BACTERIAL WILT RESISTANCE AND YIELD IN BRINJAL (*Solanum melongena* L.)

BY

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"Bacterial wilt resistance and yield in brinjal (*Solanum melongena* L.)"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship, associate-ship or other similar title of any other university or society.

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Introduction

INTRODUCTION

Brinjal (*Solanum melongena* L.) is a popular vegetable crop grown throughout the country. India being the primary centre of origin, a wide range of diversity this crop exists here and the wider ecological adaptability facilitated its spread to different parts of the country. In India the present productivity of brinjal is 13.08 t/ha with the production of 58.4 lakh tonnes from an area of 4.47 lakh hactares. Orissa, Bihar, West Bengal, Karnataka, Gujarat and Madhya Pradesh are leading in production of brinjal in the country. Statistics indicate that the area under brinjal in Kerala is very meagre. However, it is grown in all homesteads and commercial cultivation is limited to certain villages in the state. The delicious preparations made of brinjal are highly appreciated.

Kerala has a unique system of homestead farming consisting of small operational holdings, wherein vegetable cultivation has become an integral part. In case of brinjal, the major part of planted area is in garden lands as a part of homestead farming system, rather than in a larger commercial scale as found in many other states. Consumer's preference varies with colour, shape and size of the brinjal fruits from region to region. Nutritionally this fruit is equivalent to tomato and is a good source of vitamin C and calcium (12 and 18 mg/100 g respectively). It is used in ayurvedic treatments as an appetiser, aphrodisiac and cardiotonic and is also reported to be good for diabetic patients.

The low productivity of brinjal is mainly ascribed to poor genetic stock, lack of information on scientific package of practices and incidence of pest and diseases like bacterial wilt, phomopsis blight, fruit and shoot borer and jassids.

Variability in the population is an improtant pre-requisite for the success of any crop improvement programme. Wide range of variation existing in brinjal offers great scope for the improvement. Exploitation of hybrid vigour has been used as a tool for increasing productivity and is economical and feasible in brinjal since each fruit contains large number of seeds.

The main limitation for brinjal cultivation in the traditional growing tracts in Kerala is the incidence of bacterial wilt caused by *Pseudomonas solanacearum* E.F. Smith. The warm humid tropical climate and acidic soil conditions in Kerala favour the incidence of bacterial wilt. Crop loss upto 100 per cent occurs due to this disease. Chemical control measures have not been successful in controlling this disease. Therefore, cultivation of resistant varieties/hybrids is the obvious method to tackle this problem. Incidence of jassids (*Amrasca biguttula biguttula*) is another serious problem restricting the cultivation of brinjal during summer season in the state. Chemical control measures are practically ineffective due to high population build up during the season. The only way of combating this problem is cultivation of resistant varieties.

The present investigation was therefore taken up with a view of holistic improvement of brinjal with the following objectives:

1. to identify additional bacterial wilt resistant lines with high yield and desired plant and fruit characters,

2. to develop bacterial wilt resistant and high yielding F_1 hybrids differing in fruit characters and

3. to find out high yielding, bacterial wilt and jassid resistant grafts in brinjal in order to tackle the problems of bacterial wilt and jassids prevailing in the state during summer months in brinjal crop.

Review of Literature

REVIEW OF LITERATURE

The available literature relevant to the present investigations are reviewed and presented under the following heads:

A. Performance study of brinjal in Kerala

B. Bacterial wilt incidence in brinjal

C. Jassid infestation in brinjal

D. Exploitation of hybrid vigour in brinjal

E. Grafting in vegetables

A. Performance study of brinjal in Kerala

Attempts to identify high yielding brinjal varieties adaptable to Kerala conditions started in 1980s. Testing of varieties or advanced cultures developed by various research organisation under the All India Co-ordinated Vegetable Improvement Project at Vellanikkara has helped in the identification of a number of varieties. Brinjal varieties either resistant or moderately resistant to bacterial wilt only have given economic yield in Kerala.

Sheela (1982) evaluated six bacterial wilt resistant brinjal lines at the College of Horticulture, Vellanikkara and observed maximum yield in SM 56 (2.21 kg/plant) followed by SM 72 (2.10 kg/plant) and SM 48 (1.93 kg/plant). Gopimony (1983) from College of Agriculture, Vellayani, Thiruvananthapuram reported highest yield of 2.49 kg/plant in White Oval followed by Pusa Purple Cluster (2.30 kg/plant), Annamalai (1.56 kg/plant), S 507 (1.44 kg/plant) and Vellayani Local

(1.32 kg/plant). Gopimony *et al.* (1984) reported that the phenotypic coefficient of variation ranged from 12.3 to 98.85 per cent being highest for total fruit yield/plant. The genotypic coefficient of variation ranged from 10.63 to 98.20 per cent, being highest for single fruit weight. Sankar (1984) evaluated eleven genetic groups of brinjal line SM-6 for two cycles and reported that SM 6-4 had the highest yield of 1.71 kg/plant in the first cycle and SM 6-7 during the second cycle (1.9 kg/plant). Jessykutty (1985) evaluated same eleven genetic groups of brinjal line for third and fourth cycles. SM 6-2 has recorded the highest yield of 1.11 and 1.28 kg/plant for third and fourth cycles respectively followed by SM 6-6 (0.97 and 1.17 kg/plant). Thomas (1987) conducted a field trial for two seasons with six varieties and nine hybrids. SM-6 gave the highest yield (1.01 kg/plant) during February-June 1985 and Pusa Purple Cluster (0.78 kg/plant) during November 1985-March 1986. Among the nine different parental and isogenic lines of brinjal, Geetha (1989) observed highest yield in SM 6-6 (0.96 kg/plant). An ICAR adhoc scheme on "Breeding for resistance to bacterial wilt in chilli and brinjal", in the Kerala Agricultural University, Vellanikkara resulted in the development of five selection in brinjal viz., SM 129-2, SM 121-1(S), SM 48-2, SM 141-2 and SM 141-1-1 highly promising for fruit qualities, yield and resistance to bacterial wilt (KAU, 1989). In a trial conducted by Varghese (1991) for four seasons, Surya registered the highest mean yield of 1.13 kg/plant followed by SM 6-6 (0.92 kg/plant). Varma (1995) conducted studies in 23 green fruited brinjal and reported maximum yield in SM 281 (1.85 kg/plant) and maximum number of fruits/plant in SM 132 (20.5). The earliest flowering genotype was SM 281. She also observed high magnitude of variation (PCV) for fruit yield/plant (59.84), total fruits/plant (50.41), average fruit weight (47.9) and percentage of productive flowers (32.99).

A number of brinjal varieties were found adaptable during the field evaluations of All India Co-ordinated Vegetable Improvement Project at Vellanikkara (Table 1). The purple fruited varieties, ARU-2C (DARL, Almora), KT-4 (IARI, Katrain) performed well during three evaluations from 1982 to 1984. Varieties Azad Kranti, PBr 91-2, Hybrid-9, H-917, Pusa Kranti, Arka Shirish and Pusa Purple Long did not yield at all since plants were wilted before fruiting stage. Purple and long fruited 'Arka Nidhi' (IIHR, Bangalore), purple and oval fruited 'Surya', light green long and stout fruited 'SM 141' and white fruited 'Swetha' (all from KAU, Vellanikkara), light green and striated 'BB 44' (OAUT, Bhubaneshwar) outyielded all other varieties during the evaluations from 1987 to 1995. During April-October, 1989, highest yield was obtained in Swetha (21.7 t/ha) on par with Surya (21 t/ha). During September 1991-March 1992, SM 141 yielded as high as 31.6 t/ha. The other promising variety Swetha also yielded above 25 t/ha during this evaluation. During August 1994-April 1995 the Bhubaneshwar line, BB 44 recorded maximum yield (33.74 t/ha) on par with Swetha (30.25 t/ha) and BB 60-C. Though a high yielder BB 44 was not at all acceptable in Kerala because of the thick rind and light green striated nature of the fruits (AICVIP, 1996).

B. Bacterial wilt incidence in brinjal

1. History and distribution of the bacterial wilt disease

Bacterial wilt caused by *Pseudomonas solanacearum* E.F.Smith is one of the most destructive plant diseases in the warm humid regions of the world. The pathogen is known to attack a wide range of host plants. It attacks more than 200 plant species belonging to 33 families. Of these, family solanaceae has the largest number of hosts (Kelman, 1953). Yaynu-Hiskias (1989) conducted a pathogenicity

Table 1. Brinjal varieties found adaptable during All India Co-ordinated Vegetable Improvement Project evaluations at Vellanikkara centre

Year and Season	Varieties	Authority
June-October 1982	Surya, ARU-2C	AICVIP (1985)
August 1983-February 1984	Annamalai, ARU-2C, KT-4	AICVIP (1985)
August-November 1984	KT-4	AICVIP (1985)
September 1987-March 1988	Surya, SM 141, Arka Nidhi,	AICVIP (1988)
July 1988-February 1989	SM 141, Surya, Arka Nidhi	AICVIP (1990)
April-October 1989	Swetha, Surya	AICVIP (1990)
September 1991-March 1992	SM 141, Swetha, SM 132	AICVIP (1993)
October 1992-April 1993	BB 44, Swetha	AICVIP (1993)
August 1993-January 1994	Swetha, SM 141	AICVIP (1994)
November 1993-March 1994	Swetha, Arka Nidhi, SM 141	AICVIP (1994)
October 1994-April 1995	BB 44, Swetha	AICVIP (1996)

test with five solanaceous hosts and all isolates caused wilting in potato, brinjal and tomato.

The disease was first reported from Italy in 1882 (Walkar, 1952). The disease is prevalent in the warmer parts of USA, Philippines, Indonesia, Sri Lanka and India causing considerable damage. In India, it assumes serious proposition in the West Coast, Central and deccan plateau of Karnataka, Kerala, Western Maharashtra, Madhya Pradesh, Orissa, eastern plains of Assam, West Bengal and Bihar on tomato, potato, brinjal and chillies (Rao, 1972; CPRI, 1974 and Shekhawat *et al.*, 1978).

Rao and Sohi (1977), after conducting a survey on bacterial wilt in brinjal, reported that incidence ranged from 15 to 60 per cent during different seasons. Gopimony and George (1979) reported that in various districts of Kerala, the percentage of wilt incidence was as high as 100 per cent in a few improved varieties like Arka Kusumkar and Banaras Giant whereas in local varieties this varied from 20 to 60 per cent. Gangopadhyay (1984) reported a maximum yield loss upto 62.5 per cent.

2. Morphology and taxonomy of *Pseudomonas solanacearum*

As early as 1896 Smith described the disease and causal agent. Das and Chattopadhyay (1955) were the first in India to report that the organism causing wilt in brinjal was *Pseudomonas solanacearum* var. *asiaticum*. The bacterium is gram negative with short rods and motile by means of polar flagella.

P. solanacearum E.F.Smith is a complex species consisting of several races differing in many characters. Kelman (1954) distinguished two colony variants

on tetrazolium medium. One is normal or wild type which is irregularly round, entire, white or whitish with light pink and the other is mutant or butyrous type which is round, translucent, smooth, deep red with a narrow white bluish border. He reported that the wild types are highly virulent and produced wilting in 14 hours.

Based on host range, pathogenicity and colony appearance on TTC medium, Buddenhagen *et al.* (1962) classified *P. solanacearum* isolates into three races ie. race 1, race 2 and race 3 from a wide range of hosts of Central and South America.

1. Race 1 (Solanaceous strain) - wide host range, distributed throughout the low-lands of tropics and subtropics attacking tomato, tobacco and many solanaceous and other weeds.
2. Race 2 (Musaceous strain) - Restricted to Musa and a few perennial hosts initially limited to American tropics and spreading to Asia.
3. Race 3 (Potato strain) - Restricted to potato and few alternate hosts in tropics and sub-tropics.

Hayward (1964) took a classical bacteriological approach to classify *P. solanacearum* into biotypes or biochemical types based on their ability to oxidise various carbon sources and on other bacteriological reactions and called them as biotype I, biotype II, biotype III and biotype IV.

1. Biotype I	-	does not oxidise dissacharides, sugar and alcohols.
2. Biotype II	-	oxidises only dissacharides.
3. Biotype III	-	oxidises both dissacharides and alcohols.
4. Biotype IV	-	oxidises only hexahydric alcohols

In this, biotype II was potato race of Buddenhagen *et al.* (1962). No such generalisation could be made in other cases. Later two new races have been proposed; one from ornamental ginger as race 4 (Aragaki and Quinon, 1965) and other from mulberry as race 5 (He *et al.*, 1983).

Cook and Sequira (1988) used Restricted Fragment Length Polymorphism (RFLP) technique to study the relationship between biotypes I to IV of Hayward (1964) and races 1, 2 and 3 of Buddenhagen *et al.* (1962). The main conclusion was that *P. solanacearum* could be divided into two distinct groups. Group I includes strains of race 1, biotype III and IV and Group II includes strains of race 1, biotype I and races 2 and 3. In addition, they were able to distinguish strains of the pathogen both by race and biotype. For example, race 3 strains produced a very distinct gel pattern which suggests that race 3 is a homogeneous group. Similarly, race 2 strains fell into three distinct groups. These three groups represented strains from different geographical origin. In contrast, race 1 strains exhibited highly variable RFLP patterns suggesting that race 1 is highly heterogeneous.

3. Ecology of the pathogen

The ecology of the pathogen in infested soil is poorly understood. It is inferred that the primary innoculum came from the soil but there was no conclusive evidence that the pathogen is an ubiquitous inhabitant in the soil (Buddenhagen and Kelman, 1964). Under natural conditions, the pathogen was able to survive saprophytically in the soil for a long as six years (Chester, 1950).

P. solanacearum does not survive in the soil for prolonged periods because it is not a strong competitor. It does not survive in the soil itself but survives on or in plant roots. The bacterium appears to survive by continuously infecting the roots of susceptible or carrier plants or by colonising the rhizospheres of non-host plants (Sequeira, 1993). Survival of *P. solanacearum* in the rhizosphere has been documented by Granada and Sequeira (1983) who reported that the bacterium invades the roots of presumed non-hosts such as bean and maize. Long term survival was associated with localized or systemic infection of plants that did not express symptoms of bacterial wilt.

4. Symptomatology

Generally, the first and typical expression of the disease is sudden wilting of the lower leaves of the plants (Walker, 1952). This wilting is usually accompanied with yellowing of older leaves. Dwarfing and stunting of the plants may also occur. The roots and the lower parts of the stem show a browning of vascular bundles and a water soaked appearance in the root (Chupp and Sherf, 1960). Eventually dark brown to black area develop due to decay of root system and the whole plant dies off. A very distinct and characteristic indication of bacterial wilt is the appearance of bacterial ooze from the injured vascular regions (Ashrafuzzaman and Islam, 1975). In some cases wilting is usually accompanied with yellowing of older leaves and stunting of the plants may also occur.

Breakdown of plant tissues by pathogen is attributed to the cellulase and polygalacturonase enzymes produced by the pathogen (Hussain and Kelman, 1957). Continued tissue decay and plugging finally result in the death of the plant.

Following the entry of the pathogen into the host plant, visible symptoms occur within two to eight days (Kelman, 1953; Chupp and Sherf, 1960). The pathogen first enters into the intercellular spaces of cortex. From there, it moves to pith and xylem vessels (Walker, 1952). Wilting of the plant is due to vascular plugging (Walker, 1952). Kelman (1954) noted that virulence might be explained, at least in part, by the quantitative differences in EPS (extracellular polysaccharides). Baldacci (1977) opined that besides EPS, responsible for vascular plugging, a chemically unidentified fraction which alters the membrane permeability is produced by the pathogen. The bacterium also produces IAA which can initials tylose formation and increases cell wall plasticity. Ethylene production is also associated with it. Schell *et al.* (1988) have cloned and characterised the gene Pgl A that is involved in the synthesis of the polygalacturonase produced in the ordinary culture media. Allen *et al.* (1993) have shown that total galacturonase activity of the bacteria increases in the presence of the plant..

Wallis and Truter (1978) have studied the histopathology of tomato plants infected with *P. solanacearum* with emphasis in ultra structure through electron microscopy and revealed initially only small diameter cells adjacent to large vessels were invaded, the vessels remaining bacterium free. Some of these cells were stimulated to form tyloses which bulged into the vessels, bacterial migrated into the tyloses many of which were ruptured 48 to 72 hour after inoculation liberating the organism and non cellular materials into the vessels. At this time plants began to show the first signs of wilting. Within vessels bacterial multiplication and spread was rapid and was accompanied by accumulation of large amounts of fine granular material identified as bacterial extracellular polysaccharides and this is considered as

the major case for the sudden wilting of the plant. It is assumed that the bacterium has to digest its way through the primary wall of the weakened cortical cells as well as of the tracheary elements where, it is exposed between the spiral thickening (Sequeira, 1993).

5. Factors affecting wilt incidence

The pathogen enters through the root system and it is believed that a wound is necessary for the entry(Walker, 1952); Kelman, 1953; Chupp and Sherf, 1960). Hildebrant (1950) reported entry of the bacterium through natural openings of the plants. The pathogen can enter into the uninjured roots also (Libman *et al.*, 1964). They reported that root contact with infected plants was not necessary for infection. Bacteria can enter at the points of origin of secondary roots.

Resistance and susceptibility to disease are conditions with defined metabolic, environmental and genetic conditions. Kuc (1964) stated that disease resistance is not an absolute or static condition and depends on many factors. Expression of the biochemical potential, determined by the genetic component of the organism is influenced by a multitude of factors including nutrition, growth regulators, temperature, moisture, day length, stage of development and nature of tissue.

Vaughan (1944) reported that the infection occurs at soil temperatures as low as 12.8°C but symptoms of wilt do not ordinarily become apparent at 12.8° to 15.6°C.

Chupp and Serf (1960) reported that the infection occurs in dry soil and disease become serious in red laterite soils. At pH 3.5, a high wilt incidence was

reported by Kelman and Cowling (1965). Shekhawat *et al.* (1978) reported that the bacterial wilt was more widespread in heavy and acidic soils (pH 3.5 to 6.9) than in light and neutral (pH 6.5 to 7.5) to alkaline (pH 7.5 to 8.5) soils.

Gallegly and Walker (1949) reported that high moisture levels in soils affected the disease by favouring survival of bacteria in soil and thereby increasing capacity for infection. Kelman (1953) observed that high soil moisture levels usually favour development of bacterial wilt.

Winstead and Kelman (1952) suggested that increased resistance in resistant lines was apparently associated with age rather than plant size. Bell (1981) stated that each plant part changes in its level of resistance with age. Resistance level in stem and root generally increases rapidly during the first two weeks of seedlings or when new shoot grows and slowly there after. Levels of resistance in leaves and fruits frequently decline with age. He also reported that long photoperiods generally result in higher levels of resistance. Increasing the concentration of potassium and calcium enhances most often level of resistance while nitrogen decreased resistance.

Insects and nematodes also play a role in the spread of the disease (Young, 1946; Vakili and Baldwin, 1966). Goth *et al.* (1983) observed that bacterial wilt resistance was broken down when root knot nematode larvae were added at the rate of 100/10 cm pot at the time of inoculation with bacterial isolates.

Opina and Valdez (1987) reported the use of *Pseudomonas flourescens* and *Bacillus polymyxa* as biological control agents of bacterial wilt on tomato and brinjal. In brinjal, both organisms significantly reduced the incidence of wilt when seedlings were dipped in the suspension than when the suspension is drenched at the

base of stem of roots-injured seedlings. In all of the tests, *P. flourescens* gave a higher degree of protection against bacterial wilt than *Bacillus polymyxa*. Aspiras and Dela-Cruz (1989) suggested the use of root colonizing bacteria in preventing the entry of soil borne pathogen *P. solanacearum*, in the root of brinjal, thus reducing the incidence of the bacterial wilt.

Morgado *et al.* (1994) recommended wounding method can be reliably used for screening resistant genotypes of brinjal since it does not severely damage the plant.

6. Bacterial wilt resistant varieties/lines in brinjal

A large number of brinjal varieties, hybrids, wild and related species were found resistant under different agroclimatic condition by many workers. They are briefly reviewed in Table 2.

7. Genetic basis of resistance

Information on mode of inheritance and gene action of resistance of wilt would be useful in the choice of appropriate breeding programmes. Monogenic recessive, monogenic dominant and polygenic inheritance of resistance to bacterial wilt has been reported earlier by different workers.

(a) Monogenic and recessive

Dutta and Kishun (1982) found that resistant/tolerant reaction to bacterial wilt was controlled by a set of recessive genes. Manjunath and Dutta (1987) reported that resistance was controlled by recessive genes acting additively. At least two groups of dominant genes controlled susceptibility to bacterial wilt in a

Table 2. Bacterial wilt resistant brinjal varieties/F_1 hybrids/*Solanum sp.*

Name of resistant varieties/hybrids/ species	Reaction to bacterial wilt	Reported by
1	2	3
(a) Varieties/Lines		
Camuy, Long Green	Resistant	Davidson (1935)
Belyijailsevidnyi, Delicatasse	Resistant	Schmidt (1935)
Matale, Kopek	Resistant	Kelman and Winstead (1960)
Taiwan Long	Resistant	Suzuki *et al.* (1964)
Purple Long Datta	Resistant	Sreenivasan *et al.* (1969)
SM 164	Tolerant	Daly (1970)
Nihinnassu	Resistant	Akiba *et al.* (1972) and Grubben (1977)
Gulla	Resistant	Gowda *et al.* (1974)
Improved Muktakeshi	Resistant	Khan (1974), Mukherjee and Mukhopadhyay (1982)
Pusa Purple Cluster	Resistant	Khan (1974), Rao *et al.* (1976) Sitaramaiah *et al.* (1981, 1985) Mukherjee and Mukhopadhyay (1982), Deka *et al.* (1992) and Bora *et al.* (1993)
Long Purple, Udipi, Purple Long	Resistant	Khan (1974)
Dingras Multiple Purple	Highly resistant	Rao *et al.* (1976) Mochizuki and Yamakawa (1979)
Sinampira	Highly resistant	Rao *et al.* (1976)

Contd.

Table 2. Continued

1	2	3
Subah, Hitam Bulat	Resistant	Lum and Wong (1976)
SM-6	Resistant	KAU (1980, 1981, 1982) Goth *et al.* (1983), Narayanan and Nair (1983)
Pusa Purple Round, Vijay hybrid, Banaras Giant Green	Highly	Sitaramaiah *et al.* (1981, 1985)
SMI-5, SMI-10, SMI-31-2	Highly resistant	Narayanan and Nair (1983)
West Coast Green Round	Resistant	Madalageri *et al.* (1983) Gangappa and Madalageri (1986)
Long Black, 17-4	Highly resistant	Yien and Rathiah (1984)
Surya	Resistant	AICVIP (1985, 1988, 1990) and Gopalakrishnan *et al.* (1990)
ARU-2C	Moderately resistant	Gopalakrishnan and Gopalakrishnan (1985)
T-3, Pbr 129-5, Pbr 129-6 PBr-1, PBr 129-2, PBr-61 S-3, S-20	Resistant	Sitaramaiah *et al.* (1985)
Arka Neelkanth	Resistant	AICVIP (1988, 1990)
SM 141	Resistant	AICVIP (1988, 1990, 1993 and 1994) and KAU (1989, 1995)
Swetha	Resistant	AICVIP (1990, 1993, 1994 and 1996) and KAU (1996b)

Contd.

Table 2. Continued

1	2	3
Annamalai, JC_1, JC_2	Resistant	Deka *et al.* (1992)
BB-44	Resistant	AICVIP (1993, 1994 and 1996)
BWR 34, Yein, Rathaiah	Resistant	Bora *et al.* (1993)
IHR 180, IHR 181	Resistant	Sadashiva *et al.* (1993)
Arka Keshav, Arka Nidhi	Resistant	AICVIP (1994)
Torvum Vigor, Assist	Resistant	Monma and Matsunga (1995)
(b) F_1 hybrids		
SM 164 x Florida Market, SM 164 x Violetede Berbentane	Tolerant	Daly (1970)
West Coast Green x Pusa Kranti	Highly resistant	Madalageri *et al.* (1983)
SM-6 x Pusa Purple Long	Resistant	Narayanan (1984)
SMI-10 x Pusa Purple Long	Resistant	Narayanan (1984) KAU (1985), Thomas (1987)
SM-6 x Pusa Purple Cluster	Resistant	KAU (1985)
West Coast Green Round x Pusa Kranti	Resistant	Gangappa (1986)
SMI-10 x Pusa Purple Round, SM-6 x Black Beauty, SM-6 x Pusa Purple Round	Resistant	Thomas (1987)
SM 6-6 x SM-132 SM 6-2 x Pusa Purple Cluster	Resistant	Geetha and Peter (1993)
SM 6-6 x SM 197 SM 141 x SM 262	Resistant	Varma (1995)

Contd.

Table 2. Continued

1	2	3
(c) Species		
Solanum melongena var. *insanum*	Resistant	Sreenivasan *et al.* (1969), Gopimony and George (1979) and Gopimony (1983)
Solanum torvum	Resistant	Sreenivasan *et al* (1969) Khan (1974), Herbert (1985) Gangappa and Madalageri (1986), Ozaki and Kimura (1989) and Mondal *et al.* (1991)
Solanum texanum	Resistant	Sreenivasan *et al.* (1969)
Solanum indicum	Resistant	Sreenivasan *et al.* (1969)
Solanum nigrum	Resistant	Mochizuki and Yamakawa (1979), Herbert (1985) and Satpathy (1996)
Solanum toxicarium	Resistant	Mochizuki and Yamakawa (1979) and Gangappa and Madalageri (1986)
Solanum integrifolium	Immune	Sheela *et al.* (1984)
Solanum aethiopicum *Solanum incanum* *Solanum viarum* *Solanum warscewiezii*	Resistant	Herbert (1985)
Solanum mammosum *Solanum sisymbrifolium* *Solanum surattense*	Resistant	Mondal *et al.* (1991)

9 x 9 diallel study. Studies conducted at Kerala Agricultural University, Vellanikkara revealed that resistant F_1s could be developed by crossing resistant parents only which indicates the recessive mode of inheritance of bacterial wilt resistance (KAU, 1989). Varghese (1991) studied the nature of inheritance of the resistance to bacterial wilt and reported that it is inherited in a recessive and monogenic manner. Geetha and Peter (1993) reported that the F_1s in which only the resistant parents involved, were resistant and the hybrid, in which a susceptible genotype was one of the parents, was either susceptible or moderately resistant showing the recessive mode of inheritance of bacterial wilt resistance. In another study on tomato Kumar (1995) reported recessive gene action for inheritance of bacterial wilt resistance.

(b) Monogenic and dominant

Swaminathan and Sreenivasan (1971) reported that resistance to bacterial wilt in *Solanum melongena* var. *Insanum* was monogenically controlled and dominant. Vijayagopal and Sethumadhavan (1974) and Gopimony (1983) also revealed that wilt resistance was controlled by a single dominant gene in a study of intervarietal hybrids of brinjal. Narayanan (1984) reported that resistance to bacterial wilt was inherited as a dominant character. Gopinath and Madalageri (1986) studied resistance to bacterial wilt in brinjal and reported a high degree of heterosis for resistance to bacterial wilt in West Coast Green Round 112-8 (WCGR-112-8) x Pusa Kranti and this was inherited as a single dominant gene.

(c) Polygenic

Kelman (1953) reported that resistance to *P. solanacearum* in groundnut,

tobacco and brinjal are controlled by polygenes. Suzuki *et al.* (1964) observed that bacterial wilt resistance in varieties Taiwan Naga and OTB-1 is inherited as a quantitative character controlled by a number of genes. Kuriyama (1975) suggested that breeding a completely resistant strain of brinjal against bacterial wilt might be difficult because of polygenes involvement. Li *et al.* (1988) stated that in a few crosses where the F_1 was midway between the parents, no apparent dominance was shown. In yet another cross, resistance was improved by combining genes from two selected lines and this may be as example of additive effects of minor genes, where a few genes are contributed by both the parents. They revealed that this complex nature of wilt resistance in brinjal appears to be similar to reports showing polygenes for resistance in tomato.

8. Anatomical basis of resistance

Studies on anatomical basis of resistance to bacterial wilt are very much limited.

In an anatomical studies on roots of fingermillet colonized by vesicular-arbuscular mycorrhizae, Dyala and Bagyaraj (1990) reported that the roots colonized by mycorrhizae were considerably large and there was higher polysaccharide deposition in their cell walls compared to non-mycorrhizae colonized roots. Grimault and Prior (1994) reported that the bacterial wilt resistant scions of tomato wilted after grafting on susceptible rootstocks and the vascular tissues of resistant cultivars were not tolerant to higher bacterial population than susceptible ones. In another anatomical study of bacterial wilt in brinjal, capsicum and tomato, Grimault and Prior (1994) reported that the resistant brinjal and tomato cultivars showed a difference in bacterial colonization between taproot and midstem which suggested

that tomatoes and brinjals have similar mechanism of resistance to *P. solanacearum*. Grimault *et al.* (1994) reported that in the bacterial wilt resistant varieties, tyloses occluded the colonized vessels, limiting bacterial spread while in the susceptible cultivars no tyloses were observed in colonized vessels and bacterial spread was not limited. In microscopic studies of intercellular infection of tomato roots by *P. solanacearum*. Vasse *et al.* (1995) reported that the bacteria intercellularly infected the inner cortex and the vascular parenchyma. Following infection, the pathogenic strain of bacteria invaded protoxylem vessels degrading cell walls.

9. Biochemical basis of resistance

Resistant varieties possess physical and biochemical barriers which inhibit entry of pathogen to host cells. Akai and Kuneida (1955) suggested a resistance mechanism based on the presence of a few inhibitory substances in the leaves of brinjal varieties. Quantitative differences in phenolic compounds between resistant and susceptible brinjal varieties were also observed. Maine (1958) observed that resistant varieties became susceptible when reducing agents were applied. Muller (1959) and Cruickshank (1963) stated that a host might have two kinds of defence factors - prohibitins and phytoalexins.

Phenols are responsible for disease resistance in different crops (Farkas and Kiraly, 1962; Goodman *et al.*, 1967 and Rajan, 1985). Kuc (1964) reported that in some cases, inhibition of microorganism may result from the cumulative effect of two or more compounds. Thapliyal and Nene (1967) reported that non-diffusible chemicals like tomatine, phenols etc. have a key role in the defence mechanism. They also detected phenols, particularly chlorogenic acid, in the vascular system of young potato plants. The resistant varieties contained chlorogenic acid and the

concentration was higher in the roots of the resistant varieties than in the susceptible ones. Mahadevan (1970) reported that prohibitins are active biochemical barriers against infection. Disease results if both are overpowered by parasites. Mahadevan (1973) stated that resistance to parasitic micro-organisms like bacteria, fungi and viruses is not due to structural barriers like thick epidermis, leaf hairs, thick cuticle, sugar content, osmotic pressure, pH and other features. Chemicals like prohibitins, phytoalexins and other post infectionally formed inhibiting substances appear to be important in the defence reaction.

The main pre-infectional inhibitors, present in plants are catechol, procatechuic acids, phenols, flavanoids and tomatine (Stoessl, 1969; Langecake *et al.*, 1972 and Roddick, 1974). Russel (1978) stated that the chemical compounds which inhibit the pathogen are classified as preinfectional inhibitors. Mukherjee and Mukhopadhyay (1982) noticed that the root exudates of the brinjal variety Pusa Purple Cluster showed a very little enhancement of bacterial population while that of susceptible varieties greatly enhanced the population of bacterium.

Rajan (1985) reported that O.D. phenols were higher in roots of a resistant tomato variety LE 79 than in a susceptible variety Pusa Ruby at all stages. Sitaramaih *et al.* (1985) reported that there is no correlation between total phenol concentration of roots and disease reaction in phenol concentration of roots and disease reaction in case of *P. solanacearum*. Gangappa (1986) observed a negative association between percentage of wilt incidence and total phenol contents in the roots. Geetha (1989) noticed that the O.D. Phenol content was higher in the roots of bacterial wilt resistant genotypes of brinjal than the susceptible types like Arka Kusumkar and Arka Navneeth. Kumar (1995) reported that total phenol and O.D.

Phenol content of the bacterial wilt resistant genotypes in tomato was higher than the susceptible line in all the plant parts at all stages of growth.

C. Jassid infestation in brinjal

Lit (1989) reported a highly significant and negative linear association between the number of branches of leaf trichomes of brinjal and adult oviposition or nymphal feeding of the leaf hopper (*Amrasca biguttula biguttula*). The length and densities of trichomes were also correlated significantly and negatively with oviposition and nymphal preference. Bernardo and Taylo (1990) suggested the potential use of okra as a trap crop to protect valuable brinjal germplasm materials from severe leaf hopper damage in the field. Lit and Bernardo (1990) reported that the important mechanisms of resistance to the jassids in the brinjal varieties were antixenosis and antibiosis. Schreiner (1990) suggested that the hopper burn damage is a more significant factor in yield reduction in brinjal than the actual number of jassids. Gaikwad *et al.* (1991) reported that the leaf thickness, midrib thickness and leaf area were positively correlated with infestation levels of jassids to the brinjal varieties. Trichome length and trichome density on leaves were negatively correlated with the infestation level.

Ratnapara *et al.* (1994) reported that the minimum temperature and vapour pressure were negatively associated with the population build up of jassids. Sunshine hours had a positive association with increasing numbers of the pest. Dhamdhere *et al.* (1995) reported that the jassids remain active during summer as well as Kharif seasons, but summer was the most favourable condition for pest build up. Heavy incidence of jassids has been reported as a serious problem of brinjal during summer months in Kerala (KAU, 1996a).

D. Exploitation of hybrid vigour in brinjal

Exploitation of hybrid vigour is one of the effective ways to increase yield/unit area and is particularly important in brinjal where a large number of seeds/fruit are obtained (Goto, 1952). The oldest report on artificial hybridisation in brinjal is of Bailey and Munson (1891) in the U.S.A. The hybrids did not exhibit any heterosis, but were intermediate to parents. The first positive heterosis in brinjal was reported by Halsted (1901). He found that one of his hybrids had double the size of parents and also yielded more. In India, Rao (1934) reported first time hybridisation among brinjal varieties. Since then, heterosis has been reported for many characters in brinjal. A brief review on the topic is made in Table 3.

Odland and Noll (1948) confirmed yield increase in hybrids. The range of increased yields of hybrids over the parents varied from 11 to 153 per cent. The highest yielding hybrid outyielded the highest yielding parent by 43.23 t/ha. The hybrid New Hampshire x Florida High Bush yielded 153 per cent more than the mean yield of parents. Lantican (1963) revealed that the average yields of hybrids were 26.8 per cent higher than those of the higher yielding parents owing to increase in fruit size, weight and number. Dutt (1970) reported that the F_1s, Green Long x Pusa Purple Long and Pusa Purple Long x Cluster White performed well.

Silvetti and Brunelli (1970) reported heterosis for uniform ripening by conducting a diallel among a few brinjal varieties.

Mital *et al.* (1972) reported heterosis to the extent of 92.5 per cent and 90.21 per cent over mid and better parents respectively for yield/plant in Black

Table 3. Heterosis for different characters in brinjal

Character	Reported by
1	2
Seed germination	Pal and Singh (1946), Capinpin and Alviar (1949)
Seed weight	Kakizaki (1938) and Papova *et al.* (1976)
Rate of growth of hybrid seedlings	Lantican (1963)
Earliness	Kakizaki (1938), Pal and Singh (1946), Oganesyan (1971), Peter (1971), Vishwanathan (1973), Papova *et al.* (1976), Hani *et al.* (1977), Mishra (1977), Monteiro and Costa (1977), Singh *et al.* (1977), Vijay and Nath (1978), Gowda *et al.* (1979), Hristakes (1979), Singh (1980), Singh and Rai (1990), Geetha and Peter (1993)
Plant height	Kakizaki (1938), Pal and Singh (1946), Mishra (1961, 1962), Peter (1971), Vishwanathan (1973), Mishra (1977), Singh *et al.* (1977), Baksh (1979), Gowda *et al.* (1979), Singh (1980), Narayanan (1984), KAU (1985), Geetha (1989), Varma (1995)
Plant spread	Pal and Singh (1946), Mishra (1961, 1962) and Varma (1995)
Number of branches	Pal and Singh (1946), Mishra (1961, 1962), Gopimony and Sreenivasan (1970), Peter (1971), Baksh (1979), Narayanan (1984), KAU (1985), Geetha (1989) and Varma (1995)
Fruit setting	Capinpin and Alviar (1949)
Fruit length	Capinpin and Alviar (1949), Vishwanathan (1973), Mishra (1977), Singh *et al.* (1977), Gopinath (1987) and Singh and Rai (1990)
Fruit diameter	Vishwanathan (1973) and Singh and Rai (1990)

Contd.

Table 3. Continued

1	2
Fruit weight	Pal and Singh (1946), Mishra (1961, 1962), Gopimony and Sreenivasan (1970), Silvetti and Brunelli (1970), Peter (1971), Mital *et al.* (1972), Viswanathan (1973), Vijay and Nath (1978), Joarder *et al.* (1981), Salehuzzaman (1981), Dixit *et al.* (1982), Geetha (1989) and Varma (1995)
Fruits/plant	Pal and Singh (1946), Capinpin and Alviar (1949), Gopimony and Sreenivasan (1970), Viswanathan (1973) Mishra (1977), Vijay and Nath (1978), Gowda *et al.* (1979), Joarder *et al.* (1981), Patil and Shinde (1984), Gangappa (1986), Gopinath (1987), Geetha (1989) and Varghese and Vahab (1994)
Yield	Daskaloff (1941), Pal and Singh (1946), Silvetti and Brunelli (1970), Scossiroli *et al.* (1972), Peter and Singh (1974), Mishra and Choudhury (1975), Hani *et al.* (1977), Mishra (1977), Singh *et al* (1977), Vijay and Nath (1978), Gowda *et al.* (1979), Hristakes (1979), Bhutani *et al.* (1980), Dhankar *et al.* (1980), Joarder *et al.* (1981), Salehuzzaman (1981), Narayanan (1984), Patil and Shinde (1984), Gangappa (1986), Gopinath (1987), Singh and Rai (1990), Geetha and Peter (1993), Varghese and Vahab (1994) and Varma (1995)

Beauty Long x Pusa Purple Long. Lal *et al.* (1973) reported heterosis for yield ranging from 62.84 per cent to 112.37 per cent Mishra and Choudhury (1975) reported heterosis for yield in Wayanad Giant x Hyderpur to the extent of 160.71 and 163 per cent over the better parent and mid parent respectively.

Cherpova (1976) observed that heterosis was marked when the varieties crossed were different in stem and leaf colour and earliness. Papova *et al.* (1976) reported some useful manifestations of heterosis in brinjal. The flowers of hybrids dropped less and hybrids fruited earlier and better than their parents. They had a better developed root system and a large number of seeds per fruit.

Gowda *et al.* (1979) observed highest heterosis in respect of fruits/plant (105.21%) in S 529 x Pusa Purple Cluster and with regard to yield/plant, the highest heterosis was 94.64 per cent in Pusa Purple Cluster x Arka Kusumkar. Chadha and Sidhu (1982) evaluated 22 F_1 hybrids along with the their parents. Heterobeltiosis ranged from 0.32 per cent for fruit weight to 177. 37 per cent for fruit breadth. Singh *et al.* (1982) reported heterosis for yield to the extent 140.19 per cent in F_1, Pusa Purple Long x S 317. Sanguineti *et al.* (1985) reported that the fruit yield of the hybrids among seven purple fruited varieties was 38.1 per cent higher than parental means.

Gopinath (1987) reported positive heterosis for plant height at first and peak flowering, number of stomata and dry matter content of stem and roots.

Seethapathy (1987) reported that the cross SM 87 x CO 1 exhibited heterosis of 129 per cent, 118.05 per cent and 10.01 per cent over mid, better and the best parent respectively for yield. Singh and Kumar (1988) identified the crosses

Pusa Purple Cluster x Sel-5 as the best specific combination, heterobeltiosis for yield being 162.5 per cent. Geetha (1989) found that fruit weight was mainly responsible for increased yield in F_1 hybrids in which heterobeltiosis ranged from 3.14 per cent to 45.15 per cent and relative heterosis from 25.07 per cent to 63.05 per cent.

Shankaraiah and Rao (1990) after studying heterosis for seed size, seedling vigour, plant height, plant spread and earliness in a diallel set of crosses involving 5 cultivars of brinjal, reported that all hybrids had higher seed size which showed higher seedling vigour. Though this vigour was not maintained and reflected in final plant height, this might have contributed indirectly to plant spread. Seedling height and vigour are reported to be associated with yield. Varghese (1991) evaluated F_1 hybrids of brinjal and reported two promising crosses SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132 which exhibited heterosis upto 68.02 per cent and 97.88 per cent respectively over their better parents. Monma and Matsunga (1995) developed three F_1 hybrids of *S. melongena* resistant to bacterial wilt and Fusarium wilt and these hybrids showed positive heterosis for most of the characters observed. Varma (1995) reported two promising green brinjal F_1 hybrids namely SM 6-6 x SM 197 and SM 141 x SM 262. They exhibited relative heterosis of 90.63 per cent and 24.14 per cent and heterobeltiosis of 43.87 per cent and 19.71 per cent respectively.

E. Grafting in vegetables

The first report on growing grafted vegetables came from Japan and Korea in the late 1920s by grafting watermelons to gourd rootstock (Ashita, 1927). According to Hartmann and Kester (1975) growing of grafted vegetables in comparison to growing grafted trees, is seldom practiced in the United States or in

other western countries where land use is not intensive, ie. proper crop rotation is being practiced. But it is highly popular in Korea, Japan and some Asian and European countries where land use is very intensive and the farming area is small. Lee (1994) stated that the percentage of cultivated area grafted seedlings in out door commercial vegetable culture amounts to 81 per cent in Korea and 54 per cent in Japan. In green house cultivation, the percentage is higher in Japan (69%) and remains in same in Kore (81%).

