.68 **	13.99 **
22. R-14 × KD	3.20	-31.48 **	-3.90 **
23. R-14 × BGW	5.61	-64.49 **	68.47 **
24. R-14 × Krishna	6.61	-36.20 **	98.50 **
25. R-14 × BLP	3.90	51.75 **	116.67 **
26. R-14 × Navkiran	1.43	-39.92 **	0.00
27. BLP × KD	1.88	-13.28 **	4.44 **
28. BLP × BGW	12.96	-13.02 **	620.00 **
29. BLP × Krishna	2.30	-76.04 **	27.78 **
30. BLP × R-14	5.06	96.89 **	181.11 **
31. BLP × Navkiran	6.00	270.37 **	819.58 **
32. Navkiran × KD	2.90	-22.04 **	-102.80 **
33. Navkiran × BGW	2.96	-79.89 **	106.99 **
34. Navkiran × Krishna	6.06	-35.60 **	323.78 **
35. Navkiran × R-14	7.06	196.64	393.71 **
36. Navkiran × BLP	1.66	2.47 **	2.80
CD (P = 0.05)	1.39	1.20	1.39
CD (P = 0.01)	1.82	1.58	1.82

** Significant at 1% level

Table 84. Heterosis in respect to percent infested fruit in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Percent infested fruit	
		Percent heterosis over	
		Mid Parent	Better Parent
1. KD	10.70	—	—
2. BGW	31.00	—	—
3. Krishna	30.20	—	—
4. R-14	45.00	—	—
5. BLP	13.31	—	—
6. Navkiran	10.00	—	—
* Tal (Ch.Var-1)	25.00	—	—
* Nababganj (Ch.Var-2)	19.00	—	—
7. KD × BGW	12.00	-42.45 **	12.15 **
8. KD × Krishna	10.00	-51.10 **	-6.54 **
9. KD × R-14	5.12	-81.62 **	-52.15 **
10. KD × BLP	12.00	-0.08	-0.08
11. KD × Navkiran	11.05	6.76 **	10.50 **
12. BGW × KD	30.00	43.88 **	180.37 **
13. BGW × Krishna	30.00	-0.06	-0.66
14. BGW × R-14	30.00	-21.05 **	-3.23
15. BGW × BLP	33.00	48.92 **	147.93 **
16. BGW × Navkiran	20.02	-2.34	100.20 **
17. Krishna × KD	16.00	-21.76 **	49.53 **
18. Krishna × BGW	29.00	-0.17	-3.97 **
19. Krishna × R-14	31.00	-17.55 **	-2.65 **
20. Krishna × BLP	15.00	-31.07 **	-12.70 **
21. Krishna × Navkiran	15.00	-25.37 **	50.00 **
22. R-14 × KD	19.00	-31.78 **	-77.57 **
23. R-14 × BGW	50.00	31.58 **	61.29 **
24. R-14 × Krishna	36.00	-0.11	19.21 **
25. R-14 × BLP	14.00	-51.99 **	5.18 **
26. R-14 × Navkiran	15.00	-45.45 **	50.00 **
27. BLP × KD	9.06	-24.56 **	-15.33 **
28. BLP × BGW	25.00	12.82 **	87.83 **
29. BLP × Krishna	12.00	-44.85 **	-9.48 **
30. BLP × R-14	36.00	23.46 **	170.47 **
31. BLP × Navkiran	6.00	-48.54 **	-40.00 **
32. Navkiran × KD	7.96	-23.09 **	-20.40 **
33. Navkiran × BGW	17.90	-12.68 **	-79.00 **
34. Navkiran × Krishna	18.90	-5.97 **	89.00 **
35. Navkiran × R-14	13.09	-52.40 **	30.00 **
36. Navkiran × BLP	10.00	-14.24 **	0.00
CD (P = 0.05)	2.91	2.52	2.91
CD (P = 0.01)	3.83	3.31	3.83

** Significant at 1% level

Table 85. Heterosis in respect to percent yield loss in parents and hybrids of brinjal during 1995-96

Parents/hybrids	Mean	Percent yield loss: Percent heterosis over Mid Parent	Better Parent
1. KD	12.85	—	—
2. BGW	30.80	—	—
3. Krishna	30.00	—	—
4. R-14	45.07	—	—
5. BLP	14.00	—	—
6. Navkiran	15.20	—	—
* Tal (Ch.Var-1)	25.00	—	—
* Nababganj (Ch.Var-2)	20.00	—	—
7. KD × BGW	10.71	-50.94 **	-16.65 **
8. KD × Krishna	7.10	-66.87 **	-44.75 **
9. KD × R-14	3.16	-89.09 **	-75.41 **
10. KD × BLP	10.00	-25.54 **	-78.82 **
11. KD × Navkiran	12.85	-8.41 **	0.00
12. BGW × KD	30.89	41.50 **	140.39 **
13. BGW × Krishna	27.55	-9.38 **	-8.17 **
14. BGW × R-14	42.50	12.02 **	37.99 **
15. BGW × BLP	33.00	47.32 *	135.71 **
16. BGW × Navkiran	28.00	21.74 **	84.21 **
17. Krishna × KD	12.22	-42.98 **	-4.90 **
18. Krishna × BGW	28.00	-7.89 **	-6.67 **
19. Krishna × R-14	30.00	-20.09 **	0.00
20. Krishna × BLP	10.00	-54.55 **	-28.57 **
21. Krishna × Navkiran	19.2	-15.04 **	26.32 **
22. R-14 × KD	20.00	-30.94 **	55.64 **
23. R-14 × BGW	56.00	47.60 **	81.82 **
24. R-14 × Krishna	39.00	3.89 **	30.00 **
25. R-14 × BLP	19.00	-35.68 **	35.71 **
26. R-14 × Navkiran	18.00	-40.28 **	18.42 **
27. BLP × KD	11.20	-16.60 **	-12.84 **
28. BLP × BGW	27.00	20.54 **	110.12 **
29. BLP × Krishna	15.00	-31.82 **	16.73 **
30. BLP × R-14	39.00	32.02 **	178.57 **
31. BLP × Navkiran	7.02	-51.92 **	-53.82 **
32. Navkiran × KD	8.90	-36.56 **	-30.74 **
33. Navkiran × BGW	18.00	-21.74 **	18.42 **
34. Navkiran × Krishna	19.00	-15.93 **	25.00 **
35. Navkiran × R-14	48.00	59.26 **	215.79 **
36. Navkiran × BLP	12.00	-17.81 **	-21.05 **
CD (P = 0.05)			
CD (P = 0.01)			

** Significant at 1% level

best were obtained from the crosses Navkiran × KD, BLP × Navkiran, BLP × KD, BLP × R-14 and BLP × Navkiran with respect to number of primary branches/pl, number of secondary branches/pl, days to flowering, days taken from transplanting to picking and marketable yield.

Table 87 represents the range, mean values in parents, their crosses and heterosis over better parent for some reproductive characters. Length of fruit showed maximum for Krishna among the selected six parents and 30 F_1 hybrids. Same value was also exhibited by the hybrid of BLP × Krishna for this characters. Maximum circumference of fruit was the highest (40.00 cm) in BGW among the parents and in BGW × R-14 hybrid among the F_1s (42.00 cm). BLP among the parents (37.77) and the hybrid of R-14 × BLP (55.00) among the F_1s produced highest number of fruits/pl. Regarding the weight of fruit BGW (1.00 kg) and the F_1 of BGW × KD (1.16 kg) showed the maximum value. Navkiran appeared to be first among the parents with 6.90 kg yield/pl and highest yield was recorded for BLP × Navkiran hybrid (9.80 kg/pl).

BLP appear to be the top desirable variety among the parents with respect to some susceptibility components towards the attack of *L. orbonalis* namely, larvae/ft and holes/ft (Table 88). Hybrids for these qualities appeared to be BGW × BLP, BGW × BLP and BLP × Navkiran. BGW and BGW × KD stood first among the parents and hybridss respectively for number of holes/pl. R-14 parent showed highest value with respect to days to borer attack on branches and fruits. Respective hybrids for these characters were R-14 × BLP and R-14 × Krishna. Percent infested branches/ pl and percent infested fruits/pl were of least value for the parent Navkiran and in the hybrids of R-14 × Navkiran and KD × R-14. The latter one also showed least loss in yield. (%). Best parent showing least damage in yield was KD which recorded only 12.85% infested yield.

Performance (Fig.38) of selected six parents with relation to plant height at first flowering and harvesting revealed the highest values from Krishna at the first flowering (90.55) and also at the first harvesting (100.22).

Performance based on average values of 1991-92, 1992-93 and 1995-96 regarding number of primary and secondary branches is presented with the help of a bar-diagram (Fig.39). Highest number of primary branches was recorded for the variety Navkiran (5.66) while that of the secondary branches was for BLP (15.55).

Figure 40 diagramatically represents the mean performance of selected six varieties with respect to days to flowering and days to picking. Maximum number of days were taken for R-14 for 50% flowering of the plants (75.77) while the lowest value was for BLP (48.33). Regarding days taken from transplanting to first picking of fruits it was highest for BGW 101.78 while BLP recorded the lowest value of 77.67.

Bar diagram for marketable yields (kg/pl) for the selected 6 varieties (Fig. 41) clearly depicted that KD (5.36) and Navkiran (5.01) were the good yielding varieties, their total yields were 6.67 and 6.05 respectively (Fig. 42). This bar-diagram (Fig. 42) also indicated that the fruit weight of BGW was highest (1.01) and lowest being BLP (0.09 kg/ft).

So far the fruit length and circumference is concerned (Fig. 43) clearly indicated that the highest value was for Krishna (29.33 cm) and for the fruit circumference the highest value was for BGW (41.33 cm).

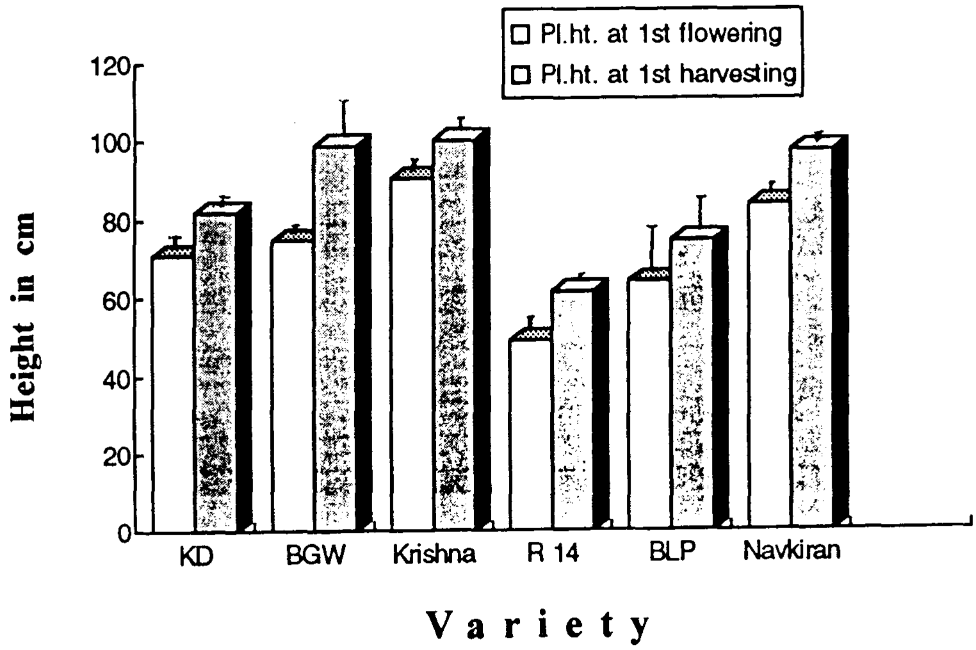


Fig. 38. **Performance of selected six parents with respect to plant height at first flowering and plant height at first harvesting**

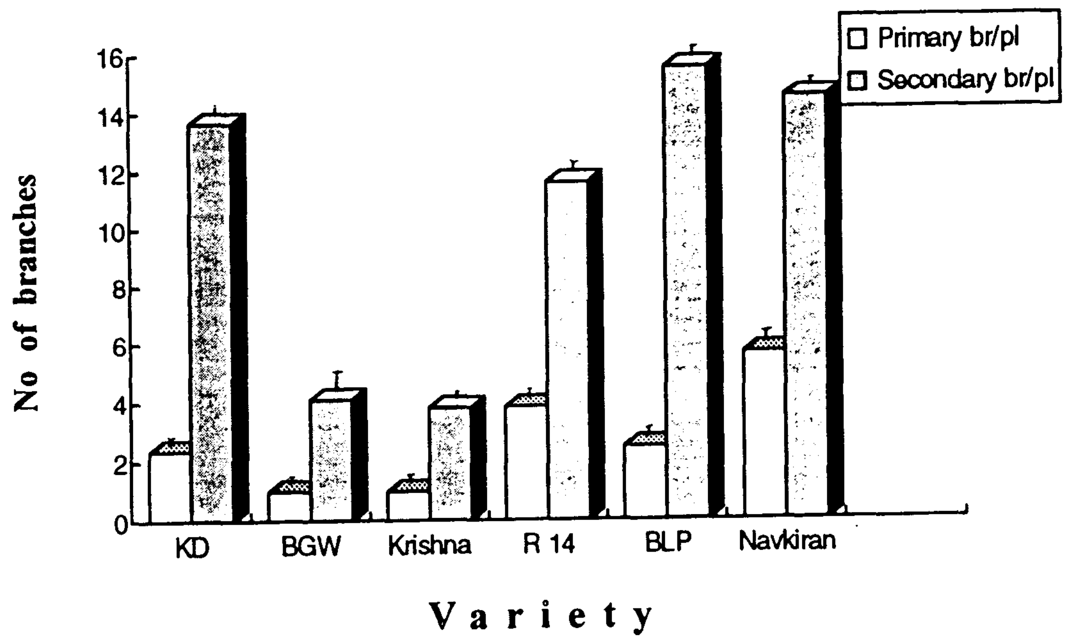


Fig. 39. **Performance of selected six varieties with respect to number of primary and secondary branches**

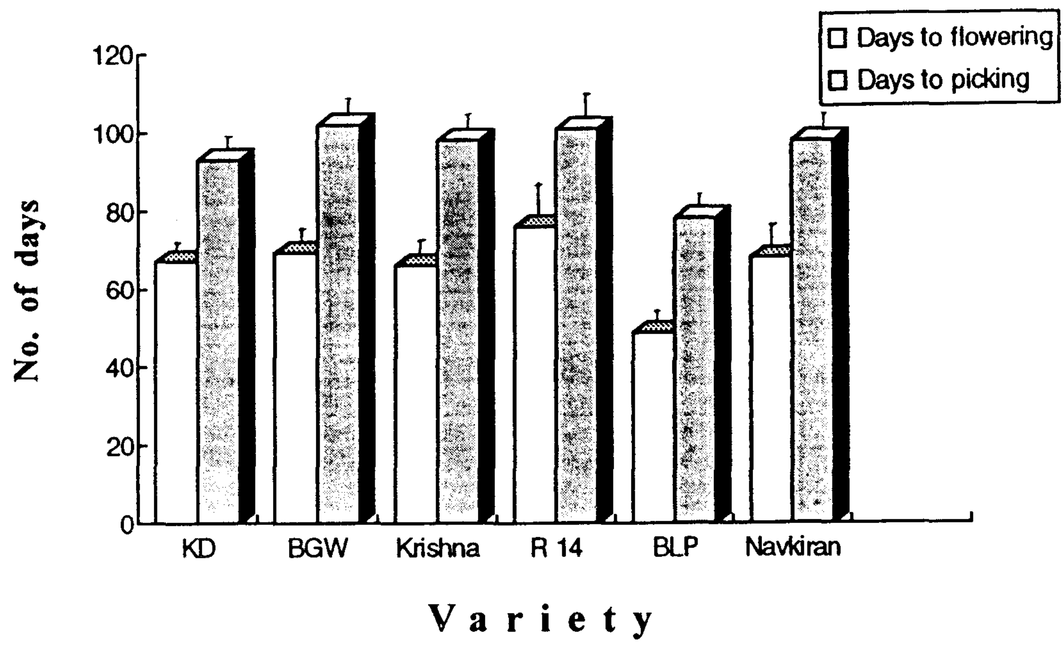


Fig. 40. **Performance of selected six varieties with respect to days to flowering and days to picking**

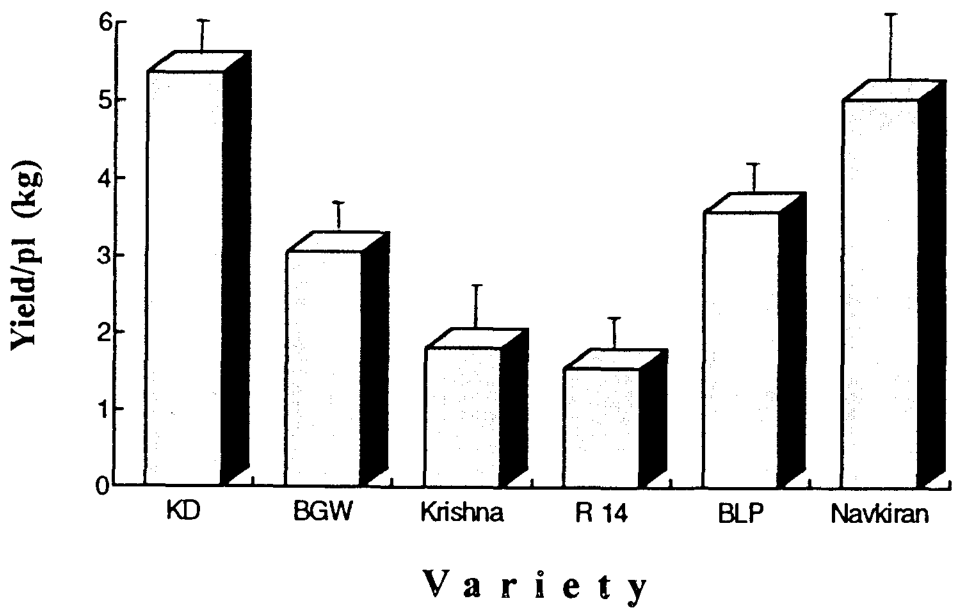


Fig. 41. **Performance of selected six varieties with respect to marketable yield/pl (kg)**

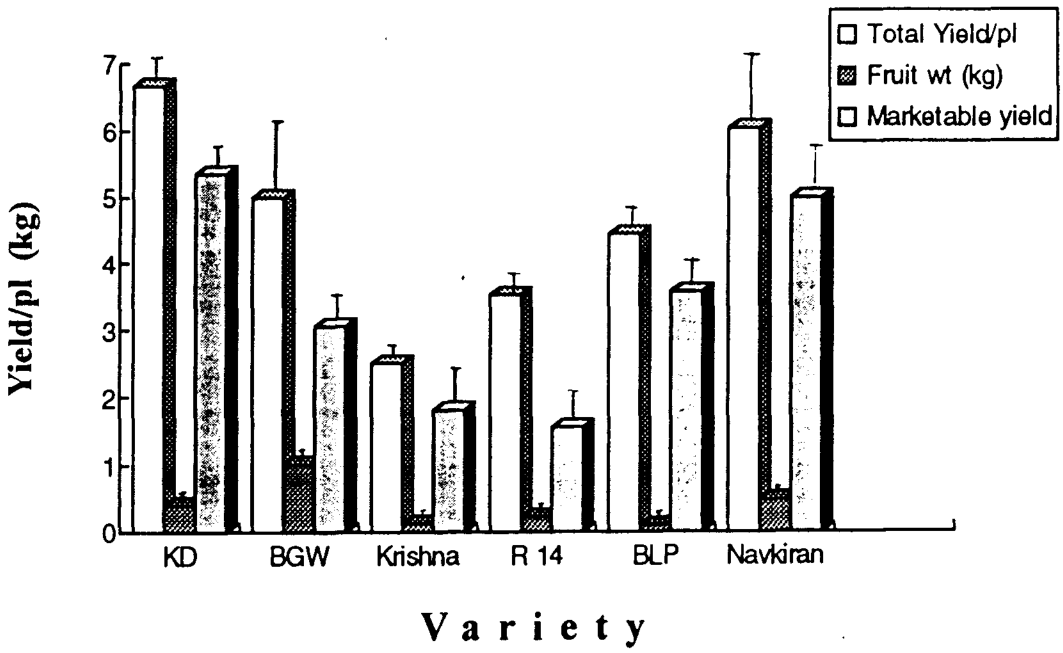


Fig. 42. **Performance of selected six parents with respect to total yield/pl, fruit weight and marketable yield**

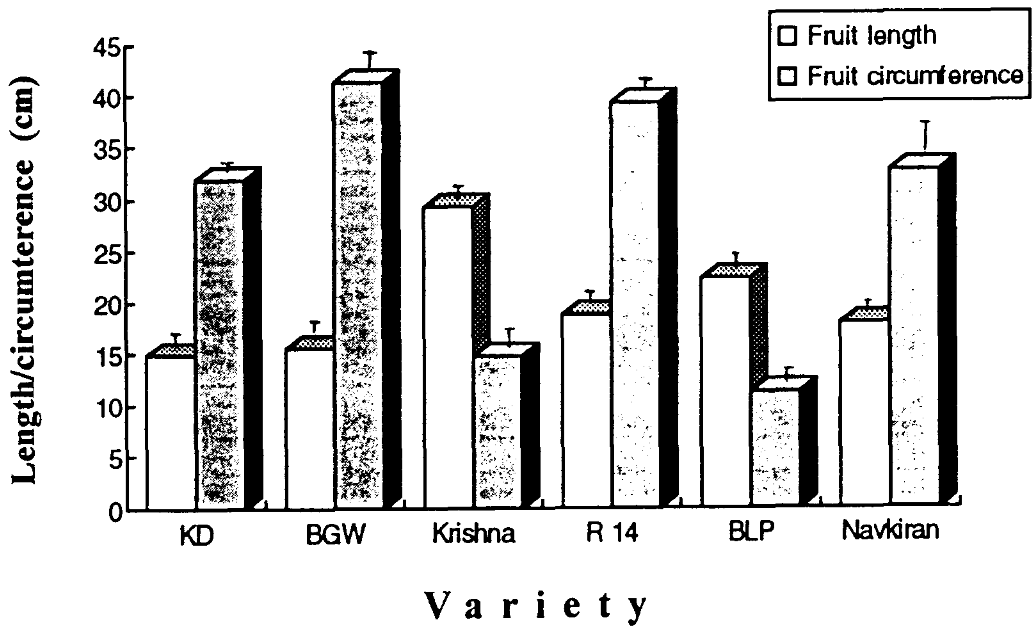


Fig. 43. **Performance of selected six varieties with respect to length of fruit and circumterence of the fruit**

