# EVALUATION OF $F_1$ HYBRIDS RESISTANT TO BACTERIAL WILT AND INHERITANCE OF RESISTANCE IN BRINJAL (*Solanum melongena* L.)

By

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**THESIS**

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## DECLARATION

I hereby declare that this thesis entitled "**Evaluation of $F_1$ hybrids resistant to bacterial wilt and inheritance of resistance in brinjal (*Solanum melongena* L.)**" is a bonafide record of research work done by me during the course of research and this thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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## CERTIFICATE

Certified that this thesis entitled "**Evaluation of $F_1$ hybrids resistant to bacterial wilt and inheritance of resistance in brinjal** (**Solanum melongena** L.)" is a record of research work done independently by **Miss. Geetha Varghese**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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*To my parents*

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# Introduction

# INTRODUCTION

Vegetables being protective foods constitute an important item of human diet. Brinjal (Solanum melongena L.) (Syn: aubergine, eggplant) is one of the most common tropical fruit vegetables. Used primarily as a cooked vegetable, brinjal is popular for making various dishes in different regions of the country. In Kerala, this crop forms an integral part of the homestead gardens. It also possesses considerable medicinal properties.

Plant diseases, inspite of various measures adopted to control them, continue to be major causes of crop losses. Bacterial wilt caused by Pseudomonas solanacearum E.F. Smith is the most serious problem in brinjal cultivation. This is more so in the warm humid tropical climate and acidic soils of Kerala; which limit cultivation of high yielding varieties/hybrids (Gopimony and George, 1979).

The average productivity of brinjal is low (20-25 t/ha) in India (Som and Maity, 1986). This is attributed to nonavailability of high yielding varieties/hybrids and incidence of serious pests and diseases. Productivity of $F_1$ hybrids is very high compared to varieties. Yield of $F_1$ hybrids like Suphal from Indo American Hybrid Seeds, Bangalore and Arka Navneeth from IIHR Bangalore are as high as 62 t/ha and 68-72 t/ha respectively. Users of $F_1$ hybrid seeds are likely to increase in coming years. Exploitation of hybrid vigour in brinjal is economical as each fruit contains a large number of seeds compared to Okra, Capsicum and Cucurbits.

Studies conducted at the Department of Olericulture, Kerala Agricultural University revealed three hybrids namely Surya x Pant Rituraj, SM 6-6 x SM 132 and SM 6-2 x Pusa Purple Cluster resistant to bacterial wilt (Geetha, 1989). Heterosis of these hybrids for yield was not significant probably because of the normal management they received in that study as hybrids are more responsive to fertilizers.

Observing the performance of hybrids under higher levels of fertilizers and other better management practices than those for varieties would be helpful in understanding their response to better environments to manifest full expression of hybrid vigour.

Evaluation of hybrids along with their parents over many environments would reveal their genetic basis of stability. A phenotypically stable and heterobeltiotic $F_1$ hybrid is more important considering the possibility of brinjal cultivation throughout the year in the warm humid tropic conditions of Kerala.

Evaluation of $F_1$ hybrids of brinjal for earliness, yield and quality and their component characters is useful in identifying hybrids suited to local market and or distant markets.

Specific objectives of the present study are:

1. To evaluate three resistant $F_1$ hybrids along with their parents under good management for phenotypic stability.
2. To study earliness, yield, quality and their component characters in resistant $F_1$s and to work out hybrid advantage in brinjal and
3. To understand inheritance of resistance to bacterial wilt.

# Review of Literature

## REVIEW OF LITERATURE

Brinjal (Solanum melongena L.) is a vegetable of considerable economic importance in many tropical and subtropical countries of the world. Its position in the east is comparable to tomatoes in the west. The major factor contributing to its popularity is the relative easiness of its cultivation.

There is controversy regarding origin of brinjal. Vavilov (1931) indicated the centre of origin of Solanum melongena as the Indo-Burma region while Filov (1940) and Coulter (1942) considered India to be the centre of origin. Bhaduri (1951) strongly supported the view of Vavilov. Omidiji (1976) suggested that S. melongena might have evolved through interspecific hybridization.

Brinjal exhibits considerable variation for flower type. Pal and Singh (1943) classified brinjal flowers as long styled, short styled and pseudo short styled. Krishnamoorthy and Subramoniam (1953) included another category ie. medium styled flowers and stated that both short styled and pseudo short styled flowers do not set fruit under natural conditions. The works done in brinjal are reviewed in the following sections with respect to heterosis breeding associated with bacterial wilt resistance.

### A. Bacterial wilt disease of brinjal

Bacterial wilt caused by *Pseudomonas solanacearum* E.F. Smith is a serious disease of solanaceous vegetables (Kelman, 1953). The bacterium infects more than two hundred species belonging to 33 families with the largest number of hosts in Solanaceae. 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 parts of Karnataka, Kerala, Orissa, Maharashtra, Madhya Pradesh, Bihar and in West Bengal (Rao, 1972; Anon, 1974). Rao and Sohi (1977) after conducting a survey on bacterial wilt in brinjal reported that incidence ranged from 15 to 60% during different seasons. Gopimony and George (1979) reported that in various districts and agricultural farms in Kerala, the percentage of wilt incidence in a few improved varieties like Arka Kusumkar and Banaras Giant were as high as 100% where as in local varieties this varied from 6% to 20%. Gangopadhyay (1984) reported a maximum yield loss upto 62.5%. The origin of the disease is lost in antiquity. Shekhawat *et al.* (1978) observed that the causal organism of this disease is endemic in India, throughout the west coast, central and deccan plateau of Karnataka, Western Maharashtra and MP, in the eastern plains of Assam, West Bengal, Orissa and Chotta Nagpur plateau on potato, tomato, brinjal, chillies and wild Datura, the incidence being 10-50%.

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 reported to be gram negative with short rods, motile by means of polar flagella. Buddenhage *et al*. (1962) designated three races on the basis of pathogenicity and cultural characteristics. Race 1 affects solanaceous crops and other hosts, but not triploid bananas. Race 2, causes bacterial wilt of triploid bananas, *Heliconia sp* and other musaceous hosts, while race 3 is primarily a pathogen of potato and also of tomato, but apparently only when following a wilted potato crop. Races 1 and 3 are pathogenic on tomato, chilli and brinjal. Hayward (1964) also described *Pseudomonas solanacearum* as a complex species consisting of several races differing in host range and pathogenicity.

**B. Bacterial wilt resistance in brinjal**

Resistance and susceptibility to the disease are conditions with defined metabolic, environmental and genetic conditions. Vaughan (1944) reported that the infection occurs at soil temperatures as low as 12.88°C but symptoms of wilt do not ordinarily become apparent at 12.8°C to 15.6°C. 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. Winstead and Kelman (1952) suggested that increased resistance in resistant lines was apparently associated with age rather than plant size. Kelman (1953) observed that high soil moisture levels usually favour development of bacterial wilt. But Chupp and Sherf (1960) reported that the infection occurs in dry soil and disease becomes serious in red laterite soils. At pH 3.5, a high wilt incidence was reported by Kelman and Cowling (1965). Kuc (1968) opined that disease resistance is not an absolute or static condition and depends on many factors. Expression of biochemical potential, determined by 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. Bell (1981) stated that factors which influence resistance may include intensity, duration and quality of light, moisture levels, nutrient levels and agricultural and industrial chemicals. He also reported that long photoperiods generally result in higher levels of resistance. Increasing the concentration of potassium and calcium enhances most often level of resistance while nitrogen decreased resistance. Bell (1981) found that each plant part changes in its level of resistance with age. Resistant levels in stem and root generally increase rapidly during the first two weeks of seedling or when new shoot grows and slowly there after. Levels of resistance in leaves and fruits frequently decline with age. 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 time of inoculation with bacterial isolates.

Brinjal cultivars, wild varieties and related species, resistant to bacterial wilt, were reported by many workers. Evaluation of brinjal varieties for resistance to bacterial wilt was done in several countries and a few resistant varieties are available in Puerto Rico (Nolla, 1931; Rogue, 1941). Ceylon (Park and Fernande, 1940), South Africa (Wager, 1946), Japan (Kuneida, 1953, **Suzuki et al. (1967)**, Philippines (Anonymous, 1962; Empig et al. 1962) and Martinique (Daly, 1972, 1973).

In India, Sreenivasan et al. (1969) reported a wild variety Solanum melongena var. insanum as resistant to bacterial wilt. Khan (1974) reported that Solanum torvum and Solanum xanthocarpum were resistant to wilt. Gopimony and George (1979) evaluated 36 forms of Solanum melongena including two wild forms for resistance to Pseudomonas solanacearum and found that only a small fruited wild form Solanum melongena var. insanum was completely resistant. Mochizuki and Yamakawa (1979) reported Solanum toxicarium to be resistant to wilt. Gopimony (1983) reported that varieties of brinjal isolated as induced recombinants following gamma irradiation of hybrid seeds of the cross between a cultivar and the wild type Solanum melongena var. insanum were resistant to bacterial wilt. Sheela et al. (1984) after conducting evaluation for wilt resistance in the field reported 7 Solanum melongena lines and Solanum integrifolium as immune to wilt. Gangappa and Madalageri (1986) reported Solanum torvum and Solanum toxicarium to be highly resistant to wilt. Ozaki and Kimura (1989) while evaluating Solanum spp for resistance to bacterial wilt, observed *Solanum torvum* to be resistant.

Kelman and Winstead (1960) reported Matale and Kopek varieties showing good resistance to *Pseudomonas solanacearum*. Suzuki *et al*. (1964) reported that among varieties tested in Japan, Taiwan Naga appeared immune to different strains of the bacterial pathogen. Akiba *et al*. (1972) reported a cultivar of Japanese origin named Nihonnassu as wilt resistant. Gowda *et al*. (1974) after assessing the reaction of 12 brinjal varieties to wilt found that a variety Gulla as resistant. Khan (1974) evaluated several brinjal varieties for resistance to wilt and concluded that Long Purple, Udipi, Improved Muktakeshi, Purple Long and Pusa Purple Cluster were resistant to *Pseudomonas solanacearum*. Rao *et al*. (1976) after studying reaction of a few brinjal varieties to wilt reported Dingras Multiple Purple, Sinampiro and Pusa Purple Cluster to be highly resistant to wilt. Mochizuki and Yamakawa (1979) reported that among the varieties tested, Dingras Multiple Purple from India and Aubergine from the USA had higher resistance than Taiwan Naga. Similar resistance as in Taiwan Naga was shown by Sinampiro, Makling and Mayon. Out of 76 lines of brinjal evaluated for resistance to bacterial wilt, the variety SM-6 from Annamalai was high yielding and resistant under field conditions (Anon, 1980). SM-6 was resistant under field conditions also (Anon, 1981). Sitaramaiah *et al.* (1981) reported that Pusa Purple Round, Vijai Hybrid, Banaras Giant Green and Pusa Purple Cluster were highly resistant to wilt. SM-6 became accepted as a source of resistance in the All India Co-ordinated Vegetable Improvement Project (Anon, 1982). Mukherjee and Mukhopadhyay (1982) reported PPC and Improved Muktakeshi to be resistant to wilt and Pusa Kranti to be moderately resistant. In 1982-83, the line SM-6 was screened under artificial conditions against seven virulent isolates of *Pseudomonas solanacearum* belonging to race 1 and race 3. SM-6 was proved resistant to 3 isolates. Goth *et al.* (1983) reported SM-6 to be resistant to bacterial wilt. Madalageri *et al.* (1983) reported West Coast Green Round as a resistant variety. Narayanan and Nair (1984) evaluated 11 brinjal varieties and found that SM-6, SMI-5, SMI-10, SMI-31-2 to be highly resistant to wilt. Sheela *et al.* (1984) reported the line SM6-1 to be immune to bacterial wilt. Yein and Rathaiah (1984) found that Long Black and 17-4 were highly resistant and Pusa Purple Cluster, Long Green and Annamalai were moderately resistant. Studies on reaction of brinjal cultivars to bacterial wilt by Sitaramaiah *et al.* (1985) revealed that Pusa Purple Round, T-3, Vijay Hybrid, Pusa Purple Cluster, Banaras Giant Green, PBr 129-5, PBr 129-6, PBr-1, PBr 129-2, PBr 61, S-3 and S-20 were resistant. Gopalakrishnan and Gopalakrishnan (1985) reported that SM 6 and Pusa Purple Cluster were resistant and ARU-2C was moderately resistant. Gangappa and Madalageri (1986) reported West Coast Green Round as a resistant variety.

C. **Heterosis in brinjal**

Exploitation of heterosis for crop improvement became popular during first decade of the present century. Although this technique of breeding was first applied to cross pollinated crops like maize, it was soon extended to certain vegetable crops as well. To obtain higher yield/unit area, exploitation of hybrid vigour is one of the effective ways and is particularly important in brinjal where a large number of seeds/fruit are obtained and it is feasible to produce $F_1$ hybrids.

The oldest record of artificial hybridization in brinjal dates back to 1891 by Bailey and Munson in the USA. The hybrids did not exhibit any heterosis, but were intermediate to parents. Bailey (1892) further reported that the hybrids were unfruitful. Halsted (1901) reported positive heterosis in brinjal. He found that one of his hybrids had double the size of parents and also yielded more. In Philippines, Bayla (1918) hybridised a few local varieties and found that the hybrids were more vigorous, stronger and healthier than the respective parents. Heterosis for total yield, fruits/plant, earliness of blossoming, earliness of maturity, plant height, number of branches, number of spines on the pedicel and fruit length were reported by Nagai and Kida (1926) in Japan. No heterosis was observed for leaf length and breadth. In India, Rao (1934) reported first time hybridization among brinjal varieties. Kakizaki (1938) observed hybrid vigour for seed weight, stem diameter, plant height and earliness of production. In Bulgaria, Daskaloff (1941) observed heterosis for yield in crosses between Bulgarian and an imported variety of brinjal. Venkataramani (1946) reported $F_1$ heterosis for germination %, yield, earliness of flowering and maturity, plant height, well branched and spreading habit, soft fruits with attractive shape and colour. Heterosis for seed germination, height, spread, height x spread value, number of branches, early flowering, fruits/ plant, fruit size and yield were reported by Pal and Singh (1946). Odland and Noll (1948) confirmed yield increase in hybrids. The range of increased yields of hybrids over mean of the respective parents varied from 11% to 153%. The highest yielding hybrid out yielded the highest yielding parent by 43.23 t/ha. The hybrid New Hampshire x Florida High Bush yielded 153% more than the mean yield of parents. Capinpin and Alviar (1949) reported that hybrid seeds had higher germination (%), the hybrids were superior to the parental lines in early flowering and setting of fruit, fruits/ plant, fruit length (in crosses between long fruited types), mean equatorial diameter of fruits and in mean fruit weight.