1. Rootstock studies

Yamakawa (1983) reported many rootstocks having distinctive characteristics. The growers select the rootstocks according to their suitability for growing season, cultivation methods, soil environments and the type of crops and cultivars (Hirata, 1975 and Lee, 1989). Gomi and Masuda (1981) reported that the prolonged duration of fruit harvest in grafted vegetables were not only due to the disease tolerance of the rootstocks, but also to enhanced water and mineral uptake. Takahashi *et al.* (1981) observed that the rootstock's vigorous root system is often capable of absorbing water and nutrients more efficiently than scion roots and serves as a good supplier of endogenous plant hormones. Yagishita *et al.* (1985) revealed that there is little or no information on the translocation of agents from scion to rootstock. Some permanent changes take place in the scion, induced by transmissible agents from the rootstock. Lee (1989) observed that the vigorous roots of *S. torvum* rootstock exhibited excellent tolerance to serious soil borne diseases caused by *Fusarium, Verticillium* and *Pseudomonas*.

2. Grafting in brinjal

Hirata (1975) reported that the purpose of grafting has been greatly expanded from reducing infection by soil borne diseases. Paily (1964) observed that *Solanum torvun* was resistant to bacterial wilt and he grafted susceptible brinjal on *S. torvum* rootstocks. Plants grafted at soil level showed some wilting. According to him, control may be due to the non accessibility of the wilt organism to the scion.

Porcelli *et al.* (1990) grafted brinjal cv. Fabine on various rootstocks and compared with plants maintained on their own roots (control). Grafts were 100 per cent successful with *S. torvum* and fruit yields were significantly higher on *S. torvum* (78.2 t/ha) than on the control (55.6 t/ha). *S. torvum* rootstock also proved best in reducing plant susceptibility to *Meloidogyne*. Vuruskan and Yanmaz (1991) reported that the brinjal cv. Perlane F_1 and Baluroi F_1 increased early and total yields after grafting onto tomato rootstocks by three different methods and total number of fruits were also increased over control. Alam *et al.* (1994) conducted an experiment to compare infestation by *Leucinodes orbonalis* of brinjal between non-grafted plants and plants grafted in wild *Solanum*. The lowest number of *L. orbonalis* infested shoots and fruits were recorded from plants grafted on wild *Solanum* as rootstock. Monma and Matsunaga (1995) reported 'Torvum Vigour' a selection of *Solanum torvum* and 'Assist' which is an interspecific hybrid between *S. melongena* and *S. integrifolium* as bacterial wilt resistant brinjal rootstocks.

Sishido *et al.* (1995) conducted an experiment on the effects of type, number of leaves and size of rootstocks (ie. graft height) on scion growth and assimilate transport in brinjal. The translocation and distribution of photosynthetic

assimilates were determined by $^{14}Co_2$ Pulse feeding and leaf area were much higher on *Solanum integrifolium* rootstocks than on *Solanum melongena*, but root weight did not differ significantly between rootstocks. Scion growth was enhanced by increasing the number of leaves left on the rootstock from 0 to 3. Satpathy (1996) observed that *Solanum nigrum* was resistant to bacterial wilt and when wilt susceptible brinjal hybrid 'Long white' was grafted onto *S. nigrum*, the grafted plants became wilt resistant.

3. Grafting in other solanaceous vegetables

Lum and Wong (1976) could control bacterial wilt incidence in tomato considerably when susceptible tomato scions were grafted to resistant brinjal root-stocks. The grafts were found totally compatible and disease incidence was reduced to 10 per cent in fields. Sunarjono *et al.* (1982) conducted an experiment on flower induction and fruit setting under tropical condition of some potato varieties by means of grafting them with *S. torvum, S. melongena, S. nigrum* and *Lycopersicum esculentum*. The results indicated that principally flowering induction can be done with all the potato varieties tested, giving different results in fruit setting depending upon environmental conditions. Brinjal variety and *S. torvum* proved to suit better as rootstocks for flower induction, but from the view point of agronomical characters *S. melongena* is more recommendable. Sheela *et al.* (1984) reported that the survival of grafts of wilt susceptible tomato 'Pusa Ruby' on *S. melongena* was 100 per cent in pots and 36 per cent in the field. This study indicated that the resistant *S. melongena* lines could be used as root stocks for susceptible tomatoes in infected soils. Ra *et al.* (1992) stated that when tomatoes were grafted to potato rootstocks, a considerable increased yield of both tomatoes and potatoes were obtained but in

potato there was considerable delay in harvest date. Matsuzoe *et al.* (1993) reported grafting of tomato cv. Momotaro scions onto *S. sisymbrifolium, S. torvum* and *S. toxicarium* rootstocks (resistant to soil borne diseases). Graft compatibility between tomato scions and each of three *Solanum* rootstocks was excellent, with a success rate of 100 per cent. Tomato grafted on *S. sisymbrifolium* yielded almost equal to that of tomato/tomato while other two grafted plants yielded less.

4. Grafting in cucurbits

Friendlander *et al.* (1977) reported influence of rootstock in sex expression of cucurbitaceous crops. Biles *et al.* (1989) reported that cucurbitaceous crops showed a significant amount of xylem sap when the vine was cut off after considerable growth. This xylem sap which was greatly influenced by the rootstock and was containing high concentrations of minerals, organic substances and plant hormones such as cytokinins and gibberellins (GA). Kang *et al.* (1992) reported that the fruit size of watermelons increased considerably when grafted to roostocks having vigorous root systems.

5. Grafting technique

Kobayashi (1991) revealed that by using most sophisticated machine, grafting efficiency could be significantly increased from the present 150 seedlings/hour/expert. Honami *et al.* (1992) developed a robotic grafting system based on a new grafting method. Perfect joining of the vascular bundles of scion and rootstock can be expected to promote smooth water and nutrient transport between scion and rootstock and, as result, lead to higher physiological activity of the grafted seedling. The "plug in method" has been proposed as an improved technique to

minimise malconnection of vascular bundles. In this method, the scion tip is shaped into a conical form. For tomato or brinjal stems are processed into a plug shape having a tapered tip using a vibration cutter. Kurata (1994) opined that though the single edged razor blade is still the most widely used grafting knife among farmers today, many other devices such as specifically designed knives, clips, tubes, have now been developed for easier grafting and post graft care. Slusarski *et al.* (1995) conducted a three year experiment in a heated plastic green house in a soil heavily infested by *Pyrenochaeta lycopersici* and *Colletotrichum coccoides* and reported that the increase of total yield was 30, 30 and 40 per cent for approach, cleft and lateral perforation grafts respectively. Grafting significantly increased the number of fruits/plant. Suzuki *et al.* (1995) reported a function check model for mechanical grafting of cucurbitaceous vegetables and concluded that mechanical grafting is viable.

Materials and Methods

MATERIALS AND METHODS

The present investigation was undertaken in the Department of Olericulture, College of Horticulture, Vellanikkara during 1993-'96. The field experiments were laid out in the vegetable research fields of Kerala Horticulture Development Programme, Kerala Agricultural University, Vellanikkara. The area is located at an altitude of 23 M above MSL and between 10° 32" and 76° 16" E longitude. The metereological data during the cropping period is presented in Appendices I to III.

The studies were conducted under the following heads:

A. Cataloguing and documentation of initial brinjal germplasm
B. Evaluation of bacterial wilt resistant and promising brinjal accessions/varieties
C. Development and performance study of F_1 hybrids in brinjal
D. Grafting for bacterial wilt and jassid resistance and yield in brinjal

A. Cataloguing and documentation of initial brinjal germplasm

1. Experimental materials

The brinjal accessions obtained from the Department of Olericulture, College of Horticulture, Vellanikkara, National Bureau of Plant Genetic Resources, Vellanikkara and collected by survey and postal correspondence from Kerala and outside were entered in the germplasm register maintained in the Kerala Horticulture Development Programme (R & D), Kerala Agricultural University, Vellanikkara were utilized for the preliminary evaluation. Seventy eight accessions were grown in

a randomised block design with two replications in the wilt sick soil during July, 1994 - February, 1995. The plants were grown in ridges and furrows at a spacing 60 x 60 cm. There were 10 plants/accession/replication. The crop was raised as per package of practices (KAU, 1993).

2. Observations recorded

Five plants/accession/replication were tagged randomly to observe the morphological and quantitative characters. Descriptions were made as per the descriptor list of IBPGR.

i) Growth habit - prostrate/intermediate/upright

ii) Leaf prickliness - prickly/non prickly

iii) Stem prickliness - prickly/non prickly

iv) Fruit calyx prickliness - prickly/non prickly

v) Leaf lamina colour - green/light purple

vi) Leaf vein colour - green/purple

vii) Fruit shape - round/oval/oblong/long/linear

viii) Fruit curvature - nil/slightly curved/sickle shaped

ix) Fruit colour - light green/green/green striated/ light green striated/white/milky white/light purple/purple/ deep purple/purple striated

x) Fruit flesh density - very loose/loose/dense

xi) Relative fruit calyx length - very short/short/intermediate/long/very long

xii) Flower colour - purple/white

xiii) Bearing habit - solitary/occasionally clustered/clustered

xiv) Duration of the crop

Short duration - crop duration less than 200 days

Long duration - crop duration more than 200 days

xv) Fruit glossiness - glossy/dull

b. Quantitative characters

i) Plant height (cm) - measured at 50% fruiting stage

ii) Plant spread (cm) - measured at 50% fruiting stage

iii) Number of primary branches

iv) Leaf length (cm) - measured on third to fourth leaf from the top at initial fruiting stage

v) Leaf width (cm) - measured on third to fourth leaf from the top at initial fruiting stage

vi) Days to flower

vii) Days to fruit set

viii) Days to first harvest

ix) Days to 50% harvest

x) Days to last harvest

days were counted from date of planting

xi) Total number of harvests

xii) Fruit length (cm)

xiii) Fruit diameter (cm)

xiv) Fruit circumference (cm)

xv) Average fruit weight (g)

Five fruits randomly selected at third harvest were utilized for recording fruit characters.

xvi) Number of fruits/plant

xvii) Yield/plant (g)

xviii) Incidence of bacterial wilt (%)

The number of plants wilted at fortnightly interval were recorded and percentage of wilt incidence was worked out. The accessions were then grouped according to Mew and Ho (1976) as follows:

R - Resistant (< 20% wilted plants)

MR - Moderately resistant (20-40% wilted plants)

MS - Moderately susceptible (40-60% wilted plants)

S - Susceptible (> 60% wilted plants)

3. Statistical analysis

The data were subjected to analysis of variance as described by Panse and Sukhatme (1978) for a randomised block design.

Variability for different quantitative characters was estimated as suggested by Burton (1952). The formula used in the estimation of variability at genotypic and phenotypic levels are:

a. Genotypic coefficient of variation (gcv) =

$$\frac{\text{Genotypic standard deviation}}{\text{Mean of the character}} \times 100$$

b. Phenotypic coefficient of variation (pcv) =

$$\frac{\text{Phenotypic standard deviation}}{\text{Mean of the character}} \times 100$$

c. Standard error of the mean =

$$\frac{\text{Environmental standard deviation}}{\sqrt{\text{Replications}}}$$

Environmental variance =

$$\frac{\text{Mean square due to genotype - mean square due to error}}{\text{Replications}}$$

Phenotypic variance = genotypic variance + error variance

d. Heritability in the broad sense was estimated by the formula suggested by Burton and Devane (1953)

$$h^2_{(b)} = \frac{\text{genotypic variance}}{\text{phenotypic variance}}$$

e. Genetic advance at 5 per cent intensity of selection was calculated using the formula of Johnson *et al.* (1955)

$$GA = h^2 \times \sigma p \times i$$

where, h^2 = heritability

p = phenotypic standard deviation

i = coefficient of intensity of selection (2.06 at p = 0.05)

f. Genetic advance (%) $= \frac{\text{genetic advance}}{\text{mean of the character}} \times 100$

B. Evaluation of bacterial wilt resistant and promising brinjal accessions/ varieties

The wilt susceptible variety Pusa Kranti and twenty four accessions found promising for bacterial wilt resistance, yield, plant and fruit characters during the preliminary screening were selected for the study. The accessions having less than 200 days duration were classified as short duration and the accessions having more than 200 days duration as long duration and were evaluated separately at different spacing. There were 25 plants/accession/replication. The crop was grown in ridges and furrows and the cultural practices were done as per the package of practices (KAU, 1993).

1. Experimental materials

a. Evaluation of short duration accessions

Fourteen short duration accessions namely Annapurna, CH 156, West Cost Green (Segregant) [WCG(S)], Surya, Swetha, Arka Keshav, SM 7, SM 59, SM 62, BB 2, BB 7, BB 44, SM 96 along with a susceptible check Pusa-Kranti were evaluated during March-October, 1995 in a randomised block design with two replications at a spacing of 60 x 60 cm.

b. Evaluation of long duration accessions

The long duration accessions namely Composite 2, Thiruvalla Green Round (TGR), SM 63, SM 69, SM 71, SM 75, SM 87, SM 113, SM 116 and SM 141 were grown during March-November, 1995 in a randomised block design with three replications at a wider spacing of 100 x 75 cm.

2. Observations recorded

a. Quantitative characters

Five plants/accession/replication were randomly selected to observe the following characters.

(i) Plant height (cm)

(ii) Plant spread (cm)

(iii) Number of primary branches

(iv) Leaf length (cm)

(v) Leaf width (cm)

(vi) Days to flower

(vii) Days to fruit set

(viii) Days to first harvest

(ix) Days to 50% harvest

(x) Days to last harvest

(xi) Number of economic harvests - where the yield/harvest exceeded 100 g was only considered as economic harvest

(xii) Total number of harvests

(xiii) Fruit length (cm)

(xiv) Fruit diameter (cm)

(xv) Fruit circumference (cm)

(xvi) Average fruit weight (g)

Five fruits randomly selected at third harvest were utilized for recording fruit characters.

(xvii) Number of fruits/plant

(xviii) Yield/plant (g)

(xix) Yield/plot - (kg/9 m^2) for short duration accessions and (kg/18.75 m^2) for long duration accessions were recorded and expressed as yield/ha (tonnes)

b. Pest and disease incidence

(i) Incidence of jassids

The jassids population on top, middle and lower leaves were counted and average of five plants were taken.

(ii) Incidence of bacterial wilt

A row of susceptible variety Pusa Kranti was planted after every plot of test accessions and on the border rows. Artificial inoculation of the bacterial wilt pathogen was done as per Winstead and Kelman (1952) by injecting bacterial ooze collected from the freshly wilted plants in the axil of third or fourth fully opened leaf. Inoculation was done at 15 and 30 days after planting and the number of wilted plants were counted at fortnightly interval and percentage was worked out. The bacterial wilt was confirmed by ooze test and the accessions were grouped as per Mew and Ho (1976).

c. Anatomical basis of bacterial wilt resistance

Hand sections of root, stem and petiole of both resistant (Surya) and susceptible (Pusa Kranti) varieties were taken. These sections were stained in aqueous safranin. The changes that are brought about in the anatomy of bacterial infected plants as compared to the healthy plants were observed under the low and

high power of the microscopes. Microphotographs of the regions of interest were taken both in susceptible and resistant variety.

d. Biochemical basis of bacterial wilt resistance

(i) Total phenols

Alcoholic extracts of roots and leaves from the plants 60 days after planting were taken for the estimation. The Folin-Coicalteu method (Mahadevan and Sridhar, 1982) was followed for estimation.

(ii) Orthodihydric phenol

Alcoholic extracts of roots and leaves from the plants 60 days after planting were taken for the estimation. The Arnow's method as suggested by Mahadevan and Sridhar (1982) was adopted for the estimation.

C. Development and performance study of F_1 hybrids in brinjal

Based on the initial cataloguing and systematic evaluation the wilt resistant varieties/accessions were selected and utilized in the hybridisation programme. A brief description of the selected parents are mentioned in Table 4.

In the hybridisation programme, accessions having same or compatible fruit colour only were inter-crossed. In the selected parents long and medium styled flowers were identified for crossing. Emasculation of flower buds was done on the previous day of flower opening and covered with butter paper cover. The male flowers were also similarly protected to avoid the chances of contamination. Pollination was performed in the next day morning, covered and labelled and F_1 seeds were extracted from ripe fruits.

Table 4. Morphological description of the selected parents for hybridisation programme

Sl. No.	Accession No./ Variety	Flower colour	Fruit colour	Fruit shape	Prickly/ nonprickly	Spreading/ nonspreading	Duration of crop	Accessions selected specifically for
1	Surya	Purple	Deep purple	Oval	Nonprickly	Nonspreading	Short	Adaptability
2	Annapurna	Purple	Purple	Long	Nonprickly	Nonspreading	Short	High yielding
3	Composite 2	Purple	Purple striated	Round	Nonprickly	Spreading	Long	Sturdy plants and longer duration
4	SH 116	Purple	Light purple	Round	Nonprickly	Spreading	Long	Longer duration, large round fruits
5	Arka Keshav	Purple	Deep purple	Linear	Nonprickly	Nonspreading	Short	Attractive extra longer fruits
6	SH 71	Purple	Light purple	Long	Nonprickly	Spreading	Long	Stout fruits and longer duration
7	Swetha	Purple	White	Long	Nonprickly	Nonspreading	Short	Adaptability
8	SH 63	White	Milky white	Long	Prickly	Spreading	Long	Longer duration
9	SH 141	White	Light green	Long	Nonprickly	Spreading	Long	Adaptability and high yield
10	WCG(S)	White	Light green	Long	Nonprickly	Nonspreading	Short	Attractive long fruits
11	TGR	White	Milky white	Oblong	Prickly	Spreading	Long	Sturdy plants and longer duration

1. Experimental materials

The following nine hybrids along with the parents were evaluated during November 1995-June 1996.

Purple fruited

a) Surya x Annapurna

b) Surya x Composite 2

c) Surya x SM 116

d) Arka Keshav x Composite 2

e) Arka Keshav x SM 71

Light green/White fruited

a) Swetha x SM 63

b) Swetha x SM 141

c) SM 141 x WCG(S)

d) SM 141 x TGR

Design	: Randomised Block Design
Replication	: 2
Number of plants/accessions/ replication	: 25

Plants were grown in ridges and furrows at a spacing of 75 x 60 cm. Plants were grown as per package of practices (KAU, 1993).

2. Observations recorded

(a) Morpholocial characters

All plants of the parents and F_1 hybrids were observed for the morphological characters as in the preliminary evaluation.

(b) Quantitative characters

(i) Plant height (cm) at 60 days after planting (DAP)

(ii) Plant height (cm) at 50% fruiting stage

(iii) Plant spread (cm) at 60 DAP

(iv) Plant spread (cm) at 50% fruiting stage

(v) Number of primary branches

(vi) Leaf length (cm) at 60 DAP - measured on third to fourth leaf from the top

(vii) Leaf length (cm) at 50% fruiting stage - measured on third to fourth leaf from the top

(viii) Leaf width (cm) at 60 DAP - measured on third to fourth leaf from the top

(ix) Leaf width (cm) at 50% fruiting stage - measured on third to fourth leaf from the top

(x) Collar circumference of stem (cm) - measured at 50% fruiting stage

(xi) Days to flower

(xii) Days to first harvest

(xiii) Days to 50% harvest

(xiv) Days to last harvest

(xv) Total number of harvests

(xvi) Fruit length (cm)

(xvii) Fruit diameter (cm)

(xviii) Fruit circumference (cm)

(xix) Average fruit weight (g)

Five fruits randomly selected at third harvest were utilized for recording fruit characters.

(xx) Number of fruits/plant

(xxi) Yield/plant (g)

(xxii) Yield/plot (kg/11.25 m^2) and expressed as yield/ha (tonnes)

c. Pest and disease incidence

(i) Incidence of jassids

Jassid population on top, middle and lower leaves were counted and average of five plants were taken.

Symptoms produced due to the jassid infestation was also scored using 0-4 scale as suggested by Singh and Rai (1995) with slight modification mentioned below:

Grade	Percentage of infection
0	Healthy (no infection)
1	Slight yellowing of margin
2	Yellowing and necrosis of the margin
3	Intense yellowing and necrosis
4	Complete necrosis

Percentage of intensity was calculated using the following formula.

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

Based on the percentage of intensity the accessions were grouped into 5 categories.

Percent intensity	Category
0	Immune
1-10	Highly Resistant
10.1-25	Moderately Resistant
25.1-50	Moderately susceptible
Above 50	Highly susceptible

(ii) Incidence of bacterial wilt

A row of susceptible variety Pusa Kranti was planted after every plot of parents/hybrids and on the border rows and inoculation and rating was done as in detailed evaluation.

(d) Organoleptic test

Fruits of all the parents and F_1 hybrids were subjected to organoleptic testing by five tasters after cooking without salt and spices. A total score of 10 was given for appearance, taste, flavour and bitterness in the ratio of 2:2.2:4. Bitter fruits were given less score.

3. Statistical analysis

(a) Estimation of heterosis

Heterosis over mid-parent (relative heterosis), better parent (heterobeltiosis) and standard variety (standard heterosis) were calculated as per Hayes *et al.* (1965). For calculating the standard heterosis in purple fruited F_1 hybrids, Surya was taken as standard parent and for calculating the standard heterosis in light green/white fruited F_1 hybrids, Swetha was taken as standard parent.

The formula used were:

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

Heterobeltiosis $$= \frac{F_1 - BP}{BP} \times 100$$

Standard heterosis $$= \frac{F_1 - SP}{SP} \times 100$$

where,

F_1, MP, BP, SP were the mean performance of F_1 hybrid, mid-parent, better parent and standard parent respectively.

The respective CDs were also calculated

CD $$= SE \times t \text{ value}$$

SE for RH $$= \sqrt{\frac{3}{2} \frac{- EMS}{r}}$$

$$\text{SE for HB and SH} = \frac{2\ \text{EMS}}{r}$$

where,

EMS = Error Mean Square

r = number of replications

D. Grafting for bacterial wilt and jassid resistance and yield in brinjal

Three wild *Solanum* species namely *S. torvum, S. indicum, S. melongena* var. *insanum* were tested for their suitability as root stock for grafting with *S. melongena*. Compared to *S. melongena, S. indicum* and *S. melongena* var. *insanum* were having very slow intial growth and stem thickness. This differential growth of brinjal scion and rootstocks of above two species did not yield perfect graft union but with *S. torvum* rootstock a perfect graft union was achieved. So, in all the further grafting studies *S. torvum* was used as rootstock.

Seeds of *S. torvum* had exhibited dormancy. Seeds were subjected to germination test at different dates of extracts. Seeds of *S. torvum* were extracted from ripe fruits during May 1995 and dried in shade. Two hundred and fifty seeds were sown in the nursery at fortnightly interval starting from the day of extraction. The seed beds were irrigated daily and observed for germination percentage.

Treatments	Sowing
T_1	Immediately after seed extraction
T_2	15 days after seed extraction
T_3	30 days after seed extraction
T_4	45 days after seed extraction
T_5	60 days after seed extraction
T_6	75 days after seed extraction
T_7	90 days after seed extraction
T_8	105 days after seed extraction

1. Experimental materials

The following eight brinjal varieties/accessions differing in resistance/ susceptibility to bacterial wilt and jassids, duration of the crop and fruit characters were selected for grafting onto *S. torvum*.

(a) Arka Keshav	Resistant to bacterial wilt, annual
(b) TGR	Resistant to bacterial wilt, perennial
(c) SM 141	Resistant to bacterial wilt, perennial
(d) SM 116	Resistant to bacterial wilt, perennial
(e) BB 7	Susceptible to bacterial wilt, annual
(f) Pusa Kranti	Susceptible to bacterial wilt, annual
(g) BB 49	Susceptible to bacterial wilt, annual
(h) Arka Shirish	Susceptible to bacterial wilt, annual

The intact plants were compared with the grafted plants during November 1995 to May 1996 in a factorial experiment with randomised block design with two replications in a wilt sick soil.

2. Method of grafting

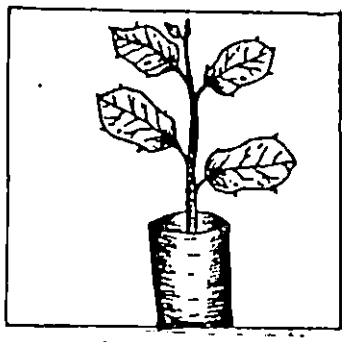
Grafting was done by wedge method 15 cm above the soil level. Seedlings of *S. torvum* with a height of 20-25 cm and a stem thickness of 0.3-0.6 cm were used as root stock. Semi hard wood cuttings of *S. torvum* were also used as root stock. Vigorously growing shoots emerging from the base of cuttings were prepared for grafting as in seedlings. Young terminal shoots of the desired variety having 10-15 cm length were cut, defoliated and used as scion. The base of the scion was made into the shape of a wedge (Fig.1).

The leafy portion of the stock was cut at 15 cm from the base. A 'V'-shaped cut was made at the top of the prepared stock. Then, wedge shaped scion was inserted into the stock and the grafted portion was tied up tightly with a one cm wide polythene strip (Plates 1, 2 and 3). Proper shade was provided to the grafted plants and were irrigated daily.

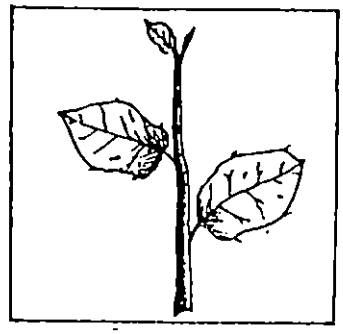
3. Evaluation of grafts

Intact plants were considered as one factor and grafted plants as the other factor. There were 10 plants/variety/replication under both the graft and intact plants and they were planted at a spacing of 75 x 60 cm in a wilt sick soil where the previous two crops were under brinjal. Plants were grown as per Package of Practices (KAU, 1993).

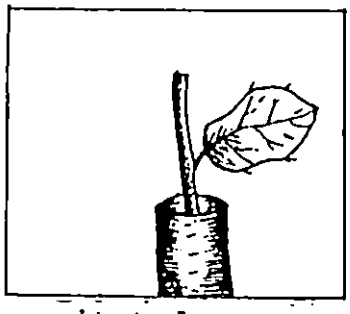
Fig.1 WEDGE GRAFTING IN BRINJAL



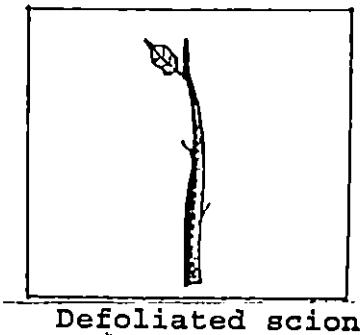
Solanum torvum seedlings



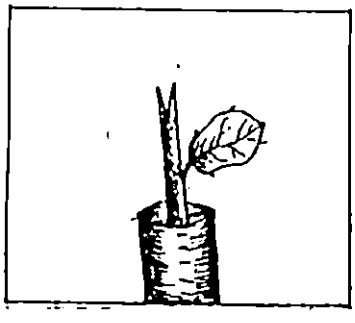
Twig of brinjal varieties



Decapitated rootstock

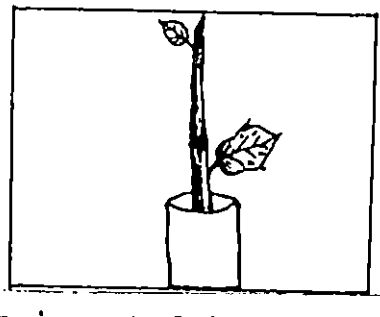


Defoliated scion

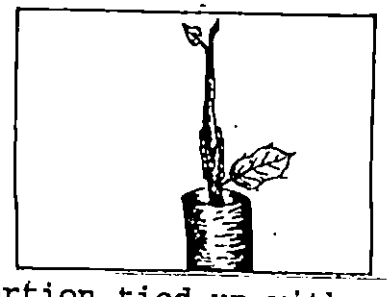


Rootstock with 'V' cut at the top

Scion after 'V' cut



Scion inserted into rootstock



Grafted portion tied up with polythene strip

Plate1
***Solanum torvum* in flowering stage**

Plate 2
***Solanum torvum* seedlings**

Plate 3
Wedge grafting

4. Observations recorded

(a) Quantitative characters

Five plants each under grafts and intact plants/replication were tagged randomly to observe the following characters.

(i) Plant height (cm) - measured from graft union at 50% fruiting stage

(ii) Plant spread (cm) - measured at 50% fruiting stage

(iii) Fruit length (cm)

(iv) Fruit diameter (cm)

(v) Fruit circumference (cm)

(vi) Average fruit weight (g)

(vii) Number of fruits/plant

(viii) Yield/plant (g)

(b) Pest and disease incidence

(i) Incidence of bacterial wilt

A row of susceptible variety Pusa Kranti was planted after every plot of grafted/intact plants and on the border rows and number of plants wilted were counted at fortnightly interval and percentage of wilt incidence was worked out.

(ii) Incidence of jassids

The jassid population was counted and symptoms of jassid infestation was also scored as in the evaluation of F_1 hybrids and parents.

(c) Organoleptic test

Fruits of all the grafted and intact plants were subjected to organoleptic testing as in the evaluation of F_1 hybrids and parents.

(d) Biochemical estimation

Total phenol content and O.D. phenol content in the leaves of 60 days old grafts/intact plants were estimated as per Folin-Coicalteu method and Arnow's method as suggested by Mahadevan and Sridhar (1982).

5. Statistical analysis

The data were subjected to analysis of variance for factorial experiment as described by Panse and Sukhatme (1978) for a randomised block design.

Results

RESULTS

Results of the present investigations are presented under the following heads:

A. Cataloguing and documentation of initial brinjal germplasm

B. Evaluation of bacterial wilt resistant and promising brinjal accessions/varieties

C. Development and performance study of F_1 hybrids in brinjal

D. Grafting for bacterial wilt and jassid resistance and yield in brinjal

A. Cataloguing and documentation of initial brinjal germpalsm

Seventy eight accessions of brinjal evaluated during July 1994-February 1995 were catalogued as per the IBPGR descriptor list (Table 5 and 6). The accessions varied in duration, 34 having a shorter duration of less than 200 days and 44 with a longer duration of above 200 days. Prickles were present in 26 accessions including CH-156, TGR and SM 63. The remaining 52 accessions were devoid of any prickles on the stem and leaf. Out of the 78 accessions 18 were purple fruited, 17 green fruited and seven having white or milky white fruits and 36 with striated/mottled fruits. All the accessions except the round fruited Composite 2, BB 2, SM 116 and SM 136 were having either oval to oblong fruits or linear to long fruits (Plate 4 and 5). Accessions SM 3, CH 156, SM 20, WCG(S), SM 63, SM 69, SM 70 SM 136, SM 137 and SM 141 were having white flowers while the remaining accessions were having purple flowers.

Table 5. Source and morphological description for vegetative characters in 78 brinjal accessions during the preliminary evaluation (July 1994-February 1995)

Sl. No.	Accession number	Name	Source of seed	Growth habit	Leaf and stem prickliness	Fruit calyx prickliness	Leaf lamina colour	Leaf vein colour	Duration of the crop
1	SM 2	Kachbachia	RAU, Bihar	Prostrate	Non prickly	Non prickly	Green	Green	Short
2	SM 3	Hara Guccha	RAu, Bihar	Prostrate	Non prickly	Non prickly	Green	Green	Short
3	SM 4	Pant Rituraj	GBPUAT, Pantnagar	Prostrate	Non prickly	Non prickly	Green	Purple	Short
4	SM 5	Annapurana	RAU, Bihar	Intermediate	Non prickly	Non prickly	Green	Purple	Short
5	SM 7	Muzaffarpur local	RAU, Bihar	Prostrate	Non prickly	Non prickly	Green	Green	Short
6	SM 10	Local	Local collection Kottayam	Intermediate	Prickly	Prickly	Green	Green	Short
7	SM 11	BB 7	Dept. of Olericulture, KAU, Vellanikkara	Prosatrate	Non prickly	Non prickly	Green	Purple	Short
8	SM 12	BB-13-1	,,	Prosatate	Non prickly	Non prickly	Green	Green	Short
9	SM 13	BB-44	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
10	SM 15	Arka Nidhi	,,	Prostrate	Non prickly	Non prickly	Green	Green	Short
11	SM 16	Arka Keshav	,,	Prostrate	Non prickly	Non prickly	Green	Green	Short
12	SM 18	Local	,,	Intermediate	Non prickly	Non prickly	Green	Green	Long
13	SM 19	CH 156	,,	Intermediate	Prickly	Non prickly	Green	Green	Short
14	SM 20	Local	,,	Intermediat	Prickly	Non prickly	Green	Green	Short
15	SM 21	DPLB-2	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
16	SM 22	BB 49	,,	Prosatrate	Non prickly	Non prickly	Green	Green	Short
17	SM 23	BB 2	,,	Prosatrate	Non prickly	Non prickly	Green	Green	Short
18	SM 24	Composite 2	,,	Prostrate	Non prickly	Non prickly	Light purple	Purple	Long
19	SM 25	KS 326	,,	Intermediate	Non prickly	Non prickly	Green	Purple	Short

Contd.

Table 5. Continued

Sl. No.	Accession number	Name	Source of seed	Growth habit	Leaf and stem prickliness	Fruit calyx prickliness	Leaf lamina colour	Leaf vein colour	Duration of the crop
20	SM 26	WCG(S) [West Cost Green (Segregant)]	Dept. of Olericulture KAU, Vellanikkara	Prostrate	Non prickly	Non prickly	Green	Green	Short
21	SM 27	TGR (Thiruvalla Green Round)	,,	Upright	Prickly	Prickly	Green	Green	Long
22	SM 28	Arka Shirish	IIHR, Bangalore	Intermediate	Non prickly	Non prickly	Green	Green	Short
23	SM 34	M 257	NBPGR, Vellanikkara	Intermediate	Non prickly	Non prickly	Green	Green	Long
24	SM 36	IC 89854	,,	Intermediate	Prickly	Prickly	Green	Purple	Short
25	SM 42	IC 89882	,,	Intermediate	Non prickly	Non prickly	Green	Green	Long
26	SM 48	IC 89890-A	,,	Prostrate	Non prickly	Non prickly	Green	Green	Long
27	SM 49	IC 89892	,,	Intermediate	Non prickly	Non prickly	Green	Green	Long
28	SM 50	IC 89894	,,	Prostrate	Non prickly	Prickly	Green	Green	Long
29	SM 54	IC 89911	,,	Upright	Non prickly	Non prickly	Green	Green	Long
30	SM 57	IC 89922-B	,,	Upright	Non prickly	Non prckly	Green	Green	Long
31	SM 59	IC 89947-A	,,	Prostrate	Non prickly	Non prickly	Green	Green	Short
32	SM 62	IC 111345-A	,,	Upright	Non prickly	Non prickly	Green	Green	Short
33	SM 63	IC 111379	,,	Intermediate	Prickly	Prickly	Green	Green	Long
34	SM 67	IC 111411-A	,,	Intermediate	Non prickly	Non prickly	Green	Green	Long
35	SM 69	IC 111416-A	,,	Upright	Prickly	Prickly	Green	Green	Long
36	SM 70	IC 111416-B	,,	Upright	Non prickly	prickly	Green	Green	Long
37	SM 71	IC 111425-A	,,	Upright	Non prickly	Non prickly	Light purple	Purple	Long

Contd.

Table 5. Continued

Sl. No.	Accession number	Name	Source of seed	Growth habit	Leaf and stem prickliness	Fruit calyx prickliness	Leaf lamina colour	Leaf vein colour	Duration of the crop
38	SM 72	IC 111426-A	NBPGR, Vellanikkara	Upright	Prickly	prickly	Green	Green	Long
39	SM 73	IC 111435	,,	Intermediate	Prickly	Prickly	Green	Green	Short
40	SM 74	IC 111436	,,	Prostrate	Non prickly	Non prickly	Green	Green	Short
41	SM 75	IC 111437-A	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
42	SM 77	IC 111440-A	,,	Prostrate	Non prickly	Non prickly	Green	Green	Long
43	SM 78	IC 111441-B	,,	Intermediate	Non prickly	Non prickly	Green	Green	Long
44	SM 82	NIC 16990	,,	Intermediate	Prickly	Prickly	Green	Green	Long
45	SM 87	IC 111461	,,	Prostrate	Non prickly	Non prickly	Green	Green	Long
46	SM 88	NIC 01190	,,	Prostrate	Non prickly	Prickly	Green	Green	Short
47	SM 89	NIC 01197	,,	Intermediate	Prickly	Prickly	Green	Green	Short
48	SM 96	V-91-F/0-184	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
49	SM 97	V-91-F/0-184-A	,,	Prostrate	Non prickly	Non prickly	Green	Purple	Long
50	SM 98	IC 126708	,,	Intermediate	Non prickly	Prickly	Green	Green	Short
51	SM 99	IC 126716	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
52	SM 101	NIC 03276	,,	Upright	Prickly	Prickly	Green	Green	Long
53	SM 104	NIC 03338	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
54	SM 105	IC 126713	,,	Intermediate	Non prickly	Non prickly	Green	Green	Short
55	SM 108	NIC 05038	,,	Intermediate	Prickly	Prickly	Green	Purple	Long
56	SM 109	IC 11308	,,	Intermediate	Prickly	Non prickly	Green	Green	Long
57	SM 110	IC 089920	,,	Prostrate	Prickly	Non prickly	Green	Green	Short
58	SM 111	IC 111303	,,	Intermediate	Prickly	Prickly	Green	Green	Long

Contd.

Table 5. Continued

Sl. No.	Accession number	Name	Source of seed	Growth habit	Leaf and stem prickliness	Fruit calyx prickliness	Leaf lamina colour	Leaf vein colour	Duration of the crop
59	SM 112	IC 089832	NBPGR, Vellanikkara	Intermediate	prickly	prickly	Green	Green	Long
60	SM 113	NIC 01207	,,	Intermediate	Non prickly	Non prickly	Green	Green	Long
61	SM 114	IC 111302	,,	Upright	Prickly	Non prickly	Green	Green	Long
62	SM 115	IC 089914	,,	Prostrate	Non prickly	Non prickly	Green	Green	Short
63	SM 116	NIC 14090	,,	Intermediate	Non prickly	Non prickly	Light purple	Purple	Long
64	SM 117	IC 111419	,,	Intermediate	Prickly	Prickly	Green	Green	Short
65	SM 118	IC 089823	,,	Intermediate	Prickly	Prickly	Green	Green	Long
66	SM 119	IC 111384	,,	Intermediate	Prickly	Prickly	Green	Green	Long
67	SM 120	Swetha	Dept. of Olericulture, KAU, Vellanikkara	Upright	Non prickly	Non prickly	Green	Green	Short
68	SM 121	Surya	,,	Prostrate	Non prickly	Non prickly	Green	Purple	Short
69	SM 122	Pusa Purple Cluster	IARI, Katrain, H.P.	Intermediate	Non prickly	Non prickly	Light purple	Purple	Short
70	SM 124	Pusa Kranti	IARI, New Delhi	Prostrate	Non prickly	Non prickly	Green	Green	Short
71	SM 126	Local	Local collection Waynad	Intermediate	Non prickly	Non prickly	Green	Green	Short
72	SM 127	Local	,,	Upright	Prickly	Prickly	Green	Green	Short
73	SM 128	Local	,,	Upright	Prickly	Prickly	Green	Green	Short
74	SM 129	Local	,,	Upright	Non prickly	Non prickly	Green	Green	Short
75	SM 132	Local	,,	Prostrate	Non prickly	Non prickly	Green	Green	Short
76	SM 136	Local	,,	Upright	Prickly	Prickly	Green	Green	Long
77	SM 137	Local	,,	Upright	Prickly	Prickly	Green	Green	Long
78	SM 141	SM 141	KHDP, KAU, Vellanikkara	Intermediate	Non prickly	Non prickly	Green	Green	Long

Table 6. Morphological description for flower and fruit characters in 78 brinjal accessions during the preliminary evaluation (July 1994-February 1995)

Sl. No.	Accession number	Fruit shape	Fruit curvature	Fruit colour	Fruit flesh density	Relative fruit calyx length	Flower colour	Bearing habit	Fruit glossiness
1	SM 2	Oval	Nil	Purple	Dense	Short	Purple	Solitary	Glossy
2	SM 3	Linear	Nil	Light gree	Loose	Very short	White	Occassionally clustered	Glossy
3	SM 4	Oval	Nil	Purple	Loose	Short	Purple	Solitary	Glossy
4	SM 5	Long	Nil	Purple	Very loose	Short	Purple	Solitary	Glossy
5	SM 7	Long	Nil	Purple	Loose	Short	Purple	Solitary	Glossy
6	SM 10	Oval	Nil	Light Purple	Dense	Short	Purple	Solitary	Dull
7	SM 11	Oval	Nil	Deep Purple	Loose	Short	Purple	Ocassionally clustered	Glossy
8	SM 12	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Dull
9	SM 13	Oblong	Nil	Light green striated	Dense	Very short	Purple	Solitary	Glossy
10	SM 15	Linear	Slightly curved	Deep purple	Loose	Very short	Purple	Ocassionally clustered	Glossy
11	SM 16	Linear	Sickle shaped	Deep purple	Very loose	Very short	Purple	Occassionally clustered	Glossy
12	SM 18	Oval	Nil	Green striated	Dense	Intermediate	Purple	Solitary	Dull
13	SM 19	Linear	Nil	Green	Loose	Short	White	Occassionally clustered.	Glossy
14	SM 20	Long	Slightly curved	Light green	Loose	Short	White	Solitary	Dull
15	SM 21	Long	Nil	White	Dense	Short	Purple	Solitary	Dull
16	SM 22	Oval	Nil	Light green	Dense	Short	Purple	solitary	Glossy
17	SM 23	Round	Nil	Green striated	Loose	Intermediate	Purple	Solitary	Dull
18	SM 24	Round	Nil	Purple striated	Dense	Short	Purple	Solitary	Dull
19	SM 25	Oblong	Sickle shaped	Purple striated	Very loose	Short	Purple	Solitary	Glossy
20	SM 26	Long	Nil	Light green	Dense	Short	White	Solitary	Glossy

Contd.