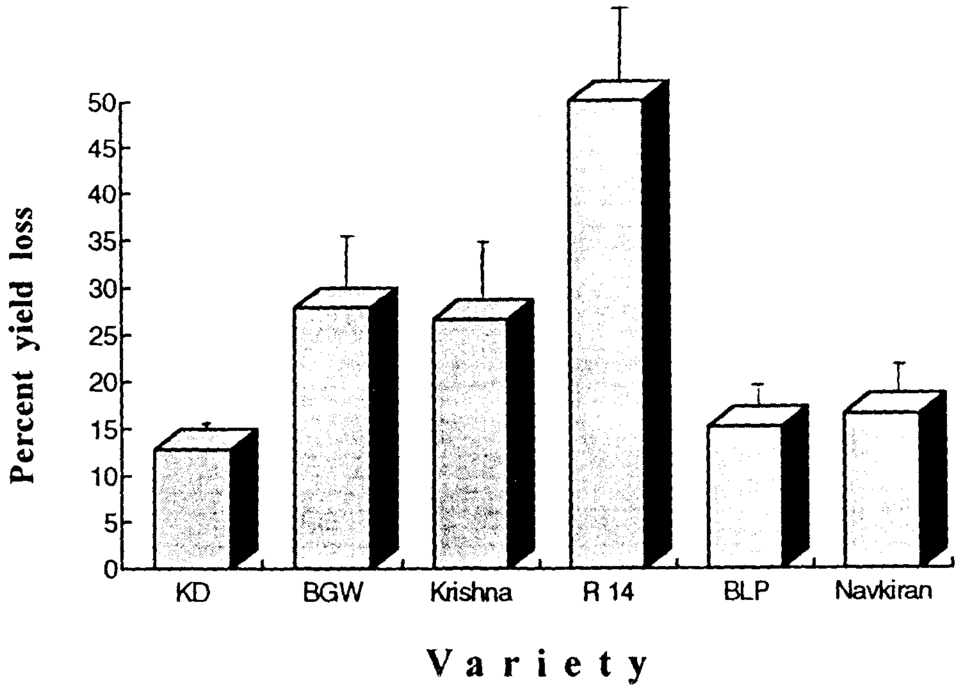


Fig. 44. **Performance of selected six varieties with respect to susceptibility (percent yield loss)**

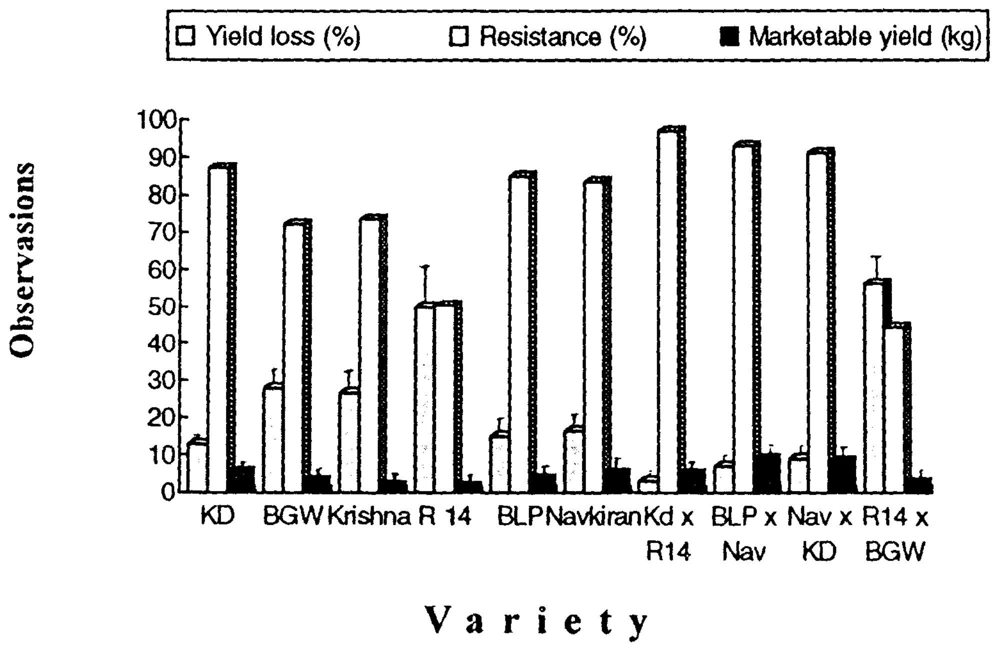


Fig. 45. **Performance of selected six parents and four hybrids with respect to % yield loss, resistance and marketable yield**

Fig. 44 shows the performance of six selected parents with respect to percent yield loss. The susceptable R-14 variety recorded the highest percent yield loss (49.80) and the resistant KD suffered a loss of 12.35% followed by BLP (15.06) and Navkiran (16.43).

Considering the performance of selected six parents and four hybrids with respect to percent yield loss, KD × R-14 hybrid showed the least percent yield loss among all the parents and hybrids (Fig. 45).

Some of the evolved and promising F_1 hybrids are shown in the photographs (Figs. 46-49).

Variability among the parents and hybrids :

Variability results are presented in Table 89 for all characters. The range of variation was 48.00 for R-14 parent and a high 95.00 for the Nababganj which is a check variety of Malda district of North Bengal with respect to plant height at first flowering. Phenotypic variance exhibited 146.97 while genotypic variance was 142.58 for this tested character. Coefficient of phenotypic and genotypic variations were observed 17.04 and 16.80 respectively. Heritability had very high value of 97.01 with genetic advance of 34.09.

Nababganj variety recorded maximum plant height even at the first harvesting stage (110 cm) and R-14 as shortest one (62.00 cm). Mean value was 88.55 cm for the 38 parents and the hybrids with standard error of $\pm$ 1.88. Phenotypic variance was 146.84 while the value 141.52 was for the genotypic variance. Coefficient of variation at phenotypic level was found to be 14.09 while it was 13.83 at genotypic level. Heritability estimates was 96.37% with 27.98 genetic advance as percent of mean.

No. of secondary br/pl → 14.00
No. of fruits/pl → 21.00
Total yield/pl (kg) → 7.00
Percent yield loss → 28.00

Fig. 46. BGW × Navkiran (F_1 hybrid)

No. of secondary br/pl → 12.00
No. of fruits/pl → 22.00
Total yield/pl (kg) → 5.96
Percent yield loss → 3.16

Fig. 47. KD × R-14 (F_1 hybrid)

No. of secondary br/pl → 15.00
No. of fruits/pl → 17.70
Total yield/pl (kg) → 8.80
Percent yield loss → 8.90

Fig. 48. Navkiran × KD (F_1 hybrid)

No. of secondary br/pl → 3.80
No. of fruits/pl → 8.33
Total yield/pl (kg) → 4.00
Percent yield loss → 56.00

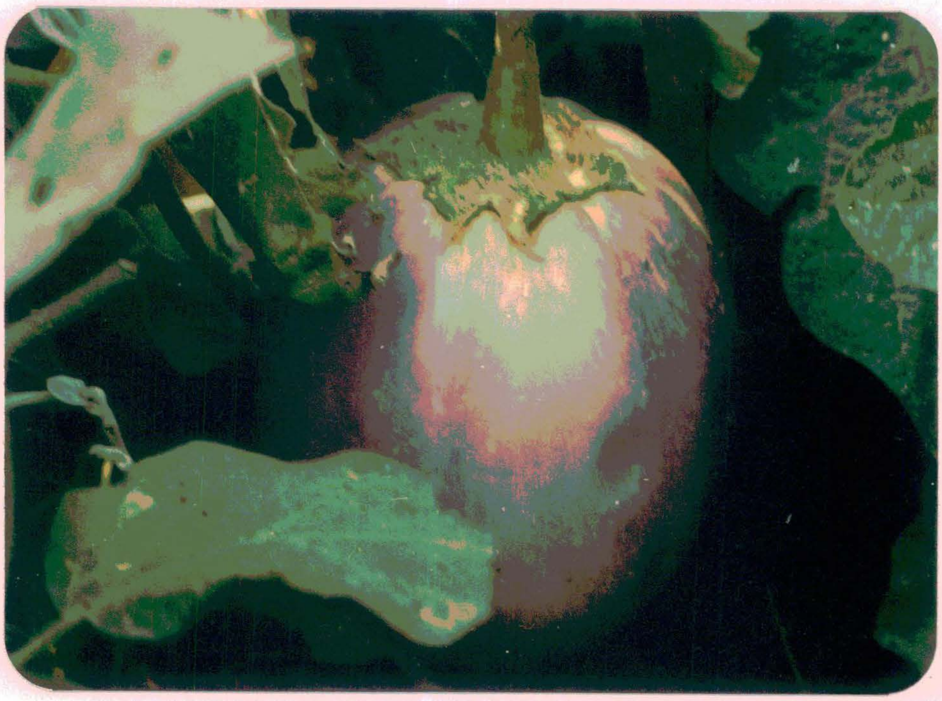


Fig. 49. R-14 × BGW (F_1 hybrid)

Number of primary branches/pl appeared to be the lowest of 1.00 in BGW and Krishna to BGW × Krishna hybrid. A higher value of 8.00 was observed in Navkiran × KD hybrid. Mean value recorded was 3.19 with ±0.33 standard error. Variance value was found to be less with 3.55 for PV and 3.17 for GV. The values for GCV and PCV were 55.94 and 57.38 respectively. Heritability estimates for this character was 95.04 with highest value of GA (112.35) among all the vegetative characters studied.

Number of secondary branches/pl showed a range of variation from 3.00 for BGW × Krishna hybrid to 16.00 for BLP × Krishna. Mean value was 10.48±0.82. PV and GV for this character were 24.10 and 23.08 respectively, while PCV and GCV were found to be 46.76 and 45.76 respectively. Heritability estimate recorded was 95.75 with 92.24% GA.

Days taken for flowering showed variation of 47.00 (BLP) to 90.00 (BLP × Navkiran). The range for maketable yield recorded was 1.73 kg (R-14 × Krishna) to 9 kg (BLP × Navkiran). All the characters showed higher value of PV than GV as general feature of variation. Estimates of heritability was the highest (99.18) for marketable yield with 79.75 GA as percent mean.

This data presented in Table 90 reveals a significant variability among the different reproductive components studied. Range of variation showed maximum for number of marketable fruits (3.33-55.00) followed by maximum circumference of fruit (10.66-45.00).

Maximum GV was exhibited by the test character number of marketable fruits/pl (141.32) followed by maximum circumference of fruit (92.41). Coefficient of variability was highest for average weight of fruit

(68.53%) at phenotypic level although it was highest for number of marketable fruits/pl (66.71) at genotypic level.

Heritability estimate recorded a maximum for the character number of marketable fruits/pl (98.93%) followed by total yield/pl (97.31%). GA was maximum (136.70) for the marketable fruits/pl while for the total yield/pl it was only 58.16%.

The data presented in the Table 91 indicates that a significant amount of variability was noticed among the tested susceptibility components for *L. orbonalis*. Variability range from 0.43 to 3.60 for larvae/pl, 0.10 to 3.00 for larvae/ft, 1.80 to 11.70 for number of holes/pl, 0.30 to 3.50 for holes/ft, 70.00 to 110.00 for days to borer attack on branches/pl, 5.12 to 50.00 for infested fruit/pl, and 3.16 to 56.00 for percent yield loss. Mean values for these 9 susceptibility characters calculated from all the parents and hybrids studied were, 1.31, 0.47, 4.16, 1.63, 94.05, 120.13, 7.62, 20.17 and 15.46, respectively.

Maximum GV was observed for the character percent yield loss (161.35%) followed by percent infested fruit (122.83%), while GCV showed maximum value (103.52) for the character larvae/ft and the least was 8.76% for days to borer attack on branches (8.76).

Heritability estimates showed a very high value for almost all the susceptibility components studied. But the GA was maximum for larvae/ft (213.09) followed by infested branches/pl (206.04).

Three levels of correlation and path analysis for parents and hybrids

For the vegetative characters :

Correlation matrix of some vegetative characters with marketable yield

Table 86. Range, mean value in parents and crosses and heterosis over better parent (BP) in brinjal with respect to some vegetative characters and yield

Parameter	Plant ht. at 1st flowering	Plant ht. at 1st harvesting	No. of primary branches/pl	No. of Secondary branches/pl	Days to flowering	Days from transplanting to picking	Marketable yield (kg/pl)
1. Range :							
a) Parents	48.00-90.00	62.00-99.00	1.00-5.64	3.00-15.00	47.00-76.00	77.00-100.00	1.86-5.60
b) F_1's	50.00-90.00	70.00-105.00	1.00-8.00	3.00-25.00	50.00-90.00	69.00-110.00	1.73-9.00
2. Mean Values :							
a) Parents	72.17	84.00	2.73	9.95	64.50	93.67	3.66
b) F_1's	72.40	85.03	4.03	10.55	63.43	87.13	4.68
3. Mean heterosis (%)	-3.79	2.23	22.52	5.95	-0.62	-9.58	27.89
4. Top Parent	Krishna	Krishna	Navkiran	BLP	BLP	BLP	Navkiran
5. Best F_1's	Navkiran × BGW	Navkiran × BGW	Navkiran × KD	BLP × Navkiran	BLP × KD	BLP × R-14	BLP × Navkiran
6. Significant heterotic crosses (%)	66.33	76.67	93.33	93.33	30.00	86.67	93.33
7. Range of heterosis(%)	-40.00 to 16.06	-14.11 to 32.35	-42.20 to 98.02	-66.67 to 72.41	-22.10 to 60.71	-25.39 to 27.91	-22.42 to 133.33
8. Maximum heterosis(%)							
a) Over BP.	7.14	21.62	41.84	66.67	38.46	15.79	83.82
b) Over Best Parent	0.00	6.60	41.84	66.67	-91.49	42.86	60.71

Table 87. **Range, mean value in parents and crosses and heterosis over better parent (BP) in brinjal with respect to some reproductive characters**

Parameter	Length of fruit (cm)	Max. circumference of fruits (cm)	Number of fruits/pl	Weight of fruits	Total yield/pl
1. Range :					
a) Parents	14.60—30.00	12.00—40.00	3.33—37.72	0.090—1.000	2.60—6.90
b) F_1's	12.00—30.00	10.66—42.00	5.06—55.00	0.100—1.160	3.00—9.80
2. Mean Values :					
a) Parents	20.15	28.06	16.31	0.380	4.93
b) F_1's	20.17	27.77	18.25	0.360	5.73
3. Mean heterosis (%)	-0.85	2.69	19.68	0.930	16.26
4. Top Parent	Krishna	BGW	BLP	BGW	Navkiran
5. Best F_1's	BLP × Krishna	BGW × R-14	R-14 × BLP	BGW × KD	BLP × Navkiran
6. Significant heterotic crosses (%)	93.33	100.00	100.00	93.33	96.67
7. Range of heterosis (%)	-28.57 to 32.98	-38.46 to 65.33	-73.08 to 246.63	-172.66 to 95.24	-25.56 to 92.75
8. Maximum heterosis (%)					
a) Over BP.	8.70	25.00	217.23	108.33	52.33
b) Over Best Parent	0.00	5.00	45.62	16.00	42.03

Table 88. Range, mean value in parents and crosses and heterosis over better parent (BP) in brinjal (*Solanum melongena* L.) with respect to some susceptibility components towards *L. orbonalis* attack during 1995-96

Parameter	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested branches/pl	Infested ft/pl	Yield loss (%)
1. Range :									
a) Parents	0.47—2.56	0.18—0.56	1.90—11.70	1.23—2.93	70.00—104.00	90.00—130.00	1.43—28.00	10.00—31.00	12.85—45.07
b) F_1's	0.43—2.70	0.15—1.30	1.80—10.60	0.30—3.50	80.00—110.00	90.00—122.00	1.43—27.00	5.12—36.00	3.16—56.00
2. Mean Values :									
a) Parents	1.38	0.37	4.84	0.59	91.00	114.50	9.66	23.37	24.65
b) F_1's	1.24	0.44	3.61	1.56	94.77	111.27	7.52	19.64	12.72
3. Mean heterosis (%)	-2.72	21.34	-17.23	-7.90	36.36	-4.05	0.71	-16.10	-13.47
4. Top Parent	BLP	BLP	BGW	BLP	R-14	R-14	Navkiran	Navkiran	KD
5. Best F_1's	BGW × BLP	BGW × BLP	BGW × KD	BLP × Navkiran	R-14 × BLP	R-14 × Krishna	R-14 × Navkiran	KD × R-14	KD × R-14
6. Significant heterotic crosses (%)	100.00	96.67	100.00	100.00	63.33	4.67	100.00	83.33	100.00
7. Range of heterosis (%)	-69.22 to 164.84	-58.97 to 215.79	-72.06 to 91.73	76.74 to 75.00	12.62 to 26.44	46.61 to 17.65	-82.68 to 270.37	-81.62 to 48.92	-89.09 to 59.26
8. Maximum heterosis (%)									
a) Over BP.	-32.00	105.26	-119.47	-75.61	13.46	16.67	-102.80	-79.00	-78.82
b) Over Best Parent	-8.51	16.67	5.26	-75.61	5.77	-3.94	0.00	-48.80	-75.41

Table 89. Mean, SE±, co-efficient of variability, heritability and genetic advance in 38 parent and hybrids of brinjal for some vegetative character

Characters	Range	Mean and SE±	Variance		Co-efficient of variation		Heritability (%)	Genetic Advance as (%) of Mean
			Phenotypic	Genotypic	Phenotypic(%)	Genotypic(%)		
	1	2	3	4	5	6	7	8
1. Plant height at first flowering	48.00-95.00	71.05±1.71	146.97	142.58	17.04	16.80	97.01	34.09
2. Plant height at first harvesting	62.00-110.00	88.55±1.88	146.84	141.52	14.09	13.83	96.37	27.98
3. Number of primary branches	1.00-8.00	3.19±0.33	3.33	3.17	57.38	55.94	95.04	112.35
4. Number of secondary branches	3.00-16.00	10.48±0.82	24.10	23.08	46.76	45.76	95.75	92.24
5. Days taken for flowering	47.00-90.00	64.74±5.05	160.15	121.82	19.70	17.18	76.06	30.88
6. Days taken from transplanting to first picking	70.00-115.00	86.71±1.62	131.83	127.87	13.26	13.06	96.99	26.49
7. Marketable yield/pl (Kg)	1.73-9.00	4.50±0.13	3.17	3.14	39.03	38.87	99.18	79.75

Table 90. Mean, SE±, co-efficient of variability, heritability and genetic advance in 38 parents and hybrids of brinjal for some reproductive characters during 1995-96

Characters	Range	Mean and SE±	Variance		Co-efficient of variation		Heritability (%)	Genetic Advance as (%) of Mean
			Phenotypic	Genotypic	Phenotypic(%)	Genotypic(%)		
	1	2	3	4	5	6	7	8
1. Fruit length (cm)	12.00-30.00	20.40±0.86	27.76	26.65	25.84	25.32	95.99	51.11
2. Fruit circumference (cm)	10.66-45.00	28.72±1.43	95.51	92.41	33.80	33.24	96.75	67.37
3. Number of marketable fruits	3.33-55.00	17.24±1.00	142.83	141.32	67.07	66.71	98.93	136.70
4. Average weight of fruit	0.120-1.160	0.38±0.09	0.06	0.05	68.53	62.03	81.92	115.66
5. Total yield/pl (Kg)	3.00-9.00	5.73±0.22	2.79	2.72	29.01	28.62	97.31	58.16

Table 91. Mean, SE±, co-efficient of variability, heritability and genetic advance in 38 parent and hybrids of brinjal for some susceptibility components during 1995-96

Characters	Range	Mean and SE±	Variance		Co-efficient of variation		Heritability	Genetic Advance
			Phenotypic	Genotypic	Phenotypic(%)	Genotypic(%)	(%)	as (%) of Mean
	1	2	3	4	5	6	7	8
1. Larvae/pl	0.43-3.60	1.31±0.03	0.74	0.73	65.60	65.50	99.70	134.73
2. Larvae/pl	0.10-3.00	0.47±0.01	0.2338	0.2335	103.59	103.51	99.85	213.09
3. Holes/pl	1.80-11.70	4.16±0.18	5.49	5.44	56.91	56.65	99.08	116.16
4. Holes/ft	0.30-3.50	1.63±0.04	0.49	0.48	43.11	42.95	99.25	88.16
5. Days to borer on branches	70.00-110.00	94.05±1.70	72.26	67.92	9.04	8.76	94.00	17.50
6. Days to borer on ft	90.00-130.00	120.13±2.37	114.21	105.72	9.52	9.16	92.56	18.16
7. Infested br./pl	1.25-28.00	7.62±0.70	62.90	62.15	101.23	100.62	98.80	206.04
8. Infested ft./pl	5.12-50.00	20.17±1.48	126.13	122.83	55.75	55.02	97.37	111.84
9. Yield loss (%)	3.16-56.00	15.46±1.10	163.18	161.35	56.74	56.42	98.88	115.57

during 1995-96 for 38 brinjal parents and their hybrids is presented in Table 92. The matrix was calculated at three levels of correlation, phenotypic, genotypic and environmental. The genotypic correlations in general were higher than the corresponding, phenotypic and environmental correlations. Plant height at first harvesting showed a high values both at genotypic (0.911) and phenotypic (0.879) level. Days to flowering exhibited high positive correlation, significant at 1% level with days taken from transplanting to picking both at genotypic (0.939) and phenotypic (0.806) level. Marketable yield/pl was highly correlated with number of secondary branches/pl both at genotypic (0.697) and phenotypic (0.677) level with statistically significance level at $P=0.01$.

The results of the genotypic, phenotypic and environmental path analysis are presented in Tables 93-95 respectively. The character days to flowering had a high positive and direct effect on genotypic level (0.612) followed by secondary branches/pl (0.581). Days taken from transplanting to picking showed high negative path association (-0.586) with marketable yield at genotypic level. (Table 93) . But phenotypic path co-efficient analysis revealed that secondary branches/pl had high positive direct effect (0.575) followed by plant height at first harvesting (0.336). Environmental path co-efficient analysis showed very low amount of direct effect on yield of marketable fruits.

Residual effects for genotypic, phenotypic and environmental path analysis were 0.508, 0.557 and 0.976 respectively.