Goto (1952) obtained marked total yield increase in $F_1$ hybrids among Japanese varieties. Mishra (1961) and Mishra (1962) observed heterosis for pollen grain size, plant height, plant spread, number of branches, fruit dimensions, vitamin C content, sugar content and total soluble solid content. Lantican _et al_. (1963) revealed that rate of growth of hybrid seedlings was greater than that of parents. The average yields of hybrids were 26.8% higher than those of the higher yielding parents owing to increase in fruit size, weight and number. Studies on heterosis at the Indian Agricultural Research Institute, New Delhi showed that all $F_1$ hybrids having Pusa Purple Long as the female parent and particularly Pusa Purple Long x Hyderpur performed well (Anon, 1963). Biswas (1964) observed heterosis for vegetative growth, yield and related characters in ten single crosses among five varieties. Frydrych (1964) reported that the best of the hybrids, Delikotes x Bulgarskij yielded 310.17 g of fruits/plant, the yield of Delikotes being 88.55 g and that from Bulgarskij 21.81 g. Mishra (1966) observed heterosis for all the characters as in his earlier studies.

Gopimony and Sreenivasan (1970) reported that the crosses between brinjal cultivars and wild Solanum melongena var. insanum showed a high degree of heterosis for branches/plant, flower and fruit numbers and longer tap root than cultivated varieties. They also noted higher content of dry matter, starch, protein and alkaloids in hybrids than in parents. Silvetti and Brunelli (1970) reported heterosis for yield/plant, fruit weight, and uniform ripening by conducting a diallel among a few brinjal varieties. In first generation brinjal hybrids, Oganesyan (1971) reported heterosis for earliness. Peter (1971) reported heterosis for days to flower, plant height, primary branches and average fruit weight. Mital et al. (1972) found heterosis in Black Beauty Long x Pusa Purple Long to the extent of 92.5% and 90.21% over mid and better parents respectively for yield/plant. They also reported heterosis for fruit weight and fruit shape index. Scossiroli et al. (1972) observed heterosis for yield/plant. Lal et al. (1973) reported heterosis for yield ranging from 62.84% to 112.37%. Studies conducted by Viswanathan (1973) to assess extent of hybrid vigour revealed that the hybrids exhibited heterosis for plant height, number of fruits, fruit weight, length and diameter of fruits and time of flowering. Mishra and Choudhury (1975) reported heterosis for yield in Wynad Giant x Hyderpur to the extent of 160.71% and 163.82% over better and mid parents respectively. Heterosis was marked when the varieties crossed were different in stem and leaf colour and earliness (Cherepova, 1976). Hani et al. (1977) reported a hybrid Black Beauty x Balady White Long - possessing relative heterosis for early and total yield. Mishra (1977) reported heterosis for days to flower, plant height, fruit length and number of fruits and yield/plant. Monteiro and Costa (1977) indicated that marked heterosis existed in intervarietal hybrids, the largest values being associated with early fruit yields in seasons adverse for cultivation. Singh et al. (1977) obtained heterobeltiosis for plant height, days to flower, fruit length and yield/plant in a 7 x 7 diallel excluding reciprocals. Vijay and Nath (1978) observed heterobeltiosis for fruit yield and days to flower, relative heterosis for fruit yield, number of fruits, fruit weight and fruit size. Baksh (1979) observed heterosis for plant height, number of branches, flowers and fruits and resistance to drought. Dharmegowda et al. (1979) observed heterosis for days to flower, plant height, fruits/plant, fruit density, yield/plant and seeds/ fruit. The highest heterosis in respect of fruits/plant was 105.21% in S 529 x Pusa Purple Cluster and with regard to yield/plant, the highest heterosis was 94.64% in Pusa Purple Cluster x Arka Kusumkar. Hristakes (1979) identified three $F_1$ hybrids - Black Mammoth, Goliath and Zenith as heterotic for yield, earliness and keeping quality.

In a study on combining ability and heterosis in brinjal, Bhutani et al. (1980) observed heterosis for yield in crosses Pusa Purple Long x R 34, Pusa Purple Long x BR 112, Pusa Kranti x Aushey and BR 112 x Selection 26. Dhankar et al. (1980) studied four hybrids and six parental lines. Heterosis for marketable yield was observed in BR 103 x White Long and BR 112 x Aushey. Singh (1980) observed heterosis for earliness and plant height.

Cheah et al. (1981) reported significant heterosis in the $F_1$ for canopy spread and total yield/plant. Joarder et al. (1981) observed heterosis for yield, fruit weight, fruit volume, and fruits/ plant in the $F_1$ Thal x Japani. Ram et al. (1981) reported that none of the 11 crosses, they studied, yielded better than the best parent. Studies of $F_1$ hybrids by Salehuzzaman (1981) revealed heterobeltiosis for fruit yield/plant and relative heterosis for fruit weight in four of the 12 crosses. Salimath (1981) reported heterosis for ascorbic acid content. Chadha and Sidhu (1982) evaluated 22 $F_1$ hybrids along with their parents. Heterobeltiosis ranged from 0.32% for fruit weight to 177.37% for fruit breadth. Dixit et al. (1982) observed significant heterosis in pH 4 x BR 112 for fruit weight. Singh et al. (1982) reported heterosis for yield to the extent 140.19% in $F_1$ Pusa Purple Long x 5317. Balamohan et al. (1983) reported heterosis for yield/plant in crosses involving six lines and four testers. SM 19 x SM 2 showed heterosis for yield due to increases in number of branches, fruit length and number of fruits. Kandaswamy et al. (1983) studied 45 $F_1$ hybrids of brinjal in a 10 x 10 diallel to find out heterosis and combining ability for days to first set, fruits/plant, fruit size index and early yield. Heterosis was observed for all characters except days to first fruit set. Studies by Salehuzzaman and Alam (1983) revealed that the $F_1$ of Islampuri x Thal yielded significantly more than the better parent. Narayanan (1984) reported positive heterosis for yield, number of branches and plant height by conducting studies on 9 hybrids and their six parents. Patil and Shinde (1984) studied hybrids derived from five female lines and three male lines. They reported that heterosis for fruit yield was associated with heterosis for fruits/cluster and fruits/plant. Rajput et al. (1984) studied yield/plant and seven related characters in nine crosses involving three local and three improved varieties. Bantivare x Muktakeshi showed a relatively low level of heterosis for yield but had the best per se performance of the

$F_1$s. Sanguineti _et_ _al_. (1985) studied heterosis and combining ability in brinjal and reported that the fruit yield of the hybrids among seven purple fruited varieties was 38.1% higher than parental means.

Gangappa (1986) reported a high degree of heterosis for fruit yield and fruits/plant in West Coast Green Round x Pusa Kranti. Nualsri _et_ _al_. (1986) observed significant relative heterosis and heterobeltiosis for fruits/plant and fruit yield/plant in many of the crosses studied. Verma _et_ _al_. (1986) found that Punjab Bahar x Pusa Purple Long showed 13% heterosis over the best parental line for yield/plant. In studies using 30 $F_1$ hybrids and their parents, Dixit and Gautam (1987) observed heterosis in brinjal for yield/plant, number of fruits and fruit weight. Gopinath (1987) reported significant and positive heterosis for fruits/plant, fruit yield/plant, length and breadth of fruit, plant height at first and peak flowering, number of stomata and dry matter content of stems and roots. He also reported a highly significant positive heterosis for locules/plant. Seethapathy (1987) reported that the cross SM 87 x CO 1 exhibited heterosis of 129%, 118.05% and 10.01% over mid, better and the best parent respectively for yield. Rashid _et_ _al_. (1988) reported positive and highly significant heterosis over the better parent for yield in crosses Pusa Purple Long x Uttara, Khatkhatia Long x Islampuri and Pusa Purple Long x Islampuri. Singh and Kumar (1988) identified the crosses Pusa Purple Cluster x Sel-5 as the best specific combination, heterobeltiotic for yield (162.5%). Other combinations with significant heterosis were $H_4$ x Sel-5, Annamalai x Sel-5 and Sel-5 x ARU-1. Singh and Mital (1988) reported that days to flower, plant height, branches/plant and yield/plant were controlled mainly by nonadditive gene action and therefore heterosis breeding may be adopted for high yield on commercial scale.

Chadha and Hegde (1989) conducted a 9 x 9 diallel cross and examined the $F_1$ generation for different characters. The parent $H_4$ was the best combiner and the crosses Pusa Purple Cluster x Pusa Kranti, Pusa Purple Cluster x Punjab Chamkila, Sultanpur x $H_4$ had high specific combining ability for yield and can be exploited in breeding programmes. Geetha (1989) reported heterosis for plant height, primary branches/plant, average fruit weight, fruits/plant/harvest. But $F_1$ hybrids did not show positive significant heterobeltiosis for yield. Singh and Kalda (1989) observed highly significant sca effect and over dominance for average yield/plant, thus pointing to potential for exploitation of heterosis in brinjal for yield. 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 and thus can be used as reliable indices for yield. Singh and Rai (1990) in their studies on heterosis noted only intermediate heterosis in Pusa Purple Long x Pusa purple Cluster for fruit yield, early fruit yield, fruit length, fruit length/fruit diameter (fruit shape index) and number of fruits. The cross Erangare x Pusa Purple Cluster showed heterobeltiosis for yield and fruit length and diameter, fruit length/fruit diameter (fruit shape index).

**D. Heterosis associated with resistance to wilt in brinjal**

Evolving $F_1$ hybrids for wilt resistance combined with yield and acceptable quality would be a boon for growers. Information on this line are a very few.

Daly (1970) studied tolerance of hybrids from a cross between SM 164 (local) and the susceptible local varieties Florida Market and Violet de Berbentane. $F_1$, $F_2$ and back crosses had a higher proportion of tolerant plants. He further reported that homogeneous lines were obtained from the above cross through pedigree method of selection. These lines showed an incidence less than 15% to bacterial wilt, 75 days after planting. The tolerant line L-17 yielded 47 t/ha in a three month season. Gopimony and Sreenivasan (1970) reported that hybrids of a cross between cultivated brinjal varieties and a wild variety Solanum melongena var. insanum were completely resistant to bacterial wilt. Rao and Anilkumar (1980) reported that hybrids of a cross between Solanum melongena (Pusa Purple Long) and Solanum indicum exhibited resistance under field conditions to wilt, fruit rot, leaf mosaic virus and brinjal fruit borer. Madalageri et al. (1983) reported that a hybrid obtained from West Coast Green Round tolerant to Pseudomonas solanacearum and the susceptible Pusa Kranti, is highly resistant and commercially acceptable. Narayanan (1984) observed heterosis for yield and resistance to bacterial wilt in crosses SMI-10 x Pusa Purple Long and SM 6 x Pusa Purple Cluster. Gangappa (1986) also reported a high degree of heterosis for resistance to bacterial wilt in West Coast Green Round x Pusa Kranti. Evaluation of varieties and hybrids for wilt resistance and fruit yield by Thomas (1987) revealed that hybrids of commercial value were SMI-10 x Pusa Purple Round, SMI-10 x Pusa Purple Long, SM 6 x Black Beauty and SM 6 x Pusa Purple Round. At Kerala Agricultural University, Geetha (1989) undertook heterosis breeding programme and developed two hybrids SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM-132, which were found resistant to bacterial wilt.

**E. Phenotypic stability in brinjal**

Parameters of genotype x environment (G x E) interaction are useful to measure adaptability and stability in crop plants. Genotype x environment interactions are of great importance in plant breeding on the selection of varieties over wide range of environments. In recent years, much emphasis was laid on nature of genotype x environment interactions and on techniques used for analysing such interactions.

Eberhart and Russell (1966) used the regression approach. They regarded deviation from regression as an important component of varietal stability, a stable variety being one with a regression line of unit slope, deviation from regression tending to zero, and a higher mean performance. Perkins and Jinks (1968) proposed that a regression of G x E interaction on environmental index should be obtained rather than the regression of mean performance on the environmental index. Tai (1971) used an essentially similar technique as that of Eberhart and Russell (1966). He employed an alternative method of fitting, using maximum likelihood estimates of a structural relationship, where an appropriate joint distribution was assumed. Based on the principle of structural relationship analysis, the G x E interaction effect of a variety is partitioned into two components. They are the linear response to environmental effects, which is measured by a statistic $\hat{\alpha}$, and the deviation from the linear response; $\lambda$. A perfectly stable variety has ($\alpha, \lambda$) = (-1, 1) and a variety with average stability ($\alpha, \lambda$) = (0, 1).

The parameters of stability and G x E interaction are studied in many crops for measuring phenotypic stability. Information on these aspects is generally scanty in brinjal. The available information in tomato and brinjal are reviewed here. Andronicescu et al. (1962) suggested that the expression of heterosis in tomato was affected by ecological conditions. However, Ognyanova (1970) reported that growth period being a stable character in tomato was not influenced by variation in weather conditions. Peter and Rai (1976) after conducting studies on 25 tomato varieties reported that days to fruit maturity, primary branches/plant and inflorescences/ plant were phenotypically stable characters. They also reported that the tomato varieties HS 101, $S_5$ First, Momor and Marglobe were suited for high yielding environments, while Pusa Early Dwarf, Roma and B 2247 grew well in poor environments. Kalloo and Pandey (1979) also identified HS 101 as a highly stable variety. Olalde et al. (1983) observed the effect of G x E interaction in 18 tomato varieties and reported Nova 1 (Italy) and Campbell 28 (USA) to be the most stable varieties. Sharma (1983) recommended Sweet 72 and Angurlata for high yielding environments. Stofella et al. (1983) worked on stability differences for yield in fresh market tomatoes. G x E interactions were significant for weight and number of fruits. Varieties Burgis, Castlehy 1035 and Duke were stable and suitable for high yielding conditions while the cultivar Flora Dade was suited to low yielding environments. Chong et al. (1984) studied effects of genotype, environment and their interaction on biological earliness in tomato and found that effects of these three parameters were significant, the effect of environment being the greatest. Konstantinova et al. (1984) observed that genotypes with exclusively *Lycopersicon esculentum* genetic background were more stable than those with *Lycopersicon pimpinellifolium* in their pedigree. Sharma and Nandpuri (1984) studied stability of 15 tomato varieties and found Punjab Chouhara, Punjab Kesri and Punjab Tropic as stable varieties. Cultivar trials of processing tomatoes grown in Ontario for 2 years at 5 locations, each year were studied by Poysa et al. (1986) for genotype-environment interactions. Cultivars were evaluated for phenotypic stability and desirability using regression coefficients, mean square deviation from linear regression and 't' test comparisons of genotype mean with environmental means. Genotype-environment interactions were significant for yield of marketable fruit each year and in a combined analysis across years. Regression analysis indicated that low-yielding genotypes had above average yield stability across environments, while several high yielding genotypes were unstable. Several cultivars were desirable because they had a high mean yield and did not have lower yields than the test mean in any of the 5 environments. Regression analysis alone could result in misleading conclusions about the performance of high yielding tomato genotypes. Large genotype-environment interaction variances relative to genotype variances were detected. The interaction variance components involving year were large relative to the genotype-location interaction variance, indicating the need for multi year evaluation and selection for stability even when breeding for a limited geographic region. Stability and variation for fruit yield, soluble solids and citric acid content of eight tomato cultivars were investigated by Berry et al. (1988). They found that Ohio 7814 had above average yield and yield stability. Cultivars showed a wide range of variation for soluble solid (%) and citric acid. Ohio 7870 was the least variable in soluble solids and Heinz 2653 the most variable. Regarding citric acid, 'Heinz 722' had the largest seasonal variation, where as 'Ohio 7814' had the least.