Table 6. Continued

Sl. No.	Accession number	Fruit shape	Fruit curvature	Fruit colour	Fruit flesh density	Relative fruit calyx length	Flower colour	Bearing habit	Fruit glossiness
21	SM 27	Oblong	Nil	Milky white	Dense	Short	Purple	Solitary	Dull
22	SM 28	Long	Nil	Green	Loose	Short	Purple	Solitary	Glossy
23	SM 34	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Glossy
24	SM 36	Oval	Nil	Purple	Dense	Very long	Purple	Solitary	Glossy
25	SM 42	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Dull
26	SM 48	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Dull
27	SM 49	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Glossy
28	SM 50	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Glossy
29	SM 54	oval	Nil	Green striated	Dense	Intermediate	Purple	Solitary	Dull
30	SM 57	Oblong	Nil	Green striated	Dense	Short	Purple	Solitary	Dull
31	SM 59	Oval	Nil	Green	Loose	Intermediate	Purple	Solitary	Glossy
32	SM 62	Long	Nil	Purple striated	Loose	Short	Purple	Solitary	Glossy
33	SM 63	Long	Nil	Milky white	Loose	Short	White	Solitary	Glossy
34	SM 67	Long	Nil	Light green	Loose	Short	Purple	Solitary	Dull
35	SM 69	Long	Nil	Milky white	Loose	Short	White	Solitary	Dull
36	SM 70	Long	Nil	Light green	Loose	Intermediate	White	Solitary	Dull
37	SM 71	Long	Nil	Light purple	Loose	Short	Purple	Solitary	Glossy
38	SM 72	Long	Nil	Light green striated	Loose	Short	Purple	Solitary	Dull
39	SM 73	Oval	Nil	Green striated	Loose	Short	Purple	Solitary	Dull
40	SM 74	Oval	Nil	Light green striated	Loose	Intermediate	Purple	Solitary	Glossy
41	SM 75	Oval	Nil	Light green	Loose	Short	Purple	Solitary	Glossy
42	SM 77	Oval	Nil	Green striated	Loose	Short	Purple	Solitary	Dull

Contd.

Table 6. Continued

Sl. No.	Accession Number	Fruit shape	Fruit curvature	Fruit colour	Fruit flesh density	Relative fruit calyx length	Flower colour	Bearing habit	Fruit glossiness
43	SM 78	Oval	Nil	Light green	Loose	Intermediate	Purple	Solitary	Glosssy
44	SM 82	Oblong	Nil	Purple striated	Loose	Short	Purple	Solitary	Dull
45	SM 87	Oval	Nil	Purple striated	Dense	Intermediate	Purple	Solitary	Glossy
46	SM 88	Oval	Nil	Light green striated	Loose	Long	Purple	Solitary	Dull
47	SM 89	Oval	Nil	Green striated	Dense	Short	Purple	Solitary	Glossy
48	SM 96	Oval	NIl	Purple striated	Dense	Short	Purple	Solitary	Glossy
49	SM 97	Oblong	Nil	Light green striated	Dense	Intermediate	Purple	Solitary	Glossy
50	SM 98	Oval	Nil	Green	Loose	Short	Purple	Solitary	Glossy
51	SM 99	Oval	Nil	Light green striated	Dense	Long	Purple	Solitary	Glossy
52	SM 101	Oblong	Nil	Purple	Loose	Intermediate	Purple	Solitary	Glossy
53	SM 104	Oval	Nil	Light green striated	Loose	Short	Purple	Solitary	Dull
54	SM 105	Oval	Nil	Light green striated	Dense	Short	Purple	Solitary	Dull
55	SM 108	Oval	Nil	Milky white	Loose	Short	Purple	Solitary	Dull
56	SM 109	Oblong	Nil	Milky white	Loose	Short	Purple	solitary	Dull
57	SM 110	Oval	Nil	Green striated	Loose	Short	Purple	Solitary	Dull
58	SM 111	Oval	Nil	Purple striated	Dense	Short	Purple	Solitary	Glossy
59	SM 112	Oval	Nil	Purple	Dense	Intermediate	Purple	Solitary	Glossy
60	SM 113	Oval	Nil	Green	Dense	Short	Purple	Solitary	Glossy
61	SM 114	Oval	Nil	Green striated	Loose	Shrot	Purple	Solitary	Dull

Contd.

Table 6. Continued

Sl. No.	Accession Number	Fruit shape	Fruit curvature	Fruit colour	Fruit flesh density	Relative fruit calyx length	Flower colour	Bearing habit	Fruit glossines
62	SM 115	Oval	Nil	Light green striated	Dense	Short	Purple	solitary	Dull
63	SM 116	Round	Nil	Light purple	Loose	Short	Purple	Solitary	Glossy
64	SM 117	oval	Nil	Light green	Dense	Intermediate	Purple	Solitary	Dull
65	SM 118	Oval	Nil	Purple striated	Dense	Short	Purple	Solitary	Dull
66	SM 119	oval	Nil	Green striated	Dense	Long	Purple	Solitary	Dull
67	SM 120	Long	Nil	White	Very loose	Short	Purple	Occassionally clustered	Glossy
68	SM 121	Oval	Nil	Deep purple	Loose	Short	Purple	Solitary	Glossy
69	SM 122	Oblong	Nil	Purple	Very loose	Short	Purple	Clustered	Glossy
70	SM 124	Oblong	Nil	Purple	Loose	Short	Purple	Solitary	Glossy
71	SM 126	Oval	Nil	Deep purple	Dense	Short	Purple	Solitary	Glossy
72	SM 127	Long	Slightly curved	Purple striated	Dense	Short	Purple	Solitary	Dull
73	SM 128	Long	Nil	Deep purple	Loose	Short	Purple	Solitary	Glossy
74	SM 129	Oblong	Nil	Purple striated	Dense	Short	Purple	Solitary	Glossy
75	SM 132	Long	Nil	Green	Loose	Short	White	Solitary	Dull
76	SM 136	Round	Nil	Light green striated	Loose	Intermediate	White	Solitary	Glossy
77	SM 137	Oblong	Nil	Light green	Loose	Long	Purple	Solitary	Dull
78	SM 141	Long	Nil	Light green	Very loose	Short	White	Solitary	Glossy

Plate 4
Variability for fruit characters in brinjal

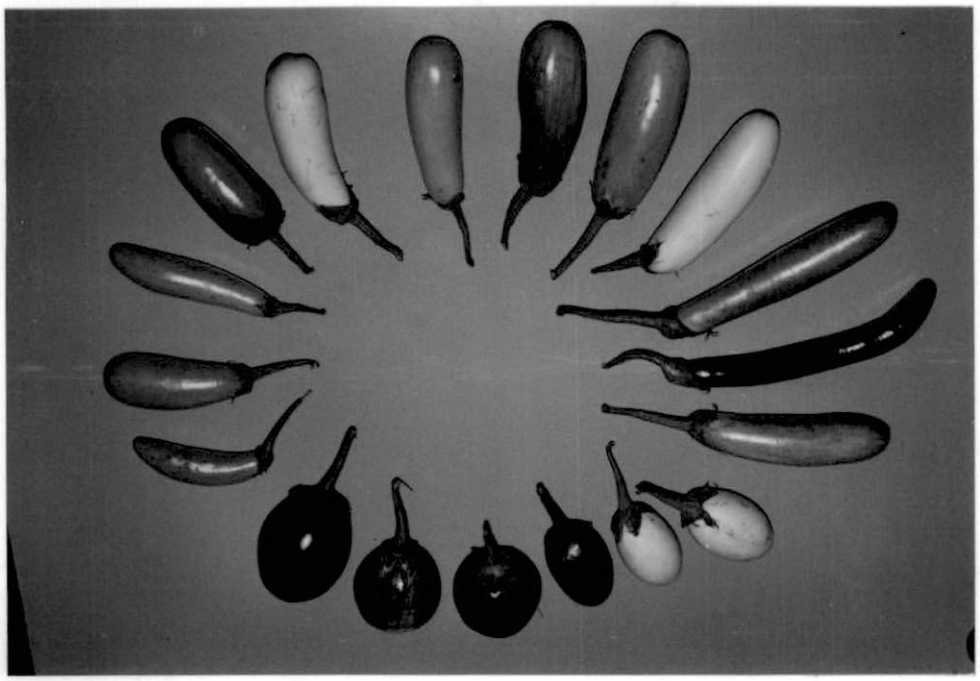


Plate 5
Variability for fruit characters in brinjal

The analysis of variance indicated significant differences among the 78 accessions for all the 18 characters studied (Appendix-IV). The phenotypic coefficient of variation ranged from 9.91 to 60.90 (Table 7). The genotypic effect on the phenotypic variation was evident by moderately high values of heritability for majority of the characters.

(1) Plant height

The coefficients of variation for height of plant was only 23.02 per cent (pcv) and 21.54 per cent (gcv). However, it had a relatively high value of heritability (0.88). The plant height ranged from 44.4 cm in BB 49 to 143.9 cm in SM 128 (Table 8). This was closely followed by SM 129 (140.0 cm) and SM 98 (139.1 cm).

(2) Plant spread

Plant spread among the accessions ranged from 53 cm for SM 96 to 141.5 cm for SM 116. The released varieties/accessions like Pant Rituraj and SM 36 were also less spreading types. Thirty three accessions including BB 44, CH 156, TGR, SM 63, SM 71, SM 75, SM 87 and SM 141 had more spreading habit.

(3) Number of primary branches per plant

There was significant variation for number of primary branches among the accessions. Arka Nidhi had the minimum number of primary branches (4.5) followed by Arka Keshav (4.9) and SM 109 (4.9). SM 70 had the maximum number of primary branches (10.8).

Table 7. Coefficients of variation, heritability and genetic advance for quantitative characters during the preliminary evaluation

Sl. No.	Character	gcv (%)	pcv (%)	ecv (%)	Heritability	Genetic advance (%)
1	Plant height	21.54	23.02	8.12	0.88	41.55
2	Plant spread	14.75	19.88	13.29	0.55	22.52
3	Leaf length	17.09	19.68	9.76	0.75	30.56
4	Leaf width	20.25	22.68	10.21	0.79	36.89
5	No. of primary branches	16.95	20.65	11.84	0.66	27.99
6	Fruit length	32.78	34.95	12.11	0.88	63.30
7	Fruit diameter	21.16	23.80	11.03	0.79	38.79
8	Fruit circum-ference	19.79	21.11	7.37	0.88	38.30
9	Average fruit weight	43.12	44.45	10.78	0.94	86.07
10	No. of fruits/plant	54.80	60.90	26.50	0.81	101.65
11	Yield/plant	52.67	57.12	22.09	0.85	106.09
12	Days to flower	7.83	9.91	6.08	0.62	12.65
13	Days to fruit set	16.33	18.89	16.24	0.51	9.29
14	Days to first harvest	13.93	16.38	8.63	0.72	24.29
15	Days to 50% harvest	29.94	30.81	7.28	0.94	59.91
16	Days to last harvest	16.15	20.37	12.42	0.63	26.43
17	Total number of harvest	25.32	40.36	31.42	0.39	32.39

Table 8. Quantitative characters of the 78 brinjal accessions during the preliminary evaluation (July 1994-February 1995)

Sl. No.	Accession No./ Variety	Plant height (cm)	Plant spread (cm)	No. of primary branches	Leaf length (cm)	Leaf width (cm)	Days to flowering	Days to fruit set	Days to first harvest	Days to 50% harvest	Days to last harvest	Total No. of harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit circum-ference (cm)	Average fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)
1	SM-2	78.0	91.5	6.8	11.5	8.9	40.4	45.8	65.7	88.6	189.2	8.5	6.9	3.7	12.9	36.9	12.4	491.6
2	SM-3	72.2	93.9	6.5	15.1	9.5	39.5	43.4	53.8	88.5	148.6	7.2	13.1	3.3	12.2	39.1	12.6	613.9
3	SM-4	63.8	56.5	6.6	10.4	8.5	33.5	39.0	50.8	81.2	91.3	3.8	5.1	4.6	14.7	42.5	3.5	308.5
4	Annapurna	101.3	94.0	7.9	17.2	12.0	41.0	44.0	55.5	88.0	191.2	13.3	13.3	3.5	12.1	93.9	32.0	2279.6
5	SM-7	78.0	99.0	8.6	16.5	10.4	45.5	51.9	65.5	87.9	182.2	11.8	10.5	3.5	12.3	85.9	21.2	1141.1
6	SM-10	93.9	106.4	7.0	17.6	14.0	44.7	50.2	64.5	166.8	182.2	11.0	8.0	4.7	14.1	92.5	15.5	817.3
7	BB-7	76.5	75.0	5.5	16.5	10.6	43.0	47.9	57.5	82.2	197.2	12.9	13.0	4.3	14.9	176.6	15.3	912.6
8	BB-13-1	76.2	80.3	8.9	13.6	9.4	32.8	38.0	50.5	82.0	191.2	14.4	8.1	4.9	17.0	73.1	15.3	825.4
9	BB-44	68.8	112.5	5.5	14.5	11.6	39.0	44.5	66.2	166.6	192.8	12.8	11.4	4.3	13.4	94.1	23.5	1543.3
10	Arka Nidhi	68.9	75.4	4.5	15.8	10.5	45.5	50.5	64.4	88.0	178.2	10.7	14.6	2.4	8.4	60.1	21.4	586.7
11	Arka Keshav	61.6	94.0	4.9	12.4	8.5	42.9	47.9	62.7	88.0	172.7	10.3	19.9	2.6	9.2	69.2	14.2	530.8
12	SM-18	90.0	100.4	9.4	13.9	9.9	43.5	48.6	60.7	171.5	215.7	10.7	4.6	3.7	10.5	28.0	25.1	699.2
13	CH-156	100.0	108.9	6.7	13.9	9.6	38.0	43.2	58.2	129.5	183.7	11.3	16.0	3.8	13.5	80.1	42.4	2103.9
14	SM-20	100.5	81.4	6.0	14.0	8.0	42.5	47.5	62.4	87.9	199.3	9.0	11.2	3.2	10.8	68.0	9.5	592.6
15	SM-21	96.4	110.4	6.6	13.9	9.9	36.0	41.2	50.4	88.2	178.1	10.1	9.8	4.5	13.5	84.5	17.4	800.4
16	BB-49	44.4	73.9	5.6	12.4	9.4	34.9	40.2	50.5	87.8	127.2	7.0	6.3	3.6	12.0	49.6	11.1	374.5
17	BB-2	81.4	101.4	5.9	14.2	9.9	34.9	40.0	50.3	94.0	178.2	11.4	10.1	4.3	14.1	70.5	21.5	1531.9
18	Composite-2	79.7	94.0	6.5	16.2	11.0	38.6	43.4	58.7	165.5	202.5	10.7	5.5	4.7	14.0	90.6	11.9	814.7
19	SM-25	69.2	71.4	6.8	14.1	8.7	43.1	48.5	62.5	73.1	122.7	3.9	9.3	3.6	12.3	75.7	6.0	394.3
20	WCG(S)	66.4	86.4	8.2	9.9	6.5	38.6	43.0	54.0	86.9	121.3	5.7	16.8	3.6	11.6	84.3	21.9	1240.4

Contd.

Table 8. Continued

Sl. No.	Accession No./ Variety	Plant height (cm)	Plant spread (cm)	No. of primary branches	Leaf length (cm)	Leaf width (cm)	Days to flowering	Days to fruit set	Days to first harvest	Days to 50% harvest	Days to last harvest	Total No. of harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit circum-ference (cm)	Average fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)
21	TGR	125.0	112.5	6.4	20.0	13.9	39.7	44.2	53.0	164.7	208.7	5.9	10.1	4.1	14.8	78.9	22.5	1625.9
22	Arka Shirish	70.8	86.4	6.0	14.6	11.1	38.7	44.1	54.1	-	-	1.4	10.4	2.9	15.7	80.9	4.2	209.3
23	SM-34	105.0	95.5	7.3	14.6	10.6	37.2	43.0	53.7	80.5	207.2	5.3	6.1	3.8	11.8	48.9	21.5	815.5
24	SM-36	93.9	63.9	5.6	16.8	12.5	44.3	50.0	64.3	129.3	185.8	4.7	8.4	5.1	19.5	95.4	6.4	368.5
25	SM-42	91.6	120.5	8.4	12.2	8.6	40.2	44.0	54.0	130.1	215.7	6.2	8.0	3.8	13.9	56.6	43.8	1329.2
26	SM-48	55.8	68.9	7.4	8.7	5.5	42.0	47.0	62.7	92.0	207.2	2.8	6.3	4.2	13.9	60.2	4.8	197.2
27	SM-49	90.5	111.4	9.7	13.0	9.9	41.1	47.0	57.5	158.5	207.0	6.4	6.0	4.4	15.9	67.4	18.5	612.8
28	SM-50	50.4	81.4	7.5	9.4	6.1	36.0	41.5	54.0	87.4	206.8	4.3	8.0	5.8	17.1	86.0	17.5	831.5
29	SM-54	107.5	112.5	8.9	14.5	9.5	42.5	46.9	56.3	129.6	207.0	5.3	8.2	5.0	17.6	79.8	17.3	803.8
30	SM-57	115.0	90.4	8.5	16.4	11.6	43.0	48.1	58.5	115.9	207.2	11.0	9.5	5.1	15.5	81.0	17.7	852.2
31	SM-59	83.5	93.9	7.7	10.0	8.4	36.8	41.6	54.0	81.4	191.0	12.7	8.0	4.2	15.1	56.5	27.5	1021.8
32	SM-62	108.9	88.0	8.1	18.8	14.0	44.9	50.9	64.3	112.5	186.9	9.5	7.1	4.2	15.4	63.2	20.2	1158.6
33	SM-63	110.7	102.5	7.7	16.5	12.1	47.0	51.0	66.9	149.0	211.1	11.2	16.6	3.8	12.9	76.6	13.7	756.8
34	SM-67	117.9	115.2	8.5	15.8	10.9	38.4	44.2	53.5	151.9	203.8	9.5	11.1	4.1	13.8	88.7	24.1	553.5
35	SM-69	116.4	111.4	5.5	18.5	14.0	43.1	49.4	63.1	169.2	208.7	10.5	15.3	4.2	14.0	100.7	14.5	699.3
36	SM-70	122.9	111.4	10.8	17.1	11.9	43.0	48.5	61.3	170.9	215.7	10.0	14.2	3.4	11.4	68.9	13.6	827.5
37	SM-71	116.6	107.5	7.0	17.8	12.2	47.2	53.1	66.5	171.2	207.0	10.5	11.0	4.5	15.6	77.2	19.0	1775.3
38	SM-72	106.4	111.6	6.5	14.5	11.7	41.0	45.9	61.3	165.7	207.0	10.9	10.2	4.2	14.1	72.4	22.8	959.0
39	SM-73	71.5	86.6	5.6	11.4	8.9	43.0	49.2	62.2	109.6	198.3	8.7	9.4	4.2	15.3	64.1	13.2	536.1
40	SM-74	76.6	98.9	7.7	12.0	8.1	41.2	46.2	58.8	93.8	117.2	4.5	6.3	3.9	13.1	32.4	17.7	324.6
41	SM-75	90.0	105.0	9.0	15.4	11.6	43.2	49.5	63.8	129.7	202.5	12.1	9.4	5.4	16.8	87.9	25.2	1433.7

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Table 8. Continued

Sl. No.	Accession No./ Variety	Plant height (cm)	Plant spread (cm)	No. of primary branches	Leaf length (cm)	Leaf width (cm)	Days to flowering	Days to fruit set	Days to first harvest	Days to 50% harvest	Days to last harvest	Total No. of harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit circum-ference (cm)	Average fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)
42	SM-77	84.0	113.0	6.8	12.5	9.6	41.1	46.0	57.5	89.0	207.2	12.0	7.0	3.9	13.9	48.0	12.2	893.2
43	SM-78	113.8	91.7	6.8	16.5	12.0	39.8	44.1	60.0	77.2	215.7	12.3	8.1	4.5	15.9	73.1	24.3	1252.0
44	SM-82	87.9	88.9	6.5	14.0	10.0	41.0	46.2	60.3	129.5	215.6	10.9	13.4	4.4	14.9	104.7	16.1	948.2
45	SM-87	87.5	129.1	8.0	12.67	9.0	38.0	44.5	56.3	109.6	207.3	9.9	7.9	4.5	15.2	87.7	18.7	977.2
46	SM-88	95.0	76.7	6.7	10.4	8.0	43.2	49.5	62.1	115.3	160.1	7.2	4.5	4.1	15.1	43.2	14.2	337.2
47	SM-89	78.2	74.1	5.5	9.8	6.3	42.4	48.5	57.4	125.9	172.8	9.7	7.4	3.8	13.4	42.7	24.1	962.4
48	SM-96	101.3	53.0	5.5	15.2	10.1	43.5	49.0	62.1	134.5	185.0	10.4	6.4	4.9	17.3	72.2	8.9	605.0
49	SM-97	94.0	100.0	8.5	15.5	10.5	38.0	44.1	57.7	78.5	215.7	12.7	10.6	5.1	18.3	129.1	18.5	1493.6
50	SM-98	139.1	100.0	8.2	15.9	11.0	41.7	48.0	57.5	152.9	198.3	10.7	9.9	5.0	16.7	89.2	14.3	1071.3
51	SM-99	79.0	78.0	7.0	11.7	9.3	40.7	45.2	57.4	89.2	160.7	6.8	6.6	3.9	13.4	52.6	6.6	243.1
52	SM-101	117.5	112.5	7.2	14.2	9.3	40.2	44.9	57.7	89.0	207.0	12.2	7.3	3.9	12.1	54.1	62.3	1546.5
53	SM-104	67.5	83.9	8.7	8.9	6.9	41.5	46.0	57.5	89.1	160.8	7.7	8.6	3.5	12.6	50.1	12.8	634.4
54	SM-105	91.0	104.2	6.1	12.0	9.4	43.0	48.0	62.3	110.9	138.2	5.1	10.4	4.5	13.9	58.1	5.2	266.4
55	SM-108	103.0	97.5	6.5	22.0	14.4	42.3	47.0	58.7	184.6	215.5	6.1	8.1	4.6	18.1	71.8	22.1	1038.8
56	SM-109	108.9	92.6	4.9	16.5	9.1	40.7	45.5	54.7	170.7	207.2	8.5	11.1	4.4	14.8	70.5	11.6	485.2
57	SM-110	77.2	90.0	7.0	11.8	7.1	43.2	48.7	57.7	85.0	106.2	5.0	8.3	4.5	14.3	70.4	3.0	359.9
58	SM-111	102.5	125.5	7.0	15.0	10.2	43.7	49.5	62.8	180.2	207.2	10.7	9.1	4.0	14.1	82.1	21.3	843.6
59	SM-112	98.9	86.7	7.4	12.0	10.2	41.0	45.8	57.5	85.2	207.1	10.5	14.2	4.6	14.6	89.2	8.9	466.7
60	SM-113	62.9	95.0	6.8	13.4	9.7	39.9	46.0	57.3	109.4	208.7	11.4	8.4	4.0	14.5	84.1	20.1	1321.4
61	SM-114	113.9	127.8	7.5	15.9	11.0	41.9	45.8	57.4	80.5	215.5	12.5	12.2	3.5	13.3	103.2	25.2	1336.2
62	SM-115	80.5	70.6	5.5	14.7	10.7	46.6	50.8	57.5	125.8	171.7	9.5	6.4	3.7	13.8	79.8	15.9	422.3

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Table 8. Continued

Sl. No.	Accession No./ Variety	Plant height (cm)	Plant spread (cm)	No. of primary branches	Leaf length (cm)	Leaf width (cm)	Days to flowering	Days to fruit set	Days to first harvest	Days to 50% harvest	Days to last harvest	Total No. of harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit circum-ference (cm)	Average fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)
63	SM-116	93.0	141.5	8.4	19.0	13.8	48.2	53.5	66.6	170.4	215.4	10.2	8.0	6.6	20.5	89.1	17.5	1431.2
64	SM-117	76.4	108.9	8.0	18.2	9.8	43.0	48.1	63.4	80.5	198.5	10.2	10.5	4.7	16.3	90.2	7.9	534.9
65	SM-118	86.9	101.5	9.5	10.7	6.9	40.9	45.8	60.6	109.4	207.2	10.0	7.0	4.6	16.0	81.7	22.6	611.1
66	SM-119	98.0	111.5	6.8	15.2	10.0	43.9	51.2	61.4	170.4	207.2	10.2	7.9	4.5	15.6	69.1	12.7	728.9
67	Swetha	80.5	92.6	5.7	11.8	8.6	39.0	43.2	57.6	106.9	187.2	10.9	12.9	3.0	13.2	81.3	24.9	1265.6
68	Surya	76.7	97.7	6.2	11.9	9.4	39.6	44.2	57.5	101.4	187.2	12.2	7.5	4.9	16.5	65.8	22.5	1379.6
69	SM-122	94.0	81.5	5.5	14.4	10.0	41.7	45.7	62.1	106.5	184.7	10.7	11.0	3.5	12.5	80.8	39.4	926.8
70	Pusa Kranti	72.9	83.2	5.7	12.9	10.5	45.9	50.7	57.5	-	-	2.3	10.6	5.2	12.4	88.1	4.5	182.8
71	SM-126	83.0	87.5	5.6	15.5	9.9	33.5	37.9	54.3	108.2	109.4	2.2	9.3	2.6	9.5	65.0	2.5	132.3
72	SM-127	128.0	110.5	7.0	17.5	12.6	35.0	40.1	50.5	89.0	128.2	4.8	15.6	3.4	11.7	75.5	5.3	466.4
73	SM-128	143.9	115.0	5.5	16.8	13.5	34.8	40.1	54.0	88.0	125.4	2.7	14.2	3.3	11.7	79.2	3.3	244.5
74	SM-129	140.0	119.1	5.4	17.9	11.7	40.5	45.5	54.0	85.2	103.2	2.0	15.5	5.3	17.8	85.0	1.2	134.5
75	SM-132	71.1	99.1	5.3	18.4	11.2	42.0	47.0	53.9	92.7	142.7	3.5	5.2	4.6	15.2	190.5	3.0	198.7
76	SM-136	90.0	120.0	5.5	22.5	16.4	47.9	55.2	66.7	148.2	207.2	4.5	8.6	9.7	30.3	235.4	22.7	1112.3
77	SM-137	107.7	106.4	5.4	20.9	16.0	43.1	47.7	58.1	170.4	207.2	8.9	16.0	6.3	18.9	226.4	10.8	956.3
78	SM-141	101.5	105.0	7.0	19.4	15.4	45.8	48.5	62.2	170.5	207.2	14.4	13.7	3.8	13.4	105.5	21.8	1635.0
CD(p=0.01)		14.88	25.73	1.635	2.862	2.111	4.966	5.769	10.80	16.73	45.83	5.601	2.396	0.9403	2.128	17.30	9.165	376.9
CV		8.12%	13.19%	11.85%	9.76%	10.21%	6.08%	6.24%	8.62%	7.28%	12.42%	31.42%	12.11%	11.02%	7.37%	10.78%	26.57%	22.09%

(4) Leaf length

Leaf length was minimum in SM 48 (8.7 cm) followed by SM 104 (8.9 cm). SM 136 had the maximum leaf length (22.5 cm). The perennial accession TGR also had large sized leaves having a length of 20 cm.

(5) Leaf width

Minimum width of 5.5 cm was observed for the leaves of SM 148 followed by SM 50 (6.1 cm). The accession SM 136 which had the longest leaves also had maximum width (16.4 cm) for the leaves.

(6) Days to flower

The coefficients of variation was minimum for this character (pcv 9.91% and gcv 7.83%). BB-13-1 was the earliest to flower (32.8 days) followed by SM 126 (33.5 days) and SM 4 (33.5 days). SM 116 took maximum days for flowering (48.2 days) followed by SM 136 (47.9 days).

(7) Days to fruit set

SM 126 was the earliest to set fruit (37.9 days) followed by BB-13-1 (38 days) and SM 4 (39 days). SM 136 took maximum days to set fruit (55.2 days) followed by SM 116 (53.5 days).

(8) Days to first harvest

As in case of days to flower, days to first harvest also had low values of phenotypic and genotypic coefficients of variation (16.38% and 13.93% respectively). Days for first harvesting ranged from 50.3 days to 66.9 days. BB 2

took the minimum days of 50.3 for first harvesting followed by SM 121 (50.4 days). Maximum number of days for the first harvest was taken by SM 63 (66.9 days) followed by SM 116 (66.6 days) and SM 71 (66.5 days).

(9) Days to 50 per cent harvest

The value for peak harvesting stage ranged from 73.1 to 184.6 days. SM 25 took minimum number of days for peak harvesting (73.1) and maximum was taken by SM 108 (184.6 days). The days taken for peak harvesting by SM 71, SM 141, SM 116, Composite 2, TGR, SM 63, Swetha, Surya,Annapurna, Arka Keshav and WCG(S) was 171.2, 170.5, 170.4, 165.5, 164.7, 149, 106.9, 101.4, 88, 88 and 86.9 respectively.

(10) Days to last harvest

The fruiting period ranged from a low value of 91.3 days for SM 4 to a high value of 215.7 days for SM 18, SM 42, SM 70, SM 78 and SM 97. BB 7, BB 44, Annapurna, Surya, Swetha, CH 156, Arka Keshav and WCG(S) had a crop duration of 197.2, 192.8, 191.2, 187.2, 186.9, 182.2, 172.7 and 121.3 days whereas SM 116, SM 63, TGR, SM 141, SM 71 and Composite 2 had a longer crop duration of 215.4, 211.1, 208.7, 207.2, 207 and 202.5 days respectively.

(11) Total number of harvests

Among the quantitative characters, the heritability was minimum for total number of harvest in brinjal which was due to high value of environmental coefficient of variation (31.42%). The number of harvests ranged from 1.2 to 14.4. Minimum number of harvests were recorded from SM 129 (1.2) and Arka Shirish

(1.4). SM 141 and BB-13-1 had given the maximum number of harvests (14.4). Annpurna, BB 7, BB44, Surya, SM 75, SM 7, SM 113, SM 63, BB2, Swetha, Composite 2, SM 69, SM 71, SM 96, Arka Keshav, SM 116, SM 87, TGR and WCG(S) gave 13.3, 12.9, 12.8, 12.2, 12.1, 11.8, 11.4, 11.2, 11.2, 10.9, 10.7, 10.5, 10.5, 10.4, 10.3, 10.2, 9.9, 5.9 and 5.7 number of harvests respectively.

(12) Fruit length

SM 88 had the shortest fruits (4.5 cm) followed by SM 18 (4.6 cm). Length of fruit was maximum in Arka Keshav (19.9 cm) followed by WCG(S) (16.8 cm) and SM 63 (16.6 cm). Varieties/accessions like Arka Nidhi, Arka Keshav, SM 20, SM 25 and SM 127 having long and slender fruits were either slightly curved or sickle shaped.

(13) Fruit diameter

The fruit diameter was minimum for Arka Nidhi (2.4 cm) followed by Arka Keshav (2.6 cm). Maximum fruit diameter was recorded by round fruited accession SM 136 (9.7 cm) followed by SM 116 (6.6 cm) and SM 137 (6.3 cm).

(14) Fruit circumference

Minimum fruit circumference of 8.4 cm was observed for Arka Nidhi followed by Arka Keshav (9.2 cm). Maximum fruit circumference of 30.3 cm was recorded in SM 136 followed by SM 116 (20.5 cm).

(15) Average fruit weight

Though average fruit weight had moderate values of phenotypic

coefficient of variation (44.45%) and genotypic coefficient of variation (43.12), the heritability value was maximum (0.94). It had a comparatively high value of genietic advance also (86.07%). The average fruit weight ranged from 28 g in SM 18 to 235.4 g in SM 136. SM 136 was closely followed by SM 137 (226.4 g). Accessions like SM 132, BB 7, SM 97, SM 141 and SM 69 also had large sized fruits (190.5, 176.6, 129.1, 105.5 and 100.7 g respectively).

(16) Number of fruits per plant

Phenotypic and genotypic coefficient of variations were maximum for number of fruits/plant (60.90% and 54.80% respectively). The heritability of this character was also high (0.81). The minimum number of fruits were in the Waynad collections SM 129 (1.2), SM (2.5), SM 132 (3.0) and SM 128 (3.3). The maximum number of fruits were recorded in SM 101 (62.3) followed by SM 41 (43.8), CH 156 (42.4), SM 122 (39.4) and Annapurna (32).

(17) Yield per plant

There was significant differences among the 78 accessions for yield/plant. It had a high value of phenotypic coefficient of variation (57.12%) and genotypic coefficient of variation (52.67%). The genetic advance was also maximum for this character (106.09%). Yield/plant ranged from 132.3 g in SM 126 to 2279.6 g in Annapurna. This was followed by CH 156 (2103.9 g), SM 71 (1775.3 g), SM 141 (1635 g), TGR (1625.9 g), SM 101 (1546.5 g), BB 44 (1543.3 g), BB 2 (1531.9 g), SM 97 (1493.6 g), SM 75 (1433.7 g), SM 116 (1431.2 g), Surya (1379.6 g), SM 114 (1336.2 g), SM 42 (1329.2 g), SM 113 (1321.4 g), Swetha (1265.5 g) and SM 78 (1252 g).

(18) Incidence of bacterial wilt

The incidence of bacterial wilt among the 78 brinjal accessions ranged from 0 to 100 per cent (Table 9). The infected plants succumbed to wilt from seedling to final harvestable stage (Plate 6 and 7). The varieties like Arka Shirish and Pusa Kranti completely lost by bacterial wilt even before 90 days after planting. None of the plants in the above varieties were there in the field at the time of peak harvesting. Varieties/accessions like SM 10, BB-13-1, BB 44, Arka Keshav, SM 18, CH 156, SM 20, WCG(S), TGR, SM 50, SM 63, SM 67, SM 70, SM 71, SM 72, SM 78, SM 82, SM 96, SM 97, SM 101, SM 111, SM 113, SM 116, SM 119, Surya, Swetha, SM 122, SM 127, SM 132, SM 137 and SM 141 were completely free from bacterial wilt during the field evaluation. Incidence of bacterial wilt was below 20 per cent in SM 2, SM 3, Annapurna, SM 7, Arka Nidhi, BB 2, Composite 2, SM 25, SM 42, SM 48, SM 49, SM 59, SM 62, SM 69, SM 75, SM 87, SM 98, SM 108, SM 109, SM 114, SM 115, SM 117, SM 118, SM 128, SM 129 and SM 136. The wilt incidence ranged from 20 to 40 per cent in accessions/varieties like BB 7, SM 4, SM 21, SM 36, SM 54, SM 57, SM 74, SM 77, SM 88, SM 89, SM 99, SM 104, SM 105, SM 110 and SM 112. Incidence of bacterial wilt was more than 40 per cent but below 60 per cent in three accessions SM 34, SM 36, SM 73 and SM 126. Bhubaneshwar line BB 49 was susceptible to wilt (70%).

B. Evaluation of bacterial wilt resistant and promising brinjal accessions/ varieties

Twenty four accessions/varieties which exhibited better performance for resistance to bacterial wilt, productivity and desirable fruit and plant characters

Table 9. Bcacterial wilt incidence in 78 brinjal accessions during preliminary evaluation (July 1994-February 1995)

Sl. No.	Accession No./ variety	Wilting (%)	Disease reaction	Sl. No.	Accession No./ variety	Wilting (%)	Disease reaction
1	SM 2	15 (0.3692)	MR	22	Arka Shirish	100 (1.412)	S
2	SM 3	15 (0.3692)	R	23	SM 34	50 (0.7854)	MS
3	SM 4	35 (0.6322)	MR	24	SM 36	50 (0.7854)	MS
4	Annapurna	5 (0.2403)	R	25	SM 42	5 (0.2403)	R
5	SM 7	10 (0.3218)	R	26	SM 48	10 (0.3112)	R
6	SM 10	0 (0.1588)	R	27	SM 49	15 (0.3692)	R
7	BB7	30 (0.5742)	MR	28	SM 50	0 (0.1588)	R
8	BB-13-1	0 (0.1588)	R	29	SM 54	25 (0.5216)	MR
9	BB 44	0 (0.1588)	R	30	SM 57	25 (0.5216)	MR
10	Arka Nidhi	5 (0.2403)	R	31	SM 59	5 (0.2403)	R
11	Arka Keshav	0 (0.1588)	R	32	SM 62	5 (0.2403)	R
12	SM 18	0 (0.1588)	R	33	SM 63	0 (0.1588)	R
13	CH-156	0 (0.1588)	R	34	SM 67	0 (0.1588)	R
14	SM 20	0 (0.1588)	R	35	SM 69	5 (0.2403)	R
15	SM 21	25 (0.5216)	MR	36	SM 70	0 (0.1588)	R
16	BB 49	70 (0.9914)	S	37	SM 71	0 (0.1588)	R
17	BB 2	5 (0.2403)	R	38	SM 72	0 (0.1588)	R
18	Composite-2	5 (0.2403)	R	39	SM 73	50 (0.7854)	MS
19	SM 25	10 (0.3218)	R	40	SM 74	35 (0.6322)	MR
20	WCG(S)	0 (0.1558)	R	41	SM 75	5 (0.2403)	R
21	TGR	0 (0.1588)	R	42	SM 77	35 (0.6322)	MR

Contd.

Table 9. Continued

Sl. No.	Accession No./ variety	Wilting (%)	Disease reaction	Sl. No.	Accession No./ Variety	Wilting (%)	Disease reaction
43	SM 78	0 (0.1588)	R	61	SM 114	5 (0.2403)	R
44	SM 82	0 (0.1588)	R	62	SM 115	5 (0.2403)	R
45	SM 87	5 (0.2403)	R	63	SM 116	0 (0.1588)	R
46	SM 88	35 (0.6245)	MR	64	SM 117	5 (0.2403)	R
47	SM 89	25 (0.5216)	MR	65	SM 118	15 (0.3692)	R
48	SM 96	0 (0.1588)	R	66	SM 119	0 (0.1588)	R
49	SM 97	0 (0.1588)	R	67	Swetha	0 (0.1588)	R
50	SM 98	5 (0.2403)	R	68	Surya	0 (0.1588)	R
51	SM 99	30 (0.5742)	MR	69	SM 122	0 (0.1588)	R
52	SM 101	0 (0.1588)	R	70	Pusa Kranti	100 (1.412)	S
53	SM 104	35 (0.6245)	MR	71	SM 126	45 (0.7351)	MS
54	SM 105	25 (0.5216)	MR	72	SM 127	0 (0.1588)	R
55	SM 108	5 (0.2403)	R	73	SM 128	10 (0.3218)	R
56	SM 109	10 (0.3112)	R	74	SM 129	10 (0.3927)	R
57	SM 110	30 (0.5536)	MR	75	SM 132	0 (0.1588)	R
58	SM 111	0 (0.1588)	R	76	SM 136	15 (0.3927)	R
59	SM 112	25 (0.5216)	MR	77	SM 137	0 (0.1588)	R
60	SM 113	0 (0.1588)	R	78	SM 141	0 (0.1588)	R
CD (p = 0.01)		- 0.2439					
CV		- 37.26%					

Data in parentheses indicates transformed value
R - Resistant - wilting less than 20%
MR - Moderately Resistant - wilting 20-40%
MS - Moderately Susceptible - wilting 40-60%
S - Susceptible - wilting more than 60%

Plate 6
Wilted plant at the initial flowering stage

Plate 7
Wilted plant at the post flowering stage

during the preliminary evaluation were progressed for detailed evaluation during March-November 1995. The accessions selected, being different in duration of crop, were evaluated separately under different spacing keeping the susceptible variety Pusa Kranti as check. The accessions/varieties Swetha (Plate 8), Surya (Plate 9), Arka Keshav (Plate 10), BB 7 (Plate 11), Annapurna (Plate 12), CH 156, WCG(S), SM 7, SM 59, SM 62, BB2, BB 44 and SM 96 were evaluated under short duration accessions and SM 116 (Plate 13), SM 141 (Plate 14), Composite 2 (Plate 15), TGR, SM 63, SM 69, SM 71, SM 75, SM 87 and SM 113 under long duration. The analysis of variance showed that there were significant differences for all the characters studied except for the fruit diameter of long duration accessions (Appendix-V and VI).

(1) Plant height

a. Short duration type

Plant height ranged from 83.2 cm in Surya to 183 cm in WCG(S) (Table 10). WCG(S) was closely followed by Annapurna (141.55 cm) and CH 156 (134.15 cm). Swetha recorded a height of 111.55 cm and Arka Keshav, 85 cm.

b. Long duration type

The plant height ranged from 63.87 cm in SM 113 to 187.77 cm in TGR (Table 11). SM 141 recorded a height of 155.63 cm and SM 71 140.4 cm.