For the reproductive characters :

Correlation co-efficients between different reproductive characters are shown in Table 96. The character fruit circumference showed high level of negative correlation at genotypic level (-0.513) with number of fruits/pl but a positive correlation with fruit weight (0.537) having the significance at 5% level. Phenotypic and enviromental correlation showed lower values for all the reproductive components tested.

Direct and indirect effect of reproductive characters on total yield of all the parents and hybrids during 1995-96 are presented in Tables 97-99. Fruit weight had high positive direct effect (0.561) on the total yield followed by number of fruits/pl (0.319). Other characters showed very lower value and as such residual effect was 0.882 at genotypic path analysis (Table 97). Similarly at phenotypic level fruit weight (0.443) followed by fruit number (0.273) showed positive direct effect but fruit length and circumference showed lower negative value of path coefficient with total yield of fruits in brinjal. Residual effect was 0.914 (Table 98). Environmental path analysis exhibited very low level of positive and negative direct impact on yield. Residual effect at environmental level of path anlysis registered very high value of 0.977 (Table 99)

For the susceptibility components :

Three levels of correlation coefficients are presented in Table 100. The character days to borer attack on branches had significant positive correlation with days to borer attack on fruit. The significant values were 0.702 at the genotypic level (p=0.01) and 0.660 at phenotypic level (p=0.05). Percent yield loss in brinjal had high correlation with the characters holes/ft and infested fruit/pl. Correlation coefficient registered at genotypic level for these characters were 0.674 and 0.864 and at phenotypic level were 0.666 and 0.852. Environmental correlation value in general was lower as compared with the genotypic and phenotypic correlation co-efficients.

Direct and indirect effect of some susceptibility components on percent yield loss of all the parents and hybrids of brinjal during 1995-96 are shown in Tables 101-103. Infested fruit/pl showed high positive direct effect (0.792) followed by holes/ft (0.211) and days to borer on fruit (0.201) at genotypic level. At phenotypic level of path analysis it was found that infested fruit/pl showed high positive direct effect (0.763) followed by larvae/ft (0.300), holes/ft (0.217) and days to borer attack on fruit (0.159). Environmental path showed very low level of positive and negative direct effects for all the susceptibility components excepting the trait larvae/ft which showed somehow comparatively higher value (0.421) among the pairs of characters examined.

Residual effect for genotypic, phenotypic and environmental path coefficients were 0.283, 0.319 and 0.860 respectively.

Table 92. **Correlation matrix of some vegetative characters with marketable yield during 1995-96 for 38 brinjal parents and hybrids**

Characters		Pl. ht at 1st flowering	Pl. ht at 1st harvesting	No. of primary br/pl	No. of secondary br/pl	Days to flowering	Days from transplanting to picking	Marketable yield (kg/pl)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plant ht. at 1st flowering	g	—	0.911[a]	0.155	-0.046	0.303	0.286	0.398
	p	—	0.879[a]	0.150	-0.034	0.263	0.276	0.392
	e	—	-0.071	0.020	0.299	0.037	-.0.44	0.096
Plant ht. at 1st harvesting	g	—	—	0.150	0.027	0.222	0.180	0.471
	p	—	—	0.142	0.027	0.209	0.175	0.460
	e	—	—	-0.023	0.017	0.203	0.040	-0.014
Number of primary br/pl	g	—	—	—	0.507	0.295	0.084	0.549
	p	—	—	—	0.480	0.250	0.080	0.533
	e	—	—	—	-0.018	-0.010	0.049	-0.006
Number of secondary br/pl	g	—	—	—	—	0.290	0.162	0.697[a]
	p	—	—	—	—	0.246	0.156	0.677[a]
	e	—	—	—	—	-0.011	0.015	-0.130
Days to flowering	g	—	—	—	—	—	0.939[a]	0.351
	p	—	—	—	—	—	0.806[a]	0.307
	e	—	—	—	—	—	-0.011	0.048
Days from transplanting to picking	g	—	—	—	—	—	—	0.176
	p	—	—	—	—	—	—	0.173
	e	—	—	—	—	—	—	0.075

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = Significant at 1% level
b = Significant at 5% level

Table 93. **Direct and indirect effect of some vegetative characters as yield components of 38 parents and hybrids of brinjal during 1995-96 (Genotypic path analysis)**

Characters	Pl. ht at 1st flowering	Pl. ht at 1st harvesting	No. of primary br/pl	No. of secondary br/pl	Days to flowering	Days from transplanting to picking	'g' with marketable yield (kg/pl)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Plant ht. at 1st flowering	*0.110*	0.288	0.009	-0.027	0.186	-0.168	0.398
2. Plant ht. at 1st harvesting	0.100	*0.316*	0.009	0.016	0.136	-0.106	0.471
3. Number of primary br/pl	0.017	0.047	*0.058*	0.295	0.181	-0.049	0..549
4. Number of secondary br/pl	-0.005	0.009	0.030	*0.581*	0.178	-0.095	0.697
5. Days to flowering	0.033	0.070	0.017	0.169	*0.612*	-0.551	0.351
6. Days from transplanting to picking	0.032	0.057	0.005	0.094	0.575	*-0.586*	0.176
7. Marketable yield	0.044	0.149	0.032	0.405	0.215	-0.103	

* Italicized diagonal values are direct effect

* Residual effect = 0.508

Table 94. **Direct and indirect effect of some vegetative characters as yield components of 38 parents and hybrids of brinjal during 1995-96 (Phenotypic path analysis)**

Characters	Pl. ht at 1st flowering	Pl. ht at 1st harvesting	No. of primary br/pl	No. of secondary br/pl	Days to flowering	Days from transplanting to picking	'p' with marketable yield (kg/pl)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Plant ht. at 1st flowering	*0.089*	0.295	0.026	-0.020	0.029	-0.029	0.392
2. Plant ht. at 1st harvesting	0.079	*0.336*	0.025	0.016	0.023	-0.018	0.460
3. Number of primary br/pl	0.013	0.048	*0.176*	0.276	0.028	-0.008	0.533
4. Number of secondary br/pl	-0.003	0.009	0.085	*0.575*	0.028	-0.016	-0.677
5. Days to flowering	0.024	0.070	0.044	0.141	*0.112*	-0.084	0.307
6. Days from transplanting to picking	0.025	0.059	0.014	0.090	0.090	*-0.105*	0.173
7. Marketable yield	0.035	0.154	0.094	0.389	0.034	-0.018	

* Italicized diagonal values are direct effect
* Residual effect = 0.508

Table 95. Direct and indirect effect of some vegetative characters as yield components of 38 parents and hybrids of brinjal during 1995-96 (Environmental path analysis)

Characters	Pl. ht at 1st flowering	Pl. ht at 1st harvesting	No. of primary br/pl	No. of secondary br/pl	Days to flowering	Days from transplanting to picking	'e' with marketable yield (kg/pl)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Plant ht. at 1st flowering	*0.150*	0.001	-0.000	-0.053	0.002	-0.004	-0.096
2. Plant ht. at 1st harvesting	-0.011	*-0.013*	0.000	-0.003	0.009	0.003	-0.014
3. Number of primary br/pl	0.003	0.000	*-0.016*	0.003	-0.000	0.004	-0.006
4. Number of secondary br/pl	0.045	-0.000	0.000	*-0.176*	-0.000	0.001	-0.130
5. Days to flowering	0.006	-0.003	0.000	0.002	*0.044*	-0.001	-0.048
6. Days from transplanting to picking	-0.007	-0.001	-0.001	-0.003	0.000	*0.086*	0.075
7. Marketable yield	0.014	0.000	0.000	0.023	0.002	0.006	

* Italicized diagonal values are direct effect

* Residual effect = 0.508

Table 96. **Correlation matrix of some reproductive characters with total yield of brinjal during 1995-96 for 38 parents and hybrids**

Characters		Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	Total yield (kg/pl)
	g	—	-0.211	0.168	0.070	-0.091
Fruit length	p	—	-0.196	0.159	0.057	-0.093
(cm)	e	—	0.196	-0.261	-0.064	-0.192
Fruit	g	—	—	-0.513[b]	0.537[b]	0.108
circumference	p	—	—	-0.502	0.477	0.104
(cm)	e	—	—	0.0004	-0.008	-0.046
Fruit	g	—	—	—	-0.493	0.046
number	p	—	—	—	-0.455	0.047
	e	—	—	—	-0.247	0.079
Fruit	g	—	—	—	—	0.351
weight	p	—	—	—	—	0.308
(kg)	e	—	—	—	—	-0.068

g = genotypic correlation

p = phenotypic correlation

e = environmental correlation

b = Significant at 5% level

Table 97. **Direct and indirect effect of reproductive characters on total yield of 38 parents and hybrids of brinjal during 1995-96 (Genotypic path analysis)**

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	'g' with total yield (kg/pl)
	(1)	(2)	(3)	(4)	(5)
1. Fruit length (cm)	***-0.199***	0.015	0.054	0.039	-0.091
2. Fruit circumference (cm)	0.042	***-0.071***	-0.164	0.301	0.108
3. Fruit number	-0.033	0.037	***0.319***	-0.276	0.046
4. Fruit weight (kg)	-0.014	-0.038	-0.157	***0.561***	0.351
5. Total yield (kg/pl)	0.018	-0.008	-0.015	0.197	

* Italicized diagonal values are direct effect

* Residual effect = 0.882

Table 98. **Direct and indirect effect of reproductive characters on total yield of 38 parents and hybrids of brinjal during 1995-96 (Phenotypic path analysis)**

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	'p' with total yield (kg/pl)
	(1)	(2)	(3)	(4)	(5)
1. Fruit length (cm)	*-0.163*	0.000	0.043	0.025	-0.094
2. Fruit circumference (cm)	0.032	*-0.002*	-0.137	0.211	0.104
3. Fruit number	-0.026	0.001	*0.273*	-0.201	0.047
4. Fruit weight (kg)	-0.009	-0.001	-0.124	*0.443*	0.308
5. Total yield (kg/pl)	0.015	-0.00	0.013	0.136	

* Italicized diagonal values are direct effect

* Residual effect = 0.882

Table 99. Direct and indirect effect of reproductive characters on total yield of 38 parents and hybrids of brinjal during 1995-96 (Environmental path analysis)

Characters	Fruit length (cm)	Fruit circumference (cm)	Fruit number	Fruit weight (kg)	'e' with total Yield (kg/pl)
	(1)	(2)	(3)	(4)	(5)
1. Fruit length (cm)	*-0.199*	0.015	0.054	0.039	-0.091
2. Fruit circum-ference (cm)	-0.039	*-0.008*	0.000	0.001	-0.046
3. Fruit number	0.052	-0.000	*0.008*	0.019	0.079
4. Fruit weight (kg)	0.013	0.000	-0.002	*-0.079*	-0.068
5. Total yield (kg/pl.)	0.039	0.000	0.001	0.005	

* Italicized diagonal values are direct effect

* Residual effect = 0.977

Table 100. **Correlation matrix for some susceptibility components on yield loss in brinjal during 1995-96 for 38 parents and hybrids**

Characters		Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested branches/pl	Infested ft./pl	Yield loss (%)
Larvae/pl	g	—	0.363	0.470	0.568	0.539	0.260	0.093	0.458	0.464
	p	—	0.362	0.468	0.566	0.521	0.248	0.093	0.453	0.461
	e	—	-0.004	0.201	0.136	-0.051	-0.075	-0.173	0.106	-0.024
Larvae/ft	g		—	-0.008	0.496	0.149	0.049	0.155	0.143	0.483
	p		—	-0.010	0.494	0.144	0.048	0.154	0.141	0.482
	e		—	-0.081	-0.153	-0.047	0.097	0.121	-0.043	0.433
Holes/pl	g			—	0.607	0.270	0.461	-0.164	0.447	0.417
	p			—	0.602	0.263	0.441	-0.162	0.441	0.412
	e			—	0.068	0.118	-0.028	0.040	0.108	-0.074
Holes/ft	g				—	0.177	0.233	0.008	0.486	0.674[a]
	p				—	0.173	0.226	0.008	0.476	0.666[b]
	e				—	0.071	0.109	-0.080	0.029	-0.100
Days to borer on branches	g					—	0.702[a]	0.016	0.147	0.160
	p					—	0.660[b]	0.019	0.141	0.153
	g					—	0.069	0.137	0.023	-0.057
Days to borer on fruit	g						—	-0.168	0.079	0.186
	p						—	-0.163	0.076	0.178
	e						—	-0.076	0.007	-0.0007
Infested br/pl	g							—	0.411	0.350
	p							—	0.403	0.348
	e							—	-0.001	0.171
Infested fruit/pl	g								—	0.864[a]
	p								—	0.852[a]
	e								—	0.201

g = genotypic correlation
p = phenotypic correlation
e = environmental correlation

a = Significant at 1% level
b = Significant at 5% level

Table 101. **Direct and indirect effect of some susceptibility components on yield loss of 38 parents and hybrids of brinjal during 1995-96 (Genotypic path analysis)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested branches/pl	Infested ft./pl	'g' with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	***-0.077***	0.108	-0.041	0.120	-0.062	0.052	0.000	0.063	0.464
2. Larvae/ft	-0.028	***0.299***	0.001	0.105	-0.017	0.010	0.001	0.113	0.483
3. Holes/pl	-0.036	-0.003	***-0.087***	0.128	-0.031	0.093	-0.001	0.354	0.417
4. Holes/ft	-0.044	0.148	-0.053	***0.211***	-0.020	0.047	0.000	0.385	0.674
5. Days to borer on branches	-0.042	0.045	-0.024	0.037	***-0.114***	0.141	0.000	0.116	0.160
6. Days to borer on ft	-0.020	0.015	-0.040	0.049	-0.080	***0.201***	-0.001	0.063	0.186
7. Infested br./pl	-0.007	0.046	0.014	0.002	-0.002	-0.034	***0.005***	0.325	0.350
8. Infested ft./pl	-0.035	0.043	-0.039	0.103	-0.017	0.016	0.002	***0.792***	0.864
9. Yield loss (%)	-0.036	0.144	-0.036	0.142	-0.018	0.037	0.002	0.684	

* Italicized diagonal values represent direct effect

* Residual effect = 0.283

Table 102. **Direct and indirect effect of some susceptibility components on yield loss of 38 parents and hybrids of brinjal during 1995-96 (Phenotypic path analysis)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested branches/pl	Infested ft./pl	'p' with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	***-0.090***	0.109	-0.026	0.123	-0.041	0.039	0.002	0.346	0.461
2. Larvae/ft	-0.032	***0.300***	0.001	0.107	-0.011	0.008	0.003	0.108	0.482
3. Holes/pl	-0.042	-0.003	***-0.056***	0.130	-0.021	0.070	-0.003	0.337	0.412
4. Holes/ft	-0.051	0.148	-0.034	***0.217***	-0.014	0.036	0.000	0.363	0.666
5. Days to borer on branches	-0.047	0.043	-0.015	0.037	***-0.079***	0.105	0.000	0.108	0.153
6. Days to borer on ft	-0.022	0.014	-0.025	0.049	-0.052	***0.159***	-0.003	0.058	0.178
7. Infested br./pl	-0.008	0.046	0.009	0.002	-0.002	-0.026	***0.019***	0.308	0.348
8. Infested ft./pl	-0.041	0.042	-0.025	0.103	-0.011	0.012	0.008	***0.763***	0.852
9. Yield loss (%)	-0.041	0.145	-0.023	0.144	-0.012	0.028	0.007	0.650	

* Italicized diagonal values represent direct effect

* Residual effect = 0.283

Table 103. **Direct and indirect effect of some susceptibility components on yield loss of 38 parents and hybrids of brinjal during 1995-96 (Environmental path analysis)**

Characters	Larvae/pl	Larvae/ft	Holes/pl	Holes/ft	Days to borer on branches	Days to borer on fruit	Infested branches/pl	Infested ft./pl	'e' with yield loss
	1	2	3	4	5	6	7	8	9
1. Larvae/pl	*-0.015*	-0.002	-0.012	-0.003	0.003	0.002	0.021	0.024	-0.024
2. Larvae/ft	0.000	*0.421*	0.005	0.003	0.002	-0.003	0.015	0.010	0.433
3. Holes/pl	-0.003	-0.034	*-0.060*	-0.001	-0.006	0.001	0.005	0.025	-0.074
4. Holes/ft	-0.002	-0.064	-0.004	*-0.019*	-0.004	-0.003	-0.010	0.007	-0.100
5. Days to borer on branches	-0.001	-0.020	-0.007	-0.001	*-0.050*	-0.002	0.017	0.005	-0.057
6. Days to borer on ft	0.001	0.041	0.002	-0.002	-0.003	*-0.031*	-0.009	0.002	-0.001
7. Infested br./pl	0.003	0.051	-0.002	0.002	-0.007	0.002	*-0.123*	-0.000	0.171
8. Infested ft./pl	-0.002	-0.018	-0.007	-0.001	-0.001	-0.000	-0.000	*0.229*	0.201
9. Yield loss (%)	-0.000	0.182	0.004	0.002	0.003	0.000	0.021	0.046	—

* Italicized diagonal values represent direct effect
* Residual effect = 0.283

5. DISCUSSION

5.1. Screening of *Solanum melongena* against four major insect pests

5.1.1. Screening for resistance to *Leucinodes orbonalis* as a fruit borer :

The damage index has been generally more during 1991-92 on weight basis than on number basis despite there are some overlappings. The findings agrees with the results of Lal *et al.* (1976).

Contrary to the result of 1991-92, in the subsequent year (1992-93) susceptible reaction is found to be more as is evident from the Tables 6 and 7. The varieties R-14, Sufal, Pusa Purple Round, Rajkrishna, Pyratuni, Krishnanagar Hybrid Variety '90, KB-2 are highly susceptible both on number and weight basis.

It is clear from the observations that the varieties NIL, Nurki, Shyamla Dhepa, Kalo Dhepa, IR-8- Baramasi, BLP, BB_1, Murshidabad Local and Navkiran possess fairly resistance characters against *L. orbonalis*. Panda *et al.* (1971) and Lal *et al.* (1976) have reported that Pusa Purple Round, Pusa Purple Long, PPC and Black Beauty are susceptible to the shoot and fruit borer *L. orbonalis* which is in agreement with the present finding (Tables 6 and 7).

A general fact revealed from the summarised data in Tables 6 and 7 is that the Indo-American hybrids (R-14, L-13 and Sufal) are usually highly susceptible to this pest. This finding of susceptibility corroborates the earlier observation of *Subbaratnam et al.* (1981), Mandal *et al.* (1994, 1995).

Panda *et al.* (1971) have reported that Muktakeshi suffers more than 40% damage even during winter months and is to be considered under susceptible grade. This grading is corroborated by the present findings on the varietal performance. On the basis of fruit number, PPC appears to be tolerant, although susceptible on weight basis. Such variable tolerance reaction was also reported by Dhankhar *et al.* (1977) from Haryana and Subbaratnam *et al.* (1981) from New Delhi. On the other hand Lal *et al.* (1976) have made a report on the PPC cultivar from Himachal Pradesh showing variation from fairly resistant to tolerant on number and weight bases respectively. Such differences may be due to the local agroclimatic influence at different experimental locations and also during different years. Nevertheless, most of the authors reported tolerance of this variety from different localities emphasizing a sound genetic basis of the cultivar for tolerance.

An analysis of the present data reveals the fact that PPL, PPR and Indo-American hybrids show susceptible to highly susceptible reaction to the insect pest. This is in agreement with the findings Panda *et al.* (1971), Lal *et al.* (1976) and Subbaratnam *et al.* (1981). Despite climatic variation, similar observation on the susceptibility gives a possible indication of a genetic basis for lack of resistance of the concerned varieties.

While the variety Nurki is recorded as fairly resistant under North Bengal climate both on number and weight bases, it has been found to be highly susceptible under the climatic conditions of Himachal Pradesh (Lal *et al.*, 1976) in Western India.

***L. orbonalis* as a shoot borer :**

Grade index of Subbaratnam *et al.* (1981) was used for measuring the degree of shoot borer infestation in different cultivars of brinjal. The perusal of the data presented in Table 9, clearly indicated the variance in the degree of resistance or tolerance towards the borer pest and as such relative susceptibility reaction was graded into tolerant, moderately tolerant, susceptible and highly susceptible groups.

The variation in the relative susceptibility of the cultivars may depend on the physical, chemical and genotypic variations which cause differential ovipositional preferences by the shoot borer (Panda and Das, 1974). Generally, the dense pubescent varieties have long, tuft and erect trichomes on the leaf surface which are disadvantageous both for ovipositing moths and the young hatching larvae. On the dense pubescent varieties, the just-hatched larvae can hardly reach the normal boring site (apical shoot) as a result of which they perish on the way. Thorny varieties are also less preferred by moths for egg laying (Panda and Das, 1974).

5.1.2. Screening for resistance to jassid, aphid and spotted leaf beetle :

In the present investigation Pusa Kranti has shown moderate tolerance. A number of workers have also reported field resistance of some varieties including Pusa Kranti to jassid attack (Mote, 1978; Bindra and Mahal, 1981; Subbaratnam and Butani, 1981; Mote, 1982 and Subbaratnam *et al.*, 1983).

Grade indexing after Subbaratnam *et al.* (1981) as shown in Table 9 and also the analysis of variance for relative susceptibility to major insect pests (Table 8) have shown significant variation among the 41 genotypes screened for jassids, aphids and spotted leaf beetle.

The different category of susceptibility of the brinjal cultivars to the degree of attack of these pests observed even in the same season might be related to the different resistance factors. The notable physical factors might be the hairiness, the density of hairs, trichomes, offering resistance against these pests (Subbaratnam *et al.,* 1983). Inheritence of hairiness and other characters associated with jassid resistance in American cotton is also reported by Bhat *et al.* (1982).

There have been slight variation in the population dynamics and incidence of the insect-pests during 1991-92 and 1992-93, which apparently seems to be due to the differences in weather conditions during the crop growing season. Temperature, relative humidity and rainfall were different in the two years of observation. The differences are expected to have variable influence on the egg plant varieties and hence, the differential incidence of the insect pests. Such findings are evident also from the observations of Mall *et al.* (1991) regarding the influence of climatological factors on the incidence of these pests on brinjal. Moreover, it is probable that the biochemical basis of host resistance also plays a part in conferring high or fair resistance in the concerned varieties with respect to pest species. Such a basis of resistance in brinjal to insect pests have already been studied and established by Bajaj *et al.* (1989) and some other workers.