Ushamani (1987) evaluated 26 improved lines of brinjal during two seasons in two contrasting environments-highly fertile and low fertile. The genotype x environment interaction was highly significant for plant height, primary branches/plant, average fruit weight and yield/plant. The line SM 6-6 PL and SM 6-3 SP were suitable for high yielding environments and SM 6-8 PL and SM 6-1 SP suitable for low yielding environments. It was observed that stability for yield, in general, depended on stability of primary branches/plant (r = 0.55) and fruits/plant (r = 0.60). Khurana et al. (1987), while studying the performance of 11 brinjal varieties at Hissar during 1982-84, observed differential response among varieties to environments and significant genotype-environment interaction. Significant differences existed among varieties for yield and stability parameters. H4 yielded the highest and was the most stable. Sidhu (1989) examined the phenotypic stability of 15 promising long and round fruited genotypes of brinjal in 4 environments. All the genotypes used in the study and the environments differed significantly from each other. The genotypes interacted considerably with the environmental conditions of different years. The genotype S-16 exhibited above average stability. It also gave above average yields in all environments indicating its suitability for all the environments.

Varieties P-8, Annamalai, PPL and BR-112 were also stable. Varieties KT-4, Punjab Chamkila and ARU 2-C were unstable. Vadivel and Bapu (1989) evaluated 10 promising genotypes of brinjal for fruit yield in bimonthly staggered plantings during 1987-1988 and reported significant genotype-environment interactions, indicating differential response of genotypes. The genotypes Ep 65 and Annamalai were more stable with high fruit yield over the environments. CO-2 faired well under less favourable environments and the genotypes CO-1 and Ep 44 faired well under less favourable environments.

**F. Inheritance of wilt resistance**

Information on mode of inheritance of resistance to wilt would be useful in the choice of appropriate breeding programmes.

Kelman (1953) reported that resistance to Pseudomonas solanacearum in tobacco and brinjal had all the appearance of being horizontal ie. resistance to wilt was controlled by polygenes. Suzuki et al. (1964) observed that bacterial wilt resistance in brinjal varieties Taiwan Naga and OTB-1 was hereditary and inherited as a quantitative character controlled by a number of genes. Akiba et al. (1972) reported that resistance to Pseudomonas solanacearum is controlled by a pair of dominant genes. Kuriyama (1975) reported that breeding a completely resistant strain of brinjal against bacterial wilt might be difficult because of the involvement of polygenes. Graham and Yap (1976) conducted a variance component analysis of $P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$ generations of a cross between resistant and susceptible cultivars. Estimates of heritability of 42% (narrow sense) and 53% (broad sense) with a degree of dominance of 75% were observed for yield. Using a set of 9 parents, 9 $F_1$ hybrids, 9 $F_2$ progenies and 17 back cross progenies involving 3 resistant, 3 tolerant and 3 susceptible parents, Dutta and Kishun (1982) found that resistant/tolerant reaction to bacterial wilt was controlled by a set of recessive genes. Manjunath and Dutta (1987) in a 9 x 9 dialled study to ellicit information on the genetics of wilt resistance observed the action of both additive and non additive genes in controlling bacterial wilt resistance. The additive genetic variance was more than three times that of dominance variance indicating preponderance of additive genes in controlling resistance. They further confirmed that resistance to bacterial wilt was controlled by recessive genes acting additively. At least two groups of dominant genes controlled susceptibility to bacterial wilt in brinjal. Li et al. (1988) stated that in a few crosses where the $F_1$ did not differ significantly from the more resistant parents, dominance was shown. In another cross, where $F_1$ 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 gene, 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 or a particularly dominant or recessive inheritance of bacterial wilt resistance in tomato.

Swaminathan and Sreenivasan (1971) reported that resistance to bacterial wilt was monogenically controlled and was transmitted to $F_1$ and back cross progenies completely. The donor parent Solanum melongena var. insanum carried dominant gene for resistance. The $F_1$ hybrids were resistant since it had the dominant gene for resistance. Studies of intervarietal hybrids of brinjal by Vijayagopal and Sethumadhavan (1974) revealed that wilt resistance was controlled by a single dominant gene. Gopimony (1983) studied inheritance of bacterial wilt resistance in brinjal and concluded that it is monogenically and dominantly controlled. This character was confirmed to be purely of a qualitative nature from screening results of $F_3M_3$ families. 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.

Studies conducted at Kerala Agricultural University involving crosses of 3 isogenic lines of brinjal namely SM 6-2, SM 6-6 and SM 6-7 with Pusa Purple Cluster, SM-132 and Pant Rituraj revealed that the $F_1$s in which both the parents involved were resistant, were resistant. But hybrid in which a susceptible genotype was one of the parents was either susceptible or moderately resistant. This shows that ressistant $F_1$s could be developed by crossing resistant parents only which reveals the recessive mode of inheritance of bacterial wilt resistance (KAU, 1989).

# Materials and Methods

# MATERIALS AND METHODS

## A. Evaluation of $F_1$ hybrids resistant to bacterial wilt

The present studies were initiated during January 1990 and the evaluations were made during April 1990-June 1991 in the vegetable research plots of Department of Olericulture, Kerala Agricultural University, Vellanikkara. This area is located at an altitude of 23 m above MSL and is between 10° 32" N and 76° 16" E longitude. It enjoys a warm humid tropical climate.

### 1. Experimental materials

The materials comprised of six lines of brinjal and their 3 $F_1$ hybrids. Three of the above lines SM 6-2, SM 6-6 and SM 6-7 (Surya) were derived from SM-6 a highly segregating line reported resistant to bacterial wilt (Gopalakrishnan and Gopalakrishnan, 1985). These three lines were evolved through pureline and single plant methods of selection practiced continuously for eight generations (Sheela, 1982; Shankar, 1984; Jessykutty, 1985; Ushamani, 1987). The other lines were Pusa Purple Cluster, SM-132 and Pant Rituraj. The three $F_1$ hybrids were SM 6-2 x Pusa Purple Cluster, SM 6-6 x SM 132 and SM 6-7 x Pant Rituraj. Sources and distinct morphological characters of the lines are given in Table 1 and Plates 1-9.

Table 1. Sources, pedigree and distinct morphological characters of 6 genotypes of brinjal

| Genotypes | Sources | Pedigree | Prickly/ non-prickly | Flower colour | Fruit shape | Fruit colour | Clustered/ solitary | Resistance/ susceptibility to bacterial wilt |
|---|---|---|---|---|---|---|---|---|
| Surya | K.A.U. | Single plant selection from SM 6 | Non prickly | Purple | Oval | Purple | Solitary | Resistant |
| Pant Rituraj | GBPUAT Pant Nagar | Derivative of $T_3$ x PPC | Non prickly | Purple | Round | Purple | Solitary | Susceptible |
| SM 6-6 | K.A.U. | Pure line selection from SM 6 | Non prickly | Purple | Long | White | Solitary | Resistant |
| SM 132 | K.A.U. | Local collection from Palai | Prickly | Purple | Long | White | Solitary | Resistant |
| SM 6-2 | K.A.U. | Single plant selection from SM 6 | Non prickly | Purple | Long | Purple | Solitary | Resistant |
| Pusa Purple Cluster | I.A.R.I. New Delhi | Selection from Nurki | Non prickly | Purple | Long | Purple | Clustered | Resistant |

Plate 1. Surya

Plate 2. Pant Rituraj

Plate 3.  SM 6-6

Plate 4. SM-132

Plate 5. SM 6-2

Plate 6. Pusa Purple Cluster

Plate 7. Surya x Pant Rituraj

Plate 8. SM 6-6 x SM-132

Plate 9. SM 6-2 x Pusa Purple Cluster

2. Experimental methods

(a) Development of $F_1$ hybrids

The six parents were grown in the plots and pots and hybridization was done during February to May 1990. Long and medium styled flowers were selected for crossing purpose. Emasculation of flower buds was carried out and they were covered with paper bags. The flower buds from male parents were similarly protected to avoid contamination by foreign pollen grains. Pollination was performed in the very next day of emasculation. Pollinated flowers were covered and labelled. The following $F_1$s were generated.

SM 6-7 x Pant Rituraj

SM 6-6 x SM 132

SM 6-2 x Pusa Purple Cluster

(b) Experimental design

Seedlings were transplanted after 40th day of sowing in a randomized block design with 3 replications.

Number of treatments - 9

$T_1$ - Surya

$T_2$ - Pant Rituraj

$T_3$ - Surya x Pant Rituraj

$T_4$ - SM 6-6

$T_5$ - SM 132

$T_6$ - SM 6-6 x SM 132

$T_7$ - SM 6-2

$T_8$ - Pusa Purple Cluster

$T_9$ - SM 6-2 x Pusa Purple Cluster

| | | |
|---|---|---|
| Number of plants/plot | - | 16 |
| Plot size ($m^2$) | - | 7.2 |
| Spacings | - | 75 cm x 60 cm |
| Number of seasons | - | 4 - April-September 1990<br>June-January 1990-91<br>October-April 1990-91<br>February-June 1991 |

Basal dose of farm yard manure (20 t/ha) was applied. Chemical fertilizers were applied at the rate of $1\frac{1}{2}$ times the Kerala Agricultural University Package of Practices Recommendations 1989 of 75:40:25 kg/ha of $N:P_2O_5$ and $K_2O$ respectively. Full $P_2O_5$, $\frac{1}{2}$ N and $\frac{1}{2}$ $K_2O$ were applied as basal dose, $\frac{1}{4}$ N and $\frac{1}{2}$ $K_2O$ were applied 25 days after planting. The remaining $\frac{1}{4}$th N was applied one month after first top dressing. Plots were irrigated twice a week during non rainy seasons.

(c) Observations recorded

Plant height: This observation was taken from 8 plants at random at 90 and 120 days after transplanting. Plant height was measured in cm from the base to the growing tip of these plants and the average worked out.

Days to flower: The number of days taken from transplanting to first flowering was noted on 8 plants and the average recorded.

Days to first fruit set: The number of days taken from transplanting to first fruit set on 8 observation plants were noted and the average recorded.

Days to first harvest: The number of days from transplanting to first harvest for vegetable purpose were observed on 8 plants and average worked out.

Primary branches/plant: The total number of primary branches were counted at final harvest stage in all the 8 observation plants and the average recorded.

Total fruit/plant: The number of fruits in all the harvests were counted in 8 plants and the average recorded.

Total yield/plant: The weight of fruits in all the harvests were taken from all the 8 plants, the average worked out and recorded in g/plant.

Fruit weight: Weight of six fruits from all the observation plants were taken, the average worked out and recorded in g.

Fruiting period: The period of fruiting of in the 8 observation plants was recorded from the first harvest to the last harvest, the average worked out and presented in days.

Percentage of productive flowers: The total number of flowers as well as the productive flowers (those which set fruits) were counted in all the 8 observation plants, the average worked out and presented as percentage of productive flowers.

Percentage of wilted plants: Wilted plants were counted after conducting ooze tests in all the plots throughout the cropping period. The genotypes were scored according to Mew and Ho (1976).

R - Resistant ( 20% plants wilted)

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

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

S - Susceptible ( 60% plants wilted)

Index to earliness: This was estimated using the formula,

Index to Earliness $$IE = \frac{a_1 + a_2 + \ldots\ldots\ldots\ldots\ldots a_n}{c_1 + c_2 + \ldots\ldots\ldots\ldots\ldots c_n}$$

where ai = yield of variety/hybrid on $i^{th}$ day

ci = yield of control (Surya) on $i^{th}$ day

n = 5 (number of harvest)

3. Statistical analysis

(a) Analysis of variance

Data recorded were analysed character wise as described by Panse and Sukhatme (1967).

General analysis of variance and pooled analysis of variance were done for all the quantitative characters.

(b) Estimation of heterosis

Heterosis over mid parent (relative heterosis), better parent (heterobeltiosis) and standard variety (standard heterosis) were calculated (Hayes *et al.*, 1965).

The formulae used were

$$\text{Relative heterosis} = \frac{\bar{F}_1 - \bar{MP}}{\bar{MP}} \times 100$$

$$\text{Heterobeltiosis} = \frac{\bar{F}_1 - \bar{BP}}{\bar{BP}} \times 100$$

$$\text{Standard heterosis} = \frac{\bar{F}_1 - \bar{SV}}{\bar{SV}} \times 100$$

where

$\bar{F}_1$, $\bar{MP}$, $\bar{BP}$, $\bar{SV}$ were the mean performance of $F_1$ hybrid, mid parent, better parent and standard variety respectively. The respective CDs were also calculated.

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

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

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

where

EMS - Error Mean Square

r - Number of replications

(c) Stability Analysis

Stability analysis for all the characters over four environments were carried out as per Eberhart and Russell (1966).

Eberhart and Russell model (1966) (ER model)

$$Y_{ij} = u_i + BiIj + \delta ij$$

where,

$Y_{ij}$ = Variety mean of the $i^{th}$ variety at the $j^{th}$ environment ($i = 1, 2 \ldots\ldots\ldots, v$; $j = 1, 2 \ldots\ldots\ldots, n$)

$u_i$ = Mean of $i^{th}$ variety over all environments

$\beta i$ = Regression coefficient that measures the response of the $i^{th}$ variety to varying environments

Ij = Environmental index which is defined as the deviation of the mean of all varieties at the $j^{th}$ environment from the grand mean

$\delta ij$ = Deviation from regression of the $i^{th}$ variety in the $j^{th}$ environments

Ij is obtained as

$$Ij = \sum_{i=1}^{t} \frac{Y_{ij}}{t} - \sum_{i=1}^{t} \sum_{j=1}^{S} \frac{Y_{ij}}{st}$$

i = 1, 2 ........................ 55

j = 1, 2 ...... 3

So that $\sum_{j=1}^{S} I_j = 0$

The two parameters of stability are

$$\text{Regression coefficient (bi)} = \frac{\sum_{j=1}^{S} Y_{ij} \cdot I_j}{\sum_{j=1}^{S} I_j^2}$$

$$\text{Mean square deviation } (Sdi^2) = \sum_{j=1}^{S} \frac{\delta_{ij}^2}{S-2} - \frac{Se^2}{r}$$

where $\sum_{j=1}^{S} \delta_{ij}^2 = \sigma_{vi}^2 - bi \sum_{j=1}^{S} Y_{ij} I_j$

$$\sigma_{vi}^2 = \sum_{j=1}^{S} Y_{ij}^2 - \frac{Y_{i.}^2}{S}$$

$$bi. \sum_{j=1}^{S} Y_{ij} . I_j = \frac{\sum_{j=1}^{S} Y_{ij} . I_j^2}{\sum_{j=1}^{S} I_j^2}$$

Analysis of variance table under Eberhart and Russell (1966) model are given below

| Source | df | SS | MS |
|---|---|---|---|
| Total | St-1 | $\sum_{i=1}^{t} \sum_{j=1}^{S} Y_{ij}^{2} - CF$ | |
| Varieties | t-1 | $\frac{1}{S} \sum_{i=1}^{t} Y_{i.}^{2} - CF$ | $MS_1$ |
| Envt + Var x Environment | (-1)+(t-1) (S-1) | $\sum_{i=1}^{t} \sum_{j=1}^{S} Y_{ij}^{2} - \sum_{i=1}^{T} \frac{Y_{i.}^{2}}{S}$ | |
| Environment (linear) | 1 | $\frac{1}{t} \frac{\left( \sum_{j=1}^{S} Y_{ij} I_j \right)^2}{\sum_{j=1}^{S} I_j^{2}}$ | |
| Variety x environment (linear) | (t-1) | $\sum_{i=1}^{t} \frac{\sum_{j=1}^{S} Y_{ij} I_j^{2}}{\sum_{j=1}^{S} I_j^{2}}$ - S.S.due to environment | $MS_2$ |
| Pooled deviation | t(S-2) | $\sum_{j=1}^{t} \sum_{j=1}^{S} \delta_{ij}^{2}$ | $MS_3$ |
| Variety 1 | (S-2) | $\sum_{j=1}^{S} \delta_{ij}^{2}$ | |
| ⋮ | | | |
| Variety t | S-2 | $\sum_{j=1}^{S} \delta_{ij}^{2}$ | |
| Pooled error | S(t-1) (r-1) | | $\frac{Se^2}{r}$ |

'F' test

1. To test the difference of the difference among the variety means, the 'F' test is defined as $F = \frac{MS_1}{MS_3}$

2. The equality of regression coefficient is tested by 'F' test $F = MS_2/MS_3$

3. The individual deviation from linear regression is tested as,

$$F = \frac{\sum_{j=1}^{S} ( \delta ij^2 \; S-2)}{Se^2}$$

A genotype with unit regression coefficient (b(i)=1) and deviations from regression not significantly different from zero ($S^2d(i) = 0$) was considered to be stable one.