(2) Plant spread

a. Short duration type

The spread also showed significant differences among the accessions

Plate 8 **Swetha**

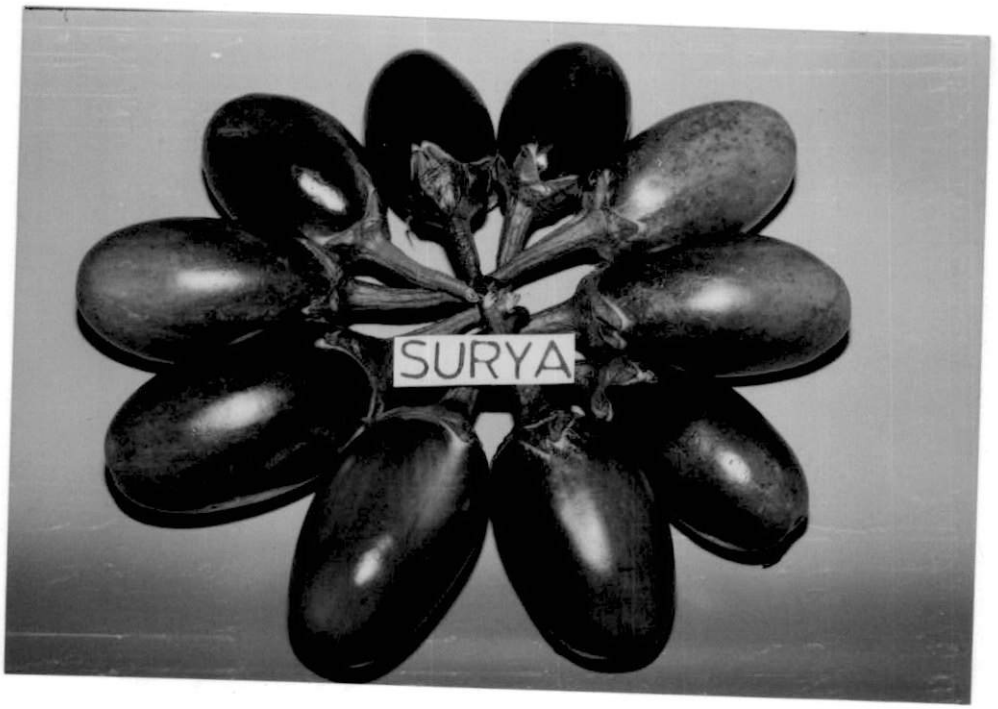

Plate 9 **Surya**

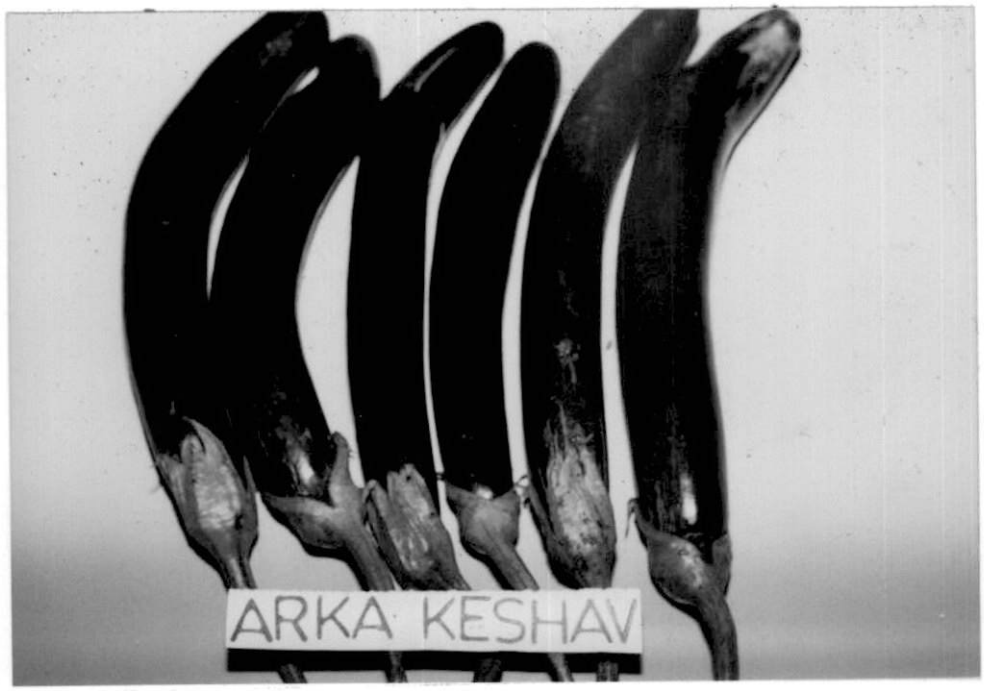

Plate 10 **Arka Keshav**

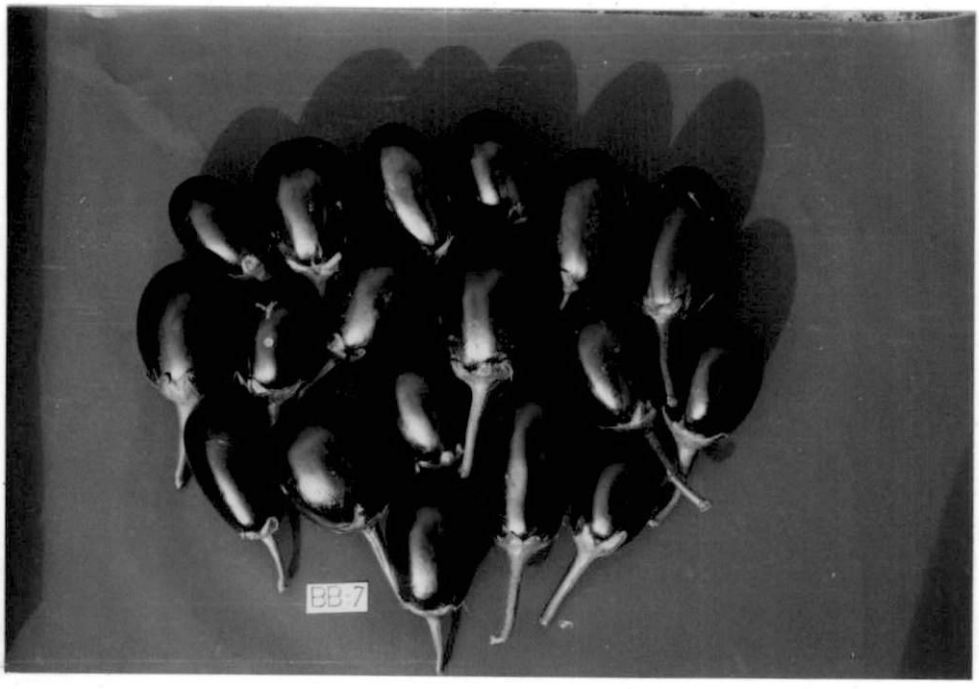

Plate 11 **BB 7**

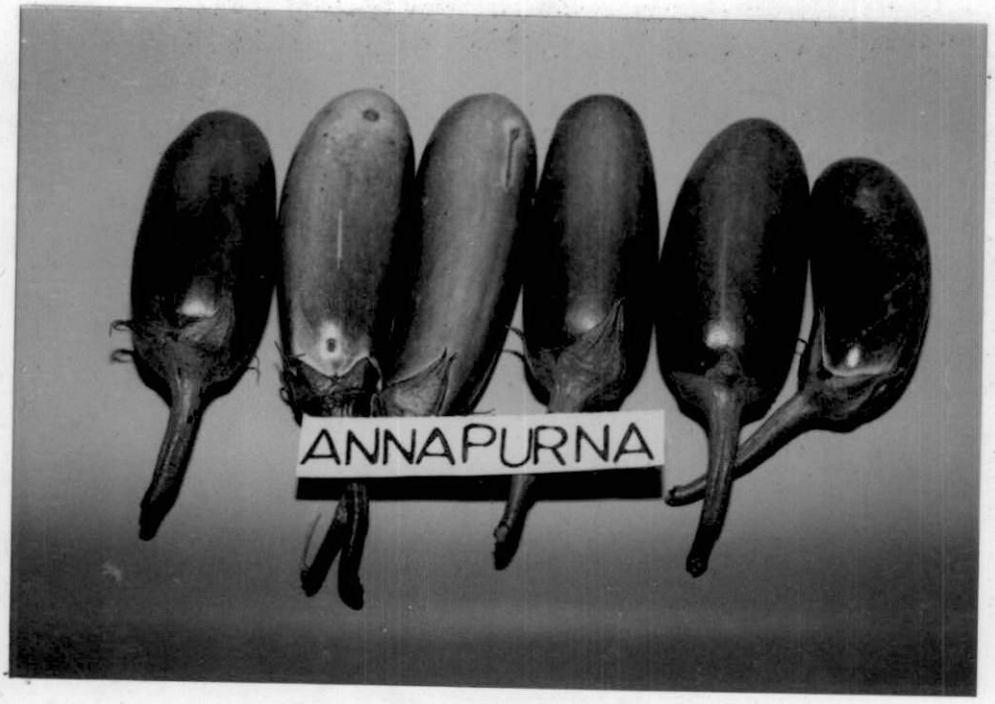

Plate 12
Annapurna

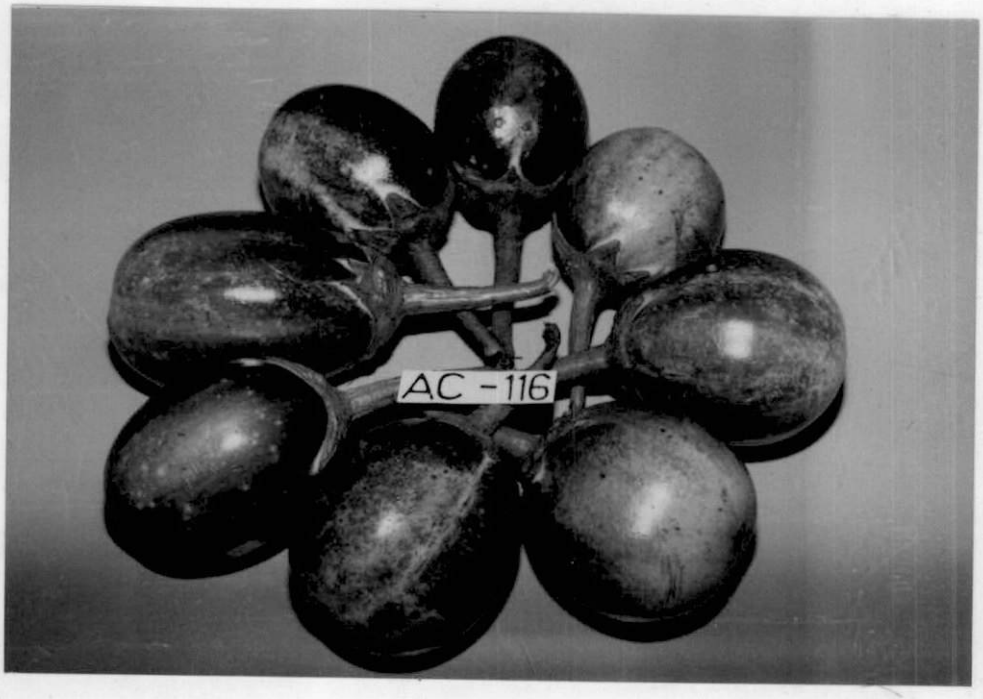

Plate 13
SM 116

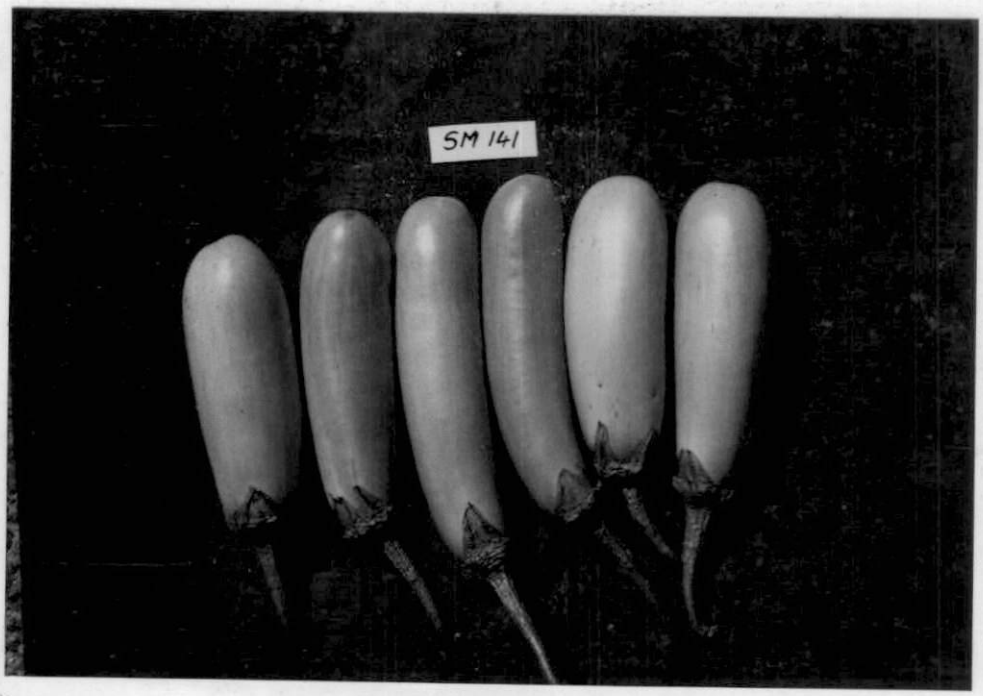

Plate 14
SM 141

Plate 15
Composite 2

Table 10. Vegetative characters of 15 short duration brinjal accessions (March-October 1995)

Sl. No.	Accession No./ Variety	Plant height (cm)	Plant spread (cm)	No. of primary branches	Leaf length (cm)	Leaf width (cm)
1	Annpurna	141.55	104.20	6.6	11.50	9.70
2	CH-156	134.15	128.90	6.2	13.55	10.00
3	WCG (S)	183.00	110.55	6.1	11.00	7.80
4	Swetha	111.55	100.70	6.3	12.30	7.10
5	SM-59	126.55	89.05	6.5	9.00	6.40
6	Arka Keshav	85.00	110.50	6.0	12.00	7.85
7	BB-13-1	98.75	151.65	8.5	12.30	9.35
8	BB-2	92.70	89.05	6.0	10.20	8.35
9	SM-96	95.40	53.20	2.8	4.85	4.30
10	BB-7	96.35	102.55	6.0	10.95	7.40
11	Surya	83.20	113.20	7.0	11.00	8.00
12	SM-7	122.80	91.80	7.5	11.90	9.65
13	BB-44	131.55	121.55	6.3	12.50	9.90
14	SM-62	98.90	110.50	6.4	12.75	9.90
15	Pusa Kranti	97.90	61.65	6.0	11.55	9.85
CD (p=0.01)		22.05	15.22	1.289	1.192	1.523
CV		9.08%	6.96%	9.56%	4.99%	8.48%

Table 11. Vegetative characters of 10 long duration brinjal accessions (March-November 1995)

Sl. No.	Accession No./ Variety	Plant height (cm)	Plant spread (cm)	No. of primary branches	Leaf length (cm)	Leaf width (cm)
1	SM-63	146.13	159.67	5.9	15.30	9.30
2	SM-141	155.63	154.43	6.1	15.83	12.00
3	SM-75	97.07	107.63	7.2	14.73	9.70
4	SM-69	145.53	140.37	6.4	14.57	10.17
5	TGR	187.77	171.30	5.2	20.37	12.17
6	Composite-2	134.27	138.87	6.1	13.37	8.03
7	SM-71	140.40	191.87	5.4	16.47	10.23
8	SM-116	124.43	175.53	6.8	16.83	12.33
9	SM-113	63.87	102.83	8.1	10.17	7.90
10	SM-87	88.87	127.07	5.7	11.0	7.70
CD(P = 0.01)		24.05	22.35	1.212	1.863	1.648
CV		10.92%	8.87%	11.25%	7.31%	9.65%

tested. The value ranged from 53.2 cm to 151.65 cm. As in the initial evaluation SM 96 was the least spreading type followed by Pusa Kranti (61.65 cm) and BB 2 (89.05 cm). The maximum spread was noticed in BB-13-1 (151.65 cm) followed by CH 156 (128.9 cm) and BB 44 (121.55 cm). Surya had a spread of 113.2 cm and Swetha of 100.7 cm.

b. Long duration type

The plant spread ranged from 102.83 cm to 191.87 cm. Minimum spread was observed for SM 113 (102.83 cm) and maximum for SM 71 (191.87 cm). This was followed by SM 116 (175.53 cm) and TGR (171.3 cm). The round and firm fruited Composite 2 had a plant spread of 138.87 cm.

(3) Number of primary branches per plant

a. Short duration type

The number of primary branches was minimum for SM 96 (2.8) and maximum for BB-13-1 (8.5). Surya had seven numbers of primary branches and ARka Keshav, six.

b. Long duration type

The lowest number of primary branches was observed for TGR (5.2) followed by SM 71 (5.4) and highest number of branches was for SM 113 (8.1).

(4) Leaf length

a. Short duration type

Minimum leaf length was recorded in SM 96 (4.85 cm) and maximum in

CH 156 (13.55 cm). Leaves of Arka Keshav had a length of 12 cm and Surya, 11 cm.

b. Long duration type

The value for leaf length in long duration accessions ranged from 10.17 cm to 20.37 cm. As in the initial evaluation, maximum leaf length was observed for TGR (20.37 cm). SM 116 gave a leaf length of 16.83 cm and SM 71, 16.47 cm.

(5) Leaf width

a. Short duration type

Minimum leaf width was observed for SM 96 (4.3 cm) followed by SM 59 (6.4 cm) and maximum for CH 156 (10 cm) followed by BB 44 (9.9 cm) and SM 62 (9.9 cm). Surya recorded leaf width of 8 cm and Arka Keshav, 7.85 cm.

b. Long duration type

The value of leaf width ranged from 7.7 cm in SM 87 to 12.33 cm in SM 116. SM 71 had a leaf width of 10.23 cm.

(6) Days to flower

a. Short duration type

Surya was the earliest to flower (25.5 days) followed by Swetha (29.7 days) (Table 12). Arka Keshav took maximum days to flower (39.8 days) followed by BB 7 (39.7 days).

Table 12. Earliness and duration of 15 short duration brinjal accessions (March-October 1995)

Sl. No.	Accession No./ variety	Days to flower	Days to fruit set	Days to first harvest	Days to 50% harvest	Days to last harvest	No. of economic harvests	Total No.of harvest
1	Annapurna	33.5	39.8	48.8	128.4	198.4	14.3	16.3
2	CH-156	32.2	37.4	49.7	141.6	198.5	14.7	16.7
3	WCG(S)	36.8	43.8	53.5	154.2	198.7	14.3	16.3
4	Swetha	29.7	35.1	47.2	108.3	198.4	14.0	16.5
5	SM-59	30.5	35.5	47.3	88.5	162.8	13.4	14.4
6	Arka Keshav	39.8	45.0	55.4	139.0	198.3	12.3	14.8
7	BB-13-1	34.9	40.5	51.5	115.8	198.5	13.9	15.9
8	BB-2	30.0	36.4	46.5	138.4	177.0	14.8	14.8
9	SM-96	35.8	41.0	55.2	71.1	109.0	2.7	2.7
10	BB-7	39.7	44.3	55.9	138.5	187.3	13.0	15.0
11	Surya	25.5	31.2	43.5	109.5	192.2	13.4	14.4
12	SM-7	33.5	39.0	48.8	124.4	198.4	10.9	10.9
13	BB-44	33.4	38.0	53.5	142.5	198.6	9.3	11.3
14	SM-62	30.4	34.5	49.0	138.6	193.0	8.3	10.3
15	Pusa Kranti	32.8	37.5	50.4	67.0	91.4	2.7	2.7
CD (P=0.01)		1.910	1.900	3.204	18.75	27.85	2.104	2.284
CV		2.68%	2.30%	2.96%	7.26%	6.59%	7.36%	8.28%

b. Long duration type

Long duration accessions took more time for the emergence of flowers. SM 116 took maximum days for flowering (44.9 days) followed by TGR (42.9 days) and SM 71 (41.3 days) (Table 13).

(7) Days to fruit set

a. Short duration type

Surya was the earliest to set fruit (31.2 days) followed by SM 62 (34.5 days) and Swetha (35.1 days). Arka Keshav took maximum days to set fruits (45 days).

b. Long duration type

SM 113 was the earliest to set fruits (39 days) while SM 116 took maximum days to set fruits (49.3 days) followed by TGR (47.2 days) and SM 71 (46 days).

(8) Days to first harvest

a. Short duration type

Minimum number of days for first harvesting was noticed in Surya (43.5 days) followed by BB2 (46.5 days) and Swetha (47.2 days). Maximum days to first picking was taken by BB 7 (55.9 days) followed by Arka Keshav (55.4 days).

b. Long duration type

Harvesting was delayed in long duration accessions and maximum days

Table 13. Earliness and duration of 10 long duration brinjal accessions (March-November 1995)

Sl. No.	Accession No./ Variety	Days to flower	Days to fruit set	Days to first harvest	Days to 50% harvest	Days to last harvest	No.of economic harvests
1	SM-63	39.9	44.9	56.4	166.3	225.7	15.6
2	SM-141	40.5	44.9	57.4	153.5	240.3	18.4
3	SM-75	35.5	40.5	52.6	109.4	207.4	15.8
4	SM-69	38.9	43.9	56.5	148.9	240.5	17.3
5	TGR	42.9	47.2	62.5	162.6	240.5	15.5
6	Composite 2	41.0	45.3	59.9	117.9	240.5	10.7
7	SM-71	41.3	46.0	60.3	159.1	236.4	11.9
8	SM-116	44.9	49.3	64.3	159.7	240.3	14.1
9	SM-113	33.3	39.0	52.6	120.1	217.9	14.4
10	SM-87	38.1	43.5	55.4	139.4	212.9	13.7
CD (P=0.01)		2.909	2.823	3.156	12.00	18.35	2.687
CV		4.29%	3.70%	3.18%	4.87%	4.86%	12.80%

for first harvesting was taken by SM 116 (64.3 days) followed by SM 71 (60.3 days).

(9) Days to 50 per cent harvest

a. Short duration type

Among the short duration accessions maximum days for 50 per cent harvest was taken by WCG(S) (154.2 days) followed by BB 44 (142.5 days). Surya took 109.5 days for 50 per cent harvesting and Arka Keshav, 139 days.

b. Long duration type

Minimum days for 50 per cent harvesting was taken by SM 75 (109.4 days) followed by Composite 2 (117.9 days). SM 63 took maximum days for 50 per cent harvest (166.3 days) followed by TGR (162.6 days). SM 116 (159.7 days) and SM 71 (159.1 days) also took more days for 50 per cent harvesting.

(10) Days to last harvest

a. Short duration type

The purple fruited wilt susceptible variety Pusa Kranti was completely wiped off from the field even before the third harvest minimising the days to last harvest to a very low value of 91.4 days. Among the short duration acdcessions the crop could be harvested upto 198.7 days in WCG(S) which was at par with Arka Keshav (198.3 days).

b. Long duration type

The number of days for last economic harvest in the long duration acces-

sions ranged from 207.4 days in SM 75 to 240.5 days in Compsite 2, TGR and SM 69. SM 141 and SM 116 were also retained in the field for a longer period (240.3 days). Due to perennial tendency, the long duration SM 141, TGR, SM 116, SM 71 and Compsote 2 can be retained 2-3 years in the field.

(11) Number of economic harvests

a. Short duration type

The number of economic harvests yielding more than 100 g/plant ranged from 2.7 in SM 96 and Pusa Kranti to 14.8 in BB 2. The promising varieties like Swetha, Annapurna, WCG(S) and CH 156 also yielded more than 14 economic harvests within a period of 200 days.

b. Long duration type

The number of economic harvests in the late flowering accessions ranged from 10.7 in Composite 2 to 18.4 in SM 141. SM 69 also had more number of economic harvests (17.3).

(12) Total number of harvests

a. Short duration type

Minimum number of harvests (2.7) were obtained in SM 96 and Pusa Kranti due to severe wilting. Maximum number of harvests (16.7) were recorded in CH 156 which was on par with Annapurna and WCG(S). Surya gave 14.4 numbers of harvest and Arka Keshav, 14.8.

b. Long duration type

In the long duration accessions the plants become unproductive after a period of 240 days but the accessions remained in the field persistently for more than one year.

(13) Fruit length

a. Short duration type

BB-13-1 had the shortest fruits (7.8 cm) (Table 14). Fruits of Arka Keshav having attractive dark purple colour and maximum length (18.95 cm). Surya had a fruit length of 9.45 cm and Swetha, 13.85 cm.

b. Long duration type

SM 87 had the minimum fruit length (5.6 cm) followed by Composite 2 (6.97 cm) (Table 15). SM 69 having white and cylindrical fruits had maximum length (18.2 cm) followed by SM 63 (17.4 cm). SM 71 having perennial nature, stout and long fruits had an average fruit length of 11.5 cm.

(14) Fruit diameter

a. Short duration type

Minimum fruit diameter was recorded by Swetha (2.95 cm) followed by Arka Keshav (3.25 cm) while maximum was in BB 7 (4.8 cm) followed by BB 2 (4.55 cm). Surya had an average fruit diameter of 3.85 cm.

Table 14. Yield and fruit characters of 15 short duration brinjal accessions (March-October, 1995)

Sl. No.	Accession No./ Variety	Fruit length (cm)	Fruit diameter (cm)	Furit circum-ference (cm)	Average fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)	Yield/ ha (t)
1	Annapurna	13.85	3.90	13.75	79.00	65.70	3199.00	65.7
2	CH-156	16.00	3.75	14.50	61.50	49.00	2162.10	38.1
3	WCG(S)	15.75	3.75	16.65	82.00	35.50	2780.00	55.2
4	Swetha	13.85	2.95	9.15	63.60	117.20	3863.20	73.0
5	SM-59	9.75	3.45	13.10	50.40	51.70	1674.50	21.3
6	Arka Keshav	18.95	3.25	10.65	59.00	62.90	2106.60	33.9
7	BB-13-1	7.85	3.85	16.00	74.40	47.70	2930.70	57.9
8	BB-2	11.20	4.55	15.45	81.00	41.40	2335.80	49.5
9	SM-96	9.15	4.35	14.80	67.50	4.20	211.50	0.6
10	BB-7	9.50	4.80	17.35	171.70	27.20	1594.40	17.3
11	Surya	9.45	3.85	14.50	62.40	66.40	3057.70	40.5
12	SM-7	10.15	3.65	13.50	63.20	47.20	2040.70	31.3
13	BB-44	9.65	3.70	14.25	74.50	67.50	3670.70	50.7
14	SM-62	8.65	3.45	14.75	70.50	29.20	1844.40	31.8
15	Pusa Kranti	12.90	4.35	13.30	68.50	7.30	384.40	1.8
CD (P = 0.01)		1.629	0.8334	1.848	14.35	10.69	530.9	10.4
CV		6.32%	10.13%	6.10%	8.89%	10.38%	10.97%	12.78%

Table 15. Yield and fruit characters of 10 long duration brinjal accessions (March-November 1995)

Sl. No.	Accession No./ Variety	Fruit length (cm)	Fruit diameter (cm)	Fruit circum-ference (cm)	Average fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)	Yield/ ha (t)
1	SM-63	17.40	3.43	16.57	71.07	46.50	2696.54	25.7
2	SM-141	16.60	4.07	12.90	128.27	113.50	6400.54	68.8
3	SM-75	10.93	4.17	16.20	64.00	38.40	2274.73	16.2
4	SM-69	18.20	4.07	14.20	75.53	40.90	2433.93	23.3
5	TGR	10.17	4.07	16.87	84.87	45.10	3093.07	30.9
6	Composite 2	6.97	5.13	20.67	118.20	36.10	2090.37	12.7
7	SM-71	11.50	3.87	14.50	88.43	30.10	2017.20	15.5
8	SM-116	7.87	5.13	20.37	104.10	36.60	2590.63	21.7
9	SM-113	9.17	4.07	15.07	73.09	19.90	1131.43	11.4
10	SM-87	5.60	2.87	12.27	85.40	34.50	1664.20	11.8
CD (P=0.01)		3.327	1.443	1.808	12.57	16.55	1025	7.3
CV		16.95%	20.59%	6.60%	8.20%	21.86%	22.64%	17.89%

b. Long duration type

Minimum fruit diameter was noticed in SM 87 (2.87 cm) and maximum in round fruited types Composite 2 and SM 116 (5.13 cm). SM 71 having cylindrical fruits had an average fruit diameter of 3.87 cm.

(15) Fruit circumference

a. Short duration type

The circumference of fruits ranged from 9.15 cm in Swetha to 17.35 cm in BB 7 in short duration accessions.

b. Long duration type

The circumference of fruits of the long duration accessions ranged from 12.27 in SM 87 to 20.67 cm in Composite 2.

(16) Average fruit weight

a. Short duration type

The value for average fruit weight from 50.4 g in SM 59 to 171.7 g in BB 7. Surya had an average fruit weight of 62.4 g while Swetha had 63.6 g.

b. Long duration type

The average fruit weight ranged from 64 g for SM 75 to 128.27 g for SM 141. The round and firm fruited variety Composite 2 also had high fruit weight (118.2 g).The average fruit weight in round and fleshy fruits of SM 116 was 104.4 g. SM 71 had an average fruit weight of 88.43 g.

(17) Number of fruits per plant

a. Short duration type

SM 96 gave lowest number of fruits per plant (4.2). Swetha produced the highest number of fruits (117.2) followed by BB 44 (67.5) and Surya (66.4). Arka Keshav yielded 62.9 fruits per plant.

b. Long duration type

The lowest number of fruits per plant was in SM 113 (19.9) and the highest in SM 141 (113.5). SM 116 and SM 71 yielded 36.6 and 30.1 fruits per plant respectively.

(18) Yield per plant

a. Short duration type

In short duration accessions the yield/plant ranged from 211.70 g/plant in SM 96 to 3863.2 g/plant in Swetha. BB 44 having light green striated oblong fruits also yielded high (3670.7 g/plant). Productivity of Annapurna and Surya were also high (3199.0 and 3057.7 g/plant respectively).

b. Long duration type

Yield per plant ranged from 1131.43 g to 6400.54 g. The non prickly and long fruited accession SM 141 yielded as high as 6500.54 g/plant. Among the long duration accessions TGR having spreading habit, large leaves, white and oblong fruits with prickly nature ranked second in yield (3093.07 g/plant). SM 63, SM 116 and SM 71 yielded 2696.54, 2590.63 and 2017.2 g/plant respectively.

(19) Yield per hectare (t)

a. Short duration type

Production of short duration accessions ranged from 0.6 t/ha in SM 96 to 73.0 t/ha in Swetha. The non prickly and purple fruited variety Annapurna having compact and erect growth habit ranked second in productivity (65.7 t/ha). Surya and Arka Keshav yielded 40.5 and 33.9 t/ha respectively.

b. Long duration type

Among the long duration spreading accessions yield/ha ranged from 11.38 t in SM 113 to 68.8 t in SM 141. TGR, SM 63 and SM 116 yielded 30.9, 25.7 and 21.7 t respectively.

(20) Incidence of jassids

a. Short duration type

During periods of low rainfall the jassid population ranged from 1.1 to 7.3 (Table 16). In varieties like Annapurna, Pusa Kranti,BB 7 and SM 59 the jassid population was below economic threshold level of 4.7/leaf. Maximum jassids population was recorded in Swetha (7.3/leaf). In other accessions though the population was above economic threshold level yellowing symptoms were not manifested because of the frequent rainfall and low temperature during the period.

b. Long duration type

Though leaves of all the accessions, except SM 113 and Composite 2, had infestation of jassids above the economic threshold level, the visible symptoms of yellowing were not seen during the cropping season.

Table 16. Incidence of jassids in short duration and long duration brinjal accessions (March-November, 1995)

Sl.No.	Short duration accessions		Long duration accessions	
	Accession No./ Variety	No. of jassids/ leaf	Accession No./ variety	No. of jassids/ leaf
1	Annapurna	1.1	SM 63	7.5
2	CH-156	5.5	SM 141	5.8
3	WCG(S)	5.2	SM 75	6.7
4	Swetha	7.3	SN 69	5.5
5	SM-59	4.0	TGR	7.1
6	Arka Keshav	5.7	Composite 2	3.3
7	BB-13-1	5.2	SM 71	6.1
8	BB-2	7.2	SM 116	7.3
9	SM-96	4.5	SM 113	3.1
10	BB-7	2.0	SM 87	5.5
11	Surya	6.9		
12	SM-7	5.8		
13	BB-44	5.5		
14	SM-62	5.8		
15	Pusa Kranti	1.5		
CD (P=0.01)		2.5		1.7
CV		24.41%		17.21%

(21) Studies on bacterial wilt

a. Incidence of bacterial wilt under artificial inoculation

(i) Short duration type

The incidence of bacterial wilt under artificial inoculation ranged from 0 to 100 per cent among the short duration accessions (Table 17). The check variety Pusa Kranti was completely susceptible to wilt. Annapurna, WCG(S), Swetha, Arka Keshav, BB-13-1, BB 2, Surya, SM 7, BB 44 and SM 62 were completely free from bacterial wilt under artificial inoculation. BB 7 and SM 96 were susceptible to the tune of 70 per cent and 80 per cent respectively.

(ii) Long duration type

In the long duration accessions which consisted mainly of the local types wilt incidence ranged from 0 to 60 per cent. SM 141, SM 116, SM 113 and SM 87 had no incidence of bacterial wilt. SM 71, TGR and Composite 2 had a low incidence of 5.3 per cent, 13.3 per cent and 18.7 per cent wilting respectively. The accession SM 75 was highly susceptible to wilt recording 60 per cent incidence.

b. Anatomical studies of resistant and susceptible varieties

The anatomical studies of the roots of susceptible variety Pusa Kranti and resistant variety Surya revealed distinct difference in resistant and susceptible varieties. In the roots of susceptible variety Pusa Kranti, the secondary cortical cells were large in size, less healthy and loosely arranged (Plates 16 to 18). In the roots of resistant variety Surya, the cortical cells were small in size, healthier and compactly arranged (Plates 19 and 20). A cross section of roots of Pusa Kranti after wilting

Table 17. Incidence of bacterial wilt in short duration and long duration brinjal accessions (March-November, 1995)

Sl.No.	Short duration accessions			Long duration accessions		
	Accession No./ Variety	Wilt (%)	Disease reaction	Accession No/ Variety	Wilt (%)	Disease reaction
1	Annapurna	0.0 (0.1002)	R	SM 63	4.0 (0.1961)	R
2	CH-156	4.0 (0.1935)	R	SM 141	0.0 (0.1002)	R
3	WCG(S)	0.0 (0.1002)	R	SM 75	60.0 (0.8926)	MS
4	Swetha	0.0 (0.1002)	R	SM 69	4.0 (0.1961)	R
(5)	SM-59	36.0 (0.6430)	MR	TGR	13.3 (0.2950)	R
6	Arka Keshav	0.0 (0.1002)	R	Composite 2	18.7 (0.4360)	R
7	BB-13-1	0.0 (0.1002)	R	SM 71	5.3 (0.2040)	R
8	BB-2	0.0 (0.1002)	R	SM 116	0.0 (0.1002)	R
(9)	SM-96	80.0 (1.017)	S	SM 113	0.0 (0.1002)	R
(10)	BB-7	70.0 (0.9914)	S	SM 87	0.0 (0.1002)	R
11	Surya	0.0 (0.1002)	R			
12	SM-7	0.0 (0.1002)	R			
13	BB-44	0.0 (0.1002)	R			
14	SM-62	0.0 (0.1002)	R			
(15)	Pusa Kranti	100.0 (1.471)	S			
CD (P=0.01)		0.096			0.271	
CV		10.93%			60.60%	

* Data in parenthesis indicates transformed value
R = Resistant
MR = Moderately Resistant
MS = Moderately Susceptible
S = Susceptible

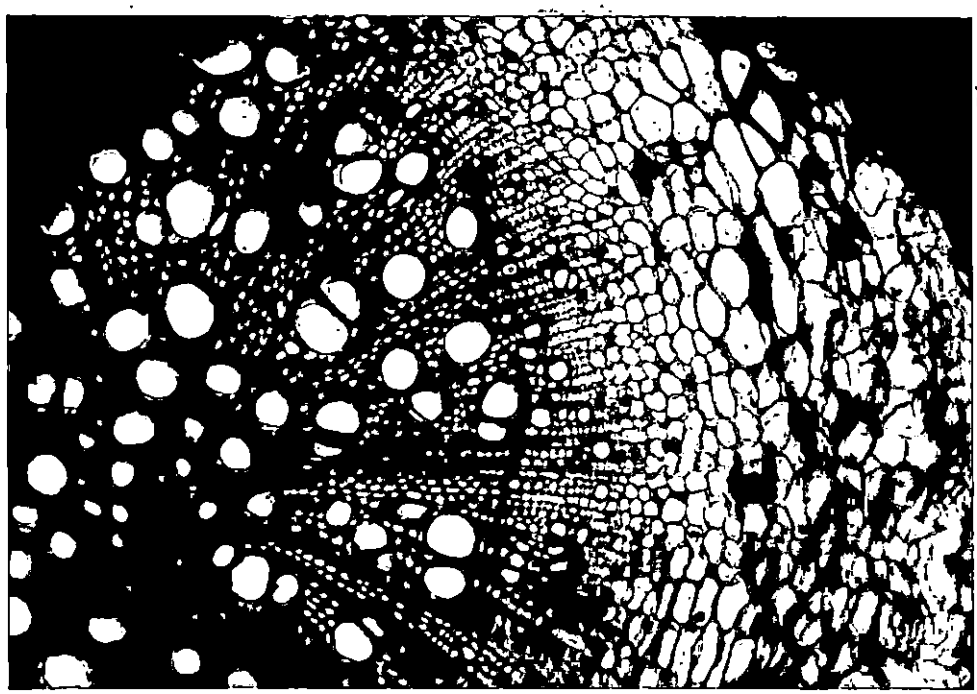

Plate 16
T.S. of roots of susceptible variety
Pusa kranti (M-10 X 7)

Plate 17
T.S of roots of susceptible variety
Pusa kranti -cortical cells (M-45 X 7)

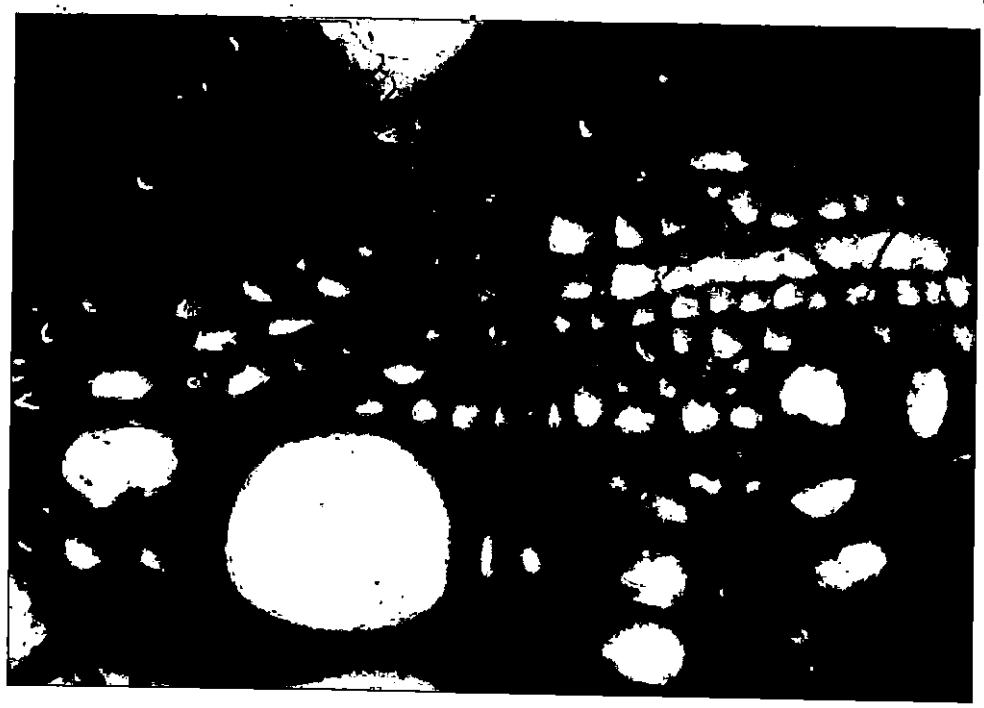

Plate 18
T.S. of roots of susceptible variety
Pusa Kranti - xylar region (M- 45 x 7)

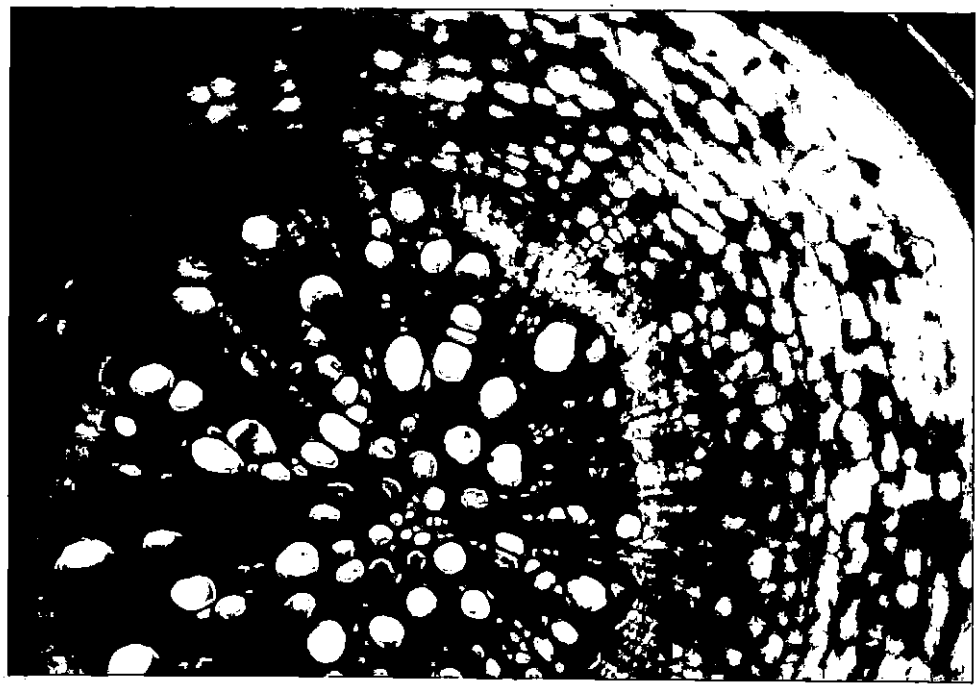

Plate 19
T.S. of roots of resistant variety
Surya (M- 10 x 7)