Mean performance for 41 cultivars (as referred in Tables for their sequences) with respect to relative susceptibility and yield attributes are clearly presented graphically (Fig. 32-34). In most of the varieties the highest range of variation (80.84-136.17) for days to borer attack in fruit and the lowest range of variation for larvae/ft as observed are similar to those documented by Dhankhar *et al.* (1977). These authors further have reported that percent infested fruits in normal crop and days to borer attack on fruits in ratoon crop of brinjal exhibit the highest range of variation. Considering the yield attributes as well as susceptibility to the pest, Kalo Dhepa, Shyamla Dhepa and Navkiran may be recommended for profitable cultivation in the agro-environment of the terai region of North Bengal, even without any obligation for pesticidal treatment.

5.2. Variability studies

5.2.1. Variability for some important vegetative characters :

The data presented in Table 19 indicates a narrow difference between phenotypic and genotypic coefficients of variation for the characters like plant height at first flowering, plant height at first harvesting, number of secondary branches/pl, days to flowering and days taken from transplanting to first picking of fruits along with marketable yield/pl. Such a situation becomes apparent when environmental influence is minimal on the expression of these characters. This suggest that the genetic variability contributes largely to the total variances, and therefore, the genetic variability of the selected cultivars opens-up ample scope for effective improvement through breeding.

Higher estimates of phenotypic and genotypic coefficients of variation have been obtained for number of primary and secondary branches/pl. Similar results have also been reported by Kabir and Som (1993) in brinjal.

Heritability indicates the accuracy with which genotype can be identified by its phenotypic performance. Although the GCV and heritability (in broader sense) are not sufficient to determine the amount of variation (Burton, 1952). The amount of heritable variation can be determined with greater accuracy when heritability along with genetic advance is studied. In the present study, genetic gain was high for number of secondary branches and number of primary branches/pl.

Selection of individual plants based on number of secondary branches/ pl and marketable yield which showed high genotypic coefficient of variation, heritability and genetic advance might, therefore, be effective for improvement in brinjal.

5.2.2. Variability for some reproductive characters :

Results (Table 20) reveal a wide range of variation for all the tested reproductive components which agree with the findings of Singh *et al.* (1974) and Kabir and Som (1992).

Narrow difference between phenotypic and genotypic coefficients of variation has been noticed for fruit circumference, number of marketable fruits/pl and total yield/pl during 1992-93. This implies less environmental interference on the expression of these characters. This again, suggests that major contribution of genetic variability towards the total variance providing ample scope for effective improvement. Higher estimates of GCV and PCV have been obtained for the number of marketable fruits/pl and average weight of fruit. The results corroborate the findings of Mandal and Dana (1992), Kabir and Som (1993) and Bora and Shadeque (1993) in brinjal crop and Anuradha and Gowda (1990) in Gladiolus.

Number of marketable fruit/pl, average weight of fruit and total yield/pl have shown higher estimates of heritability and genetic advance corroborating the findings of Singh *et al.* (1974). As GCV and heritability (in broader sense) are not sufficient to determine the amount of heritable variation which can be determined with greater accuracy when heritability along with genetic advance is studied. Hence, for further breeding programme, due consideration has to be given on these reproductive components for successful prediction in future breeding programme, atleast for these economic attributes.

5.2.3. Susceptibility components towards the attack of *L. orbonalis* :

Higher value of phenotypic variance (PV) as compared to the genotypic variance (GV) have been expressed by all the host characters. Similarly, phenotypic co-efficients of variability (PCV) have shown higher value than the genotypic co-efficients of variability (GCV). This has been a general trend of expression as evident from the Table 21 and agrees with the findings of Dhankhar *et al.* (1977) for these characters.

High heritability has been recorded for all the test-characters considered. Heritability estimates combined with high genetic advance are more useful in eliminating the susceptible varieties, otherwise selecting the best cultivar.

Result suggests that genotypic variation, in the present cultivars for these characters is probably due to a high additive genetic effects. Therefore, the selection on phenotypic basis for these characters backed by high heritability and genetic advance would be more effective in achieving desired results by employing suitable plant breeding methods.

5.3. Correlation and path analysis

5.3.1. Correlation co-efficient of some vegetative characters with marketable yield in brinjal :

Phenotypic, genotypic and environmental correlation coefficients for vegetative characters are given in the Tables 22 and 23 respectively for both the years of study. Results reveal that plant height at first flowering is associated significantly positively with the plant height at first harvesting, number of primary branches, number of secondary branches and marketable yield in brinjal. This may be concluded that the first flowering stage is the full vegetative or transitional phase when the plants enter into the reproductive stage. In this study the primary branches show positive correlation with the secondary branches during both the years of observation from the view point of genotypic and phenotypic correlations. This might be due to better accumulation of carbohydrate with in the plant. Number of primary branches enhances the number of secondary branches. This positive correlation may be due to the better photosynthetic activity of the plant.

Marketable yield/pl has highly significant positive genotypic association with the plant height, and number of secondary branches/pl and negative association with the days to 50% flowering, at both genotypic and phenotypic levels during 1992-93 (Table 23). This association is quite in agreement with the findings of Mandal and Dana (1992). The plant height at the first flowering shows a positive correlation at both genotypic and phenotypic levels with the marketable yield during both the years of observation. This may be due to the better fruit setting from the flowers of first flowering and may be also due to the translocation of metabolite from source to sink zone. Number of secondary branches also shows a positive correlation with the marketable yield. This may be concluded that the higher number of primary branches and secondary branches increase the number of flowers and ultimately cause positive effect on yield. Asna *et al.* (1988) have also provided a similar explanation for the solanaceous minor fruit, cape goose berry (*Physalis peruviana L.*). Earlier reports of significant positive correlations of yield/pl with plant height (Sinha, 1983; Sharma *et al.*, 1985) and with the number of branches/pl (Srivastava and Sachan, 1973; Sinha, 1983) are corroborative from the present observation.

From the above discussion it could be concluded that, selection criteria based on number of primary and secondary branches and plant height at first flowering can give a better success for improvement of fruit yield. Breeding for such plant type can be achieved for maximum selection pressure for these characters.

Path analysis for vegetative characters (genotypic level) :

In the Table 24 the correlations between yield on one hand and the various characters on the other have been partitioned into direct and indirect effects.

If the correlation coefficient between a causal factor and the effect is almost equal to its direct effect, then correlation explains the true relationship and a direct selection through this trait will be effective. In this case the secondary branches/pl account for direct effect on yield (0.604) almost to the total correlation (0.635). So, the varieties having more number of secondary branches should be selected for better yield.

If the correlation coefficient is positive but direct effect is negative or negligible, the indirect effect seems to be the cause of correlation. In such situation indirect causal factors are to be considered simultaneously for selection. In this case plant height at first harvesting (- 0.221), primary branches/pl (- 0.037) and days to flowering (- 0.042) had negative direct effect but positive correlations viz. 0.215, 0.262 and 0.019 respectively.

Direct and indirect effects of different vegetative parameters are indicated in the Table 25 during 1992-93 observation.

Almost similar results have been obtained in respect of secondary branches/pl. Plant height at first flowering and plant height at first harvesting, suggesting that these characters are to be included while selecting the plant type.

Residual effect is also very high during 1992-93 (0.739) indicating a similar trend of observation during both the years. This suggests that before conclusion additional number of other characters may be included in the study.

Slight variation among the vegetative characters of the 41 cultivars might be due to environmental factors although observations remains similar in both the years.

Correlation coefficient may be negative but the direct effect is positive and high. Under these circumstances, a restricted simultaneous selection model has to be followed, i.e. restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effect (Singh and Kakar, 1977). Here in case of days taken from transplanting to picking had very negligible but positive direct effect (0.089) with negative (-0.056) total correlation with marketable yield.

The residual effect (0.739) determines how best the causal factors account for the variability of the dependent factor, the yield in this case. Its estimate being 0.739, the independent variables explain only 27% of the variability in yield. The reason seem to be very low and non-significant correlations of days to flowering, days from transplanting to picking and plant height at first harvesting.

Path analysis for some vegetative characters (phenotypic level) :

Path analysis for some vegetative characters at phenotypic level is presented for 1991-92 and 1992-93 in the Tables 26 and 27 respectively. Maximum direct negative effect was observed for the characters days taken from transplanting to picking (-1.941), and plant height at first flowering (-0.906) during 1991-92. Maximum positive direct effect has been expressed by days to flowering followed by secondary branches/pl, and plant height at first harvesting. Similar results have also been observed during 1992-93 (Table 27) in respect of secondary branches/pl where direct effect (0.727) and phenotypic correlation with marketable yield have been of highest value (0.742). It may, therefore, be suggested that for selection of high fruit yield in brinjal, days to flowering, and number of secondary branches/pl will have to be considered as the effective morphological characters.

In the present study the residual effect was only 0.241 during 1991-92. This implies that the remaining characters to be included in the study had negligible effect on yield. Residual effect is quite high during 1992-93 (0.635) indicating that other characters have to be included while predicting yield potential. This is in contrary to the earlier results and might be due to slight variation in the edaphic characters and meteorological parameters.

Path analysis for some vegetative characters (environmental level) :

From Table 28, it is evident that the correlations between yield on one hand and the various characters on the other, have been partitioned into direct and indirect effects at environmental level. Direct effects for all the characters studied have been negligible which implies only negligible environmental effect. On the other hand residual effect is very high suggesting a non-significant correlation of the characters on yield for both the years of study during 1991-1992 (Table 28) and 1992-93 (Table 29).

Correlation coefficient of some reproductive characters with total yield :

Correlation matrix for some reproductive characters are presented in Tables 30 and 31 for the years 1991-92 and 1992-93 respectively. The results show that fruit length, fruit circumference, fruit number and fruit weight have a positive correlation with the total yield of brinjal. Thus, it appears that increase in any one of the above mentioned characters would increase the yield. This is true for both the years of observation and at both genotypic and phenotypic levels. The yield components exhibit varying trend of association among themselves. Number of fruits/pl shows a significant negative correlation with the fruit diameter indicating that factors favouring lower fruit diameter would increase the number of fruit/pl

(Khurana *et al.,* 1988). That the number of fruit/pl has a significant positive correlation with the yield of the plant (Sinha, 1983) is corroborated in the present finding. Sharma *et al.* (1985) and Mandal and Dana (1992) have reported that the fruit diameter or circumference do not show significant correlation with the yield but in the present study fruit diameter has been found to be positively correlated with total yield of the crop. Further the study reveals that the relationship between yield and number of fruit is positive which does not agree with the findings of Singh (1984) and Khurana *et al.* (1988). This discrepancy between the results of different workers may be attributed to the different germplasm used and the environmental conditions under which the studies were carried out.

Tables 30 and 31 show that the fruit length, fruit circumference, fruit number and fruit weight have positive influence/effect on the total yield in brinjal. Thus, it appears that increase in any one of the above mentioned characters will increase the yield. Therefore, for selection of plant type, these characters may also be important traits along with others.

Genotypic path analysis for some reproductive character :

Partitioning of genotypic correlation coefficient (Tables 32 and 33) into direct and indirect effects reveals that only number of fruits/pl has a high positive direct effect (0.686 and 0.772 respectively for 1991-92 and 1992-93) on total yield in brinjal followed by fruit weight (0.399 and 0.495 for 1991-92 and 1992-93 respectively). Besides these, fruit length and circumference have also moderate positive effect.

Thus, it can be concluded that in the improvement of fruit yield in egg plant, emphasis should be given to the selection of plants with high value of fruit number, coupled with weight, length, and circumference.

Phenotypic path analysis for some reproductive characters :

Tables 34 and 35 show that significant positive association of characters exists specially in respect of fruit number, fruit weight, followed by fruit circumference and length for both the years of study. Thus, it can be suggested that for improvement of yield, due consideration should be given on these reproductive parameters along with other characters.

Variations in the characters between the observations of two years might be due to environmental fluctuations.

Environmental path coefficients for some reproductive characters

Environmental path coefficient for both the years are presented in the Tables 36 and 37. Variation from positive direct effect to negative one might be due to abiotic factors during experimentation. But the high residual effects in both the years indicate that the environmental impact is minimum.

Correlation with some susceptibility components and percent yield loss :

Correlation matrix presented in Tables 38 and 39 reveals that all the susceptibility components studied viz. larvae/pl, larvae/ft, holes/ft, holes/pl, infested branches/pl and infested fruit/pl have significant positive correlation with the percent yield loss in brinjal at genotypic level for both the years of study. So, while selecting plant type, these characters have to be considered for resistant genotype identification.

Varying results have been obtained for different susceptibility components among themselves with respect to percent yield loss. Larvae/pl indicates very significant positive correlation with larvae/ft, holes/pl, holes/ft, infested branches/pl and infested fruit/pl and also with loss in yield for the observations in both the years. This positive relation may be implicated to more number of pest population and consumption of fruits by them through the breeding of more and more cycles of pests for infestation. Yield loss is greater due to higher number of larvae/ft which causes maximum infestation to the edible fruit leading to production of unmarketable fruit. While selecting resistant plant type these susceptibility components will have to be considered.

Genotypic path analysis for some susceptibility components towards *L. orbonalis* attack in brinjal with yield loss

Table 40 on partitioning of different susceptible components into direct and indirect effect reveals that excepting the days taken to borer attack on fruit and infested fruit/pl all the characters like larvae/pl, larvae/ft, holes/pl, holes/ft, days to borer attack on branches and infested branches/pl have positive direct effect with the loss in production of edible fruit during 1991-92. Although all the characters studied have positively related to yield loss but days taken to borer attack on branches as well as on fruit is negatively correlated at genotypic level. Although direct effect of days to borer attack on branches is positive but the genotypic correlation with loss of yield is negative due to negative indirect effect via larvae/pl, larvae/ft, holes/pl, holes/ft, days to borer attack on fruit, and infested branches/pl, which suggested that genotypes with lower value of the days taken for borer attack on branches i.e. the attack at early stage of the crop growth phase, plays an important role for increasing the number of fruits/pl and thereby yield in brinjal.

Direct and indirect effects of the susceptible components during 1992-93 (Table 41) reveals that almost all the characters are positively related to the loss in yield. Negative direct effect on yield loss has been recorded against larvae/pl, holes/pl, and infested branches/pl which has enhanced marketable yield in brinjal. This might be due to reduction of apical growth and enhancement of secondary branches leading to better yield.

Residual effect was 0.54 for both the years of study, suggesting that the other susceptibility components have to be included before drawing a conclusion.

Phenotypic path analysis of some susceptibility components of *L. orbonalis* attack with yield loss in brinjal :

The Table 42 indicates that larvae/pl, holes/pl, and days to borer attack on fruit, infested branches/pl, infested fruit/pl had negative direct effect on yield loss while larvae/ft, holes/ft and days to borer attack on branches had some amount of positive direct effect. Although negative phenotypic correlation exhibited by holes/pl, holes/ft, days to borer attack on fruit, infested branches/pl and infested fruit/pl positive correlation exists simultaneously for the larvae/pl and larvae/ft along with the parameters days to borer attack on branches during 1991-92.

On the contrary, during 1992-93 (Table 43) significant positive phenotypic correlations have been recorded for all the characters having direct positive effect on yield loss excepting the days to borer attack on fruit where direct effect is negative (-0.011).

Variations in the observation of different seasons might be related to environmental fluctuations.

Residual effect during 1991-92 has been 0.964 while in 1992-93 it has been 0.623, suggesting very a low contribution of phenotypic effect.

Path analysis at environmental level for some susceptibility components of *L. orbonalis* with loss in yield :

Direct and indirect environmental paths indicate that for both the years of observations (Tables 44 and 45) positive effect is exhibited for the components larvae/pl and days to borer attack on branches. On the other hand, both negative and positive effects are expressed for other characters at insignificant level. Such variations, again, may be attributed to the environmental factors.

Residual effect is very high 0.974 (1991-92) and 0.888 (1992-93) indicating a very low level of influence by the environmental fluctuations, if any.

5.4. Genetic divergence :

Present study reveals that during 1991-92 (Fig. 36) marketable yield, primary branches and fruit weight have contributed largely towards the divergence. But during 1992-93 (Fig.37), primary branches/pl, fruit weight, larvae/ft and days taken to flowering have contributed to the maximum for the total divergence among the 41 genotypes of brinjal screened. The degree of contribution has been marketable yield (70.6%) followed by fruit weight (28.1%) during 1991-92 while of primary branches/pl (52.5%) followed by fruit weight (28.2%) and number of larvae/ft (17.9%) during 1992-93. Contribution of fruit weight towards total divergence has also been reported by Abdul Vahab *et al.* (1994) in okra.

Hence, for selecting genetically divergent parents for hybridization, these characters demand for due consideration. From the study, it is apparent that choice of parents for any breeding programme need not necessarily be based on source of origin. Factors other than geographical origin such as genetic drift, and selection intensity could be responsible for genetic diversity. However, geographical isolation can alter genetic set up of the population (Wallace, 1963).

The 41 genotypes have been grouped into 4 clusters (Tables 46 and 49) on the basis of D^2 values, such that varieties belonging to one cluster have on an average smaller D^2 values than those belonging to the other clusters.

Interestingly, the lines collected from different sources and hybrid parents have also been included in the same cluster which reveals that geographic distance need not necessarily be related to genetic divergence (Murty *et al.*, 1966; Singh and Gupta, 1979; and Hazra *et al.*, 1993; Abdul Vahab *et al.*, 1994). Consequently it is suggested that selection of parents for hybridization or in other crop improvement need not necessarily be based on geographical diversity alone but genetic diversity must form the sound base for selection. The relationship between genetic diversity as measured by D^2 statistics and geographic diversity warrants a discussion. Geographic diversity may result from the interaction of agroclimatic conditions and natural selection. Rapid ecotype differentiation may occur in out breeding species even in the absence of reproductive isolation. Murty *et al.* (1965) expressed the view that human selection would help to intensify ecotype formation while Somayujulu *et al.* (1970) stated that it would result in erosion of genetic diversity. However, it may be possible that by hybridizing materials from different sources, the correlation between genetic and geographic diversity can be broken.

A comparision of inter and intra cluster distances (Tables 47 and 50) for each population reveals that many of the intercluster distances are quite wide, indicating that considerable variability exist amongs these varieties. The high values for intra cluster distance suggest that relatively greater number of intermating cycles might have been involved for developing these varieties / strains / lines.

Lastly, it is not easy to comprehend genetic divergence between genotypes because of large number of dimensions involved. Relationship among genotypes can be better visualized, if their dimensionality is reduced without losing essential information.

On the contrary of the general rules, parents selected from among the cluster-I could produced top hybrid with respect to the primary branches/ pl (Navkiran × KD), number of secondary branches/pl (BLP × Navkiran), days to flowering (BLP × KD), marketable yield/pl (BLP × Navkiran), length of fruit (BLP × Krishna) and total yield/pl (BLP × Navkiran). This justifies the highest genetic distances among the genotypes included in the cluster-I.

Top hybrids have also been resulted from the cross between cluster I and II for the characters plant height (Navkiran × BGW), weight of fruit (BGW × KD), larvae/pl and fruit (BGW × BLP) and holes/pl (BGW × KD). This result proves a moderate genetic distances between two clusters.

In the present investigation divergent groups (IV × I) have shown a better response towards the inheritance of pest resistance characters like days to borer attack on branches, days to borer on fruit, infested branches/pl, infested fruit/pl and loss of yield and also for the characters days taken from transplanting to first picking indicating importance of grouping and genetic divergence study.

Results of the cluster mean values during 1991-92 and 1992-93, (Tables 48 and 51 respectively) indicate that for most of the clusters the genotypes included average values for almost all the quantitative traits studied.

5.5. Screening of 12 agrochemicals using *L. orbonalis* as a shoot borer and as a fruit borer.

5.5.1. Efficacy of 12 agrochemicals on the suppression of *L. orbonalis* infesting a local cultivar

Shoot borer :

The present observation of the superiority of endosulfan, methyl parathion and pyrethoids (Table 52) is in agreement with the findings of Bothera and Dethe (1991) for endosulfan, and also Jagan Mohan and Prasad (1984) for synthetic pyrethroids. Several other recent reports also corroborate the effectiveness of synthetic pyrethroides against the shoot borer (Agnihotri *et al.,* 1990; Acharya, 1991; Thanki and Patel, 1991).

Fruit borer :

The best efficacy at the final stage with respect to cypermethrin 0.006% (Table 53) may be due to higher accumulation of the compound after 3 successive sprays as well as due to differences in the activity of meristem of the cultivar with the progress of age and interaction of meristem with azadirachtin in this exclusive climate of North Bengal terai zone. However, a conclusive explanation can be drawn only after a thorough exploration of the underlying mechanism. The efficacy of all the agrochemicals declined 15 days after spray as compared to that of 7 days after the treatment. This decline after 7 days leads to higher percent damage in yield which might be due to slow decay of the treated chemicals with the lapse of time.

5.5.2. Impact of 12 agrochemicals on growth, yield and economics of *S. melongena*

The spraying of agrochemicals has been induced vegetative growth of the plants (Table 54). Similar results of promoting vegetative growth with the use of agrochemicals have also been obtained by Uthamasamy *et al.* (1973), who found an increased growth of brinjal after disulfotan and aldicarb treatment. Singh and Kavadia (1988) have also reported an increase in plant height and number of leaves/pl in this crop. No satisfactory interpretation is available for such agrochemical-promoted growth and yield of brinjal. One simple explanation may be that the agochemicals by way of reducing the attack of insects less damage has been caused as compared with the control plants.

Results on the effect of some agrochemicals on fruit weight, yield and cost : benefit ratio reveals that generally, the marketable fruit weight has been higher than that of unmarketable fruit except in cases of quinalphos and phosphomidan treatments where a reverse situation has been recorded (Table 55). Singh and Kavadia (1988) have also reported an increased fruit weight due to endosulfan in combination with aldicarb and disulfotan, whereas aldicarb followed by aldicarb produce some adverse effects on fruit weight.

Several workers reported increased yield with insecticidal schedules (Satpathy, 1973; Joshi and Sharma; 1973, 1991). Worked in Agra climate, Rajdhar and Singh (1989) obtained a good result with aldrin and BHC in terms of yield and quality while malathion and parathion in terms of phosphorus content in soil and crude protein content in fruits. Reddy and Joshi (1990) reported from Madhya Pradesh that all the treatments with pesticides in combination with planofix (NAA-100 ppm) increased growth and fruit set in brinjal. Carbaryl or endosulfan combined with plant growth regulator gave the best yield. The endosulfan combination was the most economical. All treatments except planofix alone rersulted in significant reduction of infestation by the *L. orbonalis*. All these views agree with the present findings.