**B. Inheritance of resistance to bacterial wilt**

The cross SM 6-7 (Surya) x Pant Rituraj was used to study inheritance of resistance to bacterial wilt. Surya is a bacterial wilt resistant variety released by the Kerala Agricultural University. Pant Rituraj is a very susceptible variety to bacterial wilt under Vellanikkara conditions. Hence the $F_1$ of this cross (SM 6-7 x Pant Rituraj) was used for the study.

1. Materials

$P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$ generations of bacterial wilt resistant variety Surya and susceptible variety Pant Rituraj were utilized to study the inheritance of resistance to bacterial wilt.

2. Experimental methods

Fifty plants each under parental and $F_1$ generations and 250 plants each under $F_2$ and back cross generations were grown during March-July in a wilt sick soil. Wilted plants were counted after conducting ooze test.

3. Statistical analysis

The agreement of the observed values with the expected values is tested by $\chi^2$ test of 'goodness of fit' with n-1 df, where n is the number of classes (Panse and Sukhatme, 1954).

# Results

# RESULTS

Data recorded in the present study were analysed and results are presented under the following heads.

A. General analysis of variance for different characters

B. Heterosis in brinjal

C. Phenotypic stability in brinjal

D. Inheritance of resistance to bacterial wilt in brinjal

## A. General analysis of variance for different characters

General analysis of variance showed significant differences among genotypes for majority of the characters in all the four seasons (Table 2). The genotypes differed significantly for total fruits/plant, average fruit weight, fruiting period and wilt incidence (%) in all the four seasons. In the first season, genotypes differed significantly for days to flower, days to first fruitset, primary branches/plant, total fruits/plant, average fruit weight, fruiting period, percentage of productive flowers and percentage of wilt incidence (%). The genotypes differed significantly during the second season for plant height at 120 DAS, total fruits/plant, total yield/plant, average fruit weight, fruiting period, percentage of productive flowers and percentage of wilt incidence. During the

Table 2. General analysis of variance in 6 varieties and 3 $F_1$ hybrids of brinjal during four seasons

| Sources of variation | df | | Mean squares | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Plant height | | Days to flower | Days to first fruit set | Days to first harvest | Primary branches/ plant | Total fruits/ plant | Total yield/ plant | Average fruit weight | Fruiting period | % of productive flowers | Incidence of wilt (%) |
| | | | 90 DAS | 120 DAS | | | | | | | | | | |
| Replication | 2 | $E_1$ | 618.94 | 395.25 | 700.72 | 968.59 | 995.17 | 0.42 | 465.00 | 738702.01 | 31.98 | 1044.31 | 6.81 | 5.93 |
| | | $E_2$ | 150.93 | 141.99 | 24.67 | 58.02 | 111.73 | 0.25 | 312.18 | 121624.00 | 9.84 | 530.61 | 100.38 | 208.71 |
| | | $E_3$ | 128.34 | 91.46 | 49.80 | 47.97 | 25.24 | 0.17 | 10.25 | 11540.00 | 4.54 | 147.80 | 38.34 | 202.69 |
| | | $E_4$ | 25.27 | 120.94 | 18.30 | 0.54 | 2.21 | 0.09 | 5.34 | 22152.00 | 14.87 | 34.65 | 78.41 | 131.12 |
| Treatments | 8 | $E_1$ | 262.39 | 329.73 | 254.87* | 286.38* | 319.89 | 1.07** | 557.53* | 651707.55 | 297.03* | 2145.05** | 165.37** | 2297.13** |
| | | $E_2$ | 94.76 | 302.31* | 42.64 | 124.05 | 344.74 | 0.61 | 776.12** | 953350.26** | 88.15** | 4461.85** | 425.45** | 2936.90** |
| | | $E_3$ | 185.66** | 112.03** | 340.99** | 287.62** | 392.04** | 0.67** | 485.52** | 552090.00** | 98.19** | 1056.86** | 455.66** | 2599.35** |
| | | $E_4$ | 79.78* | 301.50** | 178.62** | 126.26** | 86.40** | 0.35 | 441.98** | 293583.49** | 915.18** | 223.09** | 98.12 | 422.98* |
| Error | 16 | $E_1$ | 115.65 | 139.48 | 74.84 | 96.05 | 125.28 | 0.25 | 189.98 | 315838.24 | 92.07 | 344.81 | 34.88 | 65.28 |
| | | $E_2$ | 49.85 | 87.89 | 281.59 | 281.26 | 195.40 | 0.26 | 53.92 | 35418.00 | 6.79 | 359.28 | 99.97 | 71.98 |
| | | $E_3$ | 37.94 | 18.64 | 69.63 | 63.71 | 76.53 | 0.10 | 26.79 | 26078.00 | 4.87 | 140.43 | 64.10 | 81.21 |
| | | $E_4$ | 28.40 | 27.61 | 18.89 | 13.79 | 8.04 | 0.19 | 6.78 | 8761.63 | 9.63 | 21.57 | 42.28 | 119.61 |

* Significant at $p = 0.05$
**Significant at $p = 0.01$

third season, significant difference was observed among genotypes for all the characters studied. Genotypes differed significantly in fourth season for all characters except primary branches/plant, and percentage of productive flowers.

Pooled analysis of variance over environments showed significant differences among environments (Table 3). Varieties differed significantly for plant height (120 DAS), total fruits/plant, total yield/plant, average fruit weight, fruiting period, % of productive flowers and % of wilt incidence. Genotype x environment interaction was significant for all characters except days to flower and days to first fruitset. Mean performance of genotypes in four seasons and pooled mean are presented in Table 4-9.

Plant Height (90 DAS)

Genotypes differed significantly only during the third season. The tallest genotype was SM 6-6 (48.63 cm) in the first season, SM 6-6 x SM-132 (34.46 cm) in the second season, Surya (39.21 cm) in the third season and SM 6-2 x PPC (38.88 cm) in the fourth season. The dwarf genotypes were Pusa Purple Cluster (24.55 cm) in the first, Pant Rituraj in the second (15.73 cm) and in the third (14.22 cm) and SM 6-6 (21.46 cm) in the fourth seasons.

Table 3. Pooled analysis of variance for 11 characters in brinjal

| Sources of variation | df | Mean squares | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Plant height | | Days to flower | Days to first fruit set | Days to first harvest | Primary branches/ plant | Total fruits/ plant | Total yield/ plant | Average fruit weight | Fruiting period | % of productive flowers | Incidence of wilt (%) |
| | | 90 DAS | 120 DAS | | | | | | | | | | |
| Seasons | 3 | 654.43** | 1240.09** | np | np | 1219.61** | 11.38** | 162.91 | 492512.66** | 278.16** | 7895.85** | 656.13** | 2344.61* |
| Treatments | 8 | 219.90 | 170.14* | np | np | 148.63 | 0.69 | 553.98** | 537065.27** | 290.70** | 1452.40** | 273.70** | 6595.98** |
| Interaction (Seasons x treatments) | 24 | 134.23** | 59.46 | np | np | 77.46 | 0.67** | 66.58 | 93281.92 | 58.49 | 392.18 | 35.94 | 553.46** |
| Pooled error | 64 | 57.46 | 68.41 | np | np | 101.31 | 0.20 | 69.37 | 96524.07 | 28.34 | 216.52 | 60.31 | 84.52 |

* Significant at p = 0.05
**Significant at p = 0.01
np - Interaction is not present

Table 4. Mean performance of 6 varieties and 3 $F_1$ hybrids of brinjal for plant height at 90 and 120 DAS

| Genotypes | Plant height (90 DAS) (cm) | | | | | Plant height (120 DAS) (cm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Season 1 | Season 2 | Season 3 | Season 4 | Mean | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
| Surya | 27.46 | 26.42 | 39.21 | 26.88 | 29.99 | 52.50 | 41.04 | 42.17 | 49.92 | 46.41 |
| Pant Rituraj | 30.43 | 15.73 | 14.22 | 29.42 | 22.45 | 69.04 | 32.07 | 28.02 | 44.89 | 43.51 |
| SM 6-6 | 48.63 | 26.67 | 26.88 | 21.46 | 30.91 | 70.46 | 41.79 | 36.75 | 44.04 | 48.26 |
| SM 132 | 36.92 | 26.92 | 23.08 | 28.58 | 28.88 | 64.25 | 51.46 | 35.13 | 53.86 | 51.18 |
| SM 6-2 | 38.46 | 24.04 | 26.13 | 29.58 | 29.55 | 49.63 | 36.04 | 30.08 | 52.00 | 41.94 |
| Pusa Purple Cluster | 24.55 | 33.75 | 18.71 | 35.33 | 28.09 | 56.46 | 51.50 | 33.00 | 72.50 | 53.37 |
| Surya x Pant Rituraj | 27.58 | 22.67 | 19.52 | 34.83 | 26.15 | 50.63 | 27.04 | 31.44 | 55.42 | 41.13 |
| SM 6-6 x SM 132 | 44.79 | 34.46 | 28.88 | 30.46 | 34.65 | 80.50 | 57.42 | 43.84 | 55.13 | 59.22 |
| SM 6-2 x Pusa Purple Cluster | 48.29 | 26.13 | 34.38 | 38.88 | 36.92 | 64.71 | 48.17 | 44.34 | 70.50 | 56.93 |
| CD (P = 0.05) | 18.61 | 12.22 | 10.66 | 9.22 | 9.76 | 20.44 | 16.22 | 7.47 | 9.10 | 6.50 |

Table 5. Mean performance of 6 varieties and 3 $F_1$ hybrids of brinjal for days to flower and days to first fruitset

| Genotypes | Days to flower | | | | | Days to first fruit set | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Season 1 | Season 2 | Season 3 | Season 4 | Mean | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
| Surya | 56.02 | 44.13 | 36.33 | 39.63 | 44.03 | 62.75 | 51.09 | 46.08 | 42.34 | 50.57 |
| Pant Rituraj | 35.87 | 48.33 | 54.33 | 38.71 | 44.31 | 41.00 | 61.06 | 62.13 | 44.17 | 52.09 |
| SM 6-6 | 28.17 | 42.38 | 39.71 | 32.50 | 35.69 | 34.25 | 49.42 | 55.00 | 36.96 | 43.91 |
| SM 132 | 43.92 | 45.29 | 52.46 | 52.89 | 48.64 | 51.63 | 54.79 | 71.21 | 53.25 | 57.72 |
| SM 6-2 | 30.04 | 43.29 | 44.33 | 31.00 | 37.17 | 36.21 | 48.17 | 56.92 | 35.84 | 44.28 |
| Pusa Purple Cluster | 51.96 | 49.71 | 70.29 | 46.05 | 54.50 | 59.71 | 55.34 | 78.88 | 50.25 | 61.04 |
| Surya x Pant Rituraj | 40.00 | 52.02 | 38.46 | 28.00 | 39.62 | 45.38 | 67.53 | 55.56 | 33.63 | 50.52 |
| SM 6-6 x SM 132 | 40.06 | 47.04 | 45.67 | 36.13 | 42.22 | 47.25 | 53.71 | 56.21 | 40.46 | 49.41 |
| SM 6-2 x Pusa Purple Cluster | 36.92 | 52.79 | 41.13 | 40.25 | 42.77 | 43.09 | 62.04 | 55.67 | 43.38 | 51.05 |
| CD (P = 0.05) | 14.97 | 29.05 | 14.44 | 7.52 | | 16.96 | 29.03 | 13.82 | 6.43 | |

Table 6. Mean performance of 6 varieties and 3 $F_1$ hybrids of brinjal for days to first harvest and primary branches/plant

| Genotypes | Days to first harvest | | | | | Primary branches/plant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Season 1 | Season 2 | Season 3 | Season 4 | Mean | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
| Surya | 79.00 | 77.32 | 64.71 | 54.04 | 68.77 | 3.71 | 2.96 | 3.71 | 4.25 | 3.66 |
| Pant Rituraj | 61.35 | 77.61 | 76.49 | 62.38 | 69.46 | 4.73 | 3.35 | 3.13 | 4.31 | 3.88 |
| SM 6-6 | 47.92 | 66.21 | 66.96 | 54.42 | 58.88 | 3.84 | 3.42 | 4.09 | 4.96 | 4.08 |
| SM 132 | 63.88 | 80.21 | 92.63 | 63.96 | 75.17 | 3.42 | 3.34 | 3.34 | 4.03 | 3.53 |
| SM 6-2 | 48.38 | 70.29 | 73.92 | 51.33 | 60.98 | 4.29 | 2.58 | 3.13 | 4.71 | 3.68 |
| Pusa Purple Cluster | 70.96 | 76.71 | 97.84 | 64.34 | 77.46 | 2.54 | 2.88 | 3.00 | 5.00 | 3.36 |
| Surya x Pant Rituraj | 58.63 | 104.82 | 72.11 | 51.00 | 71.64 | 3.92 | 2.50 | 2.71 | 4.79 | 3.48 |
| SM 6-6 x SM 132 | 60.50 | 80.00 | 84.54 | 53.04 | 69.52 | 3.79 | 3.92 | 3.83 | 4.46 | 4.00 |
| SM 6-2 x Pusa Purple Cluster | 51.50 | 80.17 | 71.42 | 57.38 | 65.12 | 3.92 | 3.34 | 2.84 | 4.79 | 3.72 |
| CD (P = 0.05) | 19.37 | 24.20 | 15.14 | 4.91 | 7.42 | 0.87 | 0.87 | 0.53 | 0.76 | 0.69 |