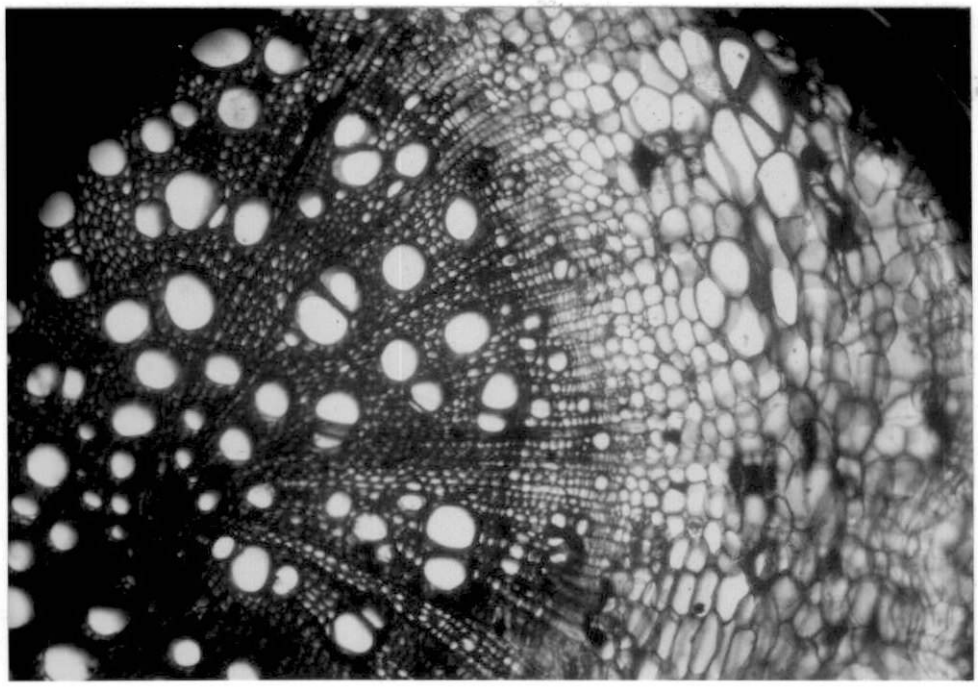

Plate 16
T.S. of roots of susceptible variety
Pusa kranti (M-10 X 7)

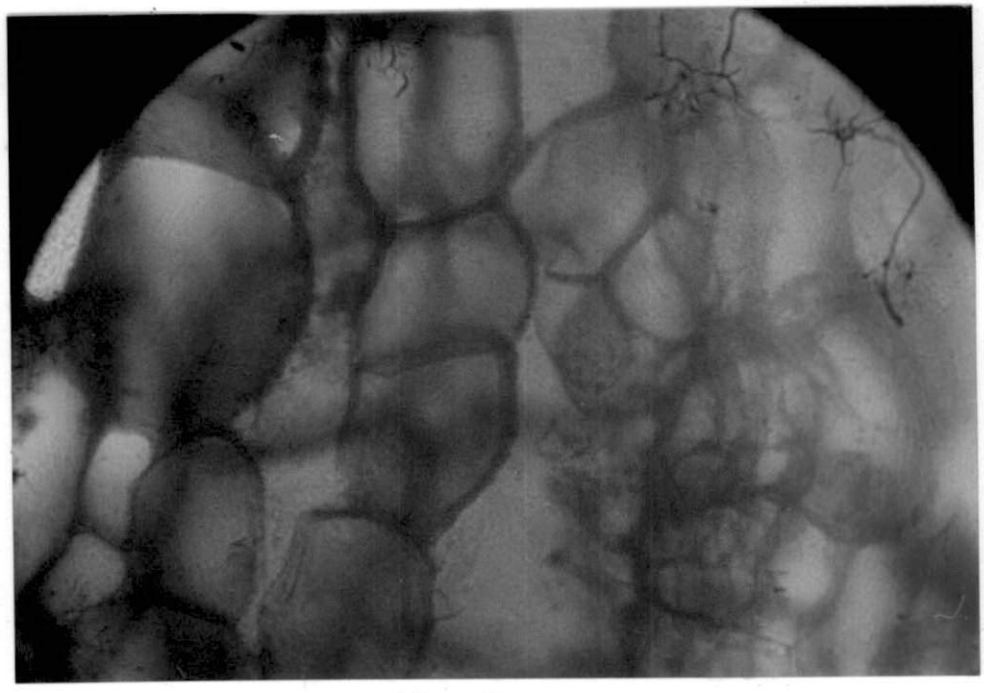

Plate 17
T.S of roots of susceptible variety
Pusa kranti -cortical cells (M-45 X 7)

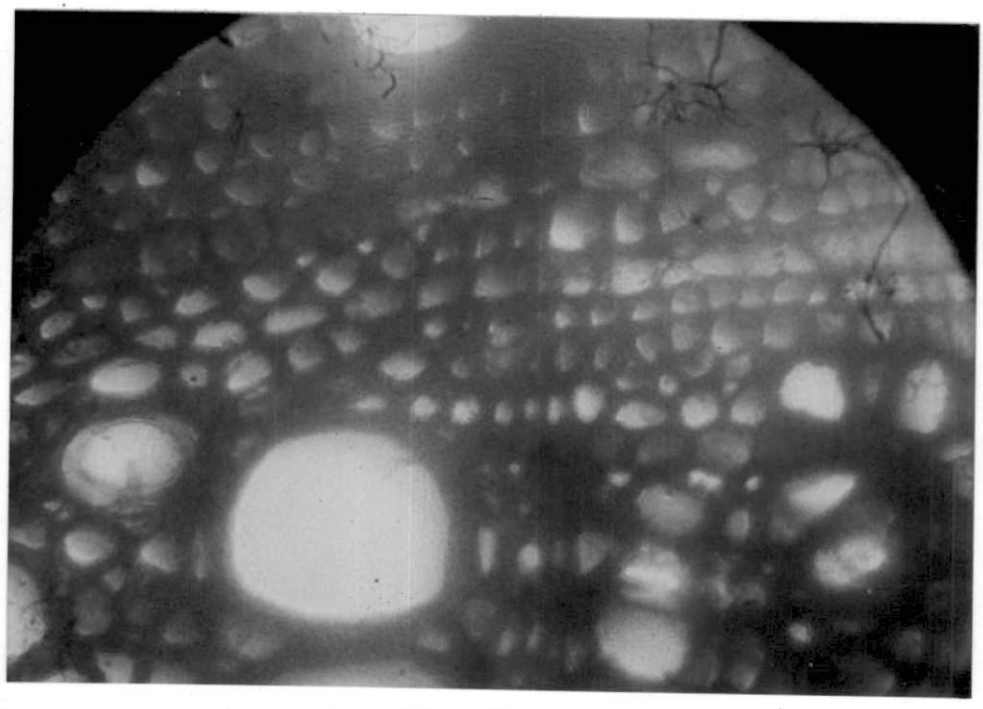

Plate 18
T.S. of roots of susceptible variety
Pusa Kranti - xylar region (M- 45 x 7)

Plate 19
T.S. of roots of resistant variety
Surya (M- 10 x 7)

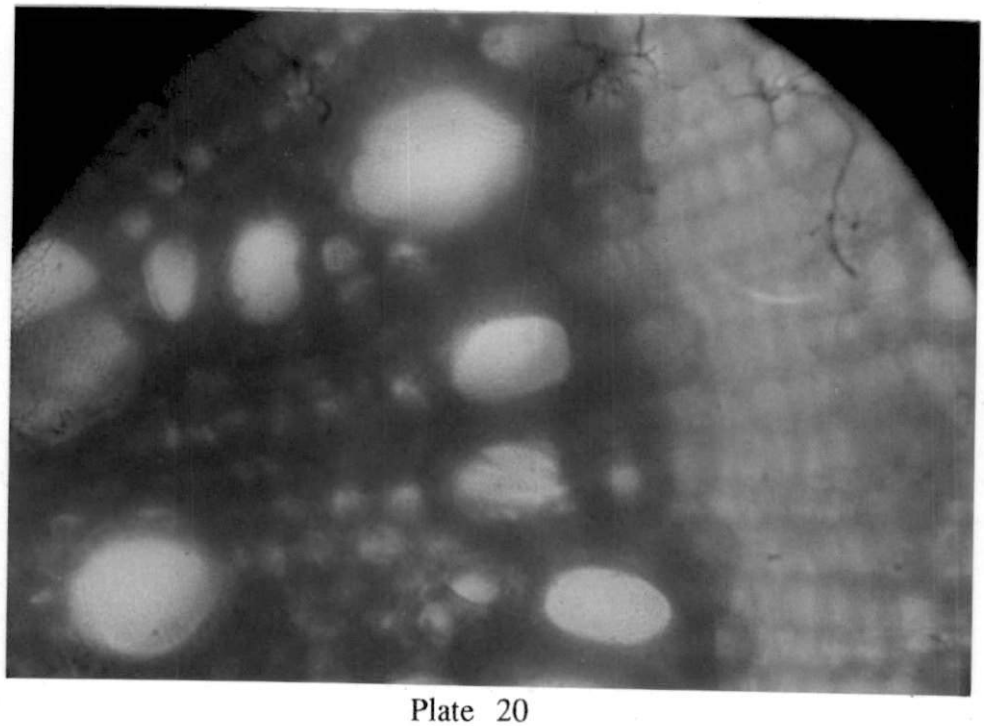

Plate 20
T.S. of roots of resistant variety
Surya- xylar region (M- 45 x 7)

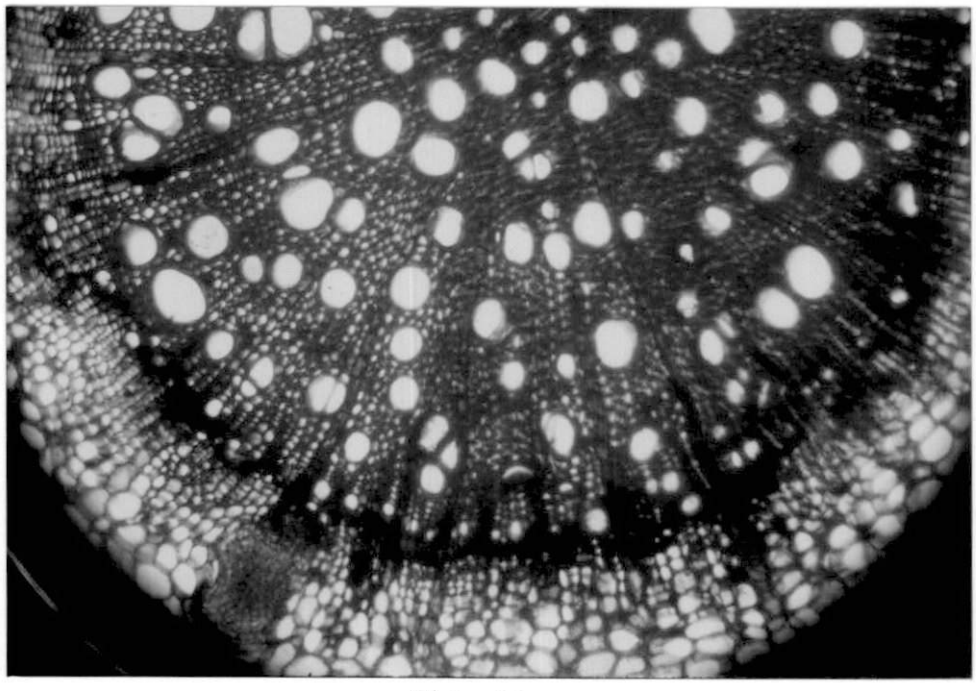

Plate 21
T.S. of roots of susceptible variety
Pusa Kranti after bacterial invasion (M- 10x 7)

showed presence of black discolouration and damaged cells of secondary xylem and phloem (Plate 21).

The details examination of stem and petiole of resistant and susceptible varieties did not reveal any conclusive results except the presence of damaged cells in the petiole and stem of susceptible variety (Plates 22 to 25).

c. Biochemical studies of resistant and susceptible varieties

(i) Total phenol

The total phenol content in the roots of resistant varieties viz., Surya, Swetha and SM 141 was from 0.38 to 0.40 per cent while in the susceptible varieties it was only 0.22 per cent in Pusa Kranti to 0.24 per cent in BB 7 (Table 18). The leaves of resistant and susceptible varieties also had same trend and it was 0.32 to 0.36 per cent in the resistant and 0.20 to 0.26 per cent in the susceptible varieties.

(ii) O.D. phenol

The O.D. phenol content in the roots and leaves of susceptible and resistant varieties also vary considerably. The O.D. phenol content in the roots of Pusa Kranti at 60 DAP was 0.001 per cent while in SM 141 it was 0.25 per cent. Swetha, Surya and SM 59 also had high values of O.D. phenol content in the roots (0.2% and 0.022%). The O.D. phenol content in the leaves was also high in the resistant variety Swetha (0.021%) than the susceptible variety Pusa Kranti (0.001).

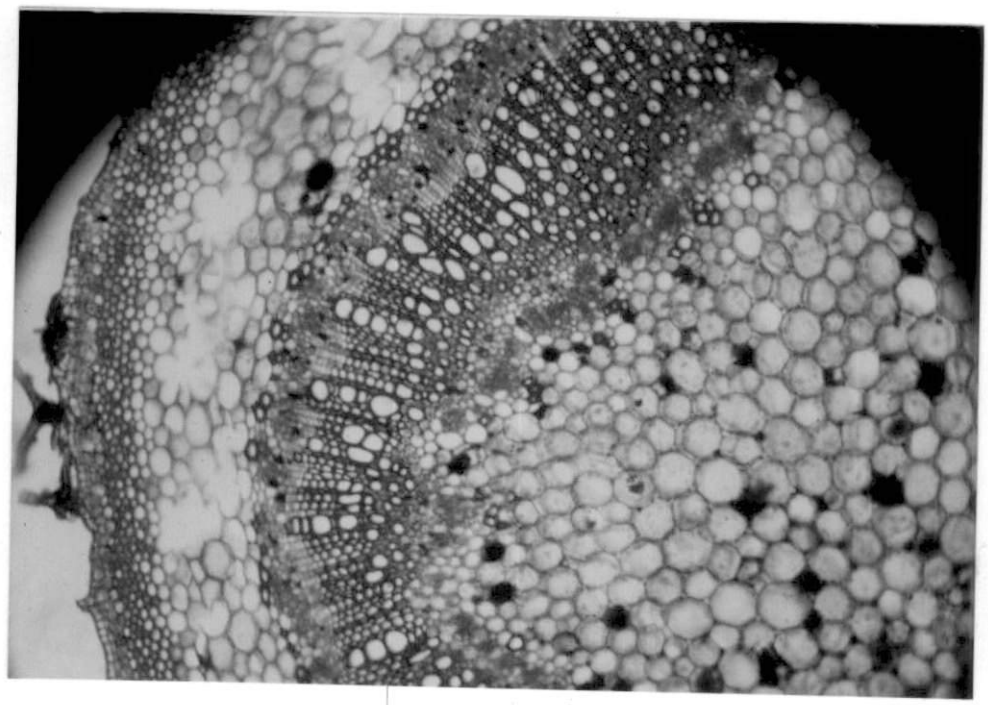

Plate 22
T.S. of stem of susceptible variety Pusa Kranti showing regions from pith to periphery
(M- 10x 7)

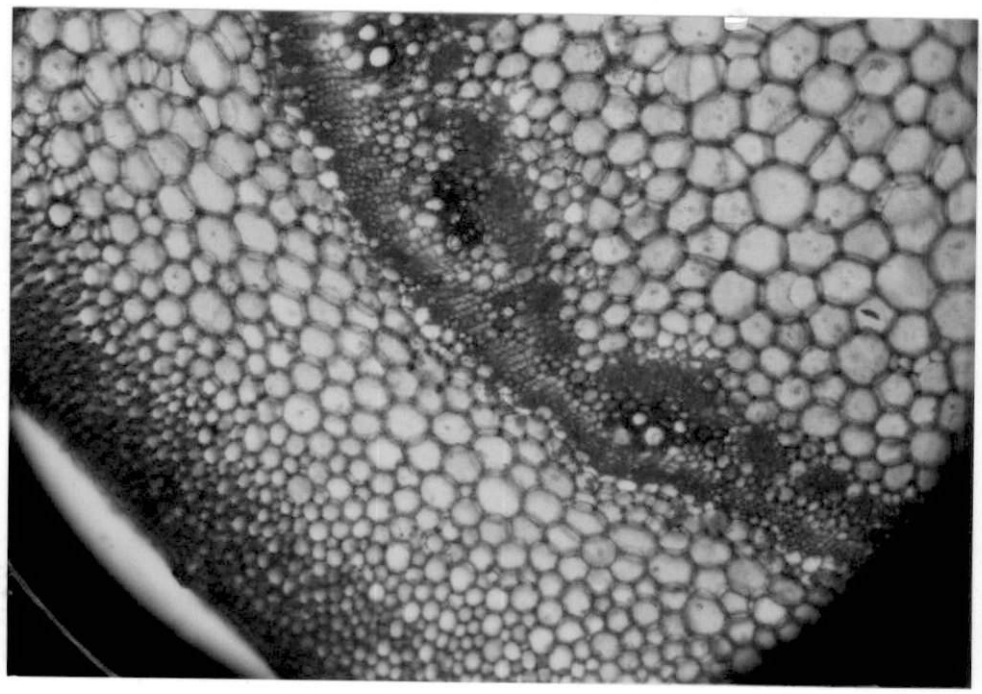

Plate 23
T.S. of stem of resistant variety Surya

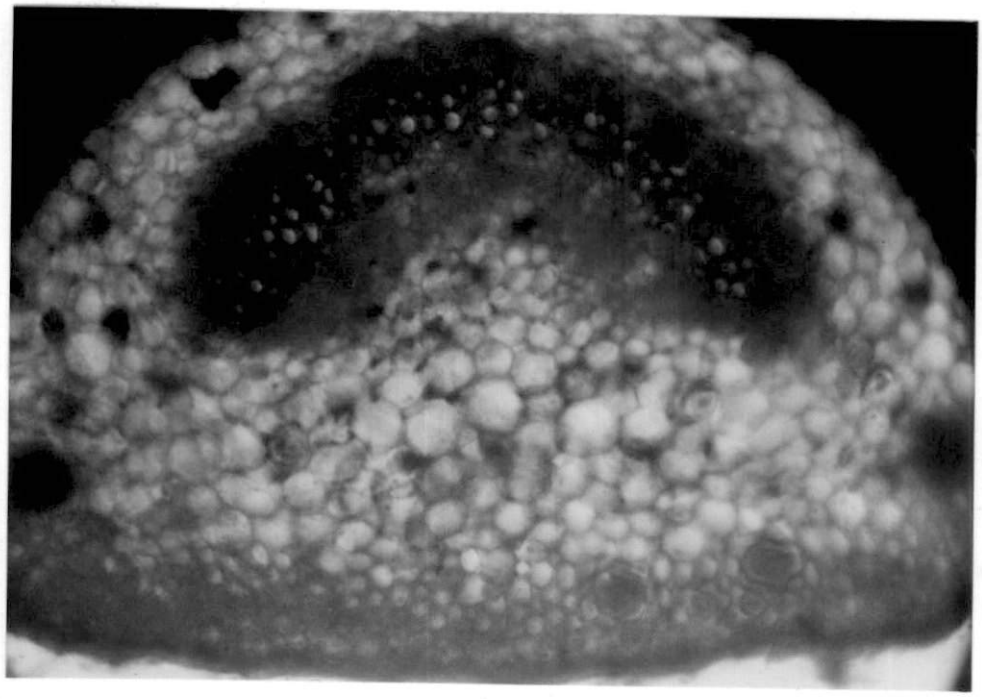

Plate 24
T.S. of petiole of susceptible variety Pusa Kranti (M- 10x 7)

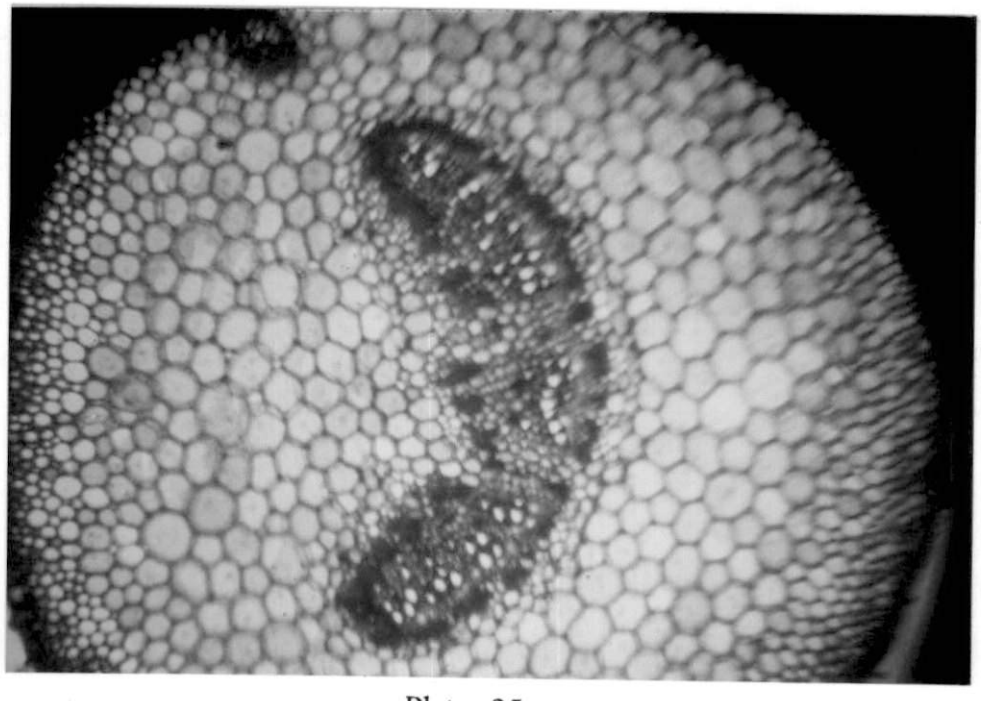

Plate 25
T.S. of petiole of resistant variety Surya (M- 5 x 7)

Table 18. Total phenol and O.D. phenol contents in the roots and leaves of brinjal plants at 60 DAP (March-November 1995)

Sl. No.	Accession No./ Variety	Total phenol (%)		O.D. Phenol (%)	
		Roots	Leaves	Roots	Leaves
1	Swetha	0.38	0.36	0.022	0.021
2	SM 59	0.35	0.34	0.020	0.020
3	Surya	0.36	0.32	0.021	0.020
4	SM 141	0.40	0.36	0.025	0.020
5	BB 7	0.24	0.26	0.002	0.001
6	Pusa Kranti	0.22	0.20	0.001	0.001

C. Development and performance study of F_1 hybrids in brinjal

Based on detailed study of selected accessions/ varieties, 11 wilt resistant parental lines having specific advantage in colour and shape of fruit, duration of crop and productivity were utilized in the hybridsation programme with the objective of developing F_1 hybrids with specific plant and fruit characteristics. Five F_1 hybrids developed by crossing six purple fruited varieties/accessions and four F_1 hybrids derived from five light green/white fruited parental lines were compared with their parents during summer, November 1995-June 1996. Though the initial growth and productivity was affected by severe incidence of jassids, the analysis of variance for the various quantitative characters showed significant difference (Appendix-VII). The performance of the parents and hybrids are given in Appendices-VIII and IX. The relative heterosis (RH), Heterobeltiosis (HB) and Standard heterosis (SH) for 19 important characters are presented in Tables 19 to 26.

(1) Plant height

The initial vigour of the hybrids were manifested by the increase in their height (41.16 cm) compared to the parents (31.78 cm) at 60 days after planting (Table 19). Plant height at 60 DAP was maximum in the Surya x Annapurna (56.3 cm) which exhibited maximum standard heterosis (81.03%) for the trait. However, later growth was more in Arka Keshav x SM 71 as indicated by the maximum height at 50 per cent fruiting stage (83.2 cm). This hybrid has maximum heterosis for the trait (RH 56.54%, HB 32.06% and SH 100.97%). All the light green/white fruited F_1 hybrids have exhibited negative heterobeltiosis for plant height at 50 per cent fruiting stage since the parents involved in the crosses itself were tall.

Table 19. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for plant height during November 1995-June 1996

Parents/hybrids	Plant height at 60 DAP				Plant height at 50% fruiting stage			
	Mean (cm)	RH%	HB%	SH%	Mean (cm)	RH%	HB%	SH%
A. Purple fruited								
Surya	31.1				41.4			
Composite 2	34.4				75.6			
SH-116	30.9				70.7			
Annapurna	46.6				77.6			
Arka Keshav	25.3				43.3			
SH-71	31.5				63.0			
Surya x Composite 2	48.2	48.18**	40.12**	54.98**	73.1	24.96*	-3.31	76.57**
Surya x SH-116	45.0	45.63**	44.69**	44.69**	70.5	25.78*	-0.20	70.29**
Surya x Annapurna	56.3	44.92**	20.82*	81.03**	72.1	21.18	-7.09	74.15**
Arka Keshav x Composit 2	53.0	77.55**	54.07**	70.42**	73.3	23.30*	-3.04	77.05**
Arka Keshav x SH-71	45.7	60.92**	45.08**	46.95**	83.2	56.54**	32.06**	100.97**
B. Light green/white fruited								
Swetha	34.1				45.5			
SH-141	31.7				69.8			
SH-63	27.4				69.5			
WCG(S)	28.2				80.1			
TGR	28.4				90.4			
Swetha x SH-141	39.3	19.45	15.25	19.45	55.7	-3.38	-20.20	20.42
Swetha x SH-63	49.9	46.33**	62.28**	62.28**	65.5	13.91	-5.76	43.96*
SH-141 x WCG(S)	36.1	20.54	13.88	5.87	55.6	-25.82**	-30.59**	22.20
SH-141 x TGR	50.9	69.38**	60.57**	46.92**	77.7	-3.00	-14.05	32.20**
Mean of parents	31.78				66.08			
Mean of hybrids	47.16				69.63			
CD (0.05)	8.13	7.04	8.13	8.13	15.53	13.45	15.53	15.53
CD (0.01)	11.11	9.62	11.11	11.11	21.23	18.38	21.23	21.23

* Significant at 1% level
** Significant at 5% level

(2) Plant spread

The increased initial vigour of the hybrids were also manifested in the spread of the plants as indicated by a plant spread of 57.9 cm at 60 DAP in the hybrids compared to 43.68 cm in the parents (Table 20). The per se performance of the trait (70.9 cm) and standard heterosis (91.62%) were maximum in Arka Keshav x Composite 2. At 50 per cent fruiting stage also this hybrid exhibited maximum plant spread (113.5 cm) and relative heterosis (31.06%). Among the light green/white fruited hybrids, standard heterosis was maximum for SM 141 x TGR (81%), but heterobeltiosis was non significant.

(3) Leaf length and leaf width

The leaf length and leaf width at 60 DAP and 50 per cent fruiting stage were also more in the hybrids than the parents (Table 21). All the purple fruited hybrids exhibited significant releative heterosis and standard heterosis for leaf length at 60 DAP, standard heterosis being maximum in Arka Keshav x SM 71 (48.67%). At peak fruiting stage SM 141 x TGR had maximum standard heterosis (43.48%) for length of leaves. Leaf width at 60 DAP and at 50 per cent fruiting stage were also more in the hybrids (Table 22). All the purple fruited F_1 hybrids exhibited significant and positive heterosis for leaf width to 50 per cent fruiting stage, standard heterosis being maximum in Arka Keshav x Composite 2 (60%). In the light green/white fruited hybrids, heterobeltiosis and relative heterosis were negative for leaf width at peak fruiting stage.

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Table 20. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for plant spread during November 1995-June 1996

Parents/Hybrids	Plant spread at 60 DAP				Plant spread at 50% fruiting stage			
	Mean (cm)	RH%	HB%	SH%	Mean (cm)	RH%	HB%	SH%
A. Purple fruited								
Surya	37.0				64.5			
Composite 2	46.4				108.1			
SH-116	47.0				85.0			
Annapurna	62.3				88.2			
Arka Keshav	36.7				65.1			
SH-71	39.9				113.0			
Surya x Composite 2	63.7	52.60**	37.28**	72.16**	93.3	8.11	-15.86	44.65**
Surya x SH-116	64.8	54.29**	37.87**	75.14**	99.5	33.11**	17.06	54.26**
Surya x Annapurna	61.6	24.07*	-7.7	66.49**	91.2	19.45	3.40	41.40*
Arka Keshav x Composit 2	70.9	70.64*	52.80**	91.62**	113.5	31.06*	5.00	75.97**
Arka Keshava x SH-71	58.8	53.52**	47.37**	58.92**	112.5	20.75*	-0.44	74.42**
B. Light green/white fruited								
Swetha	35.7				59.5			
SH-141	43.9				71.6			
SH-63	47.2				115.6			
WCG(S)	43.0				98.3			
TGR	41.4				115.5			
Swetha x SH-141	44.9	12.81	2.28	25.77	74.0	12.89	3.35	24.37
Swetha x SH-63	54.3	31.00**	13.08	52.10**	71.6	18.33	-38.06**	20.34
SH-141 x WCG(S)	45.8	5.41	4.33	28.29	103.3	21.60*	4.84	73.61**
SH-141 x TGR	56.3	32.00**	28.25*	57.70**	107.7	15.13	-6.75	81.00**
Mean of parents	43.68				89.49			
Mean of hybrids	57.90				96.29			
CD (0.05)	10.17	8.80	10.17	10.17	20.05	17.36	20.05	20.05
CD (0.01)	13.90	12.03	13.90	13.90	27.41	23.73	27.41	27.41

* Significant at 1% level
** Significant at 5% level

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Table 21. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for leaf length during November 1995-June 1996

Parents/hybrids	Leaf length of 60 DAP				Leaf length of 50% fruiting stage			
	Mean (cm)	RH%	HB%	SH%	Mean (cm)	RH%	HB%	SH%
A. Purple fruited								
Surya	11.3				12.9			
Composite 2	13.4				15.5			
SH-116	9.9				11.7			
Annapurna	11.9				12.5			
Arka Keshav	8.9				11.9			
SH-71	12.3				14.3			
Surya x Composite 2	15.6	26.32**	16.42	38.05**	16.7	17.60	7.74	29.46*
Surya x SH-116	14.8	39.62**	30.97*	30.97*	15.8	28.46**	22.48	22.48
Surya x Annapurna	16.6	31.75**	19.42	46.90**	17.0	33.86**	31.78**	31.78**
Arka Keshav x Composite 2	16.8	34.40**	25.37*	48.67**	18.0	31.39**	16.13	39.53**
Arka Keshav x SH-71	16.8	33.86**	24.44*	48.67**	18.1	38.17**	26.57*	40.31**
B. Light green/white fruited								
Swetha	9.0				11.5			
SH-141	11.4				13.7			
SH-63	12.9				14.8			
WCG(S)	12.9				14.8			
TGR	8.9				15.5			
Swetha x SH-141	12.9	12.66	12.17	43.33**	13.4	6.35	2.19	16.52
Swetha x SH-63	13.6	11.48	5.93	51.11**	15.7	19.39	6.08	36.52**
SH-141 x WCG(S)	11.9	-2.06	-7.75	32.22*	15.4	8.07	4.05	33.91*
SH-141 x TGR	14.1	38.92**	23.68	56.67**	16.5	8.55	-1.20	43.48**
Mean of parents	11.16				13.55			
Mean of hybrids	14.79				16.29			
CD (0.05)	2.70	2.33	2.70	2.70	2.92	2.53	2.92	2.92
CD (0.01)	3.69	3.18	3.69	3.69	3.99	3.46	3.99	3.99

* Significant at 1% level
** Significant at 5% level

Table 22. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for leaf width during November 1995 - June 1996

Parents/Hybrids	Lead width at 60 DAP				Lead width of 50% fruiting stage			
	Mean (cm)	RH%	HB%	SH%	Mean (cm)	RH%	HB%	SH%
A. Purple fruited								
Surya	7.4				8.0			
Composite 2	9.0				9.7			
SH-116	5.9				7.6			
Annapurna	8.9				10.0			
Arka Keshav	6.5				8.7			
SH-71	6.7				8.0			
Surya x Composite 2	10.0	21.95*	11.11	35.14**	12.1	36.72**	24.74*	51.25**
Surya x SH-116	9.9	48.87**	25.25**	25.25**	10.3	32.05**	21.25*	28.75*
Surya x Annapurna	11.8	44.79**	24.58**	59.46**	12.7	41.11**	27.00**	58.75**
Arka Keshav x Composite 2	11.0	18.92*	15.79	48.65**	12.8	39.13**	31.96**	60.00**
Arka Keshav x SH-71	11.0	35.80**	15.79	48.65**	12.0	43.71**	37.93**	50.00**
B. Light green/white fruited								
Swetha	6.1				7.1			
SH-141	7.7				8.5			
SH-63	8.8				10.8			
WCG(S)	9.7				11.4			
TGR	7.4				12.5			
Swetha x SH-141	7.0	14.49	-9.09	14.15	7.5	-3.85	-11.76	5.63
Swetha x SH-63	7.2	-3.36	-18.18	18.03	7.5	-15.64	-30.56**	5.63
SH-141 x WCG(S)	7.5	-13.79	-22.68*	22.95	8.8	-11.56	-22.80**	23.94
SH-141 x TGR	7.9	4.64	2.60	29.51*	9.9	-5.71	-20.8**	39.44**
Mean of parents	7.65				9.30			
Mean of hybrids	9.26				10.40			
CD (0.05)	1.67	1.50	1.67	1.67	1.85	1.55	1.85	1.85
CD (0.01)	2.28	2.05	2.28	2.28	2.53	2.12	2.53	2.53

* Significant at 1% level
** Significant at 5% level

(4) Days to first flower and harvest

In general, the hybrids were earlier than the parents for their first flowering (4.19 days), days to first harvest (4.07 days) and days to 50 per cent harvest (11.95 days) (Table 23). Surya x Annapurna was the earliest hybrid to flower under purple fruited types (51.4 days) but none of the hybrids exhibited significant heterobeltiosis and standard heterosis for days to flower. Relative heterosis for days to flower was significant negative and maximum in Surya x Composite 2 (-13.50%) followed by Arka Keshav x Composite 2 (-9.16%). All the light green/white fruited F_1 hybrids flowered later than the standard parent, Swetha. Heterosis for days to first harvest was non significant in all the purple fruited hybrids except Surya x Composite 2 wheich had -10.42 per cent relative heterosis. All the light green/white fruited hybrids took more days for the first harvesting than the standard parent Swetha.

(5) Days to 50 per cent harvest

Among the hybrids Swetha x SM 63 took minimum days for 50 per cent harvest (92.5 days). While SM 141 x TGR took maximum days (148.2 days). Maximum negative heterobeltiosis was observed in Swetha x SM 63 (-22.46%) followed by Swetha x SM 141 (-15.67%). These two hybrids exhibited maximum negative standard heterosis also for 50 per cent harvest (-22.46% and -15.67% respectively).

(6) Days to last harvest

In general, parents and hybrids did not vary for days to last harvest

Table 23. Mean performace of 11 parents and 9 F_1 hybrids and extent of heterosis for earliness during November 1995-June 1996

Parents/hybrids	Days to flower				Days to first harvest				Days to 50% harvest			
	Mean	RH(%)	HB(%)	SH(%)	Mean	RH(%)	HB(%)	SH(%)	Mean	RH(%)	HB(%)	SH(%)
A. Purple fruited												
Surya	57.7				76.7				136.2			
Composite-2	67.9				86.5				147.2			
SM 116	65.1				83.7				137.5			
Annapurna	54.4				73.3				131.6			
Arka Keshav	58.7				78.7				124.6			
SM 71	70.0				90.7				142.4			
Surya x Composite-2	54.2	-13.56**	-6.07	-6.07	73.1	-10.42**	-4.69	-4.69	120.1	-15.24**	-11.82**	-11.82**
Surya x SM 116	57.0	-7.17*	-1.21	-1.21	78.6	-2.00	2.48	2.48	115.5	-15.60**	-15.20**	-15.20**
Surya x Annapurna	51.4	-8.30	-5.50	-10.92	71.3	-4.93	-2.73	-7.04	131.1	-2.09	-0.40	-3.74
Arka Keshav x Composite-2	57.4	-9.16*	-2.04	-0.35	78.4	-4.85	-0.38	2.22	126.9	-6.62	1.85	-6.83*
Arka Keshav x SM 71	62.8	-2.41	6.53	8.84	82.9	-2.13	5.34	8.08	137.9	3.30	10.67**	1.25
B. Light green/white fruited												
Swetha	45.7				63.7				119.3			
SM 141	56.8				76.9				137.9			
SM 63	64.2				85.5				133.3			
WCG(S)	63.4				85.0				143.1			
TGR	62.8				83.1				143.3			
Swetha x SM 141	52.0	1.46	13.79	13.78	71.7	1.9	12.56*	12.56*	100.6	-21.77**	-15.67**	-15.67**
Swetha x SM 63	48.5	-11.74*	6.13	6.13	66.6	-10.72*	4.55	4.55	92.5	-26.76**	-22.46**	-22.46**
SM 141 x WCG(S)	62.2	3.49	9.51	36.10**	82.6	2.04	7.41	22.67**	143.2	1.92	3.84	20.03**
SM 141 x TGR	62.3	4.18	9.68	36.32**	81.3	1.63	5.72	27.63**	148.2	5.41	7.47*	24.42**
Mean of parents	60.61				80.35				135.95			
Mean of hybrids	56.42				76.28				124.00			
CD(0.05)	6.33	5.48	6.33	6.33	7.10	6.15	7.10	7.10	8.86	7.67	8.86	8.86
CD(0.01)	8.65	7.49	8.65	8.65	9.70	8.41	9.70	9.70	12.11	10.48	12.11	12.11

*Significant at 5% level
** Significant at 1% level

being maximum in Arka Keshava x SM 71 (21.04%). Heterosis for the total number of harvest were also significant in all the purple fruited hybrids, maximum standard heterosis being in Surya x Composite 2 (40%). None of the light green/white fruited hybrids had significant heterobeltiosis and standard heterosis for number of harvests.

(7) Fruit length and diameter

The length of fruit was maximum (21 cm) in the purple fruited F_1 hybrid Arka Keshav x SM 71 which had maximum values for the heterosis (RH 52.39%, HB 30.03% and SH 38.64%) (Table 25). In crosses involving the longest fruited parent Arka Keshav, all the F_1s had more fruit length. The diameter of fruits in the F_1 hybrids was 29.15 per cent more over the parents. The fruit diameter was maximum in the round fruited F_1 hybrid Surya x SM 116 (5.8 cm) which had significant values for heterosis. In SM 141 x TGR though fruit diameter was only 5.1 cm, standard heterosis was maximum (70.10%) which was 14.69 per cent more than the Surya x SM 116.