Reddy and Joshi (1990) and Dhamdhere and Sharma (1991) reported endosulfan to be the most effective and economical in terms of reducing infestation and thereby increased yield and additional income over control. The data presented in Table 55 clearly indicate that cypermethrin 10EC followed by dimethoate appear to be the economically viable pesticide for control of this fruit borer.

5.5.3. Screening of pesticides using six promising brinjal cultivars under modern concept of IPM :

An examination of the performance of 6 cultivars under unprotected, semiprotected and protected conditions (Tables 56 to 60) provides a comparative picture. Summarily, the performance of different cultivars in reference to the damage by the major insect pests under semiprotected and unprotected conditions brings to the light the following points :

1. KD, BLP, and Navkiran are relatively resistant to shoot and fruit borer whereas R-14 being most susceptible.
2. Navkiran shows relatively resistant towards all the major pests in question whereas R-14 is relatively susceptible to all the insect pests.
3. Mean yield of healthy fruit of KD is the best (5.54 kg/pl) followed by Navkiran (4.81 kg/pl).
4. Ratio of infested to healthy fruit yield on weight basis shows KD (1 : 5.08) as the most resistant followed by Navkiran (1 : 5.01) and BLP (1 : 4.86) whereas R-14 as most susceptible (1 : 0.76).

Superiority of synthetic pyrethroid over endosulfan in efficacy of insecticide combinations was reported by Umapathy and Baskaran (1991) against the borer causing its 79.7% mortality. Brar *et al.* (1992) also recorded very good result with the combination of carbofuran and cypermethrin. Islam and Quiniones (1990) reported superiority of endosulfan over methyl parathion. Further, endosulfan residues was less (0.0023 mg/kg) 6 days after the spray compared to that of parathion (0.015 mg/kg). According to Raha *et al.* (1993) residues of endosulfan in and on brinjal fruits immediately after application was below the tolerance level of 2 ppm as specified by FAO/WHO. Reddy and Joshi (1990) reported the endosulfan when applied in combination with plant growth regulators gave the best yield. The endosulfan combination was the most economic. Singh (1993) also recommended a spraying with endosulfan (0.07%) under IPM for controlling tomato borer as safe pesticide. Hence, considering the safe pesticide treatment combinations of carbofuran @ 750 g a.i./ha at 3 weeks after transplanting applied at the root zone combined with a single spray of endosulfan @ 525 g a.i./ha at 70 days after transplanting may be recommended following IPM in combination with cultivar KD. This view did agree with the findings of Mandal *et al.* (1996).

The relative differences of infestation of shoot and fruit borer and jassid in different brinjal varieties has been reported by Subbaratnam and Butani (1981), Mote (1981a) and Bajaj *et al.* (1989). However, the varieties have not been tested for their performance towards other pests and to their yield. Further, none of the varieties considered in this experimentation has been tested previously. A large number of insecticides have also been tested by several workers such as Mehto and Lal (1981), Mote (1981b), Nimbalkar and Ajri (1981), Agnihotri *et al.* (1990), Acharya (1991) and Bothera and Dethe (1991). But the information on the choice of varieties under specific chemical treatments is lacking. In fine, no brinjal cultivar has been reported to be completely resistant to the pest attack. The present approach of integrating the chemical pesticide application with the partially resistant varieties of different pest can go a long way in the economic management of the brinjal pests. On the basis of the present result the combination of carbofuran and endosulfan appear to be suitable along with the consideration of resistance. Because the residue of endosulfan is below the permissible tolerance level and this pesticide is much cheaper than the synthetic pyrethroids. Again, with the combination of carbofuran and endosulfan the selected six varieties can be ranked in the reducing order of superiority as KD > Navkiran > BLP > BGW > Krishna > R-14.

5.6. Performance of six selected parents and their 30 F_1 hybrids

Leaf characters, flower colour, fruit colour and fruit shape of the selected six parents and their 30 F_1 hybrids along with two check varieties such as Tal and Nababganj are discussed summarily with the help of Table 61.

Heterosis for some vegetative characters :

Analysis of variance (Table 62) clearly indicated variable performance among different vegetative traits.

Plant height at first flowering :

Perusal of Table 65, regarding this character reveals that the extent of heterosis over better parent ranged from - 33.33% for Krishna × R-14 hybrid to 7.14% for Navkiran × BGW. Positive heterosis for this character has also been reported by Venkataramani (1946) and Singh *et al.* (1974, 1978). But Patil and Shinde (1984) is of the opinion that plant height is negatively associated with heterosis for yield.

Heterosis defined as the manifestation of greater vigour in leaf area, growth, dry matter accumulation and higher yield of F_1 hybrid in comparison with its inbred parents (Sonone *et al.,* 1984). This has been reported for various characters in brinjal (Vishwanathan, 1973; Singh *et al.,* 1985).

Plant height at first harvesting :

An examination of the results in Table 66 for this character, among the parents and hybrids, shows a positive heterosis over better parent by the Navkiran × BGW hybrid, which is statistically significant even at 1% level of significance. This might be due to the plant height achieved at the time of flowering through heterotic effect. The heterosis for plant height at first harvesting in brinjal had also been reported by Dharmegowda *et al.* (1979), Patil and Shinde (1984), Mandal *et al.* (1994) and other workers.

Shankaraiah and Rao (1990) also reported that seedling height and vigour are to be associated with yield and thus can be used as reliable indices for yield.

Number of primary branches :

Regarding this character, only 8 out of 30 F_1 hybrids have shown a significant positive heterosis over the better parent while the other hybrids have expressed significant negative heterosis (Table 67). Besides this, two crosses, Krishna × BGW and BGW × Krishna show 0.00% heterosis over BP, suggesting no dominance. This result is in conformity with Singh *et al.* (1978), Singh (1980), Balamohan *et al.* (1983) and Patil and Shinde (1984) and Mandal *et al.* (1994).

Number of secondary branches :

Regarding this trait, the extent of heterobeltiosis ranged from - 80.00% for BLP × BGW to 66.67% for BLP × Navkiran (Table 68). This observation agrees with the earlier findings of Patil and Shinde (1984) and Mandal *et al.* (1994). Superiority of the hybrids might be due to heterosis controlled by dominant parental genes.

Number of days to flowering :

Values (Table 69) for the range of heterosis or hybrid vigour over better parent varies from - 53.00% in BLP × KD to 38.46% in BLP × Navkiran. Hence, crosses with negative values have been considered to be desirable which in turn has given an early yield from the crosses. This negative heterosis might be due to non-additive gene action corroborating the views of Dharmegowda *et al.* (1979), Patil and Shinde (1984) and Mandal *et al.* (1994).

Number of days taken from transplanting to first picking :

The magnitude of heterobeltiosis for this character has been from - 50.00% in the cross KD × R-14 to 15.79% in BLP × Navkiran (Table 70). This variation in days taken from transplanting to picking is only due to variation in days to flowering - there was no earliness of ripening of brinjal fruits (Venkataramani, 1946). Negative heterosis has also been mentioned by Chadha *et al.*, 1990 regarding this character.

Heterosis for some reproductive characters

Analysis of variance clearly indicates variable performance of the five reproductive components studied (Table 63).

Length of fruit :

The performance of parents and hybrids shows a variation for this trait in the magnitude of significant heterosis ranging from - 28.57% (KD × R-14) to 32.98% (BLP × KD). The significant positive heterosis over better parent has been recorded for BLP × KD as 8.70% (Table 72). This might be due to overdominance and it supports the results obtained by Singh (1980), Balamohan *et al.* (1983), Patil and Shinde (1984), Dahiya *et al.* (1994) and Mandal *et al.* (1994).

Maximum circumference of fruit :

Results show that in almost all the crosses there has been a depression of this trait. Range of heterobeltiosis observed has been - 60.00% (BLP × BGW) to 25.00% (BLP × Krishna) as evident from the data presented in Table 73.

Heterosis with respect to equatorial diameter was reported by Concilio and Sanguinate (1982). Significant negative heterosis over better parent indicates the presence of incomplete dominance and it contradicts the inference of Patil and Shinde (1984) who described that the phenomenon was due to over-dominance.

Number of fruits/plant :

Significant positive heterosis for the character number of fruits/pl has been recorded in 11 hybrids out of 30. The magnitude of positive heterosis over better parent ranges between 2.74% (KD × BGW) and 217.23% (R-14 × Navkiran).

It is clear from the result (Table 74) that inspite of heavy bearing in BLP (37.77) and Krishna (21.66) R-14 and Navkiran yield maximum heterotic effects which might be due to synergistic effects of dominance of both the parents in the hybrid. Although R-14 × BLP gives the highest number of fruits (55.00) which might be due to heavy bearing traits possessed by BLP in cluster. Randhawa and Sukhija (1973) also observed heterosis over better parents for this character in crosses. Thakur *et al.* (1968) reported heterosis for this character upto 34.06%. These views were also in agreement with the findings of several other workers and most of them opined that the heterobeltiosis occurred for the character number of fruits/pl due to over dominance corroborating the observation of Mandal *et al.* (1994) and the present finding.

Weight of fruits :

In general, majority of the crosses show a negative heterosis for this trait. Range of heterobeltiosis is from - 5.00% (BLP × BGW) to 108.33%

(BLP × Krishna). The result (Table 75) is not so enthusiastic as compared to the findings of Singh (1980) who has recorded comparatively a good amount of heterosis for this character.

Yield/plant :

Significant heterobeltiosis has been expressed in different F_1's ranging from - 43.48% (Navkiran × BLP) to 52.53% (BLP × Krishna) with respect to total yield/pl (Table 76). The hybrid, BLP × Navkiran shows the highest yield of 9.80 kg/pl which might be due to a good combination of the bearing habit of BLP and the weight of fruit of Navkiran variety. Results obtained in the present study clearly indicates that high yields of the hybrids have been due to higher number of fruits/pl, increased length of fruits and fruit weight. Heterosis with respect to yield/pl had also been reported by several workers who reported that positive heterosis over better parent was mainly due to over-dominance (Mishra, 1961; Thakur *et al.,* 1968; Lal *et al.,* 1974; Dharmegowda *et al.,* 1979; Dhankhar *et al.,* 1980 and Singh, 1980)

Heterosis in brinjal for yield was attributed to increase in number of branches/pl, fruit length, and number of fruits and heavy bearing habit of the hybrid induced through parental contribution (Ram *et al.,* 1981; Concilio *et al.,* 1983; Nualsri *et al.,* 1986; Gopinath *et al.,* 1986 and Mandal *et al.,* 1994).

The heterosis expressed in the hybrids of the crosses employed for the above characters can be utilized in combination with earliness of marketable fruitings for evolving high yielding and early maturing hybrid in brinjal.

Heterosis for susceptibility components :

Analysis of variance (Table 64) shows significant treatment differences among different components studied.

Very few hybrids has exhibited relative insect resistance, which might be through less number of larvae/ft, holes/ft and percent loss in yield, suggesting a probable relation between the loss in yield and all these susceptibility traits.

There are very few literature in support of this insect resistance evolved through breeding specially against the shoot and fruit borer.

Dhankhar *et al.* (1983) reported borer resistance in BR-103 × White Long and BR-112 × Aushey. Besides this Srivastava and Lal (1995) also reported that SM-202 × PPL hybrid showed moderate resistance on both number and weight basis against this pest.

In the present investigation BGW × BLP hybrid appears to be the best among all with respect to larvae/pl and larvae/ft and BLP × Navkiran shows the most desirable characters against number of holes/pl by the shoot and fruit borer. This multiple resistance could have been transmitted by the top line BLP variety, being one of the parents for these hybrid. Least number of infested branches in the hybrid of R-14 × Navkiran and the least number of infested fruit/pl in case of KD × R-14. This have resulted possibly due to insect resistance quality of the parents Navkiran and KD. Considering yield loss simply KD variety can be recommended to the farmers of Darjeeling terai region (Table 88).

Variability among the parents and hybrids :

Wide range of variation has been observed for all the vegetative characters supporting the observation of Singh *et al.* (1974) and Kabir and Som (1993). Higher values of PV as compared to GV have been expressed by all the tested characters (Table 89). Similarly, PCV has been obtained in higher value than the GCV. This has been a general trend of expression as evident from the Table 89 and agrees with the similar observation of Mandal and Dana (1992) in brinjal and Chattopadhyay (1995) in cowpea. Excepting the character days to flowering (76.06%) all the estimates of heritability (in a broad sense) are higher (above 95%). Similar observation has also recorded by Chattopadhyay (1995) in cowpea. Number of primary and secondary branches is to be given due consideration while selecting the varieties. Results suggest that genotypic variation in the present cultivars for these characters is probably due to high additive genetic effects. Therefore, the selection on phenotypic basis for these characters, backed by high heritability and genetic advance would be more effective in achieving desired results by employing suitable plant breeding methods.

Analysis of variance suggests a wide range of variability for all the reproductive characters. The results indicate considerable genetic variability for fruit number and yield. Estimates of components of variance reveals higher genotypic variance than environmental variance, supporting the views of Ahmed *et al.* (1990) in chilli. Higher genetic advance and genetic gain have been reflected for number of fruits/pl coupled with higher heritability (Table 90) indicating a large scope for the improvement of the character through selection. Higher GA and heritability for the character may be due to predominance of additive gene action as suggested by Kumar *et al.*

(1993) in chilli, Anuradha and Gowda (1994) in gladiolus, Singh *et al.* (1974) and Kabir (1981) in brinjal.

A significant amount of variability has been obtained among the tested susceptibility components of 38 strains of brinjal. Estimates of components of variance indicate a maximum genetic variation for percent yield loss followed by infested fruit/pl, while GCV shows a maximum value along with heritability and GA for the trait larvae/ft (Table 91). Therefore, selection of phenotype on the basis of these characters could be more useful for relative susceptibility to the shoot and fruit borer.

The high value of heritability suggests that all the characters are under genotypic control (Singh *et al.,* 1974). Heritability value alone provides no indication of the amount of genetic progress that would result from selecting the best individuals. Ramanujan and Tirumalechar (1967) in red pepper (*Capsicum annum* L.) discussed the limitation of estimating heritability and suggested that the heritability estimates in broad sense would be reliable if accompanied by the high genetic advance (GA) probably due to additive gene effects (Panse, 1957). Selection is thus, likely to be beneficial in improving those traits having low GA but high heritability is not always an indication of high genetic gain (Johnson *et al.,* 1955; Swarup and Chaugale, 1952). Thus, it appears that the afforesaid characters are influenced by non additive gene effects.

Correlation and path analysis for the parents and hybrids

The marketable yield/pl is highly associated with the secondary branches/pl in both genotypic and phenotypic correlations and path analysis (Tables 92-95). It suggests that this vegetative character is an important yield component for selection of genotypes. This finding corroborates that of Mandal and Dana (1992).

Number of fruits/pl had negative correlation with maximum circumference of the fruit but a high positive correlation with the fruit weight (Table 96). The results provided in the Tables 97-99 indicate that fruit weight and number of fruits had positive direct correlation on the total yield in brinjal. This view does agree with the findings of Salehuzzaman *et al.* (1979) and Singh and Singh (1980) in brinjal and also for cowpea (Chattopadhyay, 1995). It has been reported that there is a strong association between number of fruits and yield/pl (Srivastava and Sachan, 1973; Singh and Nandpuri, 1974; Hiremath and Roa, 1974). Salehuzzaman and Alam (1983) registered that the yield in egg plant is a complex character which is the product of its components. Whether one should select only for the components or for the yield itself will depend upon their heritabilities and genetic inter relationships among the yield and its components. Analysis of all the reproductive components reveals the fact that all the characters are inter-dependent and influence one another by highly positive direct and indirect effects.

Results of correlation (Table 100) and path analysis (Tables 101-103) for the susceptibility components indicate that percent infested fruit/pl has a high positive direct effect on yield loss. Again, the total yield is correlated with the percent yield loss of brinjal. By applying selection pressure on these characters, it is possible to increase the marketable yield but the total yield will be adversely affected. So the emphasis must be on the combined effect of heterosis with yield and resistance to shoot and fruit borer. This inference agrees with the conclusion of Dhankhar *et al.* (1983) and Srivastava and Lal (1995) for exploitation of hybrid vigour with respect to yield and insect pest resistance.

6. SUMMARY

6.1. Screening of *Solanum melongena* for its relative susceptibility to four major insect pests

6.1.1. Relative susceptibility to the shoot and fruit borer, *Leucinodes orbonalis* Guen. (Lepidoptera : Pyralidae) :

A field experiment was conducted during 1991-92 and 1992-93 in experimental plots at a distinct agroclimatic zone of Siliguri located in Eastern Himalayan terai. Forty one cultivars of the egg plant, *S. melongena* L. were screened for the shoot and fruit borer, *L. orbonalis*. Crop damage was evaluated both on fruit weight and fruit number bases. Among the varieties screened Nishchindipur Local, Nurki, Shyamla Dhepa, Navkiran, Kalo Dhepa, IR-8-Baramasi, Banaras Long Purple, BB_1 and Murshidabad Local showed fair resistance. (Lal's grading index, 1976) with a range of crop loss between 10 to 21% approximately. The highly susceptible varieties were R-14, Sufal, Pusa Purple Round, Rajkrishna, Pyratuni, Krishnanagar Hybrid Variety '90 and KB-2. The damage percentage varied from 41.17 to 73.05 and 41.36 to 52.27 on the bases of fruit weight and fruit number respectively. Besides other possible factors, resistance in crop varieties could, in general, be related to some physical characters of the fruits, like spinous calyx and tight arrangement of seeds.

Among the 41 cultivars tested, Baramasi proved to be the best yielder (6.91 kg/pl.) followed by Kalo Dhepa (6.79 kg/pl.). Considering the yield and relative susceptibility, Kalo Dhepa, Shyamla Dhepa and Navkiran may be recommended for profitable cultivation without any obligation to pesticidal use.

Grading was also made on the basis of Subbaratnam and Butani (1981). The experimental plots were left for natural infestation, and data on insect population and damage were recorded at 20-day intervals thoughout the period of crop growth. Although the analysis of variance showed significant differences among the genotypes screened, no variety was found totally resistant to *L. orbonalis*. However, the relatively less incidence of the pests in some varieties showed that Nishchindipur Local, Muktajhuri, Shyamla Dhepa, Navkiran, Banaras Long Purple and BB_1 were tolerant to *L. orbonalis* as a shoot borer, where as Shyamla Dhepa, Kalo Dhepa and Banaras Long Purple were tolerant to *L. orbonalis* as a fruit borer.

6.1.2. Relative susceptibility to jassid, aphid and spotted leaf beetle:

Screening was done against the incidence of the jassid, *Amrasca biguttula biguttula* Ishida (Hemiptera : Cicadellidae), aphid, *Aphis gossypii* Glover (Hemiptera : Aphididae), and spotted leaf beetle, *Epilachna vigintioctopunctata* Fab. (Coleoptera : Coccinellidae). Navakiran showed tolerance whereas R-14 was highly susceptible to all the three major pests. The varieties having tolerance or even multiple resistance were Shyamla Dhepa, Kalo Dhepa, Improved Muktakeshi, Banaras Long Purple and BB_1. These were used in the breeding programme and integrated pest management.

6.2. Variablity studies

6.2.1. Genotypic and phenotypic variability for vegetative characters :

Analysis of variance revealed significant differences for all the tested vegetative traits. Genotypic coefficient of variability (GCV) were highest for number of secondary branches followed by number of primary branches/pl. Genetic advance (GA) was found to be significantly higher in both the years of study for the character number of secondary branches/pl.

6.2.2. Variability for some reproductive characters :

The differences among the 41 varieties were significant for all the reproductive characters for both the years of study. High GCV was exhibited, by fruit weight followed by marketable fruits/pl and total yield/pl. Estimates of heritability and GA were found to be very high for all the above characters excepting for the number of fruits/pl during 1991-92.

6.2.3. Variability for some important susceptibility components for *L. orbonalis* attack :

Estimates of components of variance showed higher phenotypic variance (P.V) than genotypic variance (G.V.) for all the test characters. When the criteria larvae/ft was considered, error variance was greater than G.V. and P.V. High heritability with high genetic advance was recorded for host characters like, loss of yield, holes/ft and plant and number of larvae/pl.

6.3. Correlation and path co-efficient analysis

6.3.1. Three levels of correlation and path analysis for some important vegetative characters with marketable yield :

Plant height at first flowering was found to be significantly correlated with plant height at first harvesting as that of the characters days to flowering to days taken from transplanting to first picking. Marketable yield/pl was found to be significantly correlated with number of secondary branches/pl both at phenotypic and genotypic level during both the years of study during 1991-92 and 1992-93.

The character secondary branches/pl showed highest direct effect on marketable yield/pl while other characters showed very lower value for both the years of study. Residual effect was 0.981 for 1991-92 and 0.853 for 1992-93, suggesting importance of some other characters.

6.3.2. Three levels of correlation and path analysis for some important reproductive components with total yield :

During 1992-93, fruit circumference showed highly positive correlation (0.606) with fruit weight followed by fruit number with the total yield/pl (0.604). Path analysis showed that the number of fruits/pl had a very high positive direct effect on the production of increased amount of the total yield/pl followed by fruit circumference and fruit weight during 1991-92. But during 1992-93, values were highest for number of fruits/pl followed by fruit weight at genotypic level.

6.3.3. Three levels of correlation and path analysis for some important susceptibility components towards the attack of *L. orbonalis* with loss of yield :

Percent yield loss has shown significantly positive correlation with infested fruit/pl, infested branches/pl, holes/ft, larvae/ft and larvae/pl at genotypic level.

Path coefficient analysis indicated highly positive direct effect on the loss of yield. that had infested fruit/pl followed by larvae/ft at genotypic level during 1991-92 while it was infested fruit/pl for the year 1992-93.

6.4. Genetic divergence

Following the D^2 statistic the 41 genotypes of brinjal were grouped into 4 clusters during both the years of study. The cluster II of 1991-92 was smallest with 7 genotypes and cluster III of the same year was largest consisting of 13 genotypes. The intracluster distance was high in cluster I (80.38) during 1991-92 and that of 1992-93 it was again cluster I (50.34). Inter class distance was maximum between I and IV (97.86) during 1991-92 and that of 1992-93 was again between I and IV (56.07). Examination of the character-means for 21 traits showed that the geographical distribution and spatial distribution of clusters were not necessarily related.