Table 7. Mean performance of 6 varieties and 3 $F_1$ hybrids of brinjal for total fruits/plant and total total yield/plant (g)

| Genotypes | Total fruits/plant | | | | | Total yield/plant (g) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Season 1 | Season 2 | Season 3 | Season 4 | Mean | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
| Surya | 33.13 | 28.63 | 26.58 | 15.67 | 26.00 | 1566.04 | 1448.13 | 957.92 | 565.00 | 1134.27 |
| Pant Rituraj | 6.00 | 2.65 | 2.45 | 5.80 | 4.22 | 476.68 | 27.27 | 33.02 | 455.00 | 247.99 |
| SM 6-6 | 43.88 | 42.63 | 28.96 | 21.63 | 34.27 | 1412.92 | 1066.04 | 687.92 | 527.92 | 923.70 |
| SM 132 | 22.09 | 19.75 | 18.75 | 8.21 | 17.20 | 938.29 | 606.88 | 609.17 | 312.08 | 616.61 |
| SM 6-2 | 27.63 | 29.84 | 19.96 | 18.21 | 23.91 | 1101.92 | 940.00 | 655.42 | 583.75 | 820.27 |
| Pusa Purple Cluster | 34.59 | 30.17 | 18.09 | 44.29 | 31.78 | 848.42 | 628.34 | 357.50 | 831.67 | 666.48 |
| Surya x Pant Rituraj | 12.21 | 2.84 | 2.68 | 23.92 | 10.41 | 643.54 | 105.48 | 71.17 | 1251.25 | 517.86 |
| SM 6-6 x SM 132 | 39.13 | 36.58 | 42.83 | 17.59 | 34.03 | 1763.34 | 1359.58 | 1361.25 | 706.67 | 1297.71 |
| SM 6-2 x Pusa Purple Cluster | 44.96 | 49.00 | 26.46 | 34.59 | 38.75 | 1671.67 | 1579.38 | 917.50 | 1136.25 | 1326.20 |
| CD (P = 0.05) | 23.86 | 12.71 | 8.96 | 4.51 | 6.88 | 972.80 | 325.76 | 279.53 | 162.03 | 257.36 |

Table 8. Mean performance of 6 varieties and 3 $F_1$ hybrids of brinjal for average fruit weight (g) and fruiting period (days)

| Genotypes | Average fruit weight (g) | | | | | Fruiting period (days) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Season 1 | Season 2 | Season 3 | Season 4 | Mean | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
| Surya | 45.84 | 33.22 | 36.35 | 35.43 | 37.71 | 75.71 | 125.59 | 125.67 | 48.17 | 93.78 |
| Pant Rituraj | 54.37 | 31.45 | 30.53 | 78.50 | 48.71 | 21.78 | 45.18 | 103.63 | 31.19 | 50.45 |
| SM 6-6 | 32.20 | 26.26 | 23.93 | 25.32 | 26.93 | 101.88 | 149.04 | 120.67 | 47.25 | 104.71 |
| SM 132 | 40.74 | 30.47 | 31.45 | 38.34 | 35.25 | 95.58 | 120.42 | 93.13 | 30.93 | 85.02 |
| SM 6-2 | 40.00 | 32.36 | 33.81 | 31.97 | 34.53 | 100.63 | 140.88 | 109.96 | 51.92 | 100.85 |
| Pusa Purple Cluster | 24.14 | 20.07 | 19.15 | 18.93 | 20.58 | 69.33 | 111.54 | 65.28 | 40.96 | 71.78 |
| Surya x Pant Rituraj | 55.39 | 37.27 | 34.70 | 52.98 | 45.08 | 53.96 | 45.89 | 87.86 | 54.34 | 60.51 |
| SM 6-6 x SM 132 | 44.62 | 37.67 | 33.34 | 40.93 | 39.14 | 92.21 | 130.79 | 101.13 | 50.17 | 93.57 |
| SM 6-2 x Pusa Purple Cluster | 37.65 | 32.65 | 34.94 | 33.40 | 34.66 | 95.63 | 128.13 | 116.84 | 48.67 | 97.32 |
| CD (P = 0.05) | 16.61 | 4.51 | 3.82 | 5.37 | 6.44 | 32.14 | 32.81 | 20.51 | 8.04 | 16.69 |

Table 9. Mean performance of 6 varieties and 3 $F_1$ hybrids of brinjal for productive flowers (%) and incidence of wilt (%)

| Genotypes | Productive flowers (%) | | | | | Incidence of wilt (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Season 1 | Season 2 | Season 3 | Season 4 | Mean | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
| Surya | 45.27 | 38.77 | 34.08 | 49.68 | 41.95 | 0.00 | 14.28 | 11.71 | 14.42 | 10.10 |
| Pant Rituraj | 37.90 | 6.61 | 6.74 | 38.05 | 22.32 | 90.00 | 90.00 | 90.00 | 40.56 | 77.64 |
| SM 6-6 | 42.25 | 30.81 | 39.60 | 35.31 | 36.99 | 9.61 | 21.86 | 21.89 | 11.71 | 16.27 |
| SM 132 | 35.43 | 20.19 | 28.86 | 37.59 | 30.52 | 14.82 | 6.90 | 20.25 | 6.90 | 12.22 |
| SM 6-2 | 42.53 | 31.37 | 32.48 | 41.44 | 36.96 | 0.00 | 0.00 | 20.25 | 4.81 | 6.26 |
| Pusa Purple Cluster | 57.12 | 39.07 | 39.70 | 47.79 | 45.92 | 20.48 | 6.90 | 23.80 | 4.81 | 14.00 |
| Surya x Pant Rituraj | 32.19 | 8.40 | 8.20 | 35.06 | 20.96 | 18.30 | 66.20 | 80.00 | 6.90 | 42.85 |
| SM 6-6 x SM 132 | 35.96 | 18.97 | 33.08 | 36.63 | 31.16 | 4.81 | 6.90 | 16.51 | 0.00 | 7.06 |
| SM 6-2 x Pusa Purple Cluster | 45.21 | 26.22 | 23.55 | 33.64 | 32.16 | 11.71 | 11.71 | 18.22 | 14.81 | 14.11 |
| CD (P = 0.05) | 10.22 | 17.31 | 13.86 | 11.26 | 5.05 | 13.99 | 14.69 | 15.60 | 18.93 | 19.82 |

Pooled analysis of variance showed significant difference among environments. Interaction was also significant. The tallest genotype was SM 6-2 x Pusa Purple Cluster (36.92 cm) and the dwarfest Pant Rituraj (22.45 cm).

Plant height (120 DAS)

Significant difference was observed among genotypes for plant height during second, third and fourth seasons. The tallest genotype was SM 6-6 x SM 132 in the first (80.50 cm) and second seasons (57.42 cm); and SM 6-2 x Pusa Purple Cluster (44.43 cm) in the third season and Pusa Purple Cluster (72.50 cm) in the fourth season. The dwarfest genotypes were SM 6-2 (49.43 cm) in the first, Surya x Pant Rituraj (27.04 cm) in the second, Pant Rituraj (28.02 cm) in the third and SM 6-6 (44.04 cm) in the fourth season.

Pooled analysis of variance indicated significant differences among environments and also among genotypes. The tallest genotype was SM 6-6 x SM 132 (59.22 cm) and the shortest Surya x Pant Rituraj (41.13 cm).

Days to flower

Genotypes differed significantly for days to flower during 1st, 3rd and 4th seasons. The earliest flowered genotype was

SM 6-6 in the first and second seasons. It took 28 days and 42 days respectively from transplanting to flower. Surya was the earliest flowering genotype (36 days) in the 3rd season and Surya x Pant Rituraj (28 days) in the 4th season. The late flowering genotypes were Surya (56 days), SM 6-2 x Pusa Purple Cluster (53 days), Pusa Purple Cluster (70 days) and SM 6-6 x SM 132 (53 days) in the first, second, third and fourth seasons respectively.

Pooled analysis over four environments revealed SM 6-6 as the earliest and Pusa Purple Cluster as the latest flowering varieties. They took 36 days and 55 days respectively from transplanting to flower. Genotype x environment interaction was absent for days to flower.

Days to first fruitset

Genotypes differed significantly in the first, third and fourth seasons. SM 6-6 (34 days to set fruit) was the earliest in the first season, SM 6-2 (48 days) in the second season, Surya (46 days) in the third and Surya x Pant Rituraj (34 days) in the fourth season.

For days to first fruitset, G x E interaction was absent as revealed in pooled analysis. Earliest setting variety was SM 6-6 which took 44 days to set fruit after transplanting. Latest variety was Pusa Purple Cluster, which took 61 days to set first fruit from transplanting.

Days to first harvest

Genotypes showed significant differences among themselves only during 3rd and 4th seasons. The genotypes which took minimum days for first harvest were SM 6-6 in the first and second seasons, Surya in the third and Surya x Pant Rituraj in the fourth seasons. They took 48 days, 66 days, 65 days and 51 days respectively from transplanting to first harvest. The late genotypes for harvest were Surya (79 days) in the first season, Surya x Pant Rituraj (105 days) in the second season, Pusa Purple Cluster in the 3rd (98 days) and fourth seasons (64 days).

Pooled analysis showed SM 6-6 as the earliest variety to harvest (59 days) and Pusa Purple Cluster (77) as the last.

Primary branches/plant

During first and third seasons, the genotypes differed significantly for primary branches/plant. Maximum number of primary branches/plant was recorded in Pant Rituraj (4.73) in the first season, SM 6-6 x SM 132 (3.92) in the second season, SM 6-6 (4.09) in the third season and Pusa Purple Cluster (5.00) in the fourth season. Genotypes with the least number of primary branches/plant were Pusa Purple Cluster (2.54) in the first, Surya x Pant Rituraj in the second (2.50) and third (2.71) and SM 132 (4.03) in the fourth season.

Pooled analysis showed significant differences among environments. The interaction was also significant. The genotype with the maximum primary branches was SM 6-6 (4.08). Pusa Purple Cluster had a minimum number of primary branches/plant (3.36).

Total fruits/plant

During all the four environments the genotypes differed significantly for total fruits/plant. SM 6-2 x Pusa Purple Cluster in the first season (44.96) and 2nd season (49.00), SM 6-6 x SM 132 (42.83) in the 3rd season and Pusa Purple Cluster (44.29) in the fourth season produced the maximum fruits. Minimum number of fruits were produced by Pant Rituraj in all the four seasons (6.00, 2.65, 2.45 and 5.80).

Pooled analysis indicated differences among genotypes for total fruits/plant. Maximum fruits were borne by SM 6-2 x Pusa Purple Cluster (38.75) and minimum by Pant Rituraj (4.22).

Total yield/plant

Significant difference was observed among genotypes for total yield/plant in all the seasons except the first season. The highest yielding genotypes were SM 6-6 x SM 132 (1763.34 g) in the first, SM 6-2 x Pusa Purple Cluster (1579.38 g) in the second, SM 6-6 x SM 132 (1361.25 g) in the 3rd and Surya x Pant Rituraj (1251.25 g) in the fourth seasons. Pant Rituraj was the poorest yielding genotype in the first three seasons, which recorded a low yield of 478.68 g in the first, 27.27 g in the second and 33.02 g in the third seasons. During the fourth season SM 132 was the poorest yielder (312.08 g/plant).

Pooled analysis over four environments revealed significant difference among environments and also among genotypes. Mean yield over four seasons was the highest in SM 6-2 x Pusa Purple Cluster with an yield of 1326.20 g/plant. It was the lowest in Pant Rituraj (247.99 g).

Average fruit weight

Significant difference was observed among genotypes for average fruit weight in all the four seasons. Surya x Pant Rituraj (55.39 g) in the first, SM 6-6 x SM 132 (37.67 g) in the second, Surya (36.35 g) in the third and Pant Rituraj (78.50 g) in the 4th season gave high values of average fruit weight. Fruit weight was the lowest in Pusa Purple Cluster in all the four seasons (24.14 g, 20.07 g, 19.15 g and 18.93 g respectively).

Seasons and genotypes differed significantly as revealed by pooled analysis. Pant Rituraj recorded the highest average fruit weight (48.71 g) and Pusa Purple Cluster the lowest (20.58 g).

Fruiting period

Genotypes differed significantly in all the four seasons. Maximum days of fruiting period was recorded by SM 6-6 in the first (101.88 days) and second seasons (149.04 days), Surya in the third (125.67 days) and Surya x Pant Rituraj in the fourth (54.34 days) seasons. The lowest fruiting period was observed in Pant Rituraj in the first (21.78 days) and second (45.18 days) seasons, Pusa Purple Cluster in the third (65.28 days) and SM 132 in the fourth (30.93 days) seasons.

Pooled analysis showed significant differences among seasons and genotypes. Maximum fruiting period was recorded for SM 6-6 (104.71 days) and minimum for Pant Rituraj (50.45 days).

Percentage of productive flowers

Genotypes differed significantly in the first, second and third seasons. Maximum percentage of productive flowers was recorded in Pusa Purple Cluster in the first (57.12%), second (39.07%) and third (39.70%) seasons. During the fourth season Surya recorded the maximum percentage of productive flowers (49.68%). The lowest percentage of productive flowers was recorded in Surya x Pant Rituraj in the first season (32.19%), Pant Rituraj in the second (6.61%) and third (6.74%) and SM 6-2 x Pusa Purple Cluster in the fourth season (33.64%).

Pooled analysis of variance revealed significant differences among seasons and genotypes. Maximum percentage of productive flowers was seen in Pusa Purple Cluster (45.92%) and the lowest percentage in Surya x Pant Rituraj (20.96%).

Incidence of wilt

Significant difference was observed in genotypes for wilt (%) in all the four environments. No wilt incidence was recorded by Surya and SM 6-2 in the first and SM 6-2 in the 2nd season. In the third season, Surya recorded a wilting percentage of 11.71% and in the fourth season, no wilt incidence was reported by SM 6-2. Maximum percentage of wilting was recorded by Pant Rituraj in the first (90.00%), 2nd (90.00%), 3rd (90.00%) and 4th (40.56%) seasons.

Pooled data showed SM 6-2 as the genotype having the least incidence of wilt (6.26%) followed by SM 6-6 x SM 132 (7.06%) and Surya (10.10%). Pant Rituraj had the highest incidence (77.64%) of wilt. Significant difference was observed among genotypes and environments. Interaction was also significant.

Index to earliness

Index to earliness for the parental lines and $F_1$ hybrids are given in Table 10. None of the parents or hybrids was earlier than the standard variety Surya. Among the parents, Pusa Purple Cluster and SM 6-2 were come next to Surya in earliness. SM 132 was the latest variety. Among hybrids SM 6-2 x Pusa Purple Cluster was the earliest, followed by Surya x Pant Rituraj.