(8) Average fruit weight

The average fruit weight in the F_1 hybrids exceeded the parents by 30.28 g. Among the parents the light green SM 141 had maximum fruit weight (126.1 g) followed by the purple fruited Composite 2 (113.4 g). All the purple fruited hybrids exhibited positive heterosis for average fruit weight. Heterobeltiosis

Table 24. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for duration and number of harvests during November 1995 - June 1996

Parents/hybrids	Days to last harvest				Total number of harvest			
	Mean	RH(%)	HB(%)	SH(%)	Mean	RH(%)	HB(%)	SH(%)
A. Purple fruited								
Surya	171.1				9.5			
Composite-2	189.5				10.0			
SH 116	203.0				10.4			
Annapurna	200.9				12.9			
Arka Keshav	171.5				5.8			
SH 71	210.5				9.9			
Surya x Composite-2	189.1	4.88*	10.52**	10.52**	13.3	36.41**	33.00**	40.00**
Surya x SH 116	201.5	7.73**	17.74**	17.74**	12.2	22.61**	17.31**	28.42**
Surya x Annapurna	195.5	5.11*	11.26**	14.26**	13.2	17.86**	2.33	38.95**
Arka Keshav x Composite-2	195.6	8.37**	14.05**	14.32**	12.5	58.23**	25.00**	31.58**
Arka Keshav x SH 71	207.2	8.48**	20.82**	21.04**	12.5	59.24**	26.26**	31.88**
B. Light green/white fruited								
Swetha	176.5				11.8			
SH 141	203.7				11.6			
SH 63	191.1				11.1			
WCG(S)	195.6				9.8			
TGR	207.6				10.5			
Swetha x SH 141	184.7	-2.84	4.65	4.64	12.8	9.40	8.47	8.47
Swetha x SH 63	194.9	6.04**	10.42**	10.42**	11.8	3.06	0.0	0.0
SH 141 x WCG(S)	203.5	1.93	4.04	15.30**	11.9	11.21*	2.59	0.85
SH 141 x TGR	213.0	3.57	4.57*	20.68**	12.7	14.93**	9.48	7.60
Mean of parents	198.82				10.30			
Mean of hybrids	198.33				12.54			
CD(0.05)	9.22	7.99	9.22	9.22	1.29	1.12	1.29	1.29
CD(0.01)	12.60	10.92	12.60	12.60	1.76	1.53	1.76	1.76

* Significant at 5% level
** Significant at 1% level

Table 25. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for fruit characters during November 1995 - June 1995

Parents/hybrids	Fruit length				Fruit diameter				Average fruit weight			
	Mean (cm)	RH%	HB%	SH%	Mean (cm)	RH%	HB%	SH%	Mean (g)	RH%	HB%	SH%
A. Purple fruited												
Surya	8.8				3.7				62.0			
Composite 2	6.7				4.8				113.4			
SM-116	7.6				4.4				106.2			
Annapurna	12.0				3.4				77.5			
Arka Keshav	16.2				2.7				57.6			
SM-71	11.4				3.5				86.7			
Surya x Composite 2	7.7	-1.03	-13.07	-13.07	5.6	31.76**	16.67*	51.35**	120.5	37.40**	6.26	94.35**
Surya x SM-116	8.6	4.27	-2.84	-2.84	5.8	41.98**	30.68**	55.41**	131.0	55.77**	23.35**	111.29**
Surya x Annapurna	11.1	6.45	-7.53	25.57*	4.9	38.03**	32.43**	32.43**	114.5	64.16**	47.74**	84.68**
Arka Keshav x Composite 2	15.8	38.16**	-2.17	78.98**	5.5	45.33**	13.54	47.30**	138.2	61.64**	21.87**	122.90**
Arka Keshav x SM-71	21.0	52.39**	30.03**	138.64**	4.1	32.26**	17.14	10.81	105.2	45.81**	21.34*	69.68**
B. Light green/white fruited												
Swetha	12.0				3.0				67.7			
SM-141	14.1				3.7				126.1			
SM-63	15.8				3.6				69.6			
WCG(S)	12.5				3.6				76.9			
TGR	8.5				3.9				83.4			
Swetha x SM-141	13.7	5.14	-2.49	14.17	3.7	10.61	0.00	23.33*	95.7	-1.24	-24.11**	41.36**
Swetha x SM-63	16.7	20.14**	5.70	39.17**	3.9	17.38	6.94	30.00**	95.5	39.11**	37.21**	41.06**
SM 141 x WCG(S)	12.6	-5.28	-10.68	0.95	4.1	12.95	12.33	36.67**	112.9	11.23	-10.47	66.76**
SM 141 x TGR	13.1	15.69*	-7.12	9.17	5.1	33.60**	29.49**	70.40**	117.6	12.27*	-6.75	73.71**
Mean of parents	11.42				3.67				84.28			
Mean of hybrids	13.37				4.74				114.56			
CD (0.05)	1.88	1.63	1.88	1.88	0.65	0.56	0.65	0.65	14.48	12.54	14.48	12.54
CD (0.01)	2.57	2.23	2.57	2.57	0.89	0.77	0.89	0.89	19.79	17.14	19.79	19.79

* Significant at 5% level
** Significant at 1% level

Table 26. Mean performance of 11 parents and 9 F_1 hybrids and extent of heterosis for yield during November 1995-June 1996

Parents/Hybrids	Total No.of fruits/plant				Yield/plant				Yield/ha			
	Mean	RH(%)	HB(%)	SH(%)	Mean (g)	RH(%)	HB(%)	SH(%)	Mean (t)	RH(%)	HB(%)	SH(%)
A. Purple fruited												
Surya	19.8				632.4				13.8			
Composite-2	27.6				1831.0				27.8			
SM 116	12.7				951.8				22.3			
Annapurna	53.5				2769.6				56.4			
Arka Keshav	10.7				606.7				13.4			
SM 71	16.0				786.8				17.0			
Surya x Composite-2	29.6	24.89	7.25	49.49*	1972.9	60.18**	7.75	211.97**	39.4	89.42**	41.73**	185.51**
Surya x SM 116	42.2	159.69**	113.13**	113.13**	2475.6	212.54**	160.10**	290.04**	51.0	182.55**	128.70**	269.57**
Surya x Annapurna	36.9	0.68	-44.99**	86.36**	1758.3	3.37	-36.51**	178.10	38.9	10.83	-31.03**	181.88**
Arka Keshav x Compsite-2	38.6	101.57**	39.86**	94.95**	2498.2	104.96**	36.44**	295.03**	46.5	125.73**	67.27**	236.96**
Arka Keshav x SM 71	52.4	292.51**	227.50**	164.65**	2767.5	297.20**	251.74**	337.62**	60.0	294.74**	252.94**	334.78**
B. Light green/white fruited												
Swetha	30.2				682.5				15.8			
SM 141	32.9				1342.7				28.6			
SM 63	12.1				510.9				10.4			
WCG(S)	21.2				943.3				21.2			
TGR	14.9				744.0				15.3			
Swetha x SM 141	29.3	-7.13	-10.94	-2.98	977.9	-3.43	-27.17	43.28	21.8	-1.80	-23.78	37.97
Swetha x SM 63	39.4	86.29**	30.46*	30.46*	1206.1	102.13**	76.72*	76.72*	25.4	93.89**	60.76*	60.76*
SM 141 x WCG(S)	26.2	-3.14	-20.36	-13.24	1090.2	-4.62	-18.82	59.74	23.2	-6.83	-18.88	46.84
SM 141 x TGR	49.6	107.53**	50.76**	64.29**	2816.4	169.94**	109.76**	312.65**	60.5	175.63**	111.54**	282.91**
Mean of parents	22.87				1072.88				21.8			
Mean of hybrids	38.24				1951.46				40.7			
CD(0.05)	7.79	6.75	7.79	7.79	489.44	423.87	489.44	489.44	8.72	7.56	8.72	8.72
CD(0.01)	10.65	9.23	10.65	10.65	669.02	579.39	669.02	669.02	11.93	10.33	11.93	11.93

* Significant at 5% level
** Significant at 1% level

Table 27. Mean values of incidence of bacterial wilt in 11 parents and 9 F_1 hybrids during November 1995-June 1996

Treatment No.	Genotypes	Wilt (%)	Disease reaction
	Parents		
1	Surya	0	R
2	Composite 2	18	R
3	SM 116	0	R
4	Annapurna	0	R
5	Arka Keshav	0	R
6	SM 71	0	R
7	Swetha	0	R
8	SM 141	0	R
9	SM 63	12	R
10	WCG(S)	0	R
11	TGR	6	R
	F_1 hybrids		
12	Surya x Composite 2	6	R
13	Surya x SM 116	0	R
14	Surya x Annapurna	0	R
15	Arka Keshav x Composite 2	18	R
16	Arka Keshav x SM 71	0	R
17	Swetha x SM 141	0	R
18	Sweth x SM 63	4	R
19	SM 141 x WCG(S)	0	R
20	SM 141 x TGR	0	R
Mean of parents		3.27	
Mean of F_1 hybrids		2.55	

Swetha x SM 141, SM 141 x WCG(S) and SM 141 x TGR were completely free from the bacterial wilt.

(11) Incidence of jassids

Since the crop was raised during summer, there was heavy incidence of jassids which affected the general growth and productivity of the crop. Infested plant frist of all showed some yellowing and burning symptom in the interveined areas and leaf margins of affected leaves and then whole leaves became yellow which spread subsequently resulting in stunted growth and low yield. Swetha was highly susceptible to jassids with the maximum intensity (66.7%) and maximum number of jassids/leaf (19.3) (Table 28). Surya was also highly susceptible to jassids with 58.3 percentage intensity and 14.0 jassids/leaf. Annapurna and Composite 2 were only resistant to jassid infestation among the 11 parents and were having minimum number of jassids/leaf (2.3 and 2.8 respectively) which was below the economic threshold level of 4.7 jassids/leaf, while all other parents were susceptible to jassid infestation with a disease intensity above 35 per cent.

The hybrids tolerated the attack of jassids better than the parents. Five hybrids viz., Surya x Composite 2, Surya x SM 116, Surya x Annapurna, Arka Keshav x SM 71 and SM 141 x TGR were moderately resistant to jassids having disease intensity from 21.7 to 25 per cent and the population of jassids/leaf were below seven. The remaining four hybrids were susceptible with a disease intensity above 35 per cent and jassid population from 7.5 to 10.6/leaf.

(12) Organoleptic test

In organoleptic test of fruits, Composite 2 had the lowest score value of

Table 28. Percentage intensity due to jassid infestation and its population in 11 parents and 9 F_1 hybrids of brinjal (November 1995-June 1996)

Sl. No.	Genotypes	Percentage intensity	Category	No. of jassids/ leaf
	Parents			
1	Surya	58.3	HS	14.0
2	Composite 2	6.7	R	2.8
3	SM 116	38.3	S	8.4
4	Annapurna	5.0	R	2.3
5	Arka Keshav	36.7	S	7.5
6	SM 71	45.0	S	10.9
7	Swetha	66.7	HS	19.3
8	SM 141	43.3	S	10.0
9	SM 63	36.7	S	7.4
10	WCG(S)	43.3	S	9.8
11	TGR	40.0	S	8.7
	Hybrids			
12	Surya x Composite 2	23.3	MR	6.5
13	Surya x SM 116	25.0	MR	5.5
14	Surya x Annapurna	21.7	MR	6.9
15	Arka Keshav x Composite 2	40.0	S	10.6
16	Arka Keshav x SM 71	23.3	MR	6.3
17	Swetha x SM 141	38.3	S	8.4
18	Swetha x SM 63	36.7	S	7.5
19	SM 141 x WCG(S)	43.3	S	10.0
20	SM 141 x TGR	21.7	MR	6.5
CD (p = 0.05)				3.88

R - Resistant; MR - Moderately Resistant; S - Susceptible; HS - Highly Susceptible

5.22 out of 10.0 which only had bitter fruits (Table 29). All remaining parents were having a score value of above 7.5. Among nine F_1 hybrids, only the crosses with Composite 2 as a parent viz., Surya x Composite 2 and Arka Keshav x Composite 2 showed slight bitterness in their fruits with a low score value of 5.52 and 6.04 respectively. Remaining F_1 hybrids did not exhibit any bitter taste for their fruits and the score value was above 8.0 out of 10.0.

Observations on discrete characters of both the parents and hybrids were also made (Tables 30 to 33). In crosses involving long and round fruited parents, the F_1s were oblong fruited. The F_1s generated by crossing the accessions with deep purple fruit colour and light purple fruit colour had deep purple coloured fruits. When the parents differed in flower colour (white and purple), all the F_1 hybrids had purple flowers. When the prickly parents TGR and SM 63 were crossed to non-prickly parents, all the resulting F_1s had prickles on the stem and leaves. In crosses where Swetha was used as a female parent, all the F_1 had the bushy, branching and erect nature of Swetha. For the remaining morphological characters, such a general pattern of inheritance were not observed.

Performance of individual F_1 hybrids

The individual performance of nine F_1 hybrids are given below:

(1) Surya x Composite 2

Significant values of heterosis for majority of the vegetative characters were observed in this hybrid. It attained a height of 48.2 cm at 60 DAP and 73.1 cm at 50 per cent fruiting stage which were 54.98 per cent and 76.57 per cent more over the standard variety Surya. Similar trend was also observed for the plant

Table 29. score of organoleptic test for fruits of 11 parents and 9 F_1 hybrids of brinjal

Sl. No.	Parents/Hybrids	Appearance (out of 2)	Taste (out of 2)	Flavour (out of 2)	Bitterness (out of 4)	Total (out of 10)
1	Surya	1.58	1.72	1.58	3.60	8.48
2	Composite 2	1.48	1.10	1.42	1.22	5.22
3	SM 116	1.52	1.68	1.46	3.58	8.24
4	Annapurna	1.58	1.68	1.46	3.56	8.28
5	Arka Keshav	1.58	1.64	1.52	3.52	8.26
6	SM 71	1.56	1.62	1.44	3.44	8.06
7	Swetha	1.68	1.68	1.56	3.62	8.54
8	SM 141	1.58	1.78	1.64	3.62	8.62
9	SM 63	1.56	1.54	1.42	3.12	7.64
10	WCG(S)	1.52	1.58	1.40	3.22	7.72
11	TGR	1.54	1.56	1.52	3.36	7.98
12	Surya x Composite 2	1.48	1.22	1.36	1.46	5.52
13	Surya x SM 116	1.68	1.74	1.62	3.62	8.66
14	Surya x Annapurna	1.64	1.68	1.52	3.58	8.42
15	Arka Keshav x Composite 2	1.52	1.32	1.38	1.82	6.04
16	Arka Keshav x SM 71	1.56	1.78	1.64	3.66	8.64
17	Swetha x SM 141	1.56	1.70	1.58	3.48	8.32
18	Swetha x SM 63	1.58	1.56	1.54	3.52	8.20
19	SM 141 x WCG(S)	1.62	1.52	1.52	3.50	8.16
20	SM 141 x TGR	1.64	1.62	1.58	3.48	8.32

Table 30. Morphological description of Surya, Composite-2, SM 16, Annapurna and their hybrids

Sl. No.	Characters	PARENTS				HYBRIDS		
		Surya	Composite-2	SM 116	Annapurna	Surya x Composite-2	Surya x SM 116	Surya x Annapurna
1	Growth habit	Prostrate	Prostrate	Intermediate	Intermediate	Intermediate	Prostrate	Intermediate
2	Leaf prickliness	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly
3	Stem prickliness	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly
4	Fruit calyx prickliness	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly
5	Leaf lamina colour	Green	Light purple	Light purple	Green	Green	Green	Green
6	Leaf vein colour	Purple	Purpl	Purple	Purple	Purple	Purple	Purple
7	Fruit shape	Oval	Round	Round	Long	Round	Oval	Oblong
8	Fruit curvature	Nil	Nil	Nil	Nil	Nil	Nil	Nil
9	Fruit colour	Deep purple	Purple striated	Light purple	Purple	Deep purple striated	Deep purple	Purple
10	Fruit flesh density	Loose	Dense	Loose	Very loose	Dense	Loose	Loose
11	Relative fruit calyx length	Short	Short	Short	Short	Very long	Short	Very short
12	Flower colour	Purple	Purple	Purple	Purple	Purple	Purple	Purple
13	Bearing habit	Solitary	Solitary	Solitary	Solitary	Solitary	Solitary	Solitary

Table 31. Morphologial description of Swetha. SM 141, SM 63 and their hybrids

Sl. No.	Characters	PARENTS			HYBRIDS	
		Swetha	SM 141	SM 63	Swetha x SM 141	Swetha x SM 63
1	Growth habit	Upright	Intermediate	Intermediate	Upright	Upright
2	Leaf prickliness	Non prickly	Non prickly	Prickly	Non prickly	Prickly
3	Stem prickliness	Non prickly	Non prickly	Prickly	Non prickly	Prickly
4	Fruit calyx prickliness	Non prickly	Non prickly	Prickly	Non prickly	Prickly
5	Leaf lamina colour	Green	Green	Green	Green	Green
6	Leaf vein colour	Green	Green	Green	Green	Green
7	Fruit shape	Long	Long	Long	Long	Long
8	Fruit curvature	Nil	Nil	Nil	Nil	Nil
9	Fruit colour	White	Light green	Milky white	White	White
10	Fruit flesh density	Very loose	Very loose	Loose	Loose	Loose
11	Relative fruit calyx length	Short	Short	Short	Very short	Very short
12	Flower colour	Purple	White	White	Purple	Purple
13	Bearing habit	Occassionally clustered	Solitary	Solitary	Solitary	Occassionally clustered

Table 32. Morphological description of Arka Keshav, Composite-2, SM 71 and their hybrids

Sl. No.	Character	PARENTS			HYBRIDS	
		Arka Keshav	Composite-2	SM 71	Arka Keshav x Composite-2	Arka Keshava x SM 71
1	Growth habit	Prostrate	Prostrate	Upright	Intermediate	Prostrate
2	Leaf prickliness	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly
3	Stem prickliness	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly
4	Fruit calyx prickliness	Non prickly	Non prickly	Non prickly	Non prickly	Non prickly
5	Leaf lamina colour	Green	Light purple	Light purple	Green	Green
6	Leaf vein colour	Green	Purple	Purple	Purple	Green
7	Fruit shape	Linear	Round	Long	Oblong	Long
8	Fruit curvature	Sickle shaped	Nil	Nil	Nil	Nil
9	Fruit colour	Deep purple	Purple striated	Light purple	Deep purple striated	Deep purple
10	Fruit flesh density	Very loose	Dense	Loose	Loose	Loose
11	Relative fruit calyx length	Very short	Short	Short	Short	Long
12	Flower colour	Purple	Purple	Purple	Purple	Purple
13	Bearing habit	Occassionally clustered	Solitary	Solitary	Solitary	Solitary

Table 33. Morphological description of SM 141, WCG(S), TGR and their hybrids

Sl. No.	Characters	PARENTS			HYBRIDS	
		SM 141	WCG(S)	TGR	SM 141 x WCG(S)	SM 141 x TGR
1	Growth habit	Intermediate	Prostrate	Upright	Prostrate	Upright
2	Leaf prickliness	Non prickly	Non prickly	Prickly	Non prickly	Prickly
3	Stem prickliness	Non prickly	Non prickly	Prickly	Non prickly	Prickly
4	Fruit calyx prickliness	Non prickly	Non prickly	Prickly	Non prickly	Prickly
5	Leaf lamina colour	Green	Green	Green	Green	Green
6	Leaf vein colour	Green	Green	Green	Green	Green
7	Fruit shape	Long	Long	Oblong	Long	Oblong
8	Fruit curvature	Nil	Nil	Nil	Nil	Nil
9	Fruit colour	Light green	Light green	Milky white	Light green	Milkly white
10	Fruit flesh density	Very loose	Dense	Dense	Loose	Dense
11	Relative fruit calyx length	Short	Short	Short	Short	Short
12	Flower colour	White	White	Purple	Purple	Purple
13	Bearing habit	Solitary	Solitary	Solitary	Solitary	Occassionally clustered

spread. Leaf width at 50 per cent fruiting stage exhibited 24.74 per cent increase over the better parent Composite 2.

Compared to both the parents this F_1 hybrid was earlier in flowering, and fruiting. It also had highly significant heterosis of 36.41 per cent over mid parent and 24.81 per cent over better parent for total number of harvests.

Though Composite 2 was having a good canopy and attractive purple round fruits, organoleptic testing of the fruits, showed bitterness resulting in low score value of 5.22 out of 10.0 (Table 29). This bitterness was also transmitted to the hybrids reducing its acceptability (score 5.52). As a result of the cross between Surya, having deep purple, oval and loose fruits, and Composite 2 having round, purple striated, firm and dense fruits with more average fruit weight (113.4 g), the hybrid plants had round, firm, deep purple striated fruits having an average fruit weight of 120.5 g which was 94.35 per cent more over the standard variety Surya. Standard heterosis for total number of fruits/plant, yield/plant and yield/ha was 89.42 per cent, 41.73 per cent and 185.51 per cent respectively.

(2) Surya x SM 116

Heterosis was manifested for majority of vegetative characters in Surya x SM 116. The plant height at 60 DAP and at 50 per cent fruiting stage were 44.69 and 70.29 per cent more over the standard variety Surya. Plant spread increased from 64.8 cm at 60 DAP to 99.5 cm at 50 per cent fruiting stage in this hybrid. Initial vigour of the hybrid was evident from the maximum value of heterobeltiosis for leaf length (30.97%) and for leaf width at 60 DAP (25.25%).

Compared to both the parents the F_1 hybrid had a protracted flowering

and fruiting as evidenced by more number of harvests (12.2) which was 17.31 per cent more over the better parent SM 116 and 28.42 per cent over the standard variety Surya. The F_1 hybrid flowered more or less on the same day as that of the earliest parent (57 days) and 78.6 days for the first harvest. For duration of crop it exhibited 17.74 per cent heterosis over standard parent Surya. However, for peak fruiting, this hybrid was earlier by 15.20 per cent than the standard variety Surya.

The cross between Surya having deep purple, oval fruits and SM 116 having round and light purple fruits, the F_1 plants had large, oval and deep purple fruits which are more preferred by the consumers (Plate 26). This purple fruited hybrid exhibited 55.41 per cent standard heterosis for fruit diameter and 111.29 per cent for average fruit weight.

Among the purple fruited hybrids, Surya x SM 116 ranked second productivity yielding 2475.6 g/plant and 51.0 t/ha. This bacterial wilt resistant F_1 exhibited highly significant heterosis for yield/plant (RH 212.54%, HB 160.10%, SH 290.04%) and yield/ha (RH 182.55%, HB 128.77%, SH 269.57%).

(3) Surya x Annapurna

Highly significant and maximum value of heterosis for leaf length at 50 per cent fruiting stage was observed for this hybrid (RH 33.86%, HB 31.78%, SH 31.78%). Mean performance of this cross for leaf width at 60 DAP (11.8 cm) and at 50 per cent fruiting stage (12.7 cm) were higher than both the parents.

This F_1 hybrid, Surya x Annapurna exhibited heterosis for initial vegetative growth and earliness. The hybrid fruits were purple coloured and oblong shaped

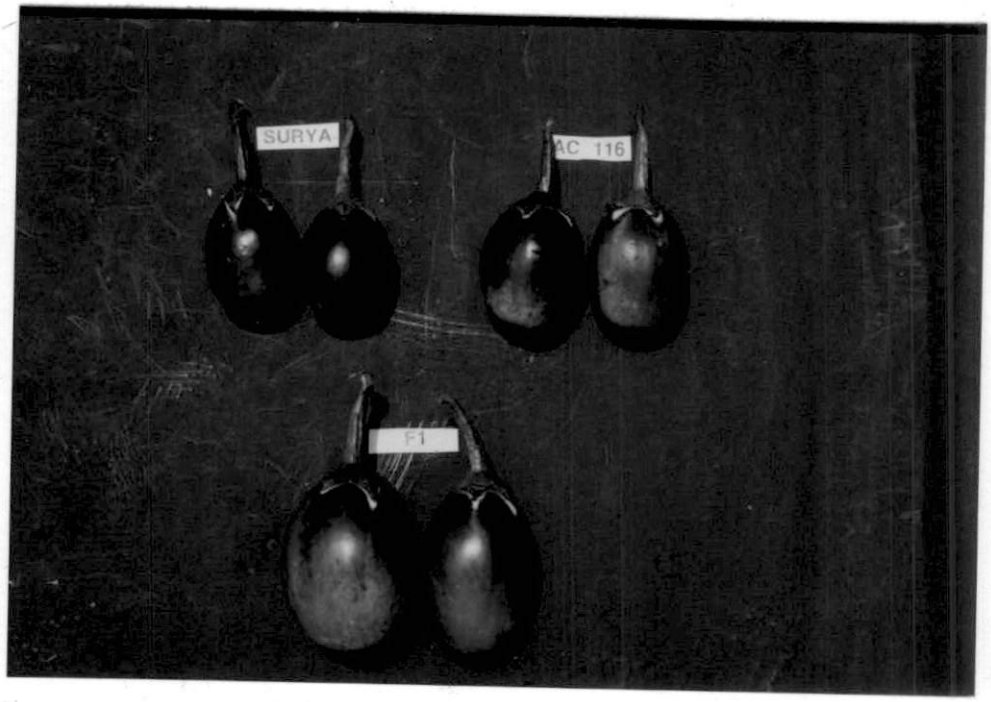


Plate 26

F_1 hybrid, Surya X SM 116

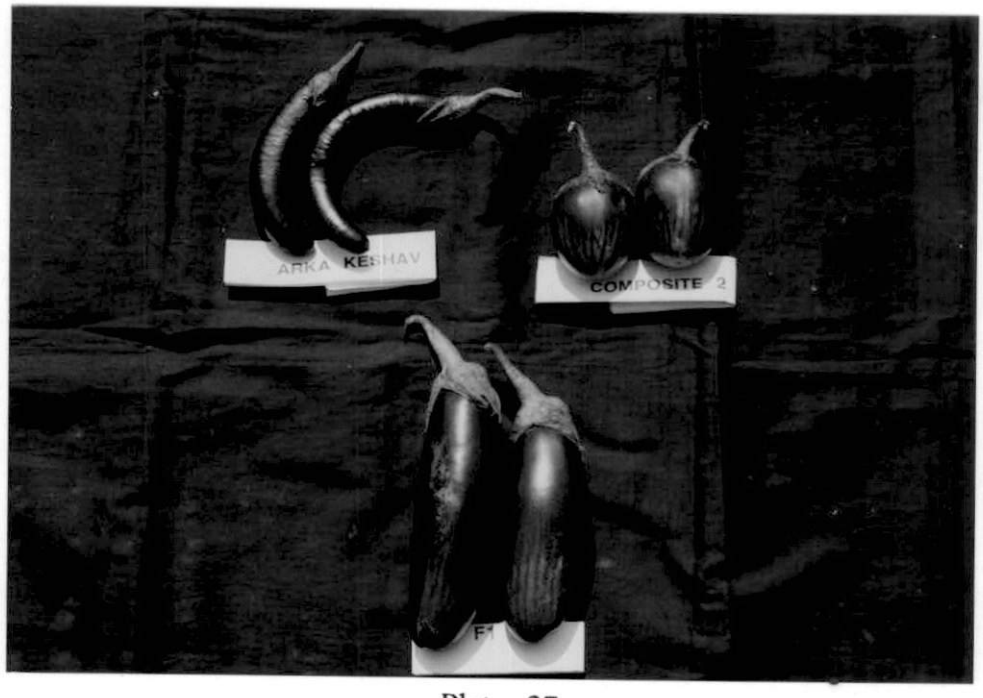


Plate 27

F_1 hybrid, Arka Keshav X Composite 2

having a length of 11.1 cm and diameter of 4.9 cm. It exhibited maximum heterobeltiosis for fruit diameter (32.43%) and fruit weight increased by 47.7 per cent over the better parent, Annapurna. Though resistant to bacterial wilt, highly significant and negative values of heterobeltiosis for total number of fruits/plant (-44.99%), yield/plant (-36.51%) and yield/ha (-31.03%) revealed inferiority of the hybrid.

(4) Arka Keshav x Composite 2

The cross Arka Keshav x Composite 2 exhibited 54.07 per cent increase in plant height over better parent Composite 2 at 60 DAP. This hybrid also showed more spreading habit than the parents in the initial stage.

Though it did not show significant earliness for flowering and early fruiting, for 50 per cent harvesting it was 6.83 per cent earlier than the standard variety Surya. Number of harvest (12.5) also exhibited 25 per cent heterosis over the better parent Composite 2.

The bitterness of fruits of Composite 2 was found to reduce in the hybrid fruits. The score for the hybrid fruits was 6.4 compared to 8.26 in Arka Keshav and 5.22 in Composite 2 and was palatable after cooking. This oblong fruited hybrid had the maximum average fruit weight (138.2 g) among nine hybrids and exhibited highest positive value of standard heterosis (122.90%) (Plate 27). Highly significant values of heterosis for yield/plant (2498.2 g) were exhibited by this hybrid (RH - 104.96%, HB - 36.44%, SH - 295.03%).

Though grouped as resistant to bacterial wilt this F_1 hybrid had bacterial wilt incidence of 18 per cent.

(5) Arka Keshav x SM 71

The vigour of the cross Arka Keshav x SM 71 was evident in the initial stage and as it exhibited significant heterosis, for almost all the vegetative characters. At 60 DAP this hybrid had 45.08 per cent more height and 47.37 per cent more spread than the better parent. Compared to the parents Arka Keshav (8.9 cm) and SM 71 (12.3 cm) this F_1 hybrid had a leaf length of 16.8 cm at 60 DAP and exhibited 25.44 per cent heterosis over better parent, SM 71. For leaf width it exhibited relative heterosis of 43.71 per cent at 50 per cent fruiting stage.

Arka Kesha x SM 71 did not exhibit earliness in flowering and fruiting. It had a dispersed flowering and fruting period as indicated by more number of harvest (12.5) which was 26.26 per cent more than the better parent SM 71 and 31.58 per cent more than the standard variety Surya. This hybrid took 82.9 days for first harvesting and 207.2 days for the last harvesting and exhibited 20.82 per cent heterosis over the better parent Arka Keshav and 21.04 per cent over the standard variety Surya for duration of the crop.

The cross between Arka Keshav with linear, deep purple and attractive fruits and SM 71 with light purple, long and stout fruits resulted in plants with very long (21 cm) and deep purple fruits which are highly desired by the consumers (Plate 28). The fruit length exhibited highly significant heterosis. In average fruit weight (105.2 g) it exhibited 21.34 per cent over superiority over better parent SM 71 and 69.98 per cent standard variety Surya. Among the purple fruited hybrids, this bacterial wilt resistant hybrid Arka Keshav x SM 71 was the most productive

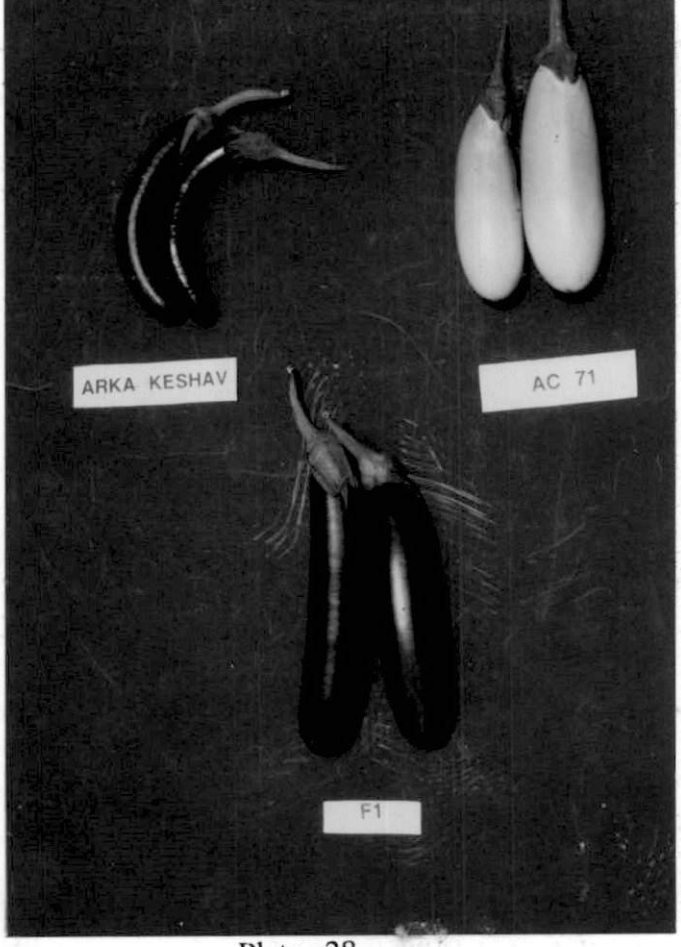
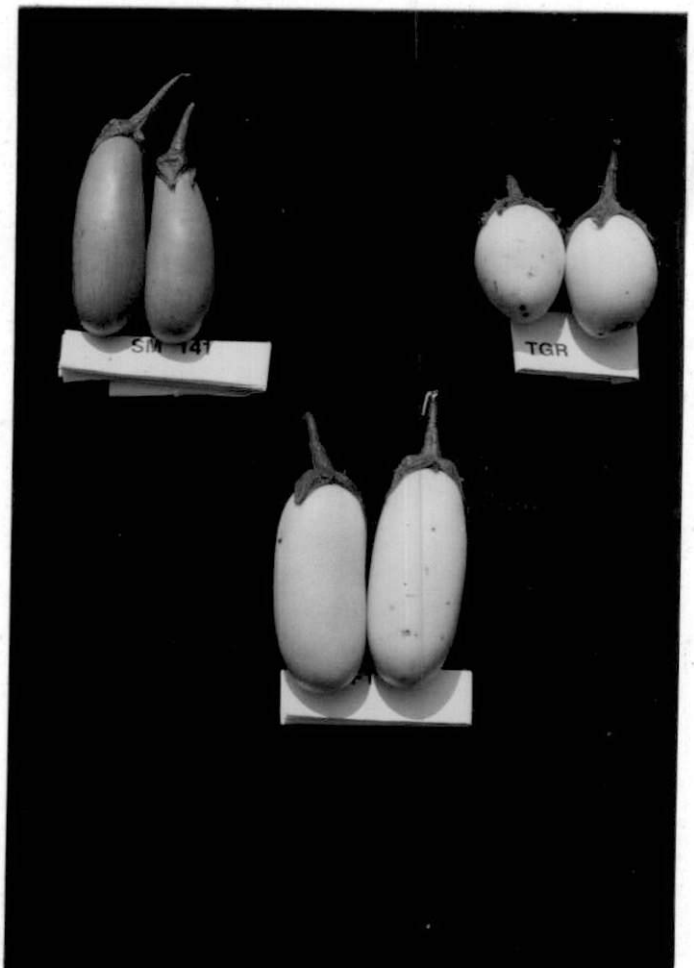


Plate 28

F_1 hybrid, Arka Keshav X SM 71



one with 52.4 fruits/plant, 2767.5 g/plant and 60 t/ha exhibiting highly significant and maximum heterosis.

(6) Swetha x SM 141

The initial rate of growth of the hybrid was faster than both the parents. In the later stage also the hybrid did not have significant superiority in the growth of the plant. This hybrid flowered later than the early flowering variety Swetha by 7 days, but it exhibited earliness by 15.67 per cent for 50 per cent harvest.

In the cross involving white and long fruited Swetha and long light green fruited SM 141, the hybrids had long and white coloured fruits. The hybrid also resembled Swetha in plant stature and colour of flower, purple as in Swetha. The average fruit weight of 95.7 g in this cross showed 41.36 per cent increase over the standard variety Swetha, though it had 24.11 per cent decrease over the better parent SM 141. This hybrid did not show superiority over its better parent or standard variety in number of fruits/plant, yield/plant or yield/ha.

(7) Swetha x SM 63

The cross Swetha x SM 63 showed vigour in the initial growth of the plant. At 60 DAP it had 62.28 per cent more height than the standard variety Swetha but at 50 per cent fruiting stage SM 63 surpassed Swetha and the hybrid in height. The general growth of the hybrid was similar to that of Swetha with bushy habit.

The hybrid did not exhibit significant heterobeltiosis for days to flower and days to first harvest but for 50 per cent harvesting it was earlier than the earliest parent Swetha by 22.64 per cent and took 10.42 days more than the better parent SM 63 for the last harvest.

The stem and leaves were prickly in SM 63 and in this long fruited hybrid the pickly nature was found to be transmitted. Eventhough the plants were prickly, the size and appearance of the hybrid fruits were attractive and white in colour with a fruit length of 16.7 cm. The average fruit weight in the hybrid was 37.21 per cent more than the better partent SM 63 and 41.06 per cent over the standard variety Swetha.

This bacterial wilt resistant hybrid also exhibited significant hetero-beltiosis and standard heterosis for number and weight of fruits per plant. In number of fruits/plant it exceeded the better parent Swetha by 30.46 per cent and in yield/plant by 76.72 per cent.

(8) SM 141 x WCG(S)

The hybrid SM 141 x WCG(S) did not exhibit significant heterosis for majority of vegetative characters and earliness. It exhibited negative heterobeltiosis for plant height at 50 per cent fruiting stage (-30.59%).

This cross had a leaf length of 11.9 cm and leaf width of 7.5 cm at 60 DAP which was less than the better parent (HB -7.75% and -22.68% respectively). SM 141 x WCG(S) took 203.5 days for last harvesting which exhibited standard heterosis of 15.30 per cent and gave 11.9 number of harvests with a relative heterosis of 11.21 per cent.

This light green and long fruited hybrid did not exhibit significant relative heterosis and heterobeltiosis for majority of the fruit and yield parameters. In the average fruit weight (112.9 g) it exhibited 66.76 per cent heterosis over standard

variety Swetha. Compared to the better parent SM 141 this wilt resistant hybrid had a lesser number of fruits/plant (26.2) and yield/plant (1090.2 g) but it exhibited standard heterosis of 59.74 per cent for yield/plant and 46.84 per cent for yield/ha.

(9) SM 141 x TGR

The cross SM 141 x TGR exhibited initial vigour for plant height at 60 DAP (50.9 cm) as evidenced by 60.57 per cent heterosis over better parent, SM 141 and 46.92 per cent heterosis over standard variety Swetha. The mean plant spread of 56.3 cm at 60 DAP also exhibited maximum heterosis values among light green/ white fruited hybrids (RH 32%, HB 28.25%, SH 57.70%). Initial vigour for this hybrid was also exhibited by significant standard heterosis for leaf length (38.92%) and leaf width (29.5%) at 60 DAP.

The hybrid did not exhibit heterosis for earliness. Compared to both the parents the hybrid had a protracted flowering and fruiting as evidenced by more number of harvest (12.7) which had 14.93 per cent relative heterosis. This cross took 81.3 days to first harvest and had longest crop duration of 213 days with spreading tendency.

In cross between SM 141 and TGR differing in many plant and fruit characters, The F_1 resembled TGR for most of the character. Purple coloured flowers and prickly nature of the TGR were transmitted to the F_1s. Like TGR thishybrids had oblong and milky white fruits (Plate 29). Compared to the parents, the fruit diameter (5.1 cm) was more in the hybrid and it exhibited positive heterosis (RH 33.60% and HB 29.49%). Average fruit weight in this hybrid was 117.6 g.

Among the light green/white fruited hybrids, the bacterial wilt resistant cross SM 141 x TGR ranked first in yield with a mean performance of 49.6 fruits/plant, 2816.4 g/plant and 60 t/ha. This milky white fruited hybrid exhibtied highly significant values of heterosis for number of fruits/plant (HB 50.76% and SH 64.24%), yield/plant (HB 109.76% and SH 312.65%) and yield/ha (HB 111.54% and SH 282.41%).

D Grafting for bacterial wilt and jassid resistance and yield in brinjal

1. Germination studies on *Solanum torvum*

The germination percentage of seeds of *S. torvum* after different period of storage is furnished in Table 34. Seeds sown immediately after extraction and on 15th day did not germinate at all. From a low germination percentage of 1.2 per cent on 30th day it increased gradually to 8.0 per cent at 75th day. The germination of the seeds sown after 90 days of extraction gave 100 per cent germination.

2. Evaluation of grafted varieties

Eight brinjal varieties viz. BB 7, Arka Keshav, BB 49, Arka Shirish, Pusa Kranti, TGR, SM 116 and SM 141 grafted on *S. torvum* rootstock were compared with the respective intact plants in a bacterial wilt sick soil during November 1995-May 1996 (Plate 30). Analysis of variance indicated significant differences between the intact and grafted plants for all the nine characters studied (Appendix-X).

a. Plant height

The height of the plant is found to increase by grafting on *S. torvum* as

Table 34. Germination percentage of *S. torvum* seeds at different days of storage

Treatments	Sowing	Germination (%)
T_1	Immediately after seed extraction	0
T_2	15 days after seed extraction	0
T_3	30 days after seed extraction	1.2
T_4	45 days after seed extraction	2
T_5	60 days after seed extraction	4
T_6	75 days after seed extraction	8
T_7	90 days after seed extraction	100
T_8	105 days after seed extraction	100

Plate 30
Graft union in brinjal

evidenced by a higher mean value of 64.4 cm in grafted plants compared to 54.5 cm in intact plants (Table 35). The increase in height by grafting in the short duration varieties ranged from 8.7 per cent in Pusa Kranti to 91.8 per cent in Arka Keshav. In the long duration accessions like TGR, SM 116 and SM 141 marked effect was not pronounced by grafting. Among the grafted plants maximum height was observed in TGR (82.8 cm).

b. Plant spread

Plant spread was also increased by grafting on *S. torvum* rootstock by 13.6 per cent. In short duration varieties the increase in spread by grafting ranged from 10.1 per cent in BB 7 to 37.5 per cen in BB 49. TGR had the maximum spread among the grafted varieties (147.8 cm) which exhibited 16.8 per cent increase by grafting. But in other two long duration accessions, SM 116 and SM 141 grafting did not make significant impact.

c. Fruit length

The increase in fruit length by grafting ranged from 2 per cent in BB 7 to 33.3 per cent in Pusa Kranti (Table 36). In Arka Keshav, having the longest fruit, length of the fruit was not increased. In general, the length of fruits increased marginally from a mean value of 10.4 cm to 11.3 cm but it was not significant.

d. Fruit diameter

Diameter of the fruit was significantly increased by grafting from a mean value of 3.7 cm in intact plants to 4.4 cm in grafted ones. The range of increase by grafting was 2.9 per cent in SM 141 to 40.4 per cent in BB 7.