6.5. Screening of 12 agrochemicals using *L. orbonalis* as a shoot borer and as a fruit borer

6.5.1. Efficacy of 12 agrochemicals on the suppression of *L. orbonalis* infesting a local cultivar :

A field trial was conducted during the rabi season of 1993-94 to evaluate bioefficacy of several pesticides against the shoot and fruit borer of brinjal. In the present investigation, endosulfan along with cypermethrin appeared to be the best pesticides for controlling *L. orbonalis* attacking brinjal shoots. For controlling fruit attack, the performance of the tested chemicals in descending order of efficacy were methyl parathion > dimethoate > cypermethrin 25 EC > endosulfan > cypermethrin 10 EC > quinalphos > monocrotophos > phosphomidon > vage guard > decamethrin > malathion > azadirachtin when the damage percentage computed on the basis of the number of fruits. Almost similar observation was recorded when the degree of infestation was calculated on the basis of weight. Evidently, the highly contact poisons, endosulfan and systemic dimethoate appeared to be much better pesticides which might be recommended for controlling *L. orbonalis* both as shoot and fruit borer of brinjal.

6.5.2. Impact of 12 agrochemicals on growth and yield of the local cultivar of brinjal and cost:benefit ratio :

Spraying of agrochemicals influenced significantly the growth and yield of egg plant. The percent increase over control ranged from 8.60 to 112.91, -2.33 to 50.00 and 5.88 to 79.41 respectively for number of secondary branches, plant height and number of leaves/pl. Synthetic pyrethroids, cypermethrin 25 EC proved best in this regard. The range of percent increase in fruit weight was recorded -4.92 to 31.41. Here also cypermethrin showed maximum increase followed by methyl parathion. Although all the pesticides proved to be efficacious, cypermethrin 10 EC appeared to be the best and economically most effective followed by systemic insecticides monocrotophos and dimethoate. Cost : benefit ratio was 1 : 44 for cypermethrin 10 EC followed by dimethoate (1 : 41). Thus, these two insecticides may be recommended as most promising and economically viable pesticides for saving egg plant from the ravages by *L. orbonalis.*

6.5.3. Selection of pesticide combinations using six promising brinjal cultivars under modern concept of IPM

Six promising cultivars obtained through initial field screening of 41 varieties for 2 successive years (1991-92 and 1992-93) were further tested in the Darjeeling Terai during the period, October-March of 1993-94 and 1994-95 to know their relative resistance against the insect pest complex. For this purpose all the 4 major pests were considered. Special emphasis was given to *L. orbonalis*. Kalo Dhepa, Navkiran and Banaras Long Purple were recorded as the highly resistant varieties in this agroclimatic zone. With reference to the ratio of infested to healthy fruit weight, the degree of resistance could be arranged as Kalo Dhepa > Navkiran > Banaras Long Purple > Banaras Giant white > Krishna > R-14. However, based on infested to healthy fruit number. Kalo Dhepa appeared to be the most resistant against the borer, though it was found to be relatively susceptible to jassid and aphid. Navkiran showed multiple resistance against all the 4 major pests. Banaras Long Purple was particularly resistant against the borer with moderate tolerance to the jassid and aphid. Trials with minimum insecticidal protection to the selected 6 promising cultivars increased the marketable yield due to reduced infestation by the 4 pests. Hence, the resistant cultivars of brinjal combined with minimum dosage of pesticides like carbofuran (@ 750 g a.i./ha) followed by single spray of endosulfan (@ 525 g a.i./ha) may be recommended under IPM, specially in the Darjeeling Terai.

6.6. Performance of six selected parents and their thirty F_1 hybrids

Vegetative characters :

As in case of earlier screening almost similar trend was found for the studies of Variability and Correlation and path analysis with the parents and hybrids. Best F_1 hybrid was Navkiran × BGW in respect of plant height at first flowering and plant height at first harvesting. Besides, Navkiran × KD performed best with regards to number of primary branches/pl but for the character number of secondary branches/pl BLP × Navkiran showed the best. With respect to days to flowering BLP × KD performed the best when the character days taken from transplanting to first picking it was BLP × R-14. BLP × Navkiran although belonged to the same group but performed best with respect to marketable yield possibly due to the combination of resistance from both the varieties against *L. orbonalis* attack as well as multiple resistance characters shown by these two varieties.

Reproductive characters :

Similarly as with earlier screening, the trend remained the same for variability and correlation and path analysis studies for parents and hybrids. Best performing F_1 hybrid were BLP × Krishna for weight of fruit, R-14 × BLP for number of fruits/pl, BGW × KD for length of fruit and

BLP × Navkiran for total yield/pl. In most of the cases the combinations belonged to the divergent groups and yielded best supporting genetic divergence study.

Susceptibility components :

As in the earlier screening (1991-92 and 1992-93) with 41 brinjal parents for variability and correlation and path analysis, with parents and hybrids almost similar trend was recorded. Considering all aspects of yield, farmers acceptability and resistance, BLP, Navkiran, Kalo Dhepa as parents and BGW × BLP, BGW × KD, BLP × R-14 hybrids may be recommended for their resistant characters and good yielding ability.

7. HIGHLIGHTS

1. Among the 41 brinjal germplasms screened for the first time under agroclimatic conditions of terai during 1991-92 and 1992-93, Nishchindipur Local, Nurki, Shyamla Dhepa, Navkiran, Kalo Dhepa, IR-8-Baramasi, Banaras Long Purple, BB_1 and Murshidabad Local, showed fair resistance against the key pest, *Leucinodes orbonalis* Guen as a shoot borer as well as a fruit borer.
2. Baramasi, a newly selected cultivar from the terai region proved to be the best yielder (6.91 kg/pl) followed by Kalo Dhepa (6.79 kg/pl).
3. Considering parameters like yield, farmers choice, marketability and relative susceptibility, Kalo Dhepa and Shyamla Dhepa, two newly selected variety, from the exclusive climate of Darjeeling foothills along with Navkiran may be recommended for profitable cultivation without any obligation of pestcidal use.
4. Based on multiple resistance criteria against the borer, jassid, aphid and spotted leaf beetle - the 4 major pests of brinjal - Shyamla Dhepa, Kalo Dhepa, Improved Muktakeshi, Banaras Long Purple and BB_1 may be used for the purpose of further breeding or may be adopted in integrated pest management.

5. Analysis of variance clearly indicated wide range of variability for all the vegetative, reproductive and susceptibility characters under question.

6. Correlation and Path coefficient analysis

   Marketable yield/pl was found to be significantly correlated with number of secondary branches/pl both at phenotypic and genotypic level during both the years of study because of its direct effects on the yield attributes.

   Total yield was found to be directly correlated with number of marketable fruits which has very high positive direct effect on yield. Percent yield loss showed significant positive correlation with infested fruit/pl and larvae/ft at genotypic level which has shown direct effect on the susceptibility to fruit and shoot borer.

   Hence, number of secondary branches/pl, number of fruits/pl, infested fruit/pl and larvae/ft characters along with others has to be given due emphasis while selecting genotypes for breeding.

7. Genetic divergence

   The 41 genotypes of brinjal were grouped into 4 divergent clusters. Resistance and high yielding ability found to be inherited from the crosses between two most divergent cluster. Examination of the characters mean for 21 traits studied clearly indicated that geographical distribution and spatial distribution of clusters were not necessarily related.

8. Alternatively under IPM pesticides like, endosulfan and cypermethrin, and the systemic insecticides, dimethoate may be recommended for controlling *L. orbonalis* as shoot and fruit borer.

9. Spraying of agrochemicals influenced significantly the growth and yield of egg plant. Synthetic pyrethroid cypermethrin 25 EC proved the best in this regard. Considering cost benefit ratio, cypermethrin 10 EC (1:44) and dimethoate (1:41) may be recommended as most promising and economically viable pestcides.

10. Subsequent screening for the borer with selected six cultivars during 1993-94-95 on the basis of infested to healthy fruit weight indicated the degree of resistance as Kalo Dhepa > Navkiran > Banaras Long Purple > Banaras Giant White > Krishna > R-14.

11. Navkiran, in general, showed multiple resistance against the 4 major pests viz. borer, jassid, aphid and spotted leaf beetle. Banaras Long Purple was also found resistance against the borer with moderate tolerance to the jassid and aphid.

12. The Resistant cultivars of brinjal combined with minimum dosage of pesticides like carbofuran (@ 750 a.i./ha) followed by single spray of endosulfan (@ 525 g. a.i./ha) may be recommended under IPM, specially in the Darjeeling Terai.

13. Performance of six selected parents and their thirty F_1 hybrid showed inheritance and heterosis of some resistant characters along with good amount of yield attributes from among the parents of divergent clusters. Considering all aspects of yield, farmers choice and insect-pest resistance Banaras Long Purple, Navkiran, and Kalo Dhepa varieties from among the 41 parents and BGW × Krishna, R-14 × Navkiran and KD × R-14 hybrids from among the 30 hybrids screened under field condition may be recommended for profitable cultivation even without any obligation of pesticidal treatments.

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ANNEXURE -I

List of Abstracts of paper presented in seminars/symposia and papers communicated for publication

List of Abstract presented

1. Bhattacharya, B and A.K. Mandal, 1990. Economic use of water in 'Pusa Ruby' tomato. (*Lycopersicon esculentum Mill.*) National seminar on the role of soil and water conservation in modern agriculture. 23-24 February, B.C.K.V., West Bengal.

2. Mandal, A.K. 1995. Insect resistant breeding in brinjal. State level seminar on modern trends in Zoological research in India. 12-13 March, Dept. of Zoology, North Bengal University.

3. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1995. Management of insect pests complex of brinjal (*Solanum melongena* L.) using resistant variety and minimum insecticides. VIth National symposium on IPM - an Entomological approach to sustainable agriculture. September 22-24. Org. by U.P. Zoological Society.

4. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1996. Genetic variability studies for relative susceptibility to shoot and fruit borer, *Leucinodes orbonalis* Gn. in brinjal, *Solanum melongena* L. National Symposium on diseases of economically important plants of Eastern India and their management, 22-28 December, Dept. of Botany, North Bengal University.

List of publications

1. Paria, N.C., H.C. Roy, A.K. Mandal and A.R. Mandal, 1991. Growth and yield of carrot *Daucus carota* L. in relation to foliar application of some micronutrients. *Environment and Ecology*, *9(1)* : 280-282.

2. Som, M.G., H. Hashim, A.K. Mandal, and T.K. Maity, 1992. Influence of organic manures on growth and yield of brinjal (*Solanum melongena* L.) *Crop. Res.*, *5(1)* : 80-84.

3. Mandal, A.K., M.K. Pandit and T.K. Maity 1994. Hoterosis in brinjal (*Solanum melongena* L.). *Crop. Res.*, *8(2)* : 291-295.

4. Mukhopadhyay, A and A.K. Mandal, 1994. Screening of brinjal (*Solanum melongena*) for resistance to major insect pests. Indian J. Agric. Sci., 64(11) : 798-803.

5. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1994. Screening of egg plant for resistance against shoot and fruit borer, *Leucinodes orbonalis* Guen. *J Appl. Zool. Res.*, *5(1)* : 37-38.

6. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1995. Evaluation of egg plant cultivars to shoot and fruit borer, *Leucinodes orbonalis* Gn., *J. Appl. Zool. Res.*, *6(1)* : 32-34.

7. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1996. Management of insect pest complex of brinjal, using resistant variety and minimum insecticides. *IPM & Sustain. Agri. - an ent.* Vol. 6. (ed. by S.C. Goel). The Uttar Pradesh Zoological Society, Muzaffarnagar. pp : 89-94 (in press).

8. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, Field evaluation on bioefficacy of some agrochemicals using shoot and fruit borer, *Leucinodes orbonalis* Guen. on brinjal, *Solanum melongena* L. *Pl. Prot. Bull.*, Directorate of plant protection, Quarantine and storage, Faridabad. Govt. of India. (Communicated and revised, 5.1.95)

9. Mandal, A. Mukhopadhyay and D.C. Deb, Impact of some agrochemicals on growth yield and economics of brinjal. *Pl. Prot. Bull.*, Directorate of Plant protection, Quarantine and Storage, Faridabad. Govt. Of India. (Communicated and revised, 14.3.96).

ANNEXURE II

List and copies of published papers related to the thesis work

1. Mukhopadhyay, A. and A.K. Mandal, 1994. Screening of brinjal (*Solanum melongena*) for resistance to major insect pests. Indian *J. Agric. Sci.*, ***64(11)*** : 798-803.

2. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1994. Screening of egg plant for resistance against shoot and fruit borer; *Leucinodes orbonalis* Guen. *J. Appl. Zool. Res.*, ***5(1)*** : 37-38.

3. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1995. Evaluation of egg plant cultivars to shoot and fruit borer, *Leucinodes orbonalis* Gn. *J. Appl. Zool. Res.*, ***6(1)*** : 32-34.

4. Mandal, A.K., A. Mukhopadhyay and D.C. Deb, 1996. Management of insect pest complex of brinjal, using resistant variety and minimum insecticides. *IPM & Sustain. Agri. - an ent.* Vol. 6. (ed. by S.C. Goel). The Uttar Pradesh Zoological Society, Muzaffarnagar. pp : 89-94 (in press).

CROP PROTECTION

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Screening of brinjal (*Solanum melongena*) for resistance to major insect pests

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ABSTRACT

A field experiment was conducted during 1991–92 and 1992–93 in a farmer's field of Siliguri in the foot-hill (*tarai*) region to evaluate the relative degree of resistance offered by 41 cultivars of brinjal (*Solanum melongena* L.) to major insect pests. The pests studied were the brinjal shoot-and-fruitborer (*Leucinodes orbonalis* Guen.), cotton leaf hopper [*Amrasca biguttula biguttula* (Ishida)], cotton aphid (*Aphis gossypii* Glover) and the spotted leaf beetle (*Epilachna vigintioctopunctata* Fabr.). The experimental plots were left for natural infestation, and data on insect population and damages were recorded at 20-day intervals throughout the period of crop growth. Although the analysis of variance showed significant differences among the genotypes screened, no variety was found resistant to any of the 4 pests. However, the relative incidence of the pests showed that 'Nishchindipur Local', 'Muktajhuri', 'Shyamla Dhepa', 'Navkiran', 'Banaras Long Purple' and 'BB 1' were tolerant to the shootborer *L. orbonalis*, whereas 'Shyamla Dhepa', 'Kalo Dhepa' and 'Banaras Long Purple' were tolerant to the fruitborer *L. orbonalis*. 'Navkiran' showed tolerance whereas 'R 14' was highly susceptible to all the major pests of brinjal. Hence the varieties having tolerance or even multiple resistance, viz 'Shyamla Dhepa', 'Kalo Dhepa', 'Improved Muktakeshi', 'Banaras Long Purple' and 'BB 1' could be used for incorporation in the breeding programme and integrated pest management.

Among the major insect pests of brinjal (*Solanum melongena* L.), shoot- and- fruit-borer (*Leucinodes orbonalis* Guen.) is the most destructive. Cotton leaf hopper [*Amrasca biguttula biguttula* (Ishida)] and cotton aphid (*Aphis gossypii* Glover) (Cruz and Bernardo 1971, Chelliah 1973) also cause extensive damage to brinjal. The spotted leaf beetle (*Epilachna vigintioctopunctata* Fabr.) is another important pest attacking both solanaceous vegetables (Pandey and Shankar 1975, Singh and Mukherjee 1987) and cucurbits (Pandey and Shankar 1975). To protect brinjal from depredation of common insect pests, various chemical control measures have been suggested. Since these control methods are costly and not absolute, plant resistance can prove an effective measure to combat the pests. Though very little work has been done on this aspect, in the present study 41 popular cultivars and lines of brinjal collected from different parts of India were screened to identify varieties with tolerance to major insect pests, especially shoot-and-fruitborer.

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MATERIALS AND METHODS

The experiment was conducted during autumn-winter seasons of 1991–92 and 1992–93 to study the response of 41 cultivars and lines of brinjal against the damage caused by major insect pests at Siliguri. The experiment was laid out in simple randomized block design with 3 replications during both the years. The size of subplot was 3.0 m x 2.8 m, having 20 plants spaced 70 cm x 60 cm apart. The crop was left for natural infestation of pests. Data were recorded from the time of first occurrence of the pests. The populations of cotton leaf hopper, cotton aphid and spotted leaf beetle were counted from 5 leaves (2 top, 2 middle and 1 bottom) from each of the 5 central plants in every subplot at 20-day intervals, till completion of harvesting. The total number of shoots damaged due to the attack of *L. orbonalis* in the central 5 plants was also recorded. The fruits were harvested at an interval of 10 days, sorted out into marketable and unmarketable fruits, counted and weighed for computation of final yield. The data were statistically analysed.

The average minimum and maximum monthly temperature (°C), total rainfall (mm), and average monthly minimum and maximum relative humidity (%) were 14.16, 28.58, 315.50, 60.69 and 75.95 respectively for 1991–92, and 14.14, 26.59, 415.70, 51.58 and 89.08 respectively for 1992–93.

Following the grade index of Subbaratnam and Butani (1981) the relative tolerance was estimated on the basis of incidence of number of pest insects/5 plants for shootborer and 5 leaves/plant for cotton leaf hopper and aphid. But the index for fruitborer was considered on the basis of fruit damage (%). On this basis the grading index considered is given here.

Grade	*Shoot-borer*	*Fruit-borer*	*Cotton leaf hopper*	*Cotton aphid*
Tolerant	< 2.0	< 15.0%	< 10.0	< 20.0
Moderately tolerant	2.1–3.0	16.0–25.0%	11.0–19.0	21.0–30.0
Susceptible	3.1–5.0	26.0–40.0%	23.0–30.0	31.0–50.0
Highly susceptible	> 5.0	> 40%	> 30.0	> 50.0

However, no grade index is available for spotted leaf beetle.

RESULTS AND DISCUSSION

Analysis of variance (Table 1) showed significant differences among the 41 cultivars for all the 4 major pests studied. But none of these varieties was found resistant to any pest (Table 2).

Leucinodes orbonalis

Varieties 'Nishchindipur Local', 'Muktajhuri', 'Shyamla Dhepa', 'Navkiran', 'Banaras Long Purple', 'BB 1' and 'Murshidabad Local' had less infestation (0.98–1.99) and number of damaged shoots/5 plants, and may therefore be considered tolerant to shootborer (Table 2). 'R 14', 'Kalo Dhepa', 'Banaras Giant White', 'KB 20', 'Banarasi', 'IR 8 Baramasi', 'Shyamla Bhangar', 'Krishnanagar Hybrid Variety 90' and 'Pusa Kranti' were found moderately tolerant (2.17–2.80 damaged shoots/5 plants). 'Sufal', 'L 13', 'KB 9', 'White Long Cluster', 'Nurki', 'Neelam Long', 'Pusa Purple Cluster', 'KB 5', 'Improved Muktakeshi', 'Krishnanagar Purple Round', 'Rajkrishna', 'Pyratuni', 'Baramasi', 'ARM 3', 'Krishna', 'KB 10', 'KB 2', 'Black Prince' and 'Suttons Long' showed 3.10–4.51 damaged shoots/5 plants, and hence were rated susceptible, whereas 'Brinjal Long Green' (5.02 damaged shoots/5 plants) was highly susceptible.

Table 1 Analysis of variance for relative incidence of major insect pests of 41 brinjal cultivars

Character	Mean sum of squares			CD
	Treatments (df = 40)	Replications (df = 2)	Errors (df = 80)	(P = 0.05)
Mean shoots damaged/5 plants	3.48**	0.03	0.09	0.47
	3.17**	0.13	0.12	0.55
No. of fruits damaged (%)	287.86**	15.18	23.59	7.76
	490.68**	9.46	32.33	9.06
Weight of fruits damaged (%)	515.30**	40.82	28.26	8.51
	531.15**	103.45	50.81	11.39
Cotton leaf hoppers/5 leaves	265.29**	3.96	2.56	2.54
	259.83**	9.50	13.32	5.82
Cotton aphids/5 leaves	4 743.68**	106.03	29.04	8.60
	5 003.41**	4.31	5.28	3.67
Spotted leaf beetles/5 leaves	1.22**	0.03	0.04	0.31
	5.83**	0.06	0.03	0.27

For each character the first row represents the value for 1991–92 and second for 1992–93
**P = 0.01

Table 2 Relative incidence of insect pests on different varieties of brinjal (pooled mean data of 2 years)

Variety	Shoots damaged/5 plants	Fruits damaged (%) on basis of		Pest (no.)/5 leaves		
		No.	Weight	Cotton leaf hopper	Cotton aphid	Spotted leaf beelte
'R 14'	2.17 M	51.73 H	52.73 H	30.70 H	141.00 H	2.17
'Nishchindipur Local'	1.66 T	16.93 M	18.01 M	21.15 M	79.50 H	1.63
'Sufal'	4.51 S	51.38 H	50.80 H	44.40 H	19.00 T	0.45
'KB 9'	4.21 S	40.06 H	41.31 H	3.55 T	153.00 H	0.42
'White Long Cluster'	4.35 S	40.55 H	45.65 H	11.00 M	83.50 H	1.31
'Nurki'	4.26 S	17.67 M	17.76 M	17.95 M	65.50 H	0.81
'Muktajhuri'	1.91 T	21.16 M	22.30 M	24.90 S	137.00 H	0.59
'Shyamla Dhepa'	1.55 T	12.22 T	12.94 T	18.20 M	80.50 H	1.04
'Neelam Long'	3.21 S	40.49 H	46.90 H	15.35 M	86.50 H	1.22
'Pusa Purple Round'	4.35 S	44.17 H	55.99 H	9.60 T	64.50 H	0.46
'Kalo Dhepa'	2.40 M	11.76 T	12.85 T	15.80 M	59.50 H	1.25
'Pusa Purple Long'	3.16 S	33.97 S	35.97 S	9.80 T	52.95 H	1.13
'Banaras Giant White'	2.35 M	27.92 S	26.40 S	9.05 T	78.80 H	0.42