**B. Heterosis in brinjal**

Heterosis over midparent (relative heterosis), better parent (heterobeltiosis) and standard variety Surya (standard heterosis) were calculated for all the three crosses in all the four seasons. Mean performance of parents and $F_1$s and extent of heterosis over mid parent, better parent and over the standard variety (Surya) are presented in Tables 11-21.

Plant height (90 DAS)

Significant relative heterosis was exhibited by SM 6-2 x Pusa Purple Cluster, in the first (53.25%) and third seasons (53.35%). In the second and fourth seasons no relative heterosis with respect to plant height was observed.

The crosses with maximum heterobeltiosis were SM 6-2 x Pusa Purple Cluster in the first (25.56%) and third (31.57%) and SM 6-6 x SM 132 in the second (28.01%) seasons.

Table 10. Index to earliness

| Genotypes | Season 1 | Season 2 | Season 3 | Season 4 | Mean |
|---|---|---|---|---|---|
| Surya | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Pant Rituraj | 0.38 | 0.03 | 0.20 | 0.56 | 0.28 |
| SM 6-6 | 0.46 | 0.33 | 0.29 | 0.43 | 0.38 |
| SM 132 | 0.22 | 0.16 | 0.09 | 0.36 | 0.21 |
| SM 6-2 | 0.46 | 0.21 | 0.24 | 0.68 | 0.40 |
| Pusa Purple Cluster | 0.36 | 0.36 | 0.11 | 1.00 | 0.46 |
| Surya x Pant Rituraj | 0.41 | 0.05 | 0.06 | 1.48 | 0.50 |
| SM 6-6 x SM 132 | 0.52 | 0.27 | 0.19 | 0.81 | 0.45 |
| SM 6-2 x Pusa Purple Cluster | 0.64 | 0.43 | 0.29 | 1.37 | 0.68 |

Table 11. Mean performance of parents and $F_1$ hybrids and extent of heterosis for plant height (90 DAS) in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (cm) | RH (%) | HB (%) | SH (%) | Mean (cm) | RH (%) | HB (%) | SH (%) | Mean (cm) | RH (%) | HB (%) | SH (%) | Mean (cm) | RH (%) | HB (%) | SH (%) |
| Surya | 27.46 | | | | 26.42 | | | | 39.21 | | | | 26.88 | | | |
| Pant Rituraj | 30.43 | | | | 15.73 | | | | 14.22 | | | | 29.42 | | | |
| SM 6-6 | 48.63 | | | | 26.67 | | | | 26.88 | | | | 21.46 | | | |
| SM 132 | 36.92 | | | | 26.92 | | | | 23.08 | | | | 28.58 | | | |
| SM 6-2 | 38.46 | | | | 24.04 | | | | 26.13 | | | | 29.58 | | | |
| Pusa Purple Cluster | 24.55 | | | | 33.75 | | | | 18.71 | | | | 35.33 | | | |
| Surya x Pant Rituraj | 27.58 | -4.73 | -9.37 | 0.44 | 22.67 | 7.54 | -14.19 | -14.19 | 19.52 | -26.95 | -50.22 | -50.22 | 34.83 | 23.73 | 18.39 | 29.58 |
| SM 6-6 x SM 132 | 44.79 | 4.70 | -7.90 | 63.11 | 34.46 | 28.58 | 28.01 | 30.43 | 28.88 | 15.61 | 7.44 | -26.35 | 30.46 | 21.74 | 6.58 | 13.32 |
| SM 6-2 x Pusa Purple Cluster | 48.29 | 53.25* | 25.56 | 75.86* | 26.13 | -9.58 | -22.58 | -1.10 | 34.38 | 53.35* | 31.57 | -12.32 | 38.88 | 19.78 | 10.05 | 44.64* |
| CD (p = 0.05) | 18.61 | 16.12 | 18.61 | 18.61 | 12.22 | 10.58 | 12.21 | 12.21 | 10.66 | 9.24 | 10.66 | 10.66 | 9.22 | 7.99 | 9.22 | 9.22 |
| CD (p = 0.01) | 25.65 | 22.19 | 25.64 | 25.64 | 16.84 | 14.57 | 16.82 | 16.82 | 14.69 | 12.73 | 14.69 | 14.69 | 12.71 | 11.01 | 12.70 | 12.70 |

Table 12. Mean performance of parents and $F_1$ hybrids and extent of heterosis for plant height (120 DAS) in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (cm) | RH (%) | HB (%) | SH (%) | Mean (cm) | RH (%) | HB (%) | SH (%) | Mean (cm) | RH (%) | HB (%) | SH (%) | Mean (cm) | RH (%) | HB (%) | SH (%) |
| Surya | 52.50 | | | | 41.04 | | | | 42.17 | | | | 49.92 | | | |
| Pant Rituraj | 69.04 | | | | 32.07 | | | | 28.02 | | | | 44.89 | | | |
| SM 6-6 | 70.46 | | | | 41.79 | | | | 36.75 | | | | 44.04 | | | |
| SM 132 | 64.25 | | | | 51.46 | | | | 35.13 | | | | 53.86 | | | |
| SM 6-2 | 49.63 | | | | 36.04 | | | | 30.08 | | | | 52.00 | | | |
| Pusa Purple Cluster | 56.46 | | | | 51.50 | | | | 33.00 | | | | 72.50 | | | |
| Surya x Pant Rituraj | 50.63 | -16.69 | -26.67 | -3.56 | 27.04 | -26.04 | -34.11 | -34.11 | 31.44 | -10.43 | -25.44 | -25.44 | 55.42 | 16.90* | 11.02 | 11.02 |
| SM 6-6 x SM 132 | 80.50 | 19.51 | 14.25 | 53.33* | 57.42 | 23.14 | 11.58 | 39.91* | 43.84 | 21.98* | 19.29 | 3.96 | 55.13 | 12.63 | 2.36 | 10.44 |
| SM 6-2 x Pusa Purple Cluster | 64.71 | 21.98 | 14.61 | 23.26 | 48.17 | 10.05 | -6.47 | 17.37 | 44.34 | 40.58** | 34.36** | 5.15 | 70.50 | 13.25* | -2.76 | 41.23** |
| CD (p = 0.05) | 20.44 | 17.70 | 20.44 | 20.44 | 16.23 | 14.06 | 16.22 | 16.22 | 7.47 | 6.47 | 7.48 | 7.48 | 9.10 | 6.78 | 9.09 | 9.09 |
| CD (p = 0.01) | 28.17 | 24.38 | 28.15 | 28.15 | 22.36 | 19.36 | 22.34 | 22.34 | 10.30 | 8.91 | 10.31 | 10.31 | 12.53 | 10.86 | 12.53 | 12.53 |

Table 13. Mean performance of parents and $F_1$ hybrids and extent of heterosis for days to flower in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) |
| Surya | 56.02 | | | | 44.13 | | | | 36.33 | | | | 39.63 | | | |
| Pant Rituraj | 35.87 | | | | 48.33 | | | | 54.33 | | | | 38.71 | | | |
| SM 6-6 | 28.17 | | | | 42.38 | | | | 39.71 | | | | 32.50 | | | |
| SM 132 | 43.92 | | | | 45.29 | | | | 52.46 | | | | 52.89 | | | |
| SM 6-2 | 30.04 | | | | 43.29 | | | | 44.33 | | | | 31.00 | | | |
| Pusa Purple Cluster | 51.96 | | | | 49.71 | | | | 70.29 | | | | 46.05 | | | |
| Surya x Pant Rituraj | 40.00 | -12.95 | -11.51 | -28.60* | 52.02 | 12.52 | 17.88 | 17.88 | 38.46 | -15.16 | 5.86 | 5.86 | 28.00 | -28.52** | -27.67** | -29.35** |
| SM 6-6 x SM 132 | 40.06 | 11.12 | -42.21 | -28.49* | 47.04 | 7.30 | 11.00 | 6.59 | 45.67 | -0.91 | -15.01 | 25.71 | 36.13 | -15.39* | 11.17 | -8.83 |
| SM 6-2 x Pusa Purple Cluster | 36.92 | -9.95 | -22.90 | -34.09* | 52.79 | 13.53 | 21.95 | 19.62 | 41.13 | -28.23* | -7.22 | 13.21 | 40.25 | 4.46 | -29.84 | 1.56 |
| CD (p = 0.05) | 14.97 | 12.97 | 14.97 | 14.97 | 29.05 | 25.14 | 29.04 | 29.04 | 14.44 | 12.51 | 14.44 | 14.44 | 7.52 | 6.51 | 7.50 | 7.50 |
| CD (p = 0.01) | 20.63 | 17.87 | 20.62 | 20.62 | 40.02 | 34.63 | 40.00 | 40.00 | 19.90 | 17.23 | 19.89 | 19.89 | 10.37 | 8.96 | 10.34 | 10.34 |

Table 14. Mean performance of parents and $F_1$ hybrids and extent of heterosis for days to first fruitset in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) |
| Surya | 62.75 | | | | 51.09 | | | | 46.08 | | | | 42.34 | | | |
| Pant Rituraj | 41.00 | | | | 61.06 | | | | 62.13 | | | | 44.17 | | | |
| SM 6-6 | 34.25 | | | | 49.42 | | | | 55.00 | | | | 36.96 | | | |
| SM 132 | 51.63 | | | | 54.79 | | | | 71.21 | | | | 53.25 | | | |
| SM 6-2 | 36.21 | | | | 48.17 | | | | 56.92 | | | | 35.84 | | | |
| Pusa Purple Cluster | 59.71 | | | | 55.34 | | | | 78.88 | | | | 50.25 | | | |
| Surya x Pant Rituraj | 45.38 | -12.53 | -10.68 | -27.68* | 67.53 | 20.42 | 32.18 | 32.18 | 55.56 | 2.68 | -20.57 | 20.57 | 33.63 | -22.26** | -20.57* | -20.57* |
| SM 6-6 x SM 132 | 47.25 | 10.04 | -37.96 | -24.70 | 53.71 | 3.07 | 8.68 | 5.13 | 56.21 | -10.93 | -2.20 | 21.98 | 40.46 | -10.31 | -9.47 | -4.44 |
| SM 6-2 x Pusa Purple Cluster | 43.09 | -10.15 | -19.00 | -31.33* | 62.04 | 19.86 | 28.79 | 21.43 | 55.67 | -18.01* | -2.20 | 20.81 | 43.38 | 0.77 | -21.04 | 2.46 |
| CD (p = 0.05) | 16.96 | 14.69 | 16.96 | 16.96 | 29.03 | 25.14 | 29.02 | 29.02 | 13.82 | 11.96 | 13.82 | 13.82 | 6.43 | 5.58 | 6.42 | 6.42 |
| CD (p = 0.01) | 23.37 | 20.15 | 23.36 | 23.36 | 40.00 | 34.63 | 39.97 | 37.97 | 19.04 | 16.47 | 19.04 | 19.04 | 8.86 | 7.68 | 8.85 | 8.85 |

Table 15. Mean performance of parents and $F_1$ hybrids and extent of heterosis for days to first harvest in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) |
| Surya | 79.00 | | | | 77.32 | | | | 64.71 | | | | 54.04 | | | |
| Pant Rituraj | 61.35 | | | | 77.62 | | | | 76.49 | | | | 62.38 | | | |
| SM 6-6 | 47.92 | | | | 66.21 | | | | 66.96 | | | | 54.42 | | | |
| SM 132 | 63.88 | | | | 80.21 | | | | 92.63 | | | | 63.96 | | | |
| SM 6-2 | 48.38 | | | | 70.29 | | | | 73.92 | | | | 51.33 | | | |
| Pusa Purple Cluster | 70.96 | | | | 76.71 | | | | 97.84 | | | | 64.34 | | | |
| Surya x Pant Rituraj | 58.63 | -16.46 | -4.43 | -25.78* | 104.82 | 35.30 | 35.57 | 35.57 | 72.11 | 2.14 | -11.44 | 11.44 | 51.00 | -12.39** | -5.63 | -5.6 |
| SM 6-6 x SM 132 | 60.50 | 8.23 | -26.25 | -23.42 | 80.00 | 9.27 | -20.83 | 3.47 | 84.54 | 5.94 | -26.25 | 30.64 | 53.04 | -10.39** | -2.54 | -1.8 |
| SM 6-2 x Pusa Purple Cluster | 51.50 | -13.69 | -6.45 | -34.81** | 80.17 | 9.07 | 14.06 | 3.69 | 71.42 | -16.84* | -3.38 | 10.37 | 57.38 | -0.80 | -11.79* | 6.1 |
| CD (p = 0.05) | 19.37 | 16.77 | 19.38 | 19.38 | 24.20 | 20.95 | 24.19 | 24.19 | 15.14 | 13.12 | 15.14 | 15.14 | 4.91 | 4.24 | 4.92 | 4.9 |
| CD (p = 0.01) | 26.70 | 23.10 | 26.69 | 26.69 | 33.34 | 28.85 | 33.32 | 33.32 | 20.86 | 18.07 | 20.85 | 20.85 | 6.76 | 5.84 | 6.77 | 6.7 |

Table 16. Mean performance of parents and $F_1$ hybrids and extent of heterosis for primary branches/plant in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | RH (%) | HB (%) | SH (%) | Mean | RH (%) | HB (%) | SH (%) | Mean | RH (%) | HB (%) | SH (%) | Mean | RH (%) | HB (%) | SH (%) |
| Surya | 3.71 | | | | 2.96 | | | | 3.71 | | | | 4.25 | | | |
| Pant Rituraj | 4.73 | | | | 3.53 | | | | 3.13 | | | | 4.31 | | | |
| SM 6-6 | 3.84 | | | | 3.42 | | | | 4.09 | | | | 4.96 | | | |
| SM 132 | 3.42 | | | | 3.34 | | | | 3.34 | | | | 4.03 | | | |
| SM 6-2 | 4.29 | | | | 2.58 | | | | 3.13 | | | | 4.71 | | | |
| Pusa Purple Cluster | 2.54 | | | | 2.88 | | | | 3.00 | | | | 5.00 | | | |
| Surya x Pant Rituraj | 3.92 | -7.11 | -17.12 | 5.66 | 2.50 | -23.08 | -29.18 | -15.54 | 2.71 | -20.76 | -26.95 | -26.95 | 4.79 | 11.92 | 11.14 | 12.7 |
| SM 6-6 x SM 132 | 3.79 | 4.41 | -1.30 | 2.16 | 3.92 | 15.98 | 14.62 | 32.43* | 3.83 | 2.96 | -6.36 | 3.23 | 4.46 | -0.89 | -10.08 | 4.9 |
| SM 6-2 x Pusa Purple Cluster | 3.92 | 14.62 | -8.62 | 5.66 | 3.34 | 22.34 | 15.97 | 12.84 | 2.84 | -7.49 | -9.27 | -23.45 | 4.79 | -1.44 | -4.20 | 12.7 |
| CD (P = 0.05) | 0.87 | 0.74 | 0.85 | 0.85 | 0.88 | 0.76 | 0.87 | 0.87 | 0.53 | 0.45 | 0.51 | 0.51 | 0.76 | 0.66 | 0.76 | 0.7 |
| CD (P = 0.01) | 1.20 | 1.02 | 1.17 | 1.17 | 1.21 | 1.05 | 1.20 | 1.20 | 0.73 | 0.61 | 0.70 | 0.70 | 1.05 | 0.91 | 1.05 | 1.05 |