Table 35. Plant height (cm) and spread (cm) of grafted and intact plants of brinjal (November 1995-May 1996)

Sl. No.	Variety	Plant height			Plant spread		
		Grafted plants	Intact plants	% increase or decrease	Grafted plants	Intact plants	% increase or decrease
1	BB-7	67.8	52.7	28.7 (+)	82.8	75.2	10.1 (+)
2	Arka Keshav	62.9	32.8	91.8 (+)	77.0	62.8	22.6 (+)
3	BB-49	32.7	25.4	28.7 (+)	55.4	40.3	37.5 (+)
4	Arka Shirish	57.9	43.0	34.7 (+)	75.4	62.9	19.9 (+)
5	Pusa Kranti	62.8	57.8	8.7 (+)	85.5	70.4	21.4 (+)
6	TGR	82.8	80.6	2.7 (+)	147.8	126.5	16.8 (+)
7	SM 116	75.5	69.7	8.3 (+)	88.0	82.8	6.3 (+)
8	SM 141	72.5	73.6	1.5 (-)	111.5	115.5	3.5 (-)
Mean		64.4	54.5	18.2 (+)	90.4	79.6	13.6 (+)
CD (p = 0.01)		11.19			11.01		
CV		13.20%			8.85%		

Table 36. Fruit length (cm) and diameter (cm) of grafted and intact of plants of brinjal (November 1995-May 1996)

Sl. No.	Variety	Fruit length			Fruit diameter		
		Grafted plants	Intact plants	% increase or decrease	Grafted plants	Intact plants	% increase or decrease
1	BB-7	10.4	10.2	2.0 (+)	7.3	5.2	40.4 (+)
2	Arka Keshav	19.0	19.3	1.6 (-)	2.2	2.0	10.0 (+)
3	BB-49	6.0	5.5	9.1 (+)	3.8	3.4	11.8 (+)
4	Arka Shirish	8.9	8.3	7.2 (+)	2.5	2.2	13.6 (+)
5	Pusa Kranti	14.0	10.5	33.3 (+)	5.3	4.3	23.3 (+)
6	TGR	8.5	8.2	3.7 (+)	4.7	3.8	23.7 (+)
7	SM 116	9.8	8.0	22.5 (+)	5.9	4.8	18.8 (+)
8	SM 141	13.7	13.4	2.2 (+)	3.6	3.5	2.9 (+)
Mean		11.3	10.4	8.7 (+)	4.4	3.7	18.9 (+)
CD (p=0.01)		1.396			0.4306		
CV		8.57%			6.97%		

Significant increase in fruit diameter by grafting was noticed only in round or oblong fruited varieties.

e. Fruit circumference

Increase in the circumference of fruit by grafting was 21.5 per cent and it ranged from 2.2 per cent in SM 141 to 53.4 per cent in SM 116 (Table 37).

f. Average fruit weight

Among the grafted plants maximum average fruit weight was recorded in BB 7 (209.5 g) followed by SM 116 (138.4 g). In short duration varieties the increase in the weight of the fruit by grafting was higher and it ranged from a low value of 3.9 per cent in Arka Shirish to 66.4 per cent in Pusa Kranti. In long duration accessions the increase was only marginal and it ranged from 6.9 per cent in SM 141 to 32.4 per cent in SM 116.

g. Number of fruits per plant

Among the grafts, maximum number of fruits (85.8) were obtained in Pusa Kranti followed by BB 49 (78.7) and BB 7 (59.0) (Table 38). The increase in the number of fruits by grafting was clearly evident in the short duration varieties as it ranged from 80.8 per cent in Arka Keshav to 2964.3 per cent in Pusa Kranti. In long duration accessions the marked increase in the fruit number was not observed.

h. Yield per plant

Among the grafted plants maximum yield was recorded in BB7 (4387.4 g/plant) (Plate 31) followed by Pusa Kranti (3619.7 g/plant) (Plate 32),

Table 37. Fruit circumference (cm) and average fruit weight (g) of grafted and intact plants of brinjal (November 1995-May 1996)

Sl. No.	Variety	Fruit circumference			Average fruit weight		
		Grafted plants	Intact plants	% increase or decrease	Grafted plants	Intact plants	% increase or decrease
1	BB-17	24.1	19.7	22.3 (+)	209.4	155.5	34.7 (+)
2	Arka Keshav	6.5	6.2	4.8 (+)	53.4	47.6	12.2 (+)
3	BB-49	13.2	12.1	9.1 (+)	32.0	26.8	19.4 (+)
4	Arka Shirish	15.6	14.5	7.6 (+)	63.5	61.1	3.9 (+)
5	Pusa Kranti	18.3	14.2	28.9 (+)	109.5	65.8	66.4 (+)
6	TGR	16.5	13.1	25.6 (+)	98.3	83.0	18.4 (+)
7	SM 116	22.7	14.8	53.4 (+)	138.4	104.5	32.4 (+)
8	SM 141	13.9	13.6	2.2 (+)	133.7	125.1	6.9 (+)
Mean		16.4	13.5	21.5 (+)	104.8	83.7	25.2 (+)
CD (p=0.01)		0.9616			8.62		
CV		4.10%			6.15%		

Table 38. Number of fruits and yield per plant (g) of grafted and intact plants of brinjal (November 1995-May 1996)

Sl. No.	Variety	Number of fruits/plant			Yield/plant		
		Grafted plants	Intact plants	% increase or decrease	Grafted plants	Intact plants	% increase or decrease
1	BB-7	59.0	29.3	101.4 (+)	4387.4	1533.8	186.0 (+)
2	Arka Keshav	43.4	24.0	80.8 (+)	1443.0	594.9	142.6 (+)
3	BB-49	78.7	23.8	230.7 (+)	1731.8	448.5	285.9 (+)
4	Arka Shirish	34.2	4.8	612.5 (+)	1504.9	294.4	503.4 (+)
5	Pusa Kranti	85.8	2.8	2964.3 (+)	3619.7	143.8	2417.2 (+)
6	TGR	13.8	15.2	9.2 (-)	1241.6	1166.7	6.4 (+)
7	SM 116	24.7	14.6	69.2 (+)	1270.7	934.9	35.9 (+)
8	SM 141	16.5	15.3	7.8 (+)	1632.2	1571.5	3.9 (+)
Mean		45.4	16.2	180.2 (+)	2103.9	836.1	151.6 (+)
CD (p=0.01)		7.979			315.3		
CV		12.09%			11.02%		

Plate 31
Promising graft, BB 7

Plate 32
Promising graft, Pusa Kranti

both resistant to jassid infestation. In short duration varieties there was marked improvement in yield by grafting and it ranged from 142.6 per cent in Arka Keshav to a very high value of 2417.2 per cent in Pusa Kranti. Among the long duration accessions the increase in yield was not conspicuous and it ranged only marginally from 3.9 per cent in SM 141 to 35.9 per cent in SM 116. Among the intact plants, in spite of the jassid infestation maximum yield was recorded in SM 141 (1571.5 g/plant).

i. Incidence of bacterial wilt

None of the grafted plants showed bacterial wilt incidence under field condition (Table 39). Varieties like Arka Shirish and Pusa Kranti, which showed 100 per cent wilting in intact plants were also completely free from bacterial wilting after grafting on to *S. torvum*. The susceptible variety BB 7 and BB 49 which had 75 and 85 per cent wilting in intact plants were also not affected by wilt after grafting on *S. torvum*.

j. Incidence of Jassids

There was heavy incidence of jassids during the cropping season which affected the general growth and productivity of the crop (Plate 33). There was apparently no difference in the jassid infestation in the grafts as well as in intact plants of the same variety (Table 40). SM 141 was highly susceptible to jassids with maximum intensity in grafted plants (65.0%) as well as in intact plants (68.3%) and having maximum population of jassids/leaf (19.3 and 20.3 respectively) (Plate 34). TGR was also highly susceptible to jassids with 65 per cent intensity in grafted plants and 66.7 per cent in intact plants with a population of 19.0 and 19.6

Table 39. Incidence of bacterial wilt in grafted and intact plants of brinjal (November 1995-May 1996)

Sl. No.	Variety	Grafted plants	Intact plants	% increase or decrease
1	BB-7	0.0	75.0	75.0 (+)
2	Arka Keshav	0.0	0.0	0.0
3	BB-49	0.0	85.0	85.0 (+)
4	Arka Shirish	0.0	100.0	100.0 (+)
5	Pusa Kranti	0.0	100.0	100.0 (+)
6	TGR	0.0	5.0	5.0 (+)
7	SM 116	0.0	0.0	0.0
8	SM 141	0.0	0.0	0.0
Mean		0.0	45.6	45.6 (+)

Table 40. Percentage intensity due to jassid infestation and its population in grafted and intact plants of brinjal (November 1995-May 1996)

Sl. No.	Accession No./ Variety	Grafted plants			Intact plants		
		Percentage intensity	Category	Jassids/leaf	Percentage intensity	Category	Jassids/leaf
1	BB 7	5.0	R	2.8	6.7	R	2.9
2	Arka Keshav	43.3	S	9.8	40.0	S	8.9
3	BB 49	35.0	S	8.8	33.3	S	8.2
4	Arka Shirish	35.0	S	8.9	26.6	S	6.6
5	Pusa Kranti	6.7	R	2.9	8.3	R	3.0
6	TGR	65.0	HS	19.0	66.7	HS	19.6
7	SH 116	43.0	S	10.0	43.3	S	10.1
8	SH 141	65.0	HS	19.3	68.3	HS	20.3
CD (p = 0.01)				1.06			1.06
CV				7.36%			7.36%

Plate 33
Yellowing caused by jassid infestation in brinjal

Plate 34
Jassid infestation in grafted SM 141

jassids/leaf respectively. BB 7 and Pusa Kranti were resistant to jassid infestation with a intensity of 5.0 to 8.3 per cent in both grafted as well as in intact plants and the population was below the economic threshed level of 4.7 jassids/leaf. Remaining four varieties were susceptible to jassids with the intensity above 25 per cent and the population of jassids/leaf was above the economic threshold level of 4.7 in both grafted as well as in intact plants.

h. Organoleptic test

In the organoleptic test, the fruits of the grafted brinjal palnts did not vary much with those of intact plants. The difference of only 0.62 in the score value of grafted and intact plants was negligible (Table 41). There was no marked difference in the appearance and flavour of the cooked fruits of grafted and intact plants (0.9 and 0.1 respectively). SM 141 was preferred by the tasters in grafted fruits as well as in intact plant fruits and scored maximum points (7.88 and 8.64 respectively). BB 49 fruits had some bitterness in taste compared to other tested varieties/accessions and received minimum points (grafted fruits 6.72 and intact plants fruit 7.00). Though cooked fruits of *S. torvum* were better in appearance, the bitter taste reduced the score value to 3.08 points.

i. Total phenol

The total phenol content in the leaves of *S. torvum* (0.63%) was higher than in *S. melongena* varieties (grafted 0.42%, intact 0.35% at 60 DAP) (Table 42). There was an increase in total phenol content in the leaves of grafted plants by 0.07 per cent over the intact plants. Leaves of bacterial wilt resistant varieties/accessions like Arka Keshav, TGR, SM 116 and SM 141 had higher

Table 41. Score of organoleptic test for fruits of grafted and intact plants of brinjal

Sl. No.	Variety	Appearance (out of 2)		Taste (out of 2)		Flavour (out of 2)		Bitterness (out of 4)		Total (out of 10)	
		Grated plants	Intact plants	Grafted plants	Intact plants	Grafted plants	Intact plants	Grafted plants	Intact plants	Grafted plants	Intact plants
1	BB-7	1.46	1.56	1.46	1.64	1.14	1.46	2.64	3.28	6.70	7.94
2	Arka Keshav	1.52	1.60	1.54	1.60	1.50	1.56	2.92	3.36	7.48	8.12
3	BB-49	1.40	1.44	1.40	1.48	1.48	1.48	2.44	2.80	6.72	7.20
4	Arka Shirish	1.44	1.56	1.48	1.52	1.38	1.48	2.52	2.98	6.82	7.54
5	Pusa Kranti	1.52	1.68	1.36	1.52	1.40	1.56	2.52	2.80	6.80	7.56
6	TGR	1.48	1.56	1.40	1.52	1.50	1.60	2.38	2.56	6.76	7.24
7	SM 116	1.52	1.56	1.40	1.60	1.60	1.60	3.24	3.12	7.76	7.88
8	SM 141	1.48	1.60	1.56	1.76	1.56	1.68	3.28	3.60	7.88	8.64
Mean		1.48	1.57	1.45	1.56	1.45	1.55	2.74	3.06	7.12	7.74
S. torvum			1.64		0.40		0.28		0.76		3.08

Table 42. Total phenol and O.D. phenol content in the leaves of grafted and intact plants of brinjal at 60 DAP (November 1995-May 1996)

Sl. No.	Variety	% total phenol		% O.D. phenol	
		Grafted plants	Intact plants	Grafted plants	Intact plants
1	BB-7	0.38	0.25	0.018	0.010
2	Arka Keshav	0.40	0.38	0.033	0.030
3	BB-49	0.37	0.25	0.015	0.002
4	Arka Shirish	0.30	0.22	0.005	0.001
5	Pusa Kranti	0.36	0.22	0.013	0.001
6	TGR	0.53	0.54	0.029	0.029
7	SM 116	0.52	0.47	0.031	0.028
8	SM 141	0.47	0.47	0.032	0.028
Mean		0.42	0.35	0.022	0.016
S. torvum		0.63	0.63	0.036	0.036

contents of total phenol in grafted plants (0.40% to 0.53%) as well as in intact plants (0.38% to 0.54%) than susceptible cultivars like BB 7, BB 49, Arka Shirih and Pusa Kranti (grafted 0.30% to 0.38% and intact 0.22% to 0.25%).

j. O.D. phenol

The O.D. phenol content in the leaves of *S. torvum* (0.036%) was higher than *S. melongena* varieties (grafted 0.022%, intact 0.016%) at 60 DAP. Among the *S. melongena* varieties maximum O.D. phenol content was detected in the leaves of grafted plants of Arka Keshav (0.033%), SM 141 (0.032%), SM 116 (0.031%) and TGR (0.029%) and minimum in Arka Shirish (0.005%), Pusa Kranti (0.013%), BB 49 (0.015%) and BB 7 (0.018%). Similar trend was also noticed in the O.D. phenol content of intact plants.

Discussion

DISCUSSION

Endowed with wide range of fruits differing in colour, shape, size and taste brinjal has become a popular vegetable of the country. Hardy and long duration nature of plants make the crop an integral component of homestead farming. The delicious preparations made out of brinjal are highly appreciated. Nutritionally brinjal is comparable to tomato. The crop is a good source of vitamin C and calcium (12 and 18 mg/100 g respectively). Brinjal is considered to have a number of medicinal uses, white and small brinjal is good for diabetic patients (Choudhury, 1976).

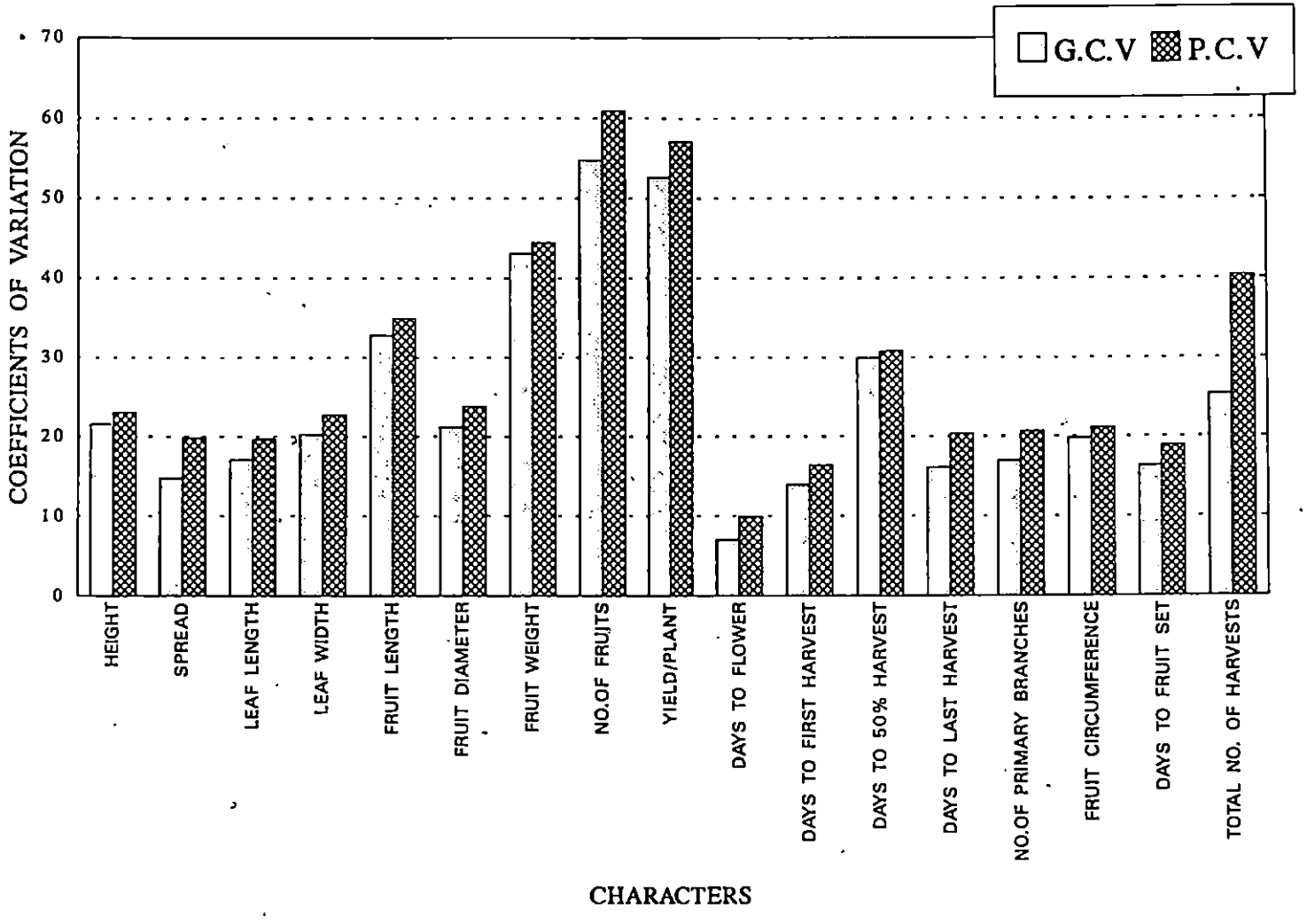
The present productivity of 13.08 t/ha in India is much less than the potential productivity of brinjal (Kalloo, 1995). Poor genetic stock, unscientific and improper cultural practices and incidence of pest and diseases particularly bacterial wilt, phomopsis blight, fruit and shoot borer and jassids are the major causes for low productivity in the country. In the warm humid tropical climatic conditions prevailing in Kerala and in the coastal areas bacterial wilt caused by *Pseudomonas solanacearum* is a serious problem. Kerala is a 'hot spot' for bacterial wilt incidence in solanaceous vegetables. Majority of the high yielding varieties including the hybrids are highly susceptible to this dreadful disease and yield loss is as high as 100 per cent in Kerala (Gopimony and George, 1979). In the present investigation a holistic approach is made to enhance the productivity of brinjal by developing wilt resistant and high yielding varieties, hybrids and grafts differing in colour and shape of fruits for meeting the region specific consumer demands.

Success of any crop improvement programme primarily depends on the extent of genetic variation and diversity in a crop. This is all the more true in an often cross pollinated crop like brinjal. To assess the extent of variation, 78 brinjal accessions collected from various parts of Kerala and outside were evaluated in a wilt sick soil during Kharif 1994. The accessions showed significant variations for plant height, plant spread, number of primary branches/plant, leaf length, leaf width, days to flower, days to fruit set, days to first harvest, days to 50 per cent harvest, days to last harvest, total number of harvests, fruit length, fruit diameter, fruit circumference, average fruit weight, number of fruits/plant and yield/plant. The large variation observed in the population was a result of natural outcrossing aided by heterostyly and protogyny. The studies conducted by Mishra *et al.* (1990), Ushakumari *et al.* (1991), Vivekanandan and Subramanian (1991), Borah and Shadeque (1993) and Varma (1995) also revealed a wide range of variability for most of the characters in brinjal indicating great scope for improvement.

In the present investigation phenotypic coefficient of variation was maximum for number of fruits/plant (60.90%) followed by yield/plant (57.12%) (Fig.2). The contribution of genotype in the phenotypic expression was studied to realise the performance of accessions. As in the case of phenotypic coefficient of variation, genotypic coefficient of variation was also maximum for number of fruits/plant and yield. Both these economically important characters had high values of heritability coupled with genetic advance which indicated scope for selection. All the characters except number of harvests/plant had heritability value more than 50

FIG- 2

GENOTYPIC AND PHENOTYPIC COEFFICIENTS OF VARIATION FOR DIFFERENT CHARACTERS IN BRINJAL



per cent indicating the high heritable nature of characters selected in the study.

The initial population of the 78 brinjal accessions exhibited wide ranges for the various vegetative characters like height, spread and number of primary branches of the plant and leaf size. The plant height ranged from 44.4 cm to 143.9 cm (Table 43). The population density mainly depends on the spread of plants and it ranged from 53 to 141.5 cm suggesting need for varied spacing depending on the spread of the varieties. Most of the local accessions including TGR, SM 63, SM 71, SM 116 and SM 141 had more spreading habit. The length and width of leaves also had a wide range (8.7-22.5 cm and 5.5-16.4 cm respectively) of variability. The perennial accessions SM 136 and TGR had large sized leaves. Sheela (1982), Sankar (1984), Rashid *et al.* (1988), Varghese (1991) and Varma (1995) also noticed wide variation for vegetative characters in brinjal.

Varietal difference in earliness had been reported earlier by many workers in brinjal (Salehuzzaman, 1981; Kandaswamy *et al.*, 1983 and Varghese, 1991). The days to first flower varied from 32.8 in BB-13-1 to 48.2 in SM 116. Days for the first harvest also ranged from 50.3 to 66.9. For attaining the peak harvesting, different accessions exhibited quite a wide difference of 111.5 days (73.1-184.6 days). From the practical point of view days to 50 per cent fruiting which is the peak fruiting stage, is more relevant than days to flower or days to first fruit set as reported by Varghese (1991) and Varma (1995). The days to last harvest also had a wide range (91.3-215.7 days) of variation among the accessions evaluated.

The shape and size of fruit has a dominant role for deciding the consumer preference. SM 88 had the shortest fruits (4.5 cm) and Arka Keshav, the

Table 43. Mean and range of important quantitative characters during the preliminary evaluation of 78 brinjal accessions

Sl. No.	Character	Mean	Range			
			Minimum		Maximum	
			Value	Accession/ variety	Value	Accession/ variety
1	Plant height (cm)	92.1	44.4	BB 49	143.9	SM 128
2	Plant spread (cm)	97.2	53.0	SM 96	141.5	SM 116
3	No.of primary branches/ plant	6.9	4.5	Arka Nidhi	10.8	SM 70
4	Leaf length (cm)	14.7	8.7	SM 48	22.5	SM 136
5	Leaf width (cm)	10.4	5.5	SM 148	16.4	SM 136
6	Days to flower	41.0	32.8	BB-13-1	48.2	SM 116
7	Days to fruit set	46.4	37.9	SM 126	55.2	SM 136
8	Days to first harvest	62.9	50.3	BB 2	66.9	SM 63
9	Days to 50% harvest	115.5	73.1	SM 25	184.6	SM 108
10	Days to last harvest	185.4	91.3	SM 4	215.7	SM 18, SM 42, SM 70, SM 78 & SM 97
11	Total no. of harvest	9.0	1.2	SM 129	14.4	SM 141 & BB-13-1
12	Fruit length (cm)	9.9	4.5	SM 88	19.9	Arka Keshav
13	Fruit diameter (cm)	4.3	2.4	Arka Nidhi	9.7	SM 136
14	Fruit circumference (cm)	14.5	8.4	Arka Nidhi	30.3	SM 136
15	Average fruit weight (g)	80.6	28.0	SM 18	235.4	SM 136
16	No. of fruits/plant	17.3	1.2	SM 129	62.3	SM 101
17	Yield/plant (g)	856.9	132.3	SM 126	2279.6	Anna-purna

longest (19.9 cm). The fruit diameter in the long fruited Arka Nidhi and Arka Keshav had minimum values (2.4 and 2.6 cm respectively). Maximum fruit diameter was recorded in round fruited accession in SM 136 (9.7 cm). The average weight of fruit ranged from a low value of 28 g in SM 18 to 235.4 g in SM 136.

Productivity in terms of number and weight of fruits had considerable variation in the existing population and number of fruits/plant varied from 1.2 to 62.3. The Wayanad collections SM 126, SM 128, SM 129 and SM 132 produced less than four fruits/plant which may be due to the non adaptability of the accessions to the warm humid tropical climate of Vellanikkara. Yield/plant ranged from 132.3 g in SM 126 to 2279.6 g in Annapurna. Significant differences in yield among the varieties were also reported earlier (Sheela, 1982; Dutta, 1988 and Varghese, 1991). The accessions/varieties like CH 156, SM 71, SM 141, TGR, SM 101, BB 44, BB 2, SM 97, SM 75, SM 116, SM 114, SM 42, SM 113, SM 78, Surya and Swetha yielded above 1.25 kg/plant.

In a crop like brinjal consumer preference varies from region to region. The regional preference is mainly for discrete characters like colour, shape and size of fruits and even the prickles on the calyx also contributes for preference. The extremely specific regional preference in brinjal might have come from the existence of tremendous variation in the brinjal crop. In the present study also, the 78 brinjal accessions when subjected to cataloguing exhibited considerable variation for the various morphological characters including duration of the crop, presence of prickles, colour and shape of fruits etc. Thirty four accessions had a shorter duration of less than 200 days while forty four had a longer duration of more than 200 days. Prickly nature of the plants which is considered as an undesirable trait was

present in 26 accessions. The remaining 52 accessions were devoid of any prickles on stem, leaf and calyx. Out of 78 accessions, 18 were purple fruited, 17 green fruited and seven having white or milky white fruits and 36 with striated/mottled fruits. Ten accessions had white flowers while the remaining 68 had purple flowers.

B. Detailed evaluation of promising brinjal accessions/varieties

Yield is an artifact of several characters (Grafius, 1956). Superiority of a genotype cannot be judged based on yield alone. Several traits like yield, size and colour of fruit, presence or absence of prickles, duration of the crop, etc. decide the acceptability of the genotype. Considering the productivity, resistance to bacterial wilt and fruit and plant characters, 24 accessions/ varieties selected from the preliminary evaluation were further subjected to detailed evaluation during March-November, 1995. Fourteen nonspreading accessions viz., Annapurna, CH-156, WCG(S), Swetha, SM 59, Arka Keshav, BB-13-1, BB 2, SM 96, BB 7, Surya, SM 7, BB 44, SM 62 having a duration less than 200 days were evaluated at the recommended spacing of 60 x 60 cm. The genetic potentiality of a variety will be fully expressed only if it is grown during the most ideal time with optimum spacing providing all the required inputs. So, the remaining ten selected accessions viz., SM 63, SM 69, SM 71, SM 75, SM 87, SM 113, SM 116, SM 141, TGR and Composite 2 having spreading habit and duration of more than 200 days were evaluated at a wider spacing of 100 x 75 cm in order to express the full genetic potentiality.

The analysis of variance for the short duration and long duration accessions done separately has indicated significant differences for all the quantitative characters except for the fruit diameter of long duration accessions. During the

detailed evaluation, the general growth and productivity of the plants were better and the plants were allowed to express maximum. The short duration accessions and long duration accessions exhibited a marked difference for all the vegetative characters. Both the groups had only a marginal difference of 15.11 cm for the height of plant while for the spread of plant long duration accessions exhibited definite superiority. The mean plant spread of ten long duration accessions was as high as 146.96 cm compared to 101.94 cm in the short duration accessions. Among short duration accessions, Surya and Swetha had a plant spread of 113.2 and 100.7 cm respectively. As in the preliminary evaluation the long duration accessions SM 71, SM 116 and TGR had maximum spreading habit (191.87, 175.53 and 171.3 cm respectively), substantiating the adoption of wider spacing for commercial cultivation. The presence of prickles on the cultivar TGR further necessitates a still wider spacing of 1.5 x 1.5 m as practised by the farmers in Kerala. The vigorously growing long duration accessions had large sized leaves as indicated by a mean length and width of 14.86 and 9.95 cm compared to 11.15 and 8.37 cm in the short duration accessions. As in the preliminary evaluation the prickly stemmed, long duration cultivar TGR had maximum sized leaves having prickles. The purple fruited SM 116 also had large sized leaves (16.83 x 12.33 cm). The late flowering and fruiting habit of the long duration accessions may be due to shifting of photosynthates for their vegetative growth. Geetha (1989) also noticed positive correlation for duration of the crop and high vegetative growth in brinjal.

Short duration accessions were earlier than the long duration accessions in flowering and first harvesting as evidenced by the mean values of 33.23 and 50.41 days respectively in short duration accessions and 39.63 and 57.78 days respectively in long duration accessions. Surya was the earliest variety for flowering

and first harvesting (25.5 and 43.5 days respectively). Earliness of Surya was also reported by Varghese (1991). As in the initial evaluation the long duration accession, SM 116 flowered last (44.9 days) and took 64.3 days for the first harvest. Compared to long duration accessions days to 50 per cent fruiting was earlier by 23.3 days in short duration accessions. Total number of economic harvests were more in long duration accessions (14.74) than short duration accessions (11.47). The economic yield in a non prickly and white flowered accession SM 141 lasted upto 240 days and on an average 18.4 harvests were taken. The long duration nature of this accession has already been reported earlier (KAU, 1995).

The duration of the crop did not have any effect on the length of fruits. However, diameter and average weight of fruit were slightly more in the long duration accessions. As in the preliminary evaluation, fruit length was maximum in deep purple and slender fruited Arka Keshav (18.95 cm) closely followed by SM 69 (18.20 cm), SM 63 (17.40 cm) and SM 141 (16.60 cm). The fruit diameter was maximum in the nonprickly, long duration accessions SM 116 and Composite 2 (5.13 cm), both having purple and round fruits. The long (16.60 cm) and thick (diameter 4.07 cm) fruited SM 141 borne fruits of maximum weight (128.27 g). The size of fruit is a deciding factor for adoption of the variety by the farmers. In the traditional growing tracts of Kerala, long and thick fruited varieties are very much preferred by the farmers mainly due to easiness in harvesting and better market demand.

In general the long duration accessions yielded more than the short duration accessions by 382.28 g/plant. Among the short duration accessions maximum yield was recorded in Swetha (3.86 kg/plant) followed by BB 44 (3.67 kg/plant),

Annapurna (3.20 kg/plant) and Surya (3.06 kg/plant). Per hectare yield was also maximum in Swetha (73 t/ha). The superiority of Swetha has already been reported earlier (AICVIP, 1990 and AICVIP, 1994). The high yield in Swetha was mainly due to the production of maximum number of small to medium sized fruits (117.20) and its resistance to bacterial wilt. BB 44 which ranked second in yield among the short duration accessions had light green straited fruits which is not appreciated by the consumers in the state. Dark green straited nature is also considered as a wild character in brinjal. The purple fruited Annapurna, a popular variety in Bihar also performed well yielding 3.20 kg/plant. The adaptable, purple and oval fruited Surya also yielded 3.06 kg/plant with a productivity of 40 t/ha within a period of 8 months. BB 7 though yielded 1.6 kg/plant, the per hectare yield was only 17.3 t which was mainly due to the susceptibility of the variety to bacterial wilt at later stages of growth.

Among the long duration accessions the light green and long fruited accession SM 141 yielded as high as 6.4 kg/plant followed by the prickly stemmed, milky white and oblong fruited cultivar TGR (3.09 kg/plant). The high yield in SM 141 was mainly due to the production of more number of large sized fruits (113.5). In the selected accessions, average fruit weight was maximum in SM 141 (128.27 g). Due to the wider spacing adopted, the per hectare yield (68.8 t) for this long duration accession was only second to Swetha. The high productivity of SM 141 under Vellanikkara condition has already been reported earlier (AICVIP, 1990 and AICVIP, 1993). SM 141 has given 18.4 economic harvests within a period of 240 days and the plant can be fruther retained in the field upto two years. The absence of prickles, long duration and more number of economic harvests coupled with high yield and resistance to bacterial wilt make SM 141 an ideal choice for the crop mix of Kerala homesteads.

Brinjal is usually cultivated as a rainfed crop in the garden lands in Kerala. Due to the distributed rainfall from June to October-November cultivation of long duration types are more suitable in the State. Moreover due to lack of irrigation facilities during summer the same land is not further utilized for growing other crops. In such a situation, the promising long duration brinjal can be further retained in the field providing life irrigation and mulching upto the next monsoon. After the receipt of rainfall in May-June the same crop can be rejuvenated for ratoon crop after prunning and application of manures and fertilizers.

C. Bacterial wilt in brinjal

Bacterial wilt caused by *Pseudomonas solanacearum* is a serious problem in solanaceous vegetables like tomato, brinjal and chilli in Kerala. The warm humid climate, high rainfall, acidic soil, low pH, intensive cultivation practices etc. favour the multiplication and spread of bacteria. Chemical control measures are practically ineffective and the only practical way of combating the disease is by the cultivation of wilt resistant varieties. Vellanikkara has been considered as a hot spot for screening for resistance to bacterial wilt.

In the field evaluation of 78 accessions, bacterial wilt incidence ranged from zero to hundred per cent. The varieties Arka Shirish and Pusa Kranti were completly lost by bacterial wilt. Thirty one accessions including Swetha, Surya, BB 44, Arka Keshav, SM 141 and good number of local collections were not affected by wilt. This might be due to predominance of land races and local collections in the present study. Gopimony and George (1979) also reported tolerance of many local collections to bacterial wilt than the improved varieties. The low

temperature prevailing during rainy season (minimum 22.4 to 23.4°C and maximum 28.6 to 35.4°C) also may have contributed for the low disease incidence during the field evaluation.

The promising accessions which were not affected by bacterial wilt during initial field evaluation were subjected to artificial inoculation. The check variety Pusa Kranti completely succumbed to bacterial wilt at the initial fruiting stage itself. The varieties Annapurna, WCG(S), Swetha, Arka Keshav, BB-13-1, BB 2, Surya, BB 44, SM 7, SM 62, SM 87, SM 113, SM 116 and SM 141 were found highly resistant to bacterial wilt even under artificial inoculation. The resistance of Surya, Swetha, Arka Keshav, BB 44, SM 141 etc. have been reported earlier by Gopalakrishnan *et al.* (1990), Varghese (1991), AICVIP (1994) and KAU (1996b).

The moderately resistant BB 7 and two accessions, SM 75 and SM 96 which were not affected by wilt in the preliminary field evaluation, bacame susceptible after artificial inoculation. Chances of 'escapes' in *P. solanacearum* screening has been noticed earlier (Gangappa, 1986). This might be the obvious reason for the resistance noticed in SM 75, SM 96 and BB 7 during the initial field screening.

In the anatomical studies, large sized, less healthy and loosely arranged cortical cells were observed in the roots of susceptible variety. In the resistant variety, the cortical cells were small sized and compactly arranged. This revealed the possibility of the easy entry of pathogenic bacteria through the loosely arranged cortical cells in the susceptible variety whereas in the resistant variety, the compactly arranged cortical cells provide a shield against the entry of bacteria into the roots

from the soil. In the roots of susceptible variety, as a result of bacterial ivasion, the secondary xylem and phloem were damaged. By the disintegration of xylem and phloem vessels and the connected tissues, phenolic compounds are released which later oxidises to quinones, giving a black discolouration in the xylem and phloem vessels of the susceptible varieties. Damage and subsequent obliteration of physiologically active secondoary xylem results in the blocking of water and nutrient flow to the stem and leaves and ultimately leads to wilting of the plants. The damage of physiologically active secondary phloem contributes to the blocking of photosynthates to the roots results in the cessation of root production. The anatomy of stem and petiole of the resistant and susceptible varieties did not show any variation suggesting the role of root system in the resistance mechanism of bacterial wilt.

In the present study, total phenol contents in the roots were higher in the resistant varieties viz., Surya (0.36%), Swetha (0.38%) and SM 141 (0.40%) compared to the susceptible varieties Pusa Kranti (0.22%) and BB 7 (0.24%). The same trend was noticed in the leaves also. The O.D. phenol contents were also higher in the roots of resistant varieties, Surya (0.021%) and Swetha (0.022%) than the susceptible variety Pusa Kranti (0.001%). The same trend was noticed in the leaves. Geetha (1989) also reported high contents of O.D. phenol in the roots of wilt resistant varieties than the susceptible one.

D. Incidence of jassids

In the present investigation the growth and productivity of the crop raised during Kharif 1995 were not affected by jassids. Though there was low incidence of jassids, the typical symptom of yellowing was not expressed. The frequent rainfall and low temperature during rainy season might be the reason for

low incidence of jassids. But during the evaluation of parents, hybrids and grafts in the summer 1996, heavy incidence of jassids affected the general growth and productivity of the crop. The high temperature and more sunshine hours prevailing during summer months might have contributed for the outburst of jassids (Ratanpara *et al.*, 1994 and Dhamdhere *et al.*, 1995).

During the evaluation of parents and hybrids, all the parents and hybrids except Composite 2 and Annapurna were having the jassid population above the threshold level of 4.7/leaf (Faleiro and Rai, 1988) and disease intensity of 20 per cent. Swetha was highly susceptible to jassids with the maximum intensity (66.7%) and maximum number of jassids/leaf (19.3). Surya was also highly susceptible to jassids with 58.3 percentage intensity and 14.0 jassids/leaf. During the evaluation of grafts, two varieties viz., Pusa Kranti and BB 7 were found resistant to the attack of jassids with a population intensity of less than three per leaf and disease intensity of less than 8.5. Genotypic variation for jassid resistance due to antixenosis and antibiosis has been reported by Lit (1989) and Gaikwad *et al.* (1991). In general, the hybrids tolerated the attack of jassids better than the parents. Five hybrids viz., Surya x Composite 2, Surya x SM 116, Surya x Annapurna, Arka Keshav x SM 71 and SM 141 x TGR were moderately resistant to jassids having disease intensity from 21.7 to 25 per cent and the population of jassids/leaf was below seven. The jassid tolerance of the hybrids has resulted in better vegetative growth during the initial stage.

In the resistant accessions, the epidermal hairs were comparatively longer and formed a compact mat whereas in the susceptible types they were shorter and had less matting effect. This gives a physical protection to the attack of jassids in the resistant varieties. Lit (1988) and Gaikwad *et al.* (1991) also reported that the

trichome length and density on leaves were negatively correlated with infestation level of jassids.

E. Heterosis in brinjal

Heterosis breeding has been extensively explored and utilized to boost up yield in a number of economically important crops. The easiness in the crop culture, medium size of flowers and more number of seeds with a single act of pollination enables brinjal as a preferred plant for exploitation of hybrid vigour (Goto, 1952). Liberalisation of import policy has made a boon for F_1 hybrids in India particularly in the private sector. Solanaceous crops especially tomato and brinjal have been exploited well for achieving high productivity. In brinjal a number of high yielding hybrids have been developed in India, but they could not be grown in the State because of susceptibility to bacterial wilt. Hence development of F_1 hybrids which are resistant to bacterial wilt would be of significant importance.

Selection of parents based on divergence and diallel crossing has resulted in a number of hetrotic hybrids in brinjal (Varma, 1995). Presence of wide variation in the plant and fruit characters viz., colour, shape, size of fruits and highly variable consumer preference from region to region necessitates consideration of above aspects in the F_1 production programme. In the present study 11 bacterial wilt resistant varieties/accessions having specific advantage of colour, shape and size of fruits, duration of the crop and productivity were selected and utilized in the hybridisation programme with the objective of developing F_1 hybrids with specific fruit and plant characters. Six purple fruited varieties/accessions viz., Surya, Composite 2, Annapurna, Arka Keshav, SM 71 and SM 116 were crossed to develop five F_1 hybrids and five light green/white fruited varieties viz., Swetha, WCG(S), TGR,

SM 63 and SM 141 were crossed to give four F_1 hybrids. All the nine hybrids viz., Surya x Composite 2, Surya x SM 116, Surya x Annapurna, Arka Keshav X Composite 2, Arka Keshav x SM 71, Swetha x SM 141, Swetha x SM 63, SM 141 x WCG(S), SM 141 x TGR were compared with parents during November 1995-June 1996.

Out of the nine hybrids tested, six viz., Surya x SM 116, Surya x Annapurna, Arka Keshav x SM 71, Swetha x SM 141, SM 141 x WCG(S) and SM 141 x TGR were highly resistant to bacterial wilt, since the parents involved in the hybridisation programme were resistant. Resistance to bacterial wilt is recessive and F_1s will be resistant only if both the parents are resistant (Geetha, 1989). Though all the hybrids were rated as resistant, crosses involving Composite 2 viz., Arka Keshav x Composite 2 and Surya x Composite 2 had 18 per cent and six per cent wilt incidence respectively. The hybrids which involved the parent SM 63 (12% wilt incidence) also had a very low wilt incidence of four per cent. This indicates necessity of inclusion of highly resistant varieties in the F_1 production programme in brinjal.

In the present study, the hybrids had an extra initial vigour which was manifested by their increase in height (+ 9.38 cm) and spread of plants (+ 14.22 cm) over parents. Among the purple fruited hybrids plant height at 60 DAP was maximum in Surya x Annapurna (56.3 cm) which exhibited maximum standard heterosis (81.03%). This increased height of the hybrid was inherited mainly from its parent Annapurna which had maximum height at 60 DAP. The leaf length and leaf width in the initial stages were also more in the hybrids compared to the parents. All the purple fruited hybrids exhibited significant relative heterosis and

standard heterosis for leaf length at 60 DAP, standard heterosis being maximum in Arka Keshav x SM 71 (48.67%). Shankaraiah and Rao (1990) also observed better seed size and more seedling vigour in the hybrids. This initial vigour might have helped the F_1 hybrids to withstand the attack of jassids better than the parent. Geetha (1989), Varghese (1991) and Varma (1995) also observed heterosis for plant height in brinjal.

The initial vigour of the F_1s were almost equalled by the parents towards the later stages of growth. At 50 per cent fruiting stage heterobeltiosis was noticed only in one hybrid, Arka Keshav x SM 71. The light green fruited F_1 hybrid, SM 141 x WCG(S) had negative heterobeltiosis (-30.59%) for plant height, though both the parents involved were tall. None of the hybrids exhibited superiority over their better parent in the plant spread also at 50 per cent fruiting stage. However, significant and high values of relative heterosis and standard heterosis were obtained in majority of the crosses which was mainly due to the bushy nature of the standard parents Surya and Swetha.

During the peak harvesting stage, significant heterobeltiosis for leaf length was observed only in Surya x Annapurna (31.78%) and Arka Keshav x SM 71 (26.57%). However, for leaf width all the purple fruited F_1 hybrids exhibited significant heterobeltiosis, being maximum in Arka Keshav x SM 71 (37.93%). In light green/white fruited crosses innvolving mainly vigorously growing parents with large leaves, the width of leaves were significantly reduced in the hybrids.

In general, the hybrids had only a little earliness than the parents for

flowering (4.19 days), first harvesting (4.07 days) and for 50 per cent harvesting (11.95 days). Though an increased initial vigour of the hybrids were observed in the vegetative characters, significant heterobeltiosis for days to flower or days to first harvest were not obtained. This finding is in agreement with the results of Varma (1995) who observed late flowering and fruiting in the high yielding hybrids. All the light green/white fruited F_1 hybrids took more days for first harvesting than their parents or standard variety Swetha. The initial vigour of the F_1 hybrids especially for the vegetative characters might have delayed the flowering in the hybrids and the flower and fruit production started only after the attainment of sufficient vegetative growth. In a crop like brinjal, flower and fruit production should be encouraged only after attaining adequate vegetative growth. Extra early flowering and fruit set is found to reduce the potential productivity of brinjal as reported by Singh and Singh (1980). However, peak harvesting was earlier in majority of the hybrids. Among the purple fruited hybrids, Surya x SM 116 exhibited maximum negative heterobeltiosis for peak harvesting (-15.20%) closely followed by Surya x Composite 2 (-11.82%). In the light green/white fruited hybrids Swetha x SM 63 had exhibited maximum heterobeltiosis (-22.46%) followed by Swetha x SM 141 (-15.67%). In both combinations, the earliest white fruited variety Swetha has been crossed to late flowering accessions SM 141 and SM 63. Similar result was reported by Cherpova (1976).