Table 2 *(continued)*

Variety	Shoots damaged/5 plants	Fruits damaged (%) on basis of		Pest (no.)/5 leaves		
		No.	Weight	Cotton leaf hopper	Cotton aphid	Spotted leaf beetle
'KB 20'	2.68 M	48.10 H	48.62 H	23.80 S	23.15 M	1.56
'L 13'	4.50 S	37.74 S	41.17 H	9.95 T	93.00 H	0.28
'Boral'	3.48 S	28.13 S	36.77 S	18.90 M	75.00 H	0.33
'Pusa Purple Cluster'	3.12 S	30.02 S	32.75 S	15.20 M	84.00 M	0.70
'Banarasi'	2.71 M	22.01 M	24.64 M	23.40 S	28.00 M	1.70
'KB 5'	3.47 S	31.04 S	29.87 S	6.40 T	47.00 S	0.63
'Improved Muktakeshi'	3.62 S	35.66 S	33.58 S	8.40 T	77.80 H	0.36
'Krishnagar Purple Round'	3.31 S	32.48 S	42.24 H	18.20 M	112.50 H	0.46
'Navkiran'	0.98 T	14.72 T	16.63 M	6.75 T	14.45 T	0.35
'Rajkrishna'	3.11 S	39.62 S	39.40 S	20.15 M	130.50 H	0.28
'Pyratuni'	3.82 S	41.57 H	42.42 H	13.45 M	163.00 H	0.32
'IR 8 Baramasi'	2.80 M	19.52 M	17.87 M	41.45 H	40.50 S	1.30
'Banaras Long Purple'	1.35 T	13.47 T	15.59 T	15.20 M	33.85 S	2.84
'Baramasi'	3.18 S	21.71 M	25.88 M	18.95 M	33.55 S	1.45
'Shyamla Bhangar'	2.72 M	41.36 H	16.78 M	18.83 M	96.10 H	0.09
'BB 1'	1.45 T	16.17 M	15.56 T	6.55 T	32.50 S	0.27
'Murshidabad Local'	1.57 T	18.77 M	20.83 M	26.60 S	52.50 H	0.43
'ARM 3'	3.10 S	31.04 S	30.50 S	18.65 M	13.50 T	0.55
'Krishna'	3.14 S	32.85 S	24.79 M	15.90 M	16.50 T	0.45
'Krishnanagar Hybrid Variety 90'	2.26 M	33.75 S	45.72 H	18.40 M	22.95 M	1.77
'KB 52'	2.71 M	34.47 S	40.41 S	32.75 H	42.80 S	0.98
'KB 10'	3.56 S	38.34 S	39.62 S	6.45 T	75.50 H	1.12
'Brinjal Long Green'	5.02 H	46.34 H	26.89 S	11.75 M	16.65 T	1.61
'Pusa Kranti'	2.37 M	30.74 S	31.46 S	11.50 M	95.00 H	0.78
'KB 2'	3.93 S	4.62 H	51.03 H	27.15 S	37.00 S	1.08
'Black Prince'	3.67 S	34.83 S	34.99 S	11.55 M	65.00 H	1.27
'Agora'	3.21 S	36.01 S	33.90 S	12.25 M	32.05 S	2.03
'Suttons Long'	4.10 S	41.57 H	36.05 S	36.45 H	17.50 T	0.98

T, Tolerant; M, moderately tolerant; S, susceptible; H, highly susceptible

Fruit damage (%) due to borer infestation on the basis of both number and weight did not differ significantly except in 'Suttons Long', 'Brinjal Long Green', 'BB 1', 'Krishnanagar Hybrid Variety 90', 'Krishnanagar Purple Round' and 'L 13'. The mean values indicate that 'Shyamla Dhepa', 'Kalo Dhepa', and 'Banaras Long Purple' had low infestation (11.76–15.59%) and hence were tolerant. 'Navkiran' on number basis (14.72%) and 'BB 1' on weight basis (15.56%) were also included in the tolerant group. 'Nishchindipur Local', 'Nurki', 'Muktajhuri', 'Banarasi', 'IR 8 Baramasi' and 'Murshidabad Local' were moderately tolerant (16.93–24.64% infestation). The susceptible varieties were 'Agora', 'Black Prince', 'Pusa Kranti', 'KB 10', 'KB 52', 'ARM 3, 'Rajkrishna', 'Improved Muktakeshi', 'KB 5', 'Pusa Purple Cluster', 'Boral', 'Banaras Giant White' and 'Pusa Purple Long', with 27.92–39.62% fruit damage. Highly susceptible varieties were 'R 14', 'Sufal', 'KB 9', 'White Long Cluster', 'Neelam Long', 'Pusa Purple Round', 'KB 20', 'Pyratuni' and 'KB 2', which showed 40.06–52.73% infestation. Our report supports the finding of Subbaratnam and Butani (1981) for varieties 'R 14' and 'Sufal'. Srinivasan and Butani (1961) evaluated 23 types of brinjal and did not find any variety resistant to *L. orbonalis*. Dhankhar *et al.* (1977) reported that wild species *S. sisymbriifolium* Lam. showed the highest degree of tolerance to *L. orbonalis*, followed by cultivated strains 'PPC 2' and 'Aushey'.

Amrasca biguttula biguttula

Singh and Butani (1963) reported that unlike cotton (*Gossypium* spp) and okra [*Hibiscus esculentus* L.; syn *Abelmoschus esculentus* (L.) Moench], brinjal suffers greatly from the attack of this. 'KB 9', 'Pusa Purple Round', 'Pusa Purple Long', 'Banaras Giant White', 'L 13', 'KB 5', 'Improved Muktakeshi', 'Navkiran', 'BB 1' and 'KB 10' had less infestation of jassid, and therefore these were regarded tolerant to the pest (Table 2). The varieties 'Nishchindipur Local', 'White Long Cluster', 'Nurki', 'Shyamla Dhepa', 'Kalo Dhepa', 'Boral', 'PPC', 'K P Round', 'Rajkrishna', 'Pyratuni', 'Banaras Long Purple', 'Baramasi', 'Shyamla Bhangar', and 'Nishchindipur Local' were considered moderately tolerant (11.50–21.15 jassids/5 leaves). The susceptible varieties were 'Muktajhuri', 'KB 20', 'Banarasi', 'Murshidabad Local' and 'KB 2', recording 23.40–27.15 jassids/5 leaves, whereas 'R 14', 'Sufal', 'KB 52' and 'IR 8 Baramasi' were highly susceptible, which showed 30.70–41.45 jassids/5 leaves. A number of workers have also reported field resistance of some varieties including 'Pusa Kranti' to jassid attack (Mote 1978, 1982, Bindra and Mahal 1981, Subbaratnam and Butani 1981, Subbaratnam *et al.* 1983). In the present study 'Pusa Kranti' showed moderate tolerance.

Aphis gossypii

'Sufal', 'Navkiran', 'ARM 3', 'Krishna', 'Brinjal Long Green' and 'Suttons Long' had lesser infestation of aphids (13.50–19.00), and were categorized tolerant (Table 2). 'KB 20', 'Banarasi' and 'Krishnanagar Hybrid Variety 90' were found moderately tolerant, with 22.95–28.00 aphids/5 leaves. But the rest of the varieties were susceptible (32.05–47.00) and highly susceptible (52.50–163.00). Subbaratnam and Butani (1981) reported that cultivar 'S 5' out of 18 screened showed resistance to *A. gossypii*.

Henosepilachna vigintioctopunctata

The population of spotted leaf beetle was less, recording 0.09 for relatively tolerant 'Shyamla Bhangar' to 2.84 for highly susceptible 'Banaras Long Purple', 'R 14' and

'Agora' showed 2.17 and 2.03 beetles respectively, which may be considered susceptible. The remaining cultivars were moderately tolerant, registering 0.43--1.77 pest population.

There was slight variation in the population and incidence of the insect pests during 1991–92 and 1992–93, perhaps due to difference in the weather conditions during the crop-growth season, especially temperature, relative humidity and rainfall and also its interaction with variety and different types of pests studied.

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SCREENING OF EGG PLANT FOR RESISTANCE AGAINST SHOOT AND FRUIT BOR ER; *LEUCINODES ORBONALIS* GUEN.

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ABSTRACT: Forty one cultivars of egg plant, *Solanum melongena* L. were screened for two years (1991-92 and 1992-93) for the shoot and fruit borer, *Leucinodes orbonalis* Guen., to evaluate crop damage both on fruit weight and fruit number bases, resulting Nishchindipur Local, Nurki, Shyamla Dhepa, Navkiran, Kalo Dhepa, IR-8 Baramasi, Banaras Long Purple, BB_1 and Murshidabad Local as fairly resistance having crop loss from 11.76% to 19.52%. The highly susceptible varities were R-14, Sufal, Pusa Purple Round, Pyratuni, KB-20 and KB-2. The damage % varied from 41.17 to 52.73 and 41.36 to 51.73 on the bases of fruit weight and fruit number respectively.

The egg plant, *Solanum melongena* L. suffers badly due to fruit and shoot borer, *Leucinodes orbonalis* Guen. (Lepidoptera:Pyralidae). The extent of damage caused by this insect varies in different cultivars and again in the same cultivar when planted under different agro-climatic situation. In view of the hazardous insecticide residues, resistant or tolerant varieties have to be developed. A little work has been done on this aspect on egg plant (PANDA *et al.*, 1971 ; LALL and AHMAD, 1965; SRINIVASAN and BASHEER, 1962) and hence investigations were undertaken.

Two field experiments were conducted at the Darjeeling during 1991-92 and 1992-93 with 41 cultivars of egg plant, collected from different parts of the country, in a RBD replicated thrice. The plot size was kept at 3.0 x 2.8 m. with 70 x 60 cm. spacing. The data on total number of fruits, number of infested fruits, total weight of fruits and weight of infested fruits were collected. The percentage of fruit infestation was calculated both on number and weight basis. The pest population was recorded as soon as the exit holes first appeared on the damaged fruits. The fruits were harvested at an interval of 10 days, throughout the crop life. The resistance grade index was calculated for each variety according to the degree of infestation. Percent fruit damage on number and weight basis were considered for gradation. The grades were marked according to LAL *et al.*, 1976) as immune (0%), highly resistant (1-10%), fairly resistant (11-20%); tolerant (21-30%), susceptible (31-40%) and highly susceptible (above 41 % infestation).

None of the test cultivars was immune or highly resistant though fairly resistant varieties were NIL, Nurki, Shyamla Dhepa, Kalo Dhepa, Navkiran, IR-8 Baramasi, Banaras Long Purple, BB_1 & Murshidabad Local having percent damage varied from 11.76 (Kalo Dhepa) to 14.52 (IR-8 Baramasi) on fruit number basis and 12.85 (Kalo Dhepa) to 20.83 (Murshidabad Local) on fruit weight basis. The highly susceptible varieties were R-14, L-13, Sufal, PPR, KB-20, Pyratuni & KB-2 both on the basis of fruit number showed a range of per cent damage from 41.36 (Shyamla Bhangar) to 51.73 (R-14), whereas based on fruit weight per cent 41.17 (L-13) to 52.73 (R-14). The damage per cent was generally been more on weight basis than on the number basis but Shyamla Bhangar showed distinct deviation along with other 11 varieties amongst 41 screened, recording 41.36 per cent damage on number and 16.78 per cent on weight basis as earliar reported by LAL *et al.* (1976). The damage percent ranged from 21.16 (Muktajhuri) to 30.74 (Pusa Kranti) for tolerant and 31.04 (KB-5) to 40.55

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(WLC) for susceptible grades on the basis of infested fruit numbers while on weight basis these were correspondingly 22.30 (Muktajhuri) to 30.50 (ARM-3) and 31.46 (Pusa Kranti) to 40.41 (KB-52).

PANDA *et al.* (1971) reported that Muktakeshi suffers above 40% damage even in winter season and graded as susceptible one which is in accordance with present finding. On the basis of fruit number, PPC appears to be tolerant although susceptible on weight basis. Such variable tolerance reaction was also reported by DHANKHAR *et al.* (1977) and SUBBARAT-NAM *et al.* (1981). On the other hand LAL *et al.* (1976) observed that the PPC cultivar from Himachal Pradesh showing variation from fairly resistant to tolerant on number and weight bases respectively. Such differences could be due to change in agroclimatic condition in different experimental localities and also during different years. PPL, PPR and Indo-American hybrids showed susceptible to highly susceptible reaction to this pest are earliar reported by SUBBARATNAM et al. (1981), PANDA *et al.* (1971) and LAL *et al.* (1976).

While the variety Nurki was recorded as fairly resistant under North Bengal climate both on number & weight bases, it was found to be highly susceptible in the climate of Himachal Pradesh (LAL *et al.*, 1976). Pusa Kranti showed tolerance on fruit number basis while susceptibility on weight basis, as earliar reported by LAL *et al.* (1976) and SUBBARATNAM *et al.* (1981).

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EVALUATION OF RELATIVE SUSCEPTIBILTY OF EGG PLANT CULTIVARS TO SHOOT AND FRUIT BORER, *LEUCINODES ORBONALIS* GN.

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ABSTRACT . Analysis of variance revealed significant differences for all the 10 test-characters. The genetic potentiality of various strains with respect to tolerance to the shoot and fruit borer, *Leucinodes orbonalis* Gn indicated that Kalo Dhepa was the least susceptible as was evident from % infested fruits. However, in general, Kalo Dhepa, Shyamla Dhepa, Navkiran, Banaras Long Purple and BB-1 could be statistically considered under fairly tolerant grade. Among the 41 cultivars tested Baramasi proved to be the best yielder (6.91 kg. pl.) followed by Kalo Dhepa (6.79 kg. pl.). Considering the yield and relative susceptibility, Kalo Dhepa, Shyamla Dhepa and Navkiran may be recommended for profitable cultivation without any obligation of pesticidal use

There are many problems of insect-pests and diseases in obtaining stable high quality marketable fruits in brinjal. Among these, the attack of shoot and fruit borer causes very heavy losses. Even with the help of potent insecticides, it is difficult to control this pest. Therefore, the main emphasis was given to relative susceptibility of egg plant varieties to shoot and fruit borer, *Leucinodes orbonalis* Gn. (Pyralidae) in the Darjeeling terai.

Forty one cultivars of *Solanum melongena* Linn. were transplanted during November 1991-92 and 1992-1993 in RBD with 3 replications in experimental plots in Siliguri. Transplantation was done with 70 cm. x 60 cm. spacing in two rows in each subplot of 7.5 sq.m. From each entry 10 randomly selected plants were taken for recording data on percent loss in fruit yield, percent infested fruits and branches per plant, days to borer attack on branches and fruit in 50% plants, number of holes per fruit and per plant, number of larvae per fruit and per plant and total fruit yield. No spraying was done for the control of any insect or disease.

Genetic potentiality of various cultivars with respect to yield components and the extent of the relative susceptibility (Table) showed that Kalo Dhepa was least susceptible as indicated by % infested fruits (10.02). However, Kalo Dhepa, Shyamla Dhepa, Navkiran, Banaras Long Purple and BB-1 could be statistically considered under same group in respect of susceptibility. These cultivars could be fairly graded as tolerant to the pest. Among the 41 genotypes of egg plant, Baramasi proved to be the best yielder (6.91kg pl.) followed by Kalo Dhepa (6.79 Kg./pl.).

Mean performance for 41 cultivars with respect to relative susceptibility and yield attributes was clearly depicted graphically (Fig. 1-3). In most of the varieties the highest range of variation 80.84 - 136.17 for days to borer attack in fruit and lowest range of variation for larvae per fruit were observed. Similar observation, i.e. lowest range of variation for larvae per fruit was documented by DHANKHAR *et al.* 1977. The same author further reported that percent infested fruits in normal crop and days to borer attack on fruits in ratoon crop of brinjal exhibited highest range. Considering the yield attributes as well as susceptibility to the pest, Kalo Dhepa, Shyamla Dhepa and Navkiran may be recommended for profitable cultivation in the agro-environment of the terai region of North Bengal, even without any obliga for pesticidal treatment.

Table 1. Analysis of variance for 10 characters in 41 egg plant cultivars

S.No.	Characters	Mean Sum of Squars		
		Replications (df = 2)#	Treatments (df = 40)	Error (df = 80)
1	Loss of	40.82	515.30**	28.26
	yield/pl.(%)	103.45	531.15**	50.81
2	Infested	15.18	287.86**	23.59
	ft./pl.(%)	9.46	490.68**	32.33
3	Infested	0.00	0.52**	0.01
	br./pl.(%)	1.61	174.13**	13.52
4	Days to	3.81	344.87**	14.06
	borer on ft.	79.73	316.12**	36.00
5	Days to	33.33	340.52**	48.83
	borer on br.	3.42	340.98**	6.11
6	Holes/ft.	0.00	196.64**	9.09
	(no.)	0.01	0.46**	0.05
7	Holes/pl.	0.16	17.49**	0.12
	(no.)	0.17	14.70**	1.65
8	Larvae/ft.	0.01	0.05**	0.01
	(no.)	0.01	0.05**	0.01
9	Larvae/pl.	0.01	1.78**	0.01
	(no.)	0.01	1.75**	0.02
10	Total	0.03	11.05**	0.11
	yield/pl.	0.03	8.90**	0.03

For each character the first row represent the value for 1991-92 and second row for 1992-93

** F-test significant at 0.01 level.

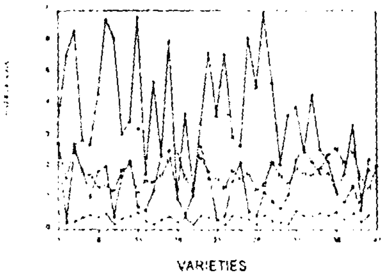

Fig-3. Mean performance of 41 egg plant cultivars with respect to : A. No. Of holes/ft., B. No. of larvae/ft., C. No. of larvae/pl., D. Total yield/pl. (Kg.)

1. R-14, 2. Nishchindipur Local, 3. Sufal, 4. KB-9, 5. White Long Cluster, 6. Nurki 7. Muktajhuri, 8. Shyamla Dehepa, 9. Neelam Long, 10. Pusa Purple Round, 11. Kalo Dhepa 12. Pusa Purple Long, 13. Banaras Giant White, 14. KB-20, 15. L-13, 16. Boral, 17. Pusa Purple Cluster, 18. Banarasi, 19. KB-5, 20 Muktakeshi, 21. Krishnanagar Purple Round, 22. Navkiran, 23. Rajkrishna, 24. Pyratuni, 25. IR-8 Baramasi, 26. Banaras Long Purple, 27. Baramasi, 28. Shyamla Bhangar, 29. BB-1, 30. Murshidabad Local, 31. ARM-3, 32. Krishna, 33. Krishnanagar Hybrid Variety-90, 34. KB-52, 35. KB-10, 36. Brinjal Long Green, 37. Pusa Kranti, 38. KB-2, 39. Black Prince, 40 Agora, 41. Suttons Long.

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Table 1. Analysis of variance for 10 characters in 41 egg plant cultivars

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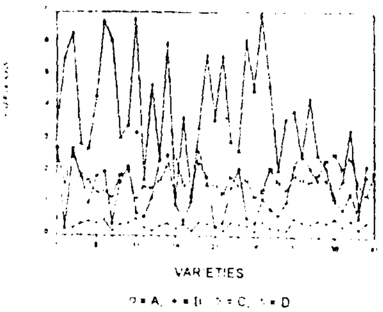
1	Loss of	40.82	515.30**	28.26
	yield/pl.(%)	103.45	531.15**	50.81
2	Infested	15.18	287.86**	23.59
	ft./pl.(%)	9.46	490.68**	32.33
3	Infested	0.00	0.52**	0.01
	br./pl.(%)	1.61	174.13**	13.52
4	Days to	3.81	344.87**	14.06
	borer on ft.	79.73	316.12**	36.00
5	Days to	33.33	340.52**	48.83
	borer on br.	3.42	340.98**	6.11
6	Holes/ft.	0.00	196.64**	9.09
	(no.)	0.01	0.46**	0.05
7	Holes/pl.	0.16	17.49**	0.12
	(no.)	0.17	14.70**	1.65
8	Larvae/ft.	0.01	0.05**	0.01
	(no.)	0.01	0.05**	0.01
9	Larvae/pl.	0.01	1.78**	0.01
	(no.)	0.01	1.75**	0.02
10	Total	0.03	11.05**	0.11
	yield/pl.	0.03	8.90**	0.03

For each character the first row represent the value for 1991-92 and second row for 1992-93

** F-test significant at 0.01 level



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MANAGEMENT OF INSECT PEST COMPLEX OF BRINJAL, *SOLANUM MELONGENA* L. USING RESISTANT VARIETY AND MINIMUM INSECTICIDES

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Six promising cultivars obtained through initial field screening of 41 varieties for two successive years were further tested in Darjeeling Terai during the period October-March, 1993-94 and 1994-95 to know their relative resistance against the insect pest complex. For this purpose four major pests were considered : the shoot and fruit borer *Leucinodes orbonalis* Guen., the jassid *Amrasca biguttula biguttula* Ishida, the aphid *Aphis gossypii* Glover and the spotted leaf beetle *Epilachna vigintioctopunctata* Fabr. Special emphasis was given to *L. orbonalis*. Kalo Dhepa, Navkiran and Banaras long purple were recorded as the highly resistant varieties in this agro-climatic zone. With reference to the ratio of infested to healthy fruit weight, the degree of resistance could be arranged as Kalo Dhepa>Navkiran>Banaras Long Purple>Banaras Giant White>Krishna>R 14. However, based on infested to healthy fruit number Kalo Dhepa appeared to be most resistant against the borer, though it was found to be relatively susceptible to jassid and aphid. Navkiran showed multiple resistance against all the 4 major pests. Banaras Long Purple was particularly resistant against the borer with moderate tolerance to the jassid and aphid. Trial with minimum insecticidal protection to the selected six promising cultivars increased the marketable yield due to reduced infestation by the four pests. Hence, the resistant cultivars of brinjal combined with minimum dosage of pesticides like carbofuran @ 750 g a.i./ha followed by single spray of endosulfan @ 525 g a.i./ha may be recommended under IPM, specially in the Darjeeling Terai.

INTRODUCTION

Among dozen of insect pests attacking brinjal crop, the shoot and fruit borer, *Leucinodes orbonalis* Guen. is the most serious. This species alone may cause as high as 52% damage to the fruits even in the winter months in the agro-climatic conditions of Darjeeling Terai (Mandel *et al.*, 1994). The foliage pests namely the jassid *Amrasca biguttula biguttula* Ishida, the spotted leaf beetle *Epilachna vigintioctopunctata* Fabr. and the aphid *Aphis gossypii* Glover rank next in importance. While the foliage pests can be easily controlled, with pesticides, indeed with their adverse environmental effects, it is difficult to control the borer even with insecticides. The management of *L. orbonalis* by adopting suitable eco-friendly technique, is the demanding need of the day. In Punjab, Singh & Sidhu (1986) suggested possible management technique, depending on the complexity of the pest problem, varietal resistance and type of chemical protection. However, no work has been done in this line from Terai belt of Darjeeling which represents a distinct climatic zone of North Bengal. This article embodies the work carried out at the North Bengal University, Siliguri (India) covering four years for the management of these pests, particularly the borer, by combining crop resistance with minimum use of insecticides. The screening of resistant cultivars was done on all the four pest species. Emphasis on eco-friendly management procedure was restricted to the borer.