Table 17. Mean performance of parents and $F_1$ hybrids and extent of heterosis for total fruits/plant in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | RH (%) | HB (%) | SH (%) | Mean | RH (%) | HB (%) | SH (%) | Mean | RH (%) | HB (%) | SH (%) | Mean | RH (%) | HB (%) | SH (%) |
| Surya | 33.13 | | | | 28.63 | | | | 26.58 | | | | 15.67 | | | |
| Pant Rituraj | 6.00 | | | | 2.65 | | | | 2.45 | | | | 5.80 | | | |
| SM 6-6 | 43.88 | | | | 42.63 | | | | 28.96 | | | | 21.63 | | | |
| SM 132 | 22.09 | | | | 19.75 | | | | 18.75 | | | | 8.21 | | | |
| SM 6-2 | 27.63 | | | | 29.84 | | | | 19.96 | | | | 18.21 | | | |
| Pusa Purple Cluster | 34.59 | | | | 30.17 | | | | 18.09 | | | | 44.29 | | | |
| Surya x Pant Rituraj | 12.21 | -37.61 | -63.15 | -63.15 | 2.84 | -81.84 | -90.08 | -90.08 | 2.68 | -81.54 | -89.92 | -89.92 | 23.92 | 122.72** | 52.65** | 52.65** |
| SM 6-6 x SM 132 | 39.13 | 18.61 | -10.82 | 18.11 | 36.58 | 17.28 | -14.19 | 27.77 | 42.83 | 79.51** | 47.89** | 61.14** | 17.59 | 17.90 | -18.68 | 12.25 |
| SM 6-2 x Pusa Purple Cluster | 44.96 | 44.52 | 29.98 | 35.71 | 49.00 | 63.28** | 62.41** | 71.15** | 26.46 | 39.04 | 32.57 | -0.45 | 34.59 | 10.69 | -21.90 | 120.74** |
| CD (P = 0.05) | 23.86 | 20.67 | 23.85 | 23.85 | 12.71 | 11.00 | 12.72 | 12.72 | 8.96 | 7.76 | 8.97 | 8.97 | 4.51 | 3.90 | 4.52 | 4.52 |
| CD (P = 0.01) | 32.87 | 28.47 | 32.85 | 32.85 | 17.51 | 15.15 | 17.52 | 17.52 | 12.34 | 10.69 | 12.35 | 12.35 | 6.21 | 5.37 | 6.22 | 6.22 |

Table 18. Mean performance of parents and $F_1$ hybrids and extent of heterosis for total yield per plant in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February- June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (g) | RH (%) | HB (%) | SH (%) | Mean (g) | RH (%) | HB (%) | SH (%) | Mean (g) | RH (%) | HB (%) | SH (%) | Mean (g) | RH (%) | HB (%) | SH (%) |
| Surya | 1566.04 | | | | 1448.13 | | | | 957.92 | | | | 565.00 | | | |
| Pant Rituraj | 476.68 | | | | 27.27 | | | | 33.02 | | | | 455.00 | | | |
| SM 6-6 | 1412.92 | | | | 1066.04 | | | | 687.92 | | | | 527.92 | | | |
| SM 132 | 938.29 | | | | 606.88 | | | | 609.17 | | | | 312.08 | | | |
| SM 6-2 | 1101.92 | | | | 940.00 | | | | 655.42 | | | | 583.75 | | | |
| Pusa Purple Cluster | 848.42 | | | | 628.34 | | | | 357.50 | | | | 831.67 | | | |
| Surya x Pant Rituraj | 643.54 | -36.99 | -58.91 | -58.91 | 105.48 | -85.70 | -92.72 | -92.72 | 71.17 | -85.64 | -92.57 | -92.57 | 1251.25 | 145.34** | 121.46** | 121.46** |
| SM 6-6 x SM 132 | 1763.34 | 49.99 | 24.80 | 12.60 | 1359.58 | 62.54** | 27.54 | -6.11 | 1361.25 | 109.89** | 97.88** | 42.10** | 706.67 | 68.25** | 33.86* | 25.07 |
| SM 6-2 x Pusa Purple Cluster | 1671.67 | 71.42 | 51.71 | 6.75 | 1579.38 | 101.41** | 68.02** | 9.06 | 917.50 | 81.16** | 39.99 | -4.22 | 1136.25 | 60.55** | 36.62** | 101.11** |
| CD (P = 0.05) | 972.80 | 872.47 | 972.80 | 972.80 | 325.76 | 282.13 | 325.76 | 325.76 | 279.53 | 242.08 | 279.52 | 279.52 | 162.03 | 140.32 | 162.03 | 162.03 |
| CD (P = 0.01) | 1340.35 | 1160.38 | 1339.90 | 1339.90 | 448.85 | 388.59 | 448.69 | 448.69 | 385.15 | 333.43 | 385.00 | 385.00 | 223.24 | 193.27 | 223.18 | 223.18 |

Table 19. Mean performance of parents and $F_1$ hybrids and extent of heterosis for average fruit weight in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (gm) | RH (%) | HB (%) | SH (%) | Mean (gm) | RH (%) | HB (%) | SH (%) | Mean (gm) | RH (%) | HB (%) | SH (%) | Mean (gm) | RH (%) | HB (%) | SH (%) |
| Surya | 45.84 | | | | 33.22 | | | | 36.35 | | | | 35.43 | | | |
| Pant Rituraj | 54.37 | | | | 31.45 | | | | 30.53 | | | | 78.50 | | | |
| SM 6-6 | 32.20 | | | | 26.[illegible]6 | | | | 23.93 | | | | 25.32 | | | |
| SM 132 | 40.74 | | | | 30.47 | | | | 31.45 | | | | 38.34 | | | |
| SM 6-2 | 40.00 | | | | 32.36 | | | | 33.81 | | | | 31.97 | | | |
| Pusa Purple Cluster | 24.14 | | | | 20.07 | | | | 19.15 | | | | 18.93 | | | |
| Surya x Pant Rituraj | 55.39 | 10.54 | 1.88 | 20.83 | 37.27 | 15.24* | 12.19 | 12.19 | 34.70 | 3.77 | -4.54 | -4.54 | 52.98 | -7.00 | -32.51 | 49.53** |
| SM 6-6 x SM 132 | 44.62 | 22.35 | 9.52 | -2.66 | 37.67 | 32.78** | 23.63** | 13.40** | 33.34 | 20.40** | 6.01 | -8.28 | 40.93 | 28.59** | 6.76 | 15.52* |
| SM 6-2 x Pusa Purple Cluster | 37.65 | 17.40 | -5.88 | -17.87 | 32.65 | 24.52** | 0.90 | -1.72 | 34.94 | 31.95 | 3.34 | -3.88 | 33.40 | 31.24** | 4.47 | -5.73 |
| CD (P = 0.05) | 16.61 | 14.37 | 16.60 | 16.60 | 4.51 | 3.90 | 4.52 | 4.52 | 3.82 | 3.30 | 3.82 | 3.82 | 5.37 | 4.64 | 5.36 | 5.36 |
| CD (P = 0.01) | 22.88 | 19.80 | 22.86 | 22.86 | 6.22 | 5.37 | 6.22 | 6.22 | 5.26 | 4.56 | 5.26 | 5.26 | 7.40 | 6.39 | 7.39 | 7.39 |

Table 20. Mean performance of parents and $F_1$ hybrids and extent of heterosis for fruiting period in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) | Mean (days) | RH (%) | HB (%) | SH (%) |
| Surya | 75.71 | | | | 125.59 | | | | 125.67 | | | | 48.17 | | | |
| Pant Rituraj | 21.78 | | | | 45.18 | | | | 103.63 | | | | 31.19 | | | |
| SM 6-6 | 101.88 | | | | 149.04 | | | | 120.67 | | | | 47.25 | | | |
| SM 132 | 95.58 | | | | 120.42 | | | | 93.13 | | | | 30.93 | | | |
| SM 6-2 | 100.63 | | | | 140.88 | | | | 109.96 | | | | 51.92 | | | |
| Pusa Purple Cluster | 69.33 | | | | 111.54 | | | | 65.28 | | | | 40.96 | | | |
| Surya x Pant Rituraj | 53.96 | 10.69 | -28.73 | -28.73 | 45.89 | -46.26 | -63.46 | -63.46 | 87.86 | -23.37 | -30.09 | -30.09 | 54.34 | 36.95** | 12.81 | 12.81 |
| SM 6-6 x SM 132 | 92.21 | -6.60 | -9.49 | 21.79 | 130.79 | -2.92 | -12.25 | 4.14 | 101.13 | -5.40 | -16.19 | -19.53 | 50.17 | 28.34** | 6.18 | 4.15 |
| SM 6-2 x Pusa Purple Cluster | 95.63 | 12.53 | -4.97 | 26.31 | 128.13 | 1.52 | -9.05 | 2.02 | 116.84 | 33.35** | 6.26 | -7.03 | 48.67 | 4.80 | -6.26 | 1.04 |
| CD (P = 0.05) | 32.14 | 27.84 | 32.14 | 32.14 | 32.81 | 28.41 | 32.82 | 32.82 | 20.51 | 17.77 | 20.52 | 20.52 | 8.04 | 6.95 | 8.03 | 8.03 |
| CD (P = 0.01) | 44.29 | 38.34 | 44.27 | 44.27 | 45.21 | 39.13 | 45.20 | 45.20 | 28.26 | 24.47 | 28.27 | 28.27 | 11.08 | 9.58 | 11.07 | 11.07 |

Table 21. Mean performance of parents and $F_1$ hybrids and extent of heterosis for percentage of productive flowers in brinjal during four seasons

| Parents & hybrids | April-September | | | | June-January | | | | October-April | | | | February-June | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (%) | RH (%) | HB (%) | SH (%) | Mean (%) | RH (%) | HB (%) | SH (%) | Mean (%) | RH (%) | HB (%) | SH (%) | Mean (%) | RH (%) | HB (%) | SH (%) |
| Surya | 45.27 | | | | 38.77 | | | | 34.08 | | | | 49.68 | | | |
| Pant Rituraj | 37.90 | | | | 6.61 | | | | 6.74 | | | | 38.05 | | | |
| SM 6-[illegible] | 42.25 | | | | 30.81 | | | | 39.60 | | | | 35.31 | | | |
| SM 132 | 35.43 | | | | 20.19 | | | | 28.86 | | | | 37.59 | | | |
| SM 6-2 | 42.53 | | | | 31.37 | | | | 32.48 | | | | 41.44 | | | |
| Pusa Purple Cluster | 57.12 | | | | 39.07 | | | | 39.70 | | | | 47.79 | | | |
| Surya x Pant Rituraj | 32.19 | -22.60 | -28.89 | -28.89 | 8.40 | -62.98 | -78.33 | -78.33 | 8.20 | -59.82 | -75.94 | -75.94 | 35.06 | -20.08 | -29.43 | -29.4 |
| SM 6-6 x SM 132 | 35.96 | -7.42 | -14.89 | -20.57 | 18.97 | -25.61 | -38.43 | -51.07 | 33.08 | -3.36 | -16.46 | -2.93 | 36.63 | 0.49 | -2.55 | -26.2 |
| SM 6-2 x Pusa Purple Cluster | 45.21 | -9.27 | -20.85 | -0.13 | 26.22 | -25.55 | -32.89 | -32.37 | 23.55 | -34.75 | -40.68 | -30.90 | 33.64 | -24.61 | -29.61 | -32.2 |
| CD (P = 0.05) | 10.22 | 8.86 | 10.22 | 10.22 | 17.31 | 14.99 | 17.30 | 17.30 | 13.86 | 12.00 | 13.86 | 13.86 | 11.26 | 9.75 | 11.26 | 11.2 |
| CD (P = 0.01) | 14.08 | 12.21 | 14.07 | 14.07 | 23.85 | 20.64 | 23.83 | 23.83 | 19.09 | 16.53 | 19.10 | 19.10 | 15.51 | 13.43 | 15.51 | 15.5 |

SM 6-2 x Pusa Purple Cluster showed a significant standard heterosis in the first (75.86%) and fourth (44.64%) seasons. In the second season, standard heterosis was maximum in SM 6-6 x SM 132 (30.43%). There was no significant standard heterosis in the third season.

Plant height (120 DAS)

No significant relative heterosis was found in the first and second seasons. During the third season, significant values of relative heterosis were observed by SM 6-2 x Pusa Purple Cluster (40.58%) and SM 6-6 x SM 132 (21.98%). In the fourth season, significant relative heterosis was shown by Surya x Pant Rituraj (16.90%) and SM 6-2 x Pusa Purple Cluster (13.25%).

Significant heterobeltiosis was observed for SM 6-2 x Pusa Purple Cluster (34.36%) in the third season. No significant heterobeltiosis was observed during first, second and fourth seasons.

Significant standard heterosis was observed for SM 6-6 x SM 132 in the first (53.33%) and second (39.91%) seasons and SM 6-2 x Pusa Purple Cluster in the fourth season (41.23%). No significant standard heterosis was observed in the third season.

Days to flower

No significant relative heterosis and heterobeltiosis were observed in the first and second seasons. In the third season

SM 6-2 x Pusa Purple Cluster exhibited a significant relative heterosis of -28.23% and there was no significant heterobeltiosis. During the fourth season, Surya x Pant Rituraj showed a significant relative heterosis of -28.52% and SM 6-6 x SM 132 showed a significant value of -15.39%. Surya x Pant Rituraj also showed significant heterobeltiosis (-27.67%).

Significant standard heterosis was exhibited by SM 6-2 x Pusa Purple Cluster (-34.09%), Surya x Pant Rituraj (-28.60%) and SM 6-6 x SM 132 (-28.49%) in the first season and Surya x Pant Rituraj (-29.35%) in the fourth season. However, none of the crosses had standard heterosis in the second and third seasons.

Days to first fruit set

Significant relative heterosis was shown by SM 6-2 x Pusa Purple Cluster (-18.01%) in the third season and by Surya x Pant Rituraj (-22.26%) in the fourth season.

No significant heterobeltiosis was observed in all the seasons except in the fourth season where Surya x Pant Rituraj showed a significant heterobeltiosis of -20.57%.

Significant standard heterosis was observed by Surya x Pant Rituraj (-27.68%) and SM 6-2 x Pusa Purple Cluster (-31.33%) during the first season and Surya x Pant Rituraj (-20.57%) during the fourth season. No significant standard heterosis was found in seasons second and fourth.

Days to first harvest

In the first and second seasons, there was no significant relative heterosis. During the third season, significant relative heterosis was shown by SM 6-2 x Pusa Purple Cluster (-16.84%). During the fourth season Surya x Pant Rituraj (-12.39%) and SM 6-6 x SM 132 (-10.39%) had maximum relative heterosis.