In general, the parents and hybrids did not vary much in their duration. However, all the purple fruited hybrids had significant heterobeltiosis and standard heterosis for the crop duration and total number of harvests. Arka Keshav x SM 71 has given economic harvest upto 207 days giving maximum values of heterobeltiosis and standard heterosis (20.82% and 21.04% respectively). The milky white fruited

and prickly hybrid SM 141 x TGR was retained in the field for maximum days (213 days). In general, the late flowered parents and hybrids were retained in the field for more number of days. In crosses involving the early variety Swetha and late variety SM 63, the F_1 has exhibited negative relative heterosis for days to flower (-11.74%), days to fruit set (-10.72%) and days to 50 per cent harvest (-26.76%).

Yield is an artifact of several traits including vegetative and fruit characters. In a crop like brinjal where tender fruits are harvested frequently, growth of plant and production of fruits should be in a complementary manner. In the present study, yield in terms of number and weight of fruits were more in the hybrids compared to the parents. Earlier Geetha and Peter (1993), Varghese and Vahab (1994) and Varma (1995) also reported significant heterosis for yield/plant in brinjal. All the purple fruited hybrids exhibited significant heterosis over the standard parent Surya for yield/plant. Yield was maximum in milky white fruited SM 141 x TGR (2816.4 g/plant) which exhibited 109.76 per cent heterobeltiosis and 312.65 per cent heterosis over the standard variety Swetha (Plate 35). But the presence of prickles on the stem and leaves makes this medium fruited cultivar unacceptable for intensive commercial cultivation. The purple fruited F_1 hybrid Arka Keshav x SM 71 ranked second in yield (2767.5 g/plant) with maximum values of heterobeltiosis (251.74%) and standard heterosis (337.62%) (Plate 36). This thick and long fruited hybrid also ranked first in number of fruits per plant (52.4) with maximum values of relative heterosis (292.51%), heterobeltiosis (227.50%) and standard heterosis (164.65%) (Table 44). The maximum number of fruits in the hybrid may have contributed for high yield. This F_1 hybrid has combined the long fruited nature and deep purple colour of Arka Keshav and thick fruited nature of SM 71. In addition, yield was also increased considerably by the phenomenon of

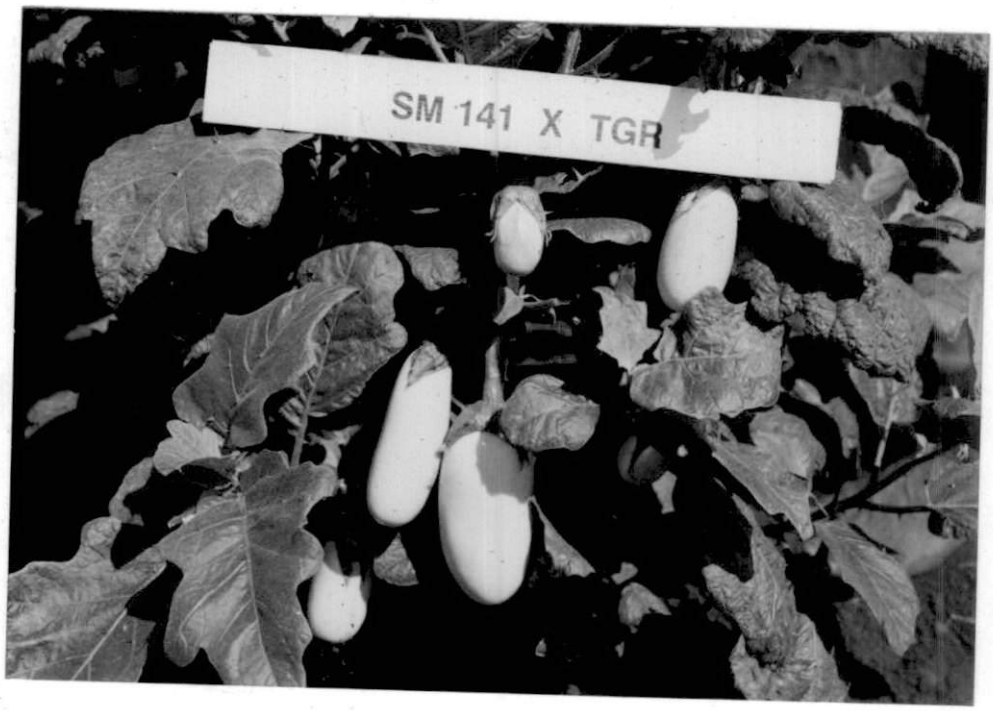


Plate 35
High yielding F_1 hybrid, SM 141 X TGR

Plate 36
High yielding F_1 hybrid, Arka Keshav X SM 71

Table 44. Salient features of promising brinjal hybrids

Sl.No.	Character	Arka Keshav x SM 71	Surya x SM 116
1	Potential yield	74.81 t/ha	63.60 t/ha
2	Yield/plant	2767.5 g	2475.6 g
3	No. of fruits/plant	52.4	42.2
4	Average fruit weight	105.2 g	13.10 g
5	Fruit length	21.0 cm	8.6 cm
6	Fruit diameter	4.1 cm	5.8 cm
7	Fruit colour	Deep purple	Deep purple
8	Fruit shape	Long	Oval
9	Plant height	83.2 cm	70.5 cm
10	Plant spread	112.5 cm	99.5 cm
11	Crop duration	207.2 days	201.5 days
12	Flower colour	Purple	Purple
13	Prickly/Non prickly	Non prickly	Non prickly

hybrid vigour.

Among the purple fruited hybrids, Arka Keshav x Composite 2 ranked second in yield (2498.2 g/plant) which was on par with Surya x SM 116 (2475.6 g/plant). Arka Keshav x Composite 2 though having long attractive purple coloured fruits with maximum weight (138.2 g), the transfer of bitterness from Composite 2 reduced its edible quality at the F_1 level. Since this hybrid had the sturdy and compact nature of Composite 2, identification of transgressive segregants with edible quality at the F_2 and subsequent generations will be of use for further improvement. The purple, large and oval fruited F_1 hybrid Surya x SM 116 having 160.10 per cent heterobeltiosis and 290.04 per cent standard heterosis had a productivity of 51.0 t/ha (Plate 37). The size and average fruit weight play prominent role in deciding the market value of brinjal fruits. Surya x SM 116 had large oval attractive and shining fruits with an average fruit weight of 131 g. This has contributed for the better performance of the hybrid. Lantican (1963) described increase in fruit size, weight and number as a major cause of heterosis for yield in brinjal. Out of the nine F_1 hybrids, six exhibited heterobeltiosis for fruit weight. High values of heterobeltiosis for fruit weight were also reported by Geetha (1989), Varghese (1991) and Varma (1995).

Fruit length was found significantly high only in one specific combination, Arka Keshav x SM 71. But, for the diameter of fruits significant and positive heterobeltiosis was exhibtied in four hybrids viz., Surya x SM 116 (5.8 cm), Surya x Composite 2 (5.6 cm), SM 141 x TGR (5.1 cm) and Surya x Annapurna (4.9 cm). Vishwanathan (1973) and Singh and Rai (1990) also reported high heterosis for fruit diameter.

Plate 37
High yielding F_1 hybrid, Surya X SM 116

An understanding on the inheritance of characters particularly discrete characters is a pre-requisite in the crop improvement programmes and especially in the development of hybrids. This will enable the breeder to select parents for hybridisation. A critical analysis of all the plants in the parents and hybrids gives valuable clues on the inheritance of certain discrete characters. In the present study, the crosses involving long and round fruited parents, the F_1s were oblong which may be due to partial dominance of long nature of fruits. The F_1s, generated by crossing accessions with deep purple fruit colour and light purple fruit colour had deep purple coloured fruits.

In crosses involving white flowered SM 141 with purple flowered Sweetha and TGR, all the F_1s were having purple flowers indicating complete dominance of purple over white. Dominance of purple flower colour over white in brinjal was also reported by Geetha (1989).

When the prickly parents, TGR and SM 63 were crossed to non prickly parents, the F_1s were completely prickly suggesting the dominance of prickly nature. Geetha (1989) also reported the dominance of prickly habit in brinjal. This revealed the necessity for exclusion of the prickly varieties in the F_1 production programmes.

In crosses where Swetha was used as female parent, all the F_1s had inherited the bushy, branching and erect nature of Swetha. This indicates scope for utilization of this variety for development of bushy varieties in brinjal.

F. Grafting in brinjal

Growing of grafted vegetables is popular in Korea, Japan and Some

European countries where the farming area is less and land use is very intensive. In Kerala due to pressure on land, the farmers are following intensive crop culture and are not following proper crop rotation. This has resulted in the occurence of soil borne diseases like bacterial wilt. Grafting has been used as a tool for reducing soil born diseases (Hirata, 1975) and for increasing productivity (Porcelli *et al.*, 1990). Sreenivasan *et al.* (1969) reported the wild *Solanum torvum* as rootstock for resistance to bacterial wilt. Lee (1989) also reported that the vigorous roots of *S. torvum* rootstock exhibited excellent tolerance to serious soil borne diseases caused by *Fusarium, Verticillium* and *Pseudomonas*. Paily (1964) has mentioned the scope of using wild *S. torvum* rootstocks for grafting susceptible brinjal cultivars. But one of the problem with *S. torvum* is the dormancy of seeds.

In the present study, *S. torvum* seeds were sown at 15 days interval starting from the day of seed extraction. Seeds sown after three months of storage only has given satisfactory germination. This reveals a dormancy of three months in *S. torvum* which can be overcome by storing seeds for three months after seed extraction. *S. torvum* can be propagated by stem cutting also and the vigorously growing side shoots may be used for grafting.

In the grafting experiment eight varieties differing in resistance to bacterial wilt and jassids, fruit colour, fruit shape, productivity and crop duration were grafted on *S. torvum* rootstock by Wedge method. All the three long duration accessions viz., SM 141, SM 116 and TGR and short duration variety Arka Keshav were considered for resistance to bacterial wilt. The remaining four varieties selected for grafting were completely susceptible to wilt. The wilt susceptible varieties BB 7 and Pusa Kranti were specifically included due to their resistance to

jassids. The grafted plants were compared with the intact plants in a wilt sick soil from November 1995 to May 1996 and there was heavy incidence of jassids during the season.

S. torvum was completely resistant to bacterial wilt. The high contents of total phenol (0.63%) and O.D. Phenol (0.036%) may be responsible for its resistance. None of the grafted plants showed incidence of bacterial wilt under field condition. Varieties Arka Shirish and Pusa Kranti which showed 100 per cent wilting in the intact plants survived completely after grafting on *S. torvum* rootstock. According to Paily (1964) resistance to bacterial wilt in the grafted plants was due to non accessability of the wilt organism to the scion.

Off season cultivation of brinjal during summer in the state is limited mainly due to the severe incidence of jassids. In the present experiment, plants of the same variety whether intact or grafted did not exhibit significant difference for jassid infestation. Pusa Kranti and BB 7 which were least affected during Kharif 1995 were again found resistant to the attack of jassids in the summer season. In the remaining varieties, the population and intensity were above the threshold level in both grafted and intact plants and they have shown severe yellowing and 'hopper burn' symptoms.

In the present investigation, the vigour of plants has been increased by grafting. But varieties responded differently after grafting on *S. torvum*. In short duration accessions increase in plant height by grafting ranged from 8.7 per cent in Pusa Kranti to 91.8 per cent in Arka Keshav and plant spread ranged 10.1 per cent in BB 7 to 37.3 per cent in BB 49. In long duration accessions this effect was not pronounced. As in the case of vegetative characters, the size and weight of fruits were also increased by grafting (Porcelli *et al.*, 1990). Though increase in fruit

length was only marginal, the diameter of fruit was significantly increased as a result of grafting. This is evident by mean fruit diameter of 3.7 cm in the intact plants compared to 4.4 cm in the grafted plants. In BB 7, an oval to round purple fruited variety, fruit diameter increased by 40.4 per cent from 5.2 cm to 7.3 cm by grafting. This in turn contributed to increase in average fruit weight from 155.5 g in the intact plants to 209.5 g in the grafted plants of BB 7. The increase in fruit weight by grafting was maximum in purple and oval fruited Pusa Kranti (66.4%). The influence of rootstock on the productivity and vigour of the plant is mainly due to the better uptake of nutrients by the roots of *S. torvum* which has a very extensive and strong root system. Takahashi *et al.* (1981) also reported that the rootstock's vigorous root system is often capable of absorbing water and nutrients more efficiently than the scion roots and serves as a good supplier of endogenous plant hormones resulting in increased vigour and productivity.

The pronounced effect of grafting on productivity, both in number and weight of fruits, is evident in the present investigation. As in the vegetative growth, the varieties behave differently in productivity also. In short duration accessions the increase in per plant yield ranged from 142.6 per cent in Arka Keshav to a very high value of 2417.2 per cent in Pusa Kranti. Maximum yield was recorded in grafts of BB 7 (4387.4 g/plant) followed by Pusa Kranti (3617.7 g/plant). In the short duration accessions the number of fruits/plant also increased upto 2964.3 per cent in Pusa Kranti (85.8 fruits). Porcelli *et al.* (1990) also obtained significantly higher yield when brinjal was grafted on *S. torvum* rootstock. Vuruskan and Yanmaz (1991) also reported increased early and total yield in brinjal after grafting.

The better performance of BB 7 and Pusa Kranti grafts was mainly due

to their ability to withstand the attack of jassids. In the intact plants of BB 7 and Pusa Kranti, since severe wilting (75 per cent and 100 per cent respectively) was observed, the genetic potentialities were not expressed fully by them. The days to first harvest in BB 7 and Arka Keshav was only 45 days compared to 55 days in the intact plants. The number of harvests also increased from seven in the intact plants to ten in grafted plants of above varieties during summer. According to Gomi and Masuda (1981) the prolonged duration of fruit harvest in grafted vegetables were not only due to disease tolerance of the rootstocks but also due to the enhanced water and mineral uptake. Among the long duration accessions, the increase in yield by grafting was not conspicuous, though perfect graft union was obtained.

In the organoleptic test of fruits, the grafted plants did not vary with the intact plants and all the fruits were quite edible. The present study clearly indicated the scope of using bacterial wilt susceptible but jassid resistant varieties like BB 7 and Pusa Kranti after grafting on *S. torvum* rootstock for cultivation in summer during which period normal cultivation of brinjal is not possible due to heavy incidence of jassids. Wedge grafting being a simple method can be done by farmers themselves and 80-100 per cent graft establishment can be easily achieved. Considering all the cost factors, grafts can be produced @ Rs.2.5-3/graft.

A holistic approach for the successful cultivation of brinjal in the bacterial wilt prone areas and in seasons of jassid outbreak has been emerged from the present set of investigations. These informations/results are of great relevance for boosting up the production of brinjal in the state. Out of 78 brinjal accessions, the short duration, white and long fruited, bacterial wilt resistant variety Swetha outyielded all others with a maximum productivity of 73 t/ha. The non prickly, long

duration, spreading, long and light green fruited, bacterial wilt resistant accession SM 141 yielded as high as 6.4 kg/plant making it an ideal choice for homestead farming in Kerala. This can be recommended for cultivation after multilocation testing and farm trials. The high productivity of the brinjal accessions under different spacing indicated the necessity for adoption of wider spacing for spreading long duration types in future evaluations.

The present investigation has resulted in the identification of 21 accessions differing in fruit and plant characters as sources of resistance to bacterial wilt. Bacterial wilt being a serious problem, this resistant materials can be utilized as source of resistance in the crop improvement programmes. In addition, two bacterial wilt resistant F_1 hybrids, Arka Keshav x SM 71 having long purple fruits and Surya x SM 116 having large oval purple fruits exhibited considerable heterosis for yield and fruit size. After studying the stability, both the hybrids can be progressed for cultivation in the state during Kharif season. The F_2 and subsequent generations of the crosses also may be explored for identification of transgressive segregants for the development of true breeding, stable and open pollinated varieties in brinjal. Though highly susceptible to bacterial wilt, the jassid resistant varieties, BB 7 and Pusa Kranti can be grown successfully during summer season after grafting on *S. torvum* rootstock.

The present investigation also indicated the need for strengthening breeding programmes for the development of high yielding varieties/hybrids having multiple resistance to bacterial wilt and jassids.

Summary

SUMMARY

The present investigation "Bacterial wilt resistance and yield in brinjal (*Solanum melongena* L)" was carried out at the College of Horticulture, Kerala Agricultural University, Vellanikkara during 1993-96.

1. Seventy eight accessions of brinjal collected from Kerala and outside were evaluated in a wilt sick soil during Kharif, 1994 and catalogued as per the IBPGR descriptor list. The accessions varied in duration, 34 having a shorter duration of less than 200 days and 44 having a longer duration of above 200 days. Out of the 78 accessions, 18 were purple fruited, 17 green fruited, 7 having white or milky white fruits and 36 with striated/mottled fruits. The accessions differed significantly for all the vegetative characters. Phenotypic coefficient of variation was maximum for number of fruits/plant (60.90%) followed by yield/plant (57.12%). The plant height ranged from 44.4 cm in BB 49 to 143.9 cm in SM 128. Plant spread ranged from 53 cm in SM 96 to 141.5 cm in SM 116. The long duration accession SM 136 and Thiruvalla Green Round (TGR) had largest leaves. The accessions also had a wide range for days to flower (32.8 to 48.2 days), days to first harvest (50.3 to 66.9 days), days to 50 per cent harvest (73.1 to 184.6 days), days to last harvest (91.3 to 215.7 days), fruit length (4.5 to 19.9 cm), fruit diameter (2.4 to 9.7 cm), fruit weight (28 to 235.4 g), number of fruits/plant (1.2 to 62.3) and yield/plant (132.3 to 2279.6 g).

2. During the initial field evaluation in a wilt sick soil, out of 78 accessions 31 were not affected by bacterial wilt. Arka Shirish and Pusa Kranti were 100 per cent susceptible. When the wilt free accessions were subjected to artificial

inoculation, 20 were resistant. In addition to the already available wilt resistant varieties viz., Surya, Swetha, Arka Keshav, BB 44, the additional accessions found resistant to wilt were SM 7, SM 62, SM 63, SM 71, SM 87, SM 113, SM 116, SM 141, Annapurna, CH-156, WCG(S), BB 2, BB-13-1, Composite 2 , TGR and SM

3. The anatomical studies of roots of bacterial wilt resistant and susceptible varieties revealed that the resistant variety has small, healthy and compact cortical cells whereas the susceptible variety has large and loosely arranged cortical cells through which entry of pathogenic bacteria from soil to root becomes easy.

4. The biochemical studies exhibited higher contents of total phenol and O.D. phenol in the roots as well as in the leaves of resistant varieties than the susceptible ones.

5. From the preliminary evaluation twenty four accessions/ varieties were selected on the basis of productivity, resistance to bacterial wilt, fruit and plant characters and were further subjected to detailed evaluation during March-November 1995. The short duration accessions (< 200 days) and long duration accessions (> 200 days) exhibited a marked difference for all the vegetative characters. Long duration accessions had a mean plant spread of 146.9 cm compared to 101.94 cm in short duration accessions suggesting the need for differential spacing depending on spread and duration of the variety.

6. In the short duration accessions maximum yield was recorded in the white fruited 'Swetha' (3863.02 g/plant) with a high productivity of 73 t/ha. The high yielding varieties Annapurna and Surya having desired plant characters and fruit qualities also yielded above three kg/plant.

7. On an average, the long duration accessions yielded 382.28 g more than the short duration accessions. In the long duration group, the accession SM 141 was the highest yielder (6.4 kg/plant) with maximum number of fruits (113.5) having maximum weight (128.27 g). The absence of prickles, long duration, maximum number of harvests, attractive long and light green fruits makes SM 141 an ideal choice for commercial cultivation as well as for growing in the homesteads of Kerala.

8. Six bacterial wilt resistant and purple fruited accessions/varieties viz. Surya, Composite 2, Annapurna, Arka Keshav, SM 71 and SM 116 were crossed to develop five F_1 hybrids (Surya x Composite 2, Surya x SM 116, Surya x Annapurna, Arka Keshav x Composite 2 and Arka Keshav x SM 71). Five promising bacterial wilt resistant and light green/white fruited accessions/varieties viz., Swetha, West Cost Green (Segregant) [WCG(S)], TGR, SM 63 and SM 141 were also crossed to generate four F_1 hybrids (Swetha x SM 141, Swetha x SM 63, SM 141 x WCG(S) and SM 141 x TGR). All the nine hybrids were compared with their parents during summer 1996.

9. The initial vigour of the hybrids were manifested by their increase in height (+9.38 cm), spread of plants (+14.22 cm), leaf length (+3.63 cm) and leaf width (+1.61 cm) at 60 DAP. Out of nine hybrids, the milky white oblong fruited SM 141 x TGR ranked first in yield/plant (2816.4 g) with significant values of heterobeltiosis (109.76%) and standard heterosis (312.65%). However, its highly prickly nature reduced its acceptability for cultivation. The bacterial wilt resistant, long and deep purple fruited hybrid Arka Keshav x SM 71 which ranked second in

yield (2767.5 g/plant) with maximum values of relative heterosis (297.20%), heterobeltiosis (251.74%) and standard heterosis (337.62%) is suitable for large scale cultivation. This hybrid had maximum number of fruits/plant (52.4) with maximum values of relative heterosis (292.51%), heterobeltiosis (227.50%) and standard heterosis (164.65%). Another promising hybrid was large, oval and purple fruited Surya x SM 116 with a yield potential of 2475.6 g/plant (RH 212.54%, HB 160.10%, SH 290.04%). All the F_1 hybrids were resistant to bacterial wilt. Heavy infestation of the jassids during the cropping period was better tolerated by the hybrids than the parents.

10. Eight selected varieties viz., BB 7, Arka Keshav, BB 49, Arka Shirish, Pusa Kranti, TGR, SM 116 and SM 141 differing in resistance to bacterial wilt and jassids, fruit and plant characters and crop duration were grafted on *Solanum torvum* rootstock by wedge method. The grafts were compared with the intact plants in a wilt sick soil during October 1995-May 1996. Seeds of *S. torvum* is found to exhibit a dormancy of three months and 100 per cent germination was obtained by sowing seeds after three months of storage.

11. None of the grafted plants wilted after grafting on *S. torvum* rootstock. The wilt susceptible varieties Arka Shirish and Pusa Kranti were found resistant after grafting on *S. torvum* rootstock.

12. During the summer evaluation, growth and yield was severely affected by jassid infestation. In the evaluation of F_1s and parent, F_1s tolerated the attack of jassids better than the parents. Bacterial wilt susceptible variety Pusa Kranti and BB 7 showed resistance to jassids because of long trichomes with high density in their leaves. All other varieties showed severe yellowing and typical 'hopper burn'

symptoms. There was no significant difference for resistance/susceptibility to jassid infestation in the grafts or intact plants of the same variety.

13. Marked increase in height and spread of plants and size and weight of fruits were achieved by grafting brinjal varieties on *S. torvum* rootstock, but varietal variation was observed. In short duration accessions, the increase was very conspicuous while in spreading and long duration varieties the effect was not pronounced.

14. Significant effect of grafting on the productivity, both in number and weight of fruits was more pronounced in the short duration accessions. Maximum yield was recorded in the grafts of BB 7 (4387.4 g/plant) followed by Pusa Kranti (3619.7 g/plant) with an increase of 186 per cent and 2417.2 per cent respectively over the intact plants. In the bacterial wilt susceptible variety Pusa Kranti, grafting has increased number fruits/plant by 2964.3 per cent and average fruit weight by 66.4 per cent. In the organoleptic test of fruits, the grafted plants did not vary with the intact plants and all the fruits were equally edible. The present study clearly indicated the scope of using bacterial wilt susceptible but jassid resistant varieties like BB 7 and Pusa Kranti after grafting on *S. torvum* rootstocks for cultivation in summer during which period normal cultivation of brinjal is not possible due to heavy incidence of jassids.

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* Originals not seen

Appendices

APPENDIX-I

Metereological data during the preliminary evaluation from July 1994-February 1995

Month	Temperature °C		Sunshine (hours)	Rainy days	Rainfall (mm)	Relative humidity (%)
	Minimum	Maximum				
July 94	22.4	28.6	1.4	29	1002.1	91
August 94	22.80	30.0	3.0	20	509.2	85
September 94	23.2	31.8	7.3	8	240.5	78
October 94	22.7	32.3	6.7	20	358.2	80
November 94	23.3	31.8	8.1	5	125.3	68
December 94	22.2	32.2	10.6	0	0.00	58
January 95	22.4	32.9	9.6	0	0.0	59
February 95	23.4	35.4	10.3	0	0.5	60

APPENDIX-II

Metereological data during the detailed evaluation from March-November 1995

Month	Temperature °C		Sunshine (hours)	Rainy days	Rainfall (mm)	Relative humidity (%)
	Minimum	Maximum				
March 95	23.4	37.6	9.3	0	2.8	60
April 95	24.9	36.6	8.0	5	118.7	71
May 95	23.9	33.5	8.0	13	370.5	78
June 95	23.1	31.6	2.1	19	500.4	86
July 95	23.2	29.9	1.4	26	884.7	89
August 95	23.7	30.6	3.0	22	448.7	86
September 95	23.5	30.1	7.3	13	282.5	82
October 95	23.2	33.2	6.7	8	110.4	78
November 95	22.5	31.3	8.1	5	88.4	80

APPENDIX-III

Metereological data during evaluation of F_1 hybrids and grafted plants from October 1995 - June 1996

Month	Temperature °C		Sunshine (hours)	Rainy days	Rainfall (mm)	Relative humidity (%)
	Minimum	Maximum				
October 95	23.2	31.3	6.7	8	110.4	78
November 95	22.5	31.3	8.1	5	88.4	80
December 95	21.3	32.5	10.6	0	0.0	57
January 96	22.4	33.1	9.4	0	0.0	53
February 96	23.4	34.7	9.9	0	0.0	53
March 96	24.3	36.4	9.3	0	0.0	60
April 96	25.6	34.6	8.3	7	152.0	73
May 96	25.2	32.8	7.7	4	95.4	77
June 96	23.8	30.5	4.7	16	400.3	85

APPENDIX-IV

General analysis of variance for quantitative characters in 78 brinjal accessions

	Source of variation		
	Replication	Genotype	Error
df	1	77	77
Mean sum of squares			
Plant height	244.200	842.5*	55.800
Plant spread	20.700	580.1*	166.900
Number of primary branches per plant	2.773	3.4*	0.674
Leaf length	0.172	18.4*	2.066
Leaf width	1.090	10.0*	1.124
Days to flower	1.809	26.8*	6.220
Days to fruit set	21.710	25.6*	8.395
Days to first harvest	47.810	182.9*	29.390
Days to 50% harvest	3.816	2461.7*	70.610
Days to last harvest	477.050	2321.0*	529.800
Total number of harvests	101.800	18.2*	7.913
Fruit length	3.990	22.9*	1.448
Fruit diameter	0.505	1.9*	0.223
Fruit circumference	1.196	17.6*	1.142
Average fruit weight	478.700	2492.3*	75.490
Number of fruits per plant	6.280	201.4*	21.180
Yield per plant	55159.200	34129425.4*	2758480.700
Incidence of bacterial wilt	0.001	0.1*	0.015

*Significant at 1 per cent level

APPENDIX-V

General analysis of variance for quantitative characters in 15 short duration brinjal accessions

	Source of variation		
	Replication	Genotype	Error
df	1	14	14
Mean sum of squares			
Plant height	101.200	1441.1*	105.700
Plant spread	243.600	1349.3*	50.350
Number of primary branches/plant	0.192	2.8	0.361
Leaf length	0.588	8.5*	0.309
Leaf width	0.075	5.4*	0.504
Days to flower	30.400	29.5*	0.793
Days to fruit set	30.800	30.9*	0.785
Days to first harvest	32.448	27.0*	2.231
Days to 50% harvest	25.392	1439.3*	76.423
Days to last harvest	85.345	6310.6*	168.162
Number of economic harvests	0.005	42.4*	1.134
Total number of harvests	0.007	43.4	1.234
Fruit length	0.363	20.7*	0.577
Fruit diameter	0.300	0.5*	0.151
Fruit circumference	0.033	8.9*	0.742
Average fruit weight	2.883	1578.5*	44.77
Number of fruits per plant	0.833	1517.0*	24.825
Yield per plant	14418.990	2222567.1*	61267.862
Yield per plot	22.530	751.7*	19.011
Incidence of jassids	2.465	7.3*	1.342
Incidence of bacterial wilt	0.000	0.4*	0.002

*Significant at 1 per cent level

APPENDIX-VI

General analysis of variance for quantitative characters in 10 long duration brinjal accessions

	Source of variation		
	Replication	Genotype	Error
df	2	9	18
Mean sum of squares			
Plant height	219.760	3925.81*	196.570
Plant spread	297.690	2547.08*	169.816
Number of primary branches per plant	1.612	2.28*	0.499
Leaf length	0.462	25.73*	1.179
Leaf width	5.592	9.45*	0.923
Days to flower	9.761	34.51*	2.875
Days to fruit set	7.380	26.86*	2.708
Days to first harvest	16.204	45.84*	3.385
Days to 50% harvest	116.201	1300.85*	48.926
Days to last harvest	228.780	2962.06*	114.479
Number of economic harvests	1.116	53.30*	2.454
Fruit length	1.101	60.59*	3.762
Fruit diameter	0.922	1.39	0.708
Fruit circumference	0.844	23.95*	1.111
Average fruit weight	10.210	1347.60*	53.660
Number of fruits per plnat	42.889	1952.66*	93.131
Yield per plant	249625.880	6148775.71*	357095.924
Yield per plot	25.350	3083.74*	63.859
Incidence of jassids	1.345	7.03*	0.981
Incidence of bacterial wilt	0.000	0.18*	0.025

* Significant at 1 per cent level

APPENDIX-VII

General analysis of variance for quantitative characters in 11 parents and 9 F_1 hybrids in brinjal

	Source of variation		
	Replication	Genotpyes	Error
df	1	19	19
Mean sum of squares			
Plant height at 60 DAP	3.364	191.60*	15.069
Plant height at 50% fruiting stage	60.516	354.87*	55.051
Plant spread at 60 DAP	2.116	4301.78*	448.240
Plant spread at 50% fruiting stage	4.356	727.80*	91.729
Leaf length at 60 DAP	3.020	9.57*	1.650
Leaf leangth at 50% fruting stage	0.144	11.73*	1.946
Leaf width at 60 DAP	3.130	5.75*	0.780
Leaf width at 50% fruiting stage	3.020	8.81*	0.630
Number of primary branches/plant	0.064	2.125*	0.590
Collar circumference of stem	0.441	10.63*	1.049
Days to flower	71.820	88.71*	9.150
Days to first harvest	69.160	96.53*	11.520
Days to 50% harvest	211.600	448.65*	17.920
Days to last harvest	156.810	296.01*	19.420
Total number of harvests	2.110	6.30*	0.370
Fruit length	0.240	27.22*	0.811
Fruit diameter	0.156	1.494*	0.096
Fruit circumference	0.056	21.67*	0.680
Average fruit weight	1.936	1169.05*	47.837
Total number of fruits per plant	35.340	360.32*	13.840
Yield per plant	194881.613	1338831.678*	54684.312
Yield per plot	64.262	702.779*	22.045
Incidence of jassids	0.001	23.904*	3.435

* Significant at 1 per cent level

APPENDIX-VIII

Mean values of plant characters in 11 parents and 9 F_1 hybrids in brinjal
(November 1995-June 1996)

Treatment No.	Genotype	Plant height (cm) at 60 DAP	Plant height (cm) at 50% fruiting stage	Plant spread (cm) at 60 DAP	Plant spread (cm) at 50% fruiting stage	No. of primary branches per plant	Colar circum-ference of stem (cm)	Leaf length (cm) at 60 DAP	Leaf length (cm) at 50% fruiting stage	Leaf width (cm) at 60 DAP	Leaf width (cm) at 50% fruiting stage
	Parents										
1	Surya	31.1	41.4	37.0	64.5	3.5	4.5	11.3	12.9	7.4	8.0
2	Composite-2	34.4	75.6	46.4	108.1	5.7	7.6	13.4	15.5	9.0	9.7
3	SM 116	30.9	70.7	47.0	85.0	5.3	11.5	9.9	11.7	5.9	7.6
4	Annapurna	46.6	77.6	62.3	88.2	7.8	7.5	11.9	12.5	8.9	10.0
5	Arka Keshav	25.3	43.3	36.7	65.1	6.6	4.0	8.9	11.9	6.5	8.7
6	SM 71	31.5	63.0	39.9	113.0	3.9	9.2	12.3	14.3	6.7	8.0
7	Swetha	34.1	45.5	35.7	59.5	5.9	4.3	9.0	11.5	6.1	7.1
8	SM 141	31.7	69.8	43.9	71.6	4.6	8.6	11.4	13.7	7.7	8.5
9	SM 63	27.4	69.5	47.2	115.6	4.9	8.5	12.9	14.8	8.8	10.8
10	WCG(S)	28.2	80.1	43.0	98.3	5.6	12.5	12.9	14.8	9.7	11.4
11	TGR	28.4	90.4	41.4	115.5	6.5	10.9	8.9	15.5	7.4	12.5
	F_1 hybrids										
12	Surya x Composite-2	48.2	73.1	63.7	93.3	5.9	7.6	15.6	16.7	10.0	12.1
13	Surya x SM 116	45.0	70.5	64.8	99.5	4.5	7.3	14.8	15.8	9.8	10.3
14	Surya x Annapurna	56.3	72.1	61.6	91.2	5.3	7.5	16.6	17.0	11.8	12.7
15	Arka Keshav x Composite-2	53.0	73.3	70.9	113.5	6.0	7.7	16.8	18.0	11.0	12.8
16	Arka Keshav x SM 71	45.7	83.2	58.8	112.5	6.4	10.5	16.8	18.1	11.0	12.0
17	Swetha x SM 141	39.3	55.7	44.9	74.0	5.1	5.7	12.9	13.4	7.0	7.5
18	Swetha x SM 63	49.9	65.5	54.3	71.6	4.8	7.5	13.6	15.7	7.2	7.5
19	SM 141 x WCG(S)	36.1	55.6	45.8	103.3	6.8	8.3	11.9	15.4	7.5	8.5
20	SM 141 x TGR	50.9	77.7	56.3	107.7	5.9	9.7	14.1	16.5	7.9	9.9
CD(0.05)		8.13	15.53	10.17	20.05	1.61	2.14	2.70	2.92	1.67	1.85
Mean of parents		31.78	66.08	43.68	89.49	5.48	8.10	11.16	13.55	7.65	9.30
Mean of F_1 hybrids		47.16	69.63	57.90	96.29	5.63	7.98	14.79	16.29	9.26	10.40

APPENDIX-IX

Mean values of earliness and fruit characters in 11 parents and 9 F_1 hybrids in brinjal
(November 1995 - June 1996)

Treatment No.	Genotypes	Days to flower	Days to first harvest	Days to 50% harvest	Days to last harvest	Total No. of harvest	Fruit length (cm)	Fruit diameter (cm)	Fruit circum-ference (cm)	Average fruit weight (g)	Total No. of fruits/ plant	Yield/plant (g)	Yield/ha (t)
	Parents												
1	Surya	57.7	76.7	136.2	171.1	9.5	8.8	3.7	13.9	62.0	19.8	632.4	13.8
2	Composite-2	67.9	86.5	147.2	189.5	10.0	6.7	4.8	19.8	113.4	27.6	1831.0	27.8
3	SM 116	65.1	83.7	137.5	203.0	10.4	7.6	4.4	20.4	106.2	12.7	951.8	22.3
4	Annapurna	54.4	73.3	131.6	200.9	12.9	12.0	3.4	13.9	77.5	53.5	2769.6	56.4
5	Arka Keshav	58.7	78.7	124.6	171.5	5.8	16.2	2.7	8.8	57.6	10.7	606.7	13.4
6	SM 71	70.0	90.7	142.4	210.5	9.9	11.4	3.5	14.4	86.7	16.0	786.8	17.0
7	Swetha	45.7	63.7	119.3	176.5	11.8	12.0	3.0	10.3	67.7	30.2	682.5	15.8
8	SM 141	56.8	76.9	137.9	203.7	11.6	14.1	3.7	12.4	126.1	32.9	1342.7	28.6
9	SM 63	64.2	85.5	133.3	191.1	11.1	15.8	3.6	12.1	69.6	12.1	510.9	10.4
10	WCG(S)	63.4	85.0	143.1	195.6	9.8	12.5	3.6	16.6	76.9	21.2	943.3	21.2
11	TGR	62.8	83.1	143.3	207.6	10.5	8.5	3.9	16.2	83.4	14.9	744.0	15.3
	F_1 hybrids												
12	Surya x Composite-2	54.2	73.1	120.1	189.1	13.3	7.7	5.6	19.4	120.5	29.6	1972.9	39.4
13	Surya x SM 116	57.0	78.6	115.5	201.5	12.2	8.6	5.8	18.8	131.0	42.2	2475.6	51.0
14	Surya x Annapurna	51.4	71.3	131.1	195.5	13.2	11.1	4.9	17.1	114.5	36.9	1758.3	38.9
15	Arka Keshav x Composite-2	57.4	78.4	126.9	195.6	12.5	15.8	5.5	16.7	138.2	38.6	2498.2	46.5
16	Arka Keshav x SM 71	62.8	82.9	137.9	207.2	12.5	21.0	4.1	12.8	105.2	52.4	2767.5	60.0
17	Swetha x SM 141	52.0	71.7	100.6	184.7	12.8	13.7	3.7	11.6	95.7	29.3	977.9	21.8
18	Swetha x SM 63	48.5	66.6	92.5	194.9	11.8	16.7	3.9	12.0	95.5	39.4	1206.1	25.4
19	SM 141 x WCG(S)	62.2	82.6	143.2	203.5	11.9	12.6	4.1	12.9	112.9	26.2	1090.2	23.2
20	SM 141 x TGR	62.3	81.3	148.2	213.0	12.7	13.1	5.1	15.9	117.6	49.6	2816.4	60.5
CD(0.05)		6.33	7.10	8.86	9.22	1.29	1.88	0.65	1.73	14.48	7.79	489.44	8.7
Mean of parents		60.61	80.35	135.95	192.82	10.30	11.42	3.67	14.44	84.28	22.87	1072.88	21.8
Mean F_1 hybrids		56.42	76.28	124.00	198.33	12.54	13.37	4.74	15.24	114.56	38.24	1951.46	40.7

APPENDIX-X

General analysis of variance for quantitative characters in grafted and intact plants of brinjal

	Source of variation		
	Genotype	Grafted/intact plants	Interaction
df	7	1	7
Mean sum of squares			
Plant height	857.951*	2288.261*	117.621
Plant spread	2255.143*	3806.281*	485.067*
Fruit length	69.265*	12.625*	1.105
Fruit diameter	8.226*	9.245*	0.726*
Fruit circumference	75.693*	83.851*	3.191*
Average fruit weight	9548.010*	5309.652*	379.060*
No. of fruits/plant	675.594*	7900.245*	655.285*
Yield/plant	2875554.151*	17842247.74*	1145436.126*
Jassids/leaf	171.748*	0.605	0.725

* Significant at 1% level

BACTERIAL WILT RESISTANCE AND YIELD IN BRINJAL (*Solanum melongena* L.)

BY

P. K. SINGH

ABSTRACT OF A THESIS

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COLLEGE OF HORTICULTURE
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ABSTRACT

Investigations on "Bacterial wilt resistance and yield in brinjal (*Solanum melongena* L.)" was undertaken in the Department of Olericulture, College of Horticulture, Vellanikkara during 1993-'96.

Preliminary evaluation of seventy eight brinjal accessions during Kharif 1994 revealed considerable variation for most of the economic characters. Twenty four accessions/varieties selected based on productivity, resistance to bacterial wilt, crop duration, fruit and plant characters from the preliminary evaluation were subjected to detailed evaluation during March-November, 1995. In the long duration accessions, the non-prickly SM 141 has yielded as high as 6.4 kg/plant with maximum number of fruits (113.5) having maximum weight (128.27 g). Among short duration accessions maximum yield was recorded in white fruited Swetha (3.9 kg/plant). The study revealed the necessity for differential spacing depending on the duration and spread of the plant.

In addition to the already available bacterial wilt (*Pseudomonas solanacearum*) resistant varieties viz., Surya, Swetha, Arka Keshav, Arka Nidhi, BB 44 some more varieties/accessions viz., Annapurna, Composite 2, TGR, SM 71, SM 116 and SM 141 were found resistant under artificial inoculation. The contents of total phenol and O.D. Phenol was higher in the resistant varieties than the susceptible ones. The anatomical studies revealed well developed secondary xylem with small compact cortical cells in the resisant variety compared to the susceptible variety.

The nine F_1 hybrids differing in size, shape and colour of fruits were compared with their parents during summer 1996. Two F_1 hybrids viz., the long stout and deep purple fruited Arka Keshav x SM 71 and oval and deep purple fruited Surya x SM 116 had surpassed the standard parent by 337.62 per cent and 290.04 per cent respectively in productivity. Both the hybrids having bacterial wilt resistance, desired plant habit and attractive fruit characters can be progressed further. In general the F_1 hybrids had more vigour and tolerated infestation of jassids better than the parents.

In Kerala the cultivation of brinjal during summer is limited mainly due to heavy incidence of jassids. In the present study varietal variation was observed for resistance to jassids (*Amrasca biguttula biguttula*). The long trichomes with high density contributing to a matting effect on the leaf surface may be responsible for the jassid tolerance in varieties like Pusa Kranti and BB 7. These jassid resistant but wilt susceptible varieties yielded 2417.2 per cent and 186.0 per cent respectively more over the intact plants after grafting onto *Solanum torvum*. The present study revealed the scope of cultivating jassid resistant varieties viz., Pusa Kranti and BB 7, though highly susceptible to bacterial wilt during the summer months in the state.