MATERIALS AND METHODS

In order to find out the immune response of the cultivars, at first screening work was carried out during autumn-winter season of 1991-92 and 1992-93. Following Lal *et al.* (1976), out of forty-one cultivars screened, three cultivars namely Kalo Dhepa (V1), Banaras Long Purple (V5) and Navkiran (V6) were identified as relatively resistant; Banaras Giant White (V2) and Krishna (V3) as moderately susceptible and R 14 (V4) as highly susceptible cultivar to this pest. The promising six cultivars thus obtained, were further tested for two more years during 1993-94 and 1994-95 for confirmation of their immune response to the four major insect pests with special emphasis to *L. orbonalis*. In all the screening experiments varieties were transplanted in a randomized block design with three replicas. The size of the sub-plots (replications) was 3.0 x 2.8 m having 20 plants spaced 70 x 60 cm apart.

Split plot technique was followed during 1993-94 and 1994-95 for pesticidal screening. During this period, variety performance of brinjal towards the borer, jassid, aphid and spotted leaf beetle was tested in an unprotected crop as control. The pesticidal screening design was as under:

P0 = Control having no treatment of water or insecticides.
P1=Root zone treatment with carbofuran @ 750 g a.i./ha at 3 weeks after transplanting followed by single foliar spray of cypermethrin @ 50 g a.i./ha at 70 days after transplanting.
P2 = Carbofuran was applied as in the first one followed by single spray of endosulfan @ 525 g a.i./ha at 70 days after transplanting.
P3 = Water spray only.

From all the experiments on varietal testing and chemical control, observations on the number of healthy and borer damaged fruits were recorded at each picking and the cumulative mean per cent fruits damaged by the borer was worked out for different treatments. The population of jassid, spotted leaf beetle and aphid were recorded from 5 leaves of each of the 5 central plants in every sub-plot and averaged out. The observations were recorded throughout the crop growth phase at 20 day interval. The yield of marketable fruits were /was recorded at each picking on whole plot basis and converted into total yield/plant for different treatments.

RESULTS AND DISCUSSION

Varietal performance against shoot and fruit borer

Results (Table I) indicated that under unprotected natural infestation, fruit damage due to the borer only occurred to the extent of 10.02-19.42% in V1, V5 and V6, 25.00-34.43% in moderately susceptible varieties like V2 and V3 and 45.12-58.35% for susceptible R 14, manifesting their relative resistance. The mean fruit damage in case of three former cultivars was

Table I : Performance of six cultivars of brinjal against shoot and fruit borer, *L. orbonalis* under unprotected condition (% infested fruit by number during different years)

Year	Variety						Mean
	Kalo Dhepa (V1)	Banaras Giant White (V2)	Krishna (V3)	R 14 (V4)	Banaras Long Purple (V5)	Navkiran (V6)	
1991 - 92	11.76	30.84	31.27	45.12	14.37	10.02	23.90
1992 - 93	11.76	25.00	34.43	58.35	12.57	19.42	25.43
1993 - 94	11.50	29.83	28.07	53.33	16.20	13.65	25.43
1994 - 95	11.55	29.20	30.44	45.76	12.99	17.65	24.60
Mean	11.64	28.72	31.05	50.64	14.03	15.18	
		Variety (V)	Years (Y)		V x Y	V x Y*	
SE(m)		00.93	00.47		03.53	01.88	
CD(p=0.005)		02.93	01.30		10.25	05.20	

* = Within same main plot

14.03 and 11.64, 15.18% as against 50.64% for susceptible variety V4. Under insecticidal semi-protection V1 showed maximum resistance to fruit borer (Table II & III) during 1993-94 and 1994-95 with 1: 7.27 as the ratio of infested to the healthy fruits (Table V). V5 and V6 suffered nearly equal damage, the ratio being 1: 5.68 and 1: 4.93 respectively. V4 appeared most susceptible with a ratio of 1: 0.85, though the damage was reduced to 21%.

Against jassid, beetle and aphid

Among the six varieties studied V6 showed multiple resistance against jassid, spotted leaf beetle and aphid whereas V4 showed relatively susceptible reaction to all these insect pests (Table IV).

Yield performance of the cultivars

Mean values of healthy and infested fruits of four years revealed the fact that maximum mean marketable yield was produced by V1 (5.54 kg/pl.) followed by V6 (4.81 kg/pl.). Considering the ratio of infested to healthy fruit yield (Table V) V1, V5 and V6 may be recommended for cultivation without any obligation to pesticidal spray, supporting the earlier findings (Mandal *et al.*, 1994; Mukhopadhayay & Mandal, 1994). Under semiprotected

Table II: Screening of pesticides with six promising cultivars in brinjal against *L. orbonalis* during 1993-94 (% infested fruits by number).

Treatments	Varieties						Mean
	V1	V2	V3	V4	V5	V6	
P0	13.00	28.00	31.00	49.33	15.00	16.00	25.39
P1	02.15	09.40	12.63	22.33	06.80	05.50	10.29
P2	03.04	12.20	14.97	25.33	08.62	06.94	11.79
P3	14.00	27.67	28.00	25.00	16.00	23.97	22.44
Mean	08.05	19.32	21.65	30.50	11.51	13.10	
		Variety	Treatments (P)		V x P	V x P*	
SE(m)		0.43	0.26		0.98	0.62	
CD (p=0.05)		1.35	0.72		2.85	2.49	

* = Within same main plot.

Table III: Screening of pesticides with six promising cultivars of brinjal against *L. orbonalis* during 1994-95 (% infested fruits by number).

Treatments	Varieties						Mean
	V1	V2	V3	V4	V5	V6	
P0	12.62	28.83	31.17	47.13	16.80	18.11	25.78
P1	04.00	10.10	12.56	21.65	21.12	07.66	12.86
P2	03.32	13.63	11.53	21.12	23.00	09.00	13.93
P3	13.67	31.67	30.37	26.38	17.66	22.11	23.64
Mean	08.40	21.06	21.41	29.57	19.65	14.22	
		Variety (V)	Treatments (P)		V x P	V x P*	
SE(m)		0.68	0.28		1.62	0.97	
CD (p=0.05)		3.18	1.13		4.82	2.68	

* = Within same main plot.

condition (Table II & III) all the relatively resistant cultivars namely V1, V5 and V6 showed less infestation of borer and thereby better yield of healthy fruits.

Summarily the performance of different cultivars in reference to the damage by the major insect pests under semiprotected and unprotected conditions brings to the light following points :

(a) For the unprotected crop

1. V1, V5 and V6 were relatively resistant to shoot and fruit borer whereas V4 being most susceptible.
2. V6 showed relatively more resistance towards all the major pests in question whereas V4 was relatively susceptible to all the insect pests.
3. Mean yield of healthy fruits of V1 was best (5.54 kg/pl.) followed by V6 (4.81 kg/pl.).
4. Ratio of infested to healthy fruit yield on weight basis showed V1 (1:5.08) as most resistant followed by V6 (1:5.01) and V5 (1: 4.86) whereas V4 as most susceptible (1: 0.76).

(b) For the semiprotected crop

The performance of the cultivars with respect to pest damage and the yield under semiprotected conditions was different from that of the unprotected crop. In general, the interaction between the degree of resistance of the cultivars and insecticidal protection minimised the borer infestation. Expecting the V2 and V3, the other 4 cultivars during both the years showed different interactions. V1 being susceptible to both jassids and aphids and fairly resistant to the borer pest proved best, followed by the multiple pest resistant varieties V5 and V6.

Table IV Mean population of jassids, aphids and beetles per 5 leaves on 6 promising cultivars for 2 successive years under unprotected condition.

Varieties	Jassids	Aphids	Beetles
V1	15.66	52.25	1.70
V2	09.03	74.40	0.58
V3	17.18	17.50	0.44
V4	25.88	137.50	2.37
V5	14.35	34.68	2.83
V6	08.35	13.98	0.37

Efficacy of insecticide combinations

Bioefficacy of the two combinations of pesticides revealed a superiority of cypermethrin over endosulfan in combination with carbofuran although both the combinations statistically were almost at par (Table II & III). This superiority of synthetic pyrethroids over endosulfan was reported by Umapathy & Baskaran (1991) against the borer causing its 79.7% mortality. Brar *et al.* (1993) also recorded very good result with the combination of carbofuran and cypermethrin.

During 1993-94, fairly resistant V1 performed best against the borer pest when treated with carbofuran and cypermethrin combination. Carbofuran and endosulfan combination with this variety was statistically at par. It was then followed by V6 and V5 treated with carbofuran and

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MANAGEMENT OF INSECT PEST COMPLEX OF BRINJAL, *SOLANUM MELONGENA* L. USING RESISTANT VARIETY AND MINIMUM INSECTICIDES

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Six promising cultivars obtained through initial field screening of 41 varieties for two successive years were further tested in Darjeeling Terai during the period October-March, 1993-94 and 1994-95 to know their relative resistance against the insect pest complex. For this purpose four major pests were considered : the shoot and fruit borer *Leucinodes orbonalis* Guen., the jassid *Amrasca biguttula biguttula* Ishida, the aphid *Aphis gossypii* Glover and the spotted leaf beetle *Epilachna vigintioctopunctata* Fabr. Special emphasis was given to *L. orbonalis*. Kalo Dhepa, Navkiran and Banaras long purple were recorded as the highly resistant varieties in this agro-climatic zone. With reference to the ratio of infested to healthy fruit weight, the degree of resistance could be arranged as Kalo Dhepa>Navkiran>Banaras Long Purple>Banaras Giant White>Krishna>R 14. However, based on infested to healthy fruit number Kalo Dhepa appeared to be most resistant against the borer, though it was found to be relatively susceptible to jassid and aphid. Navkiran showed multiple resistance against all the 4 major pests. Banaras Long Purple was particularly resistant against the borer with moderate tolerance to the jassid and aphid. Trial with minimum insecticidal protection to the selected six promising cultivars increased the marketable yield due to reduced infestation by the four pests. Hence, the resistant cultivars of brinjal combined with minimum dosage of pesticides like carbofuran @ 750 g a.i./ha followed by single spray of endosulfan @ 525 g a.i./ha may be recommended under IPM, specially in the Darjeeling Terai.

INTRODUCTION

Among dozen of insect pests attacking brinjal crop, the shoot and fruit borer, *Leucinodes orbonalis* Guen. is the most serious. This species alone may cause as high as 52% damage to the fruits even in the winter months in the agro-climatic conditions of Darjeeling Terai (Mandel *et al.*, 1994). The foliage pests namely the jassid *Amrasca biguttula biguttula* Ishida, the spotted leaf beetle *Epilachna vigintioctopunctata* Fabr. and the aphid *Aphis gossypii* Glover rank next in importance. While the foliage pests can be easily controlled. with pesticides, indeed with their adverse environmental effects, it is difficult to control the borer even with insecticides. The management of *L. orbonalis* by adopting suitable eco-friendly technique, is the demanding need of the day. In Punjab, Singh & Sidhu (1986) suggested possible management technique, depending on the complexity of the pest problem, varietal resistance and type of chemical protection. However, no work has been done in this line from Terai belt of Darjeeling which represents a distinct climatic zone of North Bengal. This article embodies the work carried out at the North Bengal University, Siliguri (India) covering four years for the management of these pests, particularly the borer, by combining crop resistance with minimum use of insecticides. The screening of resistant cultivars was done on all the four pest species. Emphasis on eco-friendly management procedure was restricted to the borer.

MATERIALS AND METHODS

In order to find out the immune response of the cultivars, at first screening work was carried out during autumn-winter season of 1991-92 and 1992-93. Following Lal *et al.* (1976), out of forty-one cultivars screened, three cultivars namely Kalo Dhepa (V1), Banaras Long Purple (V5) and Navkiran (V6) were identified as relatively resistant; Banaras Giant White (V2) and Krishna (V3) as moderately susceptible and R 14 (V4) as highly susceptible cultivar to this pest. The promising six cultivars thus obtained, were further tested for two more years during 1993-94 and 1994-95 for confirmation of their immune response to the four major insect pests with special emphasis to *L. orbonalis*. In all the screening experiments varieties were transplanted in a randomized block design with three replicas. The size of the sub-plots (replications) was 3.0 x 2.8 m having 20 plants spaced 70 x 60 cm apart.

Split plot technique was followed during 1993-94 and 1994-95 for pesticidal screening. During this period, variety performance of brinjal towards the borer, jassid, aphid and spotted leaf beetle was tested in an unprotected crop as control. The pesticidal screening design was as under:

P0 = Control having no treatment of water or insecticides.
P1=Root zone treatment with carbofuran @ 750 g a.i./ha at 3 weeks after transplanting followed by single foliar spray of cypermethrin @ 50 g a.i./ha at 70 days after transplanting.
P2 = Carbofuran was applied as in the first one followed by single spray of endosulfan @ 525 g a.i./ha at 70 days after transplanting.
P3 = Water spray only.

From all the experiments on varietal testing and chemical control, observations on the number of healthy and borer damaged fruits were recorded at each picking and the cumulative mean per cent fruits damaged by the borer was worked out for different treatments. The population of jassid, spotted leaf beetle and aphid were recorded from 5 leaves of each of the 5 central plants in every sub-plot and averaged out. The observations were recorded throughout the crop growth phase at 20 day interval. The yield of marketable fruits were recorded at each /was picking on whole plot basis and converted into total yield/plant for different treatments.

RESULTS AND DISCUSSION

Varietal performance against shoot and fruit borer

Results (Table I) indicated that under unprotected natural infestation, fruit damage due to the borer only occurred to the extent of 10.02-19.42% in V1, V5 and V6, 25.00-34.43% in moderately susceptible varieties like V2 and V3 and 45.12-58.35% for susceptible R 14, manifesting their relative resistance. The mean fruit damage in case of three former cultivars was

Table I : Performance of six cultivars of brinjal against shoot and fruit borer, *L. orbonalis* under unprotected condition (% infested fruit by number during different years).

Year	Variety						Mean
	Kalo Dhepa (V1)	Banaras Giant White (V2)	Krishna (V3)	R 14 (V4)	Banaras Long Purple (V5)	Navkiran (V6)	
1991 - 92	11.76	30.84	31.27	45.12	14.37	10.02	23.90
1992 - 93	11.76	25.00	34.43	58.35	12.57	19.42	25.43
1993 - 94	11.50	29.83	28.07	53.33	16.20	13.65	25.43
1994 - 95	11.55	29.20	30.44	45.76	12.99	17.65	24.60
Mean	11.64	28.72	31.05	50.64	14.03	15.18	
		Variety (V)	Years (Y)		V x Y	V x Y*	
SE(m)		00.93	00.47		03.53	01.88	
CD(p=0.005)		02.93	01.30		10.25	05.20	

* = Within same main plot

14.03 and/ 11.64, 15.18% as against 50.64% for susceptible variety V4. Under insecticidal semi-protection V1 showed maximum resistance to fruit borer (Table II & III) during 1993-94 and 1994-95 with 1: 7.27 as the ratio of infested to the healthy fruits (Table V). V5 and V6 suffered nearly equal damage, the ratio being 1: 5.68 and 1: 4.93 respectively. V4 appeared most susceptible with a ratio of 1: 0.85, though the damage was reduced to 21%.

Against jassid, beetle and aphid

Among the six varieties studied V6 showed multiple resistance against jassid, spotted leaf beetle and aphid whereas V4 showed relatively susceptible reaction to all these insect pests (Table IV).

Yield performance of the cultivars

Mean values of healthy and infested fruits of four years revealed the fact that maximum mean marketable yield was produced by V1 (5.54 kg/pl.) followed by V6 (4.81 kg/pl.). Considering the ratio of infested to healthy fruit yield (Table V) V1, V5 and V6 may be recommended for cultivation without any obligation to pesticidal spray, supporting the earlier/findings (Mandal *et al.*, 1994; Mukhopadhayay & Mandal, 1994). Under semiprotected

Table II: Screening of pesticides with six promising cultivars in brinjal against *L. orbonalis* during 1993-94 (% infested fruits by number).

Treatments	Varieties						Mean
	V1	V2	V3	V4	V5	V6	
P0	13.00	28.00	31.00	49.33	15.00	16.00	25.39
P1	02.15	09.40	12.63	22.33	06.80	05.50	10.29
P2	03.04	12.20	14.97	25.33	08.62	06.94	11.79
P3	14.00	27.67	28.00	25.00	16.00	23.97	22.44
Mean	08.05	19.32	21.65	30.50	11.51	13.10	
	Variety	Treatments (P)		V x P	V x P*		
SE(m)	0.43	0.26		0.98	0.62		
CD (p=0.05)	1.35	0.72		2.85	2.49		

* = Within same main plot.

Table III: Screening of pesticides with six promising cultivars of brinjal against *L. orbonalis* during 1994-95 (% infested fruits by number).

Treatments	Varieties						Mean
	V1	V2	V3	V4	V5	V6	
P0	12.62	28.83	31.17	47.13	16.80	18.11	25.78
P1	04.00	10.10	12.56	21.65	21.12	07.66	12.86
P2	03.32	13.63	11.53	21.12	23.00	09.00	13.93
P3	13.67	31.67	30.37	26.38	17.66	22.11	23.64
Mean	08.40	21.06	21.41	29.57	19.65	14.22	
	Variety (V)	Treatments (P)		V x P	V x P*		
SE(m)	0.68	0.28		1.62	0.97		
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condition (Table II & III) all the relatively resistant cultivars namely V1, V5 and V6 showed less infestation of borer and thereby better yield of healthy fruits.

Summarily the performance of different cultivars in reference to the damage by the major insect pests under semiprotected and unprotected conditions brings to the light following points :

(a) For the unprotected crop

1. V1, V5 and V6 were relatively resistant to shoot and fruit borer whereas V4 being most susceptible.
2. V6 showed relatively more resistance towards all the major pests in question whereas V4 was relatively susceptible to all the insect pests.
3. Mean yield of healthy fruits of V1 was best (5.54 kg/pl.) followed by V6 (4.81 kg/pl.).
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(b) For the semiprotected crop

The performance of the cultivars with respect to pest damage and the yield under semiprotected conditions was different from that of the unprotected crop. In general, the interaction between the degree of resistance of the cultivars and insecticidal protection minimised the borer infestation. Excepting the V2 and V3, the other 4 cultivars during both the years showed different interactions. V1 being susceptible to both jassids and aphids and fairly resistant to the borer pest proved best, followed by the multiple pest resistant varieties V5 and V6.

Table IV Mean population of jassids, aphids and beetles per 5 leaves on 6 promising cultivars for 2 successive years under unprotected condition.

Varieties	Jassids	Aphids	Beetles
V1	15.66	52.25	1.70
V2	09.03	74.40	0.58
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V4	25.88	137.50	2.37
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V6	08.35	13.98	0.37

Efficacy of insecticide combinations

Bioefficacy of the two combinations of pesticides revealed a superiority of cypermethrin over endosulfan in combination with carbofuran although both the combinations statistically were almost at par (Table II & III). This superiority of synthetic pyrethroids over endosulfan was reported by Umapathy & Baskaran (1991) against the borer causing its 79.7% mortality. Brar *et al.* (1993) also recorded very good result with the combination of carbofuran and cypermethrin.

During 1993-94, fairly resistant V1 performed best against the borer pest when treated with carbofuran and cypermethrin combination. Carbofuran and endosulfan combination with this variety was statistically at par. It was then followed by V6 and V5 treated with carbofuran and cypermethrin combination. V6 showed a very good response with carbofuran and endosulfan combination and ranked next. Interestingly, water spray alone appeared to reduce pest menace when compared with control plants in respect to relatively susceptible cultivars like V4, V3 and V2 but not in case of the fairly resistant V1, V5 and V6 cultivars.

During 1994-95, the combination of carbofuran with endosulfan was a bit superior to the other combination, when applied to the relatively resistant V1 cultivar and was statistically at par with carbofuran and cypermethrin combination. Next treatment showed superiority of V6 with P1 and P2 treatments. Islam & Quiniones (1990) reported superiority of endosulfan over methyl parathion. Further, endosulfan residue was less (0.0023 mg/kg) 6 days after the spray compared to that of parathion (0.015 mg/kg). According to Raha *et al.* (1993) residue of endosulfan in and on brinjal fruits immediately after application was below the tolerance level of 2 ppm as specified by FAO/WHO. Reddi & Joshi (1990) reported that when endosulfan was applied in combination with plant growth regulators it gave best yield. The endosulfan combination was the most economic. Singh (1993) also recommended endosulfan (0.07%) sprays under IPM for controlling tomato borer as safe pesticide. Hence, considering the safe pesticide P2 treatment combinations may be recommended following IPM in combination with cultivar V1.

Table V: Mean yield of six promising cultivars of brinjal over 4 successive years with respect to healthy (H) and infested (I) fruits.

Varieties	On fruit weight (kg/pl.)			On fruit numbers		
	H	I	Ratio (I:H)	H	I	Ratio (I:H)
V1	5.54	1.09	1 : 5.08	15.34	2.11	1 : 7.27
V2	2.83	1.47	1 : 1.93	02.75	1.28	1 : 2.15
V3	1.44	0.91	1 : 1.58	13.08	7.75	1 : 1.69
V4	1.34	1.77	1 : 0.76	06.33	7.49	1 : 0.85
V5	3.55	0.73	1 : 4.86	43.00	7.57	1 : 5.68
V6	4.81	0.96	1 : 5.01	11.92	2.42	1 : 4.93

The relative difference of infestation of shoot and fruit borer and jassid in different brinjal varieties has been reported by Subbaratnam & Bhutani (1981), Mote (1981a) and Bajaj *et al* (1989). However, the varieties have not been tested for their performance towards other pests and to their yield. Further, none of the varieties considered in this paper have been tested previously. A large number of insecticides have also been tested against different brinjal pests by many workers such as Mehto & Lal (1981), Mote (1981b), Nimbalkar & Ajri (1981), Agnihotri *et al.* (1990), Acharya (1991) and Bothera & Dethe (1991). But the information on the choice of varieties under specific chemical treatment is lacking. In final, no brinjal cultivar has been reported to be completely resistant to the pest attack. The present approach of integrating the chemical pesticide application with the partially resistant varieties to different pest can go a long way in the economic management of the brinjal pests. On the basis of our results the combination of carbofuran and endosulfan appeared to be suitable alongwith the consideration of resistance. Because residue of endosulfan is less and this pesticide is much cheaper than the synthetic pyrethroids. Again, with the combination of carbofuran and endosulfan the varieties can be ranked in the descending order of superiority as V1>V5>V6>V2>V3>V4.

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