During the first, second and third seasons, there was no significant heterobeltiosis. During the fourth season, significant heterobeltiosis was shown by SM 6-2 x Pusa Purple Cluster (11.79%).

During the first season, Surya x Pant Rituraj showed a significant standard heterosis of -25.78% and SM 6-2 x Pusa Purple Cluster -34.81%. During the 2nd, 3rd and 4th seasons there was no significant standard heterosis.

Primary branches/plant

No significant heterosis was observed in all the seasons except second season which showed a significant standard heterosis by the hybrid SM 6-6 x SM 132 (32.43%).

Total fruits/plant

In the first season, none of the hybrids were heterotic for fruits/plant. During the second season, SM 6-2 x Pusa Purple Cluster had significant relative heterosis (63.28%), heterobeltiosis (62.41%) and standard heterosis (71.15%). During the third season, SM 6-6 x SM 132 showed significant relative heterosis (79.81%), heterobeltiosis (47.89%) and standard heterosis (61.14%). Surya x Pant Rituraj showed maximum relative heterosis (122.72%) and heterobeltiosis (52.65%) in the fourth season. However standard heterosis was maximum in SM 6-2 x Pusa Purple Cluster (120.74%).

Total yield/plant

In the first season, relative heterosis and heterobeltiosis were maximum in SM 6-2 x Pusa Purple Cluster (71.42% and 51.71%) followed by SM 6-6 x SM 132 (49.99% and 24.8%) for total yield/plant. Standard heterosis was not considerable in any of the crosses.

During the second season, significant relative heterosis was exhibited by SM 6-2 x Pusa Purple Cluster (101.41%) and SM 6-6 x SM 132 (62.54%). Significant heterobeltiosis was also observed for SM 6-2 x Pusa Purple Cluster (68.02%). There was no significant standard heterosis.

During the third season SM 6-6 x SM 132 had maximum values of relative heterosis (109.99%), heterobeltiosis (97.88%)

and standard heterosis (42.1%). SM 6-2 x Pusa Purple Cluster 81.16% relative heterosis and 39.99% heterobeltiosis.

During the fourth season, all the $F_1$s had high values of heterosis. Surya x Pant Rituraj ranked first in relative heterosis (145.34%), heterobeltiosis (121.46%) and standard heterosis (121.46%). SM 6-6 x SM 132 had 68.25% relative heterosis and 33.86% heterobeltiosis. SM 6-2 x Pusa Purple Cluster had 60.55% relative heterosis, 36.62% heterobeltiosis and 101.11% standard heterosis.

Average fruit weight

There was no significant relative heterosis, heterobeltiosis or standard heterosis for average fruit weight in the first season.

During the second season, significant relative heterosis was observed in SM 6-6 x SM 132 (32.78%), SM 6-2 x Pusa Purple Cluster (24.52%) and Surya x Pant Rituraj (15.24%). SM 6-6 x SM 132 showed a significant heterobeltiosis of 23.63% and standard heterosis of 13.40%.

Significant relative heterosis was shown in the third season by SM 6-2 x Pusa Purple Cluster (31.95%) and SM 6-6 x SM 132 (20.40%). There was no significant heterobeltiosis and standard heterosis.

In the fourth season, significant relative heterosis was exhibited by SM 6-2 x Pusa Purple Cluster (31.24%) and SM 6-6 x SM 132 (28.59%). None of the hybrids exhibited significant heterobeltiosis. Surya x Pant Rituraj showed a significant standard heterosis of 49.53% and SM 6-6 x SM 132 a value of 15.52%.

Fruiting period

During the first and second seasons, no significant heterosis was observed for fruiting period. In the third season, SM 6-2 x Pusa Purple Cluster showed significant relative heterosis of 33.35%. There was no significant heterobeltiosis or standard heterosis.

During the fourth season, significant relative heterosis was recorded by Surya x Pant Rituraj (36.95%) and SM 6-6 x SM 132 (28.34%). None of the hybrids exhibited significant heterobeltiosis and standard heterosis.

Percentage of productive flowers

No significant heterosis in terms of relative heterosis, heterobeltiosis and standard heterosis was recorded for percentage of productive flowers in any season.

## C. Phenotypic stability in brinjal

Stability parameters like regression coefficient b(i) and deviation from regression $s^2d(i)$ for plant height (90 and 120 DAS), days to first harvest, primary branches/plant, total fruits/plant, total yield/plant, average fruit weight, fruiting period, % of productive flowers and % of wilt were worked out as per Eberhart and Russell (1966) and are presented in Tables 22, 23, 24 and 25.

Plant height (90 DAS)

Based on grand mean over all the four seasons, the cross SM 6-2 x Pusa Purple Cluster (36.92 cm) was the tallest and Pant Rituraj (22.45 cm) the shortest. Considering regression coefficient approximately equal to unity (b(i) 1) and deviation from regression nct significantly different from zero ($s^2d(i)$ 0) the genotype SM 6-6 x SM 132 was stable. SM 6-2 x Pusa Purple Cluster and SM 6-6 were above average stable genotypes as indicated by higher b(i) values.

Plant height (120 DAS)

The $F_1$ SM 6-6 x SM 132 was the tallest genotype based on overall mean of the four seasons. The shortest genotype was Surya x Pant Rituraj. SM 6-2 x Pusa Purple Cluster was a stable

Table 22. Analysis of variance for stability for a few characters in brinjal

| Sources of variation | Mean squares | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height | | Days to first harvest (DAT) | Primary branches/ plant | Incidence of wilt (%) | Total fruits/ plant | Total yield/ plant | Average fruit weight | Fruiting period | Productive flowers (%) |
| | 90 DAS | 120 DAS | | | | | | | | |
| Genotypes | 73.30 | 170.14* | 148.64 | 0.23 | 2198.66** | 553.98** | 537066.75** | 290.71** | 1452.39** | 273.70** |
| Environments (Linear) | 654.43 | 3720.28 | 3658.87 | 11.38 | 2344.61 | 488.73 | 1477549.46 | 834.49 | 23687.51 | 1968.39 |
| Environments + (Genotype x Environment) | 64.01 | 190.64 | 204.37 | 0.62 | 250.83 | 77.28 | 137640.97 | 82.90 | 1225.92 | 104.85 |
| Genotype x Environment (linear) | 49.46 | 29.53 | 61.62 | 0.25 | 337.69* | 45.73 | 40740.50 | 96.54* | 406.06 | 64.60* |
| Pooled deviation | 37.68 | 66.16** | 75.90* | 0.19** | 95.90** | 68.45** | 106268.39** | 35.08** | 342.44** | 19.21 |
| Pooled error | 19.32 | 22.80 | 33.77 | 0.07 | 28.17 | 23.12 | 32174.69 | 9.45 | 72.17 | 20.10 |

* Significant at P = 0.05
** Significant at P = 0.01

Table 23. Stability parameters for Plant height (90 DAS and 120 DAS), Days to first harvest and Primary branches/plant

| Genotype | Plant height (90 DAS) | | | Plant height (120 DAS) | | | Days to first harvest | | | Primary branches/plant | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (cm) | b(i) | $S^2d(i)$ | Mean (cm) | b(i) | $S^2d(i)$ | Mean | b(i) | $S^2d(i)$ | Mean | b(i) | $S^2d(i)$ |
| Surya | 29.99 | -0.61 | -14.77 | 46.41 | 0.46 | -63.46 | 68.77 | 0.35 | 79.92 | 3.66 | 0.71 | -0.10 |
| Pant Rituraj | 22.45 | 1.58 | -36.78 | 43.51 | 1.48 | -6.96 | 69.46 | 0.74 | -98.15 | 3.88 | 0.83 | 0.23 |
| SM 6-6 | 30.91 | 1.92 | 26.31 | 48.26 | 1.09 | 29.15 | 58.88 | 0.73 | -80.16 | 4.08 | 0.89 | -0.07 |
| SM 132 | 28.88 | 1.14 | -54.45 | 51.18 | 0.59 | -37.21 | 75.17 | 1.08 | -4.89 | 3.53 | 0.79 | -0.18 |
| SM 6-2 | 29.55 | 1.26 | -55.07 | 41.94 | 0.85 | -51.21 | 60.98 | 1.08 | -83.63 | 3.68 | 1.43 | -0.01 |
| Pusa Purple Cluster | 28.09 | 0.02 | 34.56 | 53.37 | 1.06 | 98.28 | 77.46 | 0.96 | 28.06 | 3.36 | 1.42 | 0.39 |
| Surya x Pant Rituraj | 26.15 | 0.77 | -12.69 | 41.13 | 1.03 | 6.52 | 71.64 | 1.74 | 128.81 | 3.48 | 1.63 | -0.14 |
| SM 6-6 x SM 132 | 34.65 | 1.20 | -33.75 | 59.22 | 1.11 | 29.74 | 69.52 | 1.28 | -88.73 | 4.00 | 0.39 | -0.15 |
| SM 6-2 x Pusa Purple Cluster | 36.92 | 1.71 | -35.91 | 56.93 | 0.98 | -25.12 | 65.12 | 1.04 | -65.98 | 3.72 | 1.21 | -0.07 |
| Mean | 29.73 | | | 49.10 | | | 68.56 | | | 3.71 | | |

Table 24. Stability parameters for total fruits/plant, Total yield/plant and Average fruit weight

| Genotype | Total fruits/plant | | | Total yield/plant | | | Average fruit weight | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | b(i) | $S^2d(i)$ | Mean (g) | b(i) | $S^2d(i)$ | Mean (g) | b(i) | $S^2d(i)$ |
| Surya | 26.00 | 1.35 | -36.55 | 1134.27 | 1.57 | 22268.83 | 37.71 | 0.71 | -5.31 |
| Pant Rituraj | 4.22 | 0.11 | -64.08 | 247.99 | 0.52 | -24025.65 | 48.71 | 3.36 | 222.35 |
| SM 6-6 | 34.27 | 2.37 | -47.39 | 923.70 | 1.59 | -68336.69 | 26.93 | 0.45 | -18.20 |
| SM 132 | 17.20 | 1.00 | -39.69 | 516.61 | 0.88 | -61464.52 | 35.25 | 0.91 | -27.86 |
| SM 6-2 | 23.91 | 1.22 | -61.21 | 820.27 | 0.97 | -84666.03 | 34.53 | 0.39 | -14.42 |
| Pusa Purple Cluster | 31.78 | 0.34 | 104.82 | 666.48 | 0.61 | -48761.71 | 20.56 | 0.26 | -22.60 |
| Surya x Pant Rituraj | 10.41 | -0.49 | 75.52 | 517.86 | 0.17 | 362625.31 | 45.08 | 1.90 | -26.77 |
| SM 6-6 x SM 132 | 34.03 | 0.98 | 94.51 | 1297.71 | 1.30 | 50750.16 | 39.14 | 0.80 | -23.21 |
| SM 6-2 x Pusa Purple Cluster | 38.75 | 2.11 | -34.19 | 1326.20 | 1.39 | -60690.88 | 34.66 | 0.22 | -23.28 |
| Mean | 24.51 | | | 839.01 | | | 35.84 | | |

Table 25. Stability parameters for Fruiting period, Productive flowers (%) and Incidence of wilt (%)

| Genotype | Fruiting period | | | Productive flowers (%) | | | Incidence of wilt (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (days) | b(i) | $S^2d(i)$ | Mean (%) | b(i) | $S^2d(i)$ | Mean (%) | b(i) | $S^2d(i)$ |
| Surya | 93.78 | 1.27 | -110.59 | 41.95 | 0.68 | -40.15 | 10.10 | 0.07 | -14.79 |
| Pant Rituraj | 50.45 | 0.67 | 1217.17 | 22.32 | 2.09 | -46.31 | 77.64 | 2.02 | 302.82 |
| SM 6-6 | 104.71 | 1.43 | -127.45 | 36.99 | 0.33 | -34.38 | 16.27 | 0.58 | -63.73 |
| SM 132 | 85.02 | 1.20 | 62.96 | 30.52 | 0.85 | -46.69 | 12.22 | 0.48 | -50.29 |
| SM 6-2 | 100.85 | 1.20 | -75.38 | 36.96 | 0.68 | -60.09 | 6.26 | 0.69 | -7.74 |
| Pusa Purple Cluster | 71.78 | 0.82 | 182.13 | 45.92 | 0.92 | -45.44 | 14.00 | 0.64 | -1.96 |
| Surya x Pant Rituraj | 60.51 | 0.15 | 275.10 | 20.96 | 1.67 | -43.53 | 42.85 | 3.65 | 92.69 |
| SM 6-6 x SM 132 | 93.57 | 1.08 | -91.94 | 31.16 | 0.77 | -23.19 | 7.06 | 0.73 | -81.30 |
| SM 6-2 x Pusa Purple Cluster | 97.32 | 1.18 | -198.72 | 32.16 | 1.01 | -30.07 | 14.11 | 0.16 | -73.28 |
| Mean | 84.22 | | | 33.22 | | | 22.27 | | |

genotype. Pusa Purple Cluster and SM 6-6 x SM 132 were above average stable genotypes. SM 132 was a below average stable genotype.

Days to first harvest

The genotype which was the earliest to harvest was SM 6-6 which took only 59 days for harvest from transplanting. The late to harvest genotype was Pusa Purple Cluster which took 77 days. Stable genotypes were SM 6-2 and SM 6-2 x Pusa Purple Cluster. SM 6-6 was a below average stable genotype.

Primary branches/plant

Based on grand mean performance over four seasons, SM 6-6 had the maximum and Pusa Purple Cluster the minimum number of primary branches/plant. Pant Rituraj, SM 6-6 and SM 6-2 x Pusa Purple Cluster were stable genotypes. SM 6-6 x SM 132 was a below average stable genotype.

Total fruits/plant

Based on grand mean over the 4 seasons, maximum number of fruits was obtained from the $F_1$ SM 6-2 x Pusa Purple Cluster (38.75) and minimum from Pant Rituraj (4.22). Stable genotypes with regard to total fruits/plant were Surya and SM 6-6 x SM 132.

SM 6-2 x Pusa Purple Cluster and SM 6-6 were above average stable genotypes. Pusa Purple Cluster was a below average stable genotype (Fig. 1).

Total yield/plant

Regarding the overall performance, the highest yield was given by SM 6-2 x Pusa Purple Cluster (1326.20 g) and the lowest by Pant Rituraj (247.99 g). Surya, SM 6-6 and SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132 were above average stable genotypes (Fig. 2).

Average fruit weight

Average fruit weight ranged from 20.56 g to 48.71 g. The highest weight of fruits was recorded in Pant Rituraj and the lowest in Pusa Purple Cluster. Surya x Pant Rituraj was a stable genotype. Pant Rituraj was above average stable. Surya and SM 6-6 x SM 132 were below average stable genotypes.

Fruiting period

Fruiting period ranged from 50.45 days for Pant Rituraj to 104.71 days for SM 6-6. Stable genotypes with regard to fruiting period were SM 132, SM 6-2, SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132. Surya and SM 6-6 were above average stable genotypes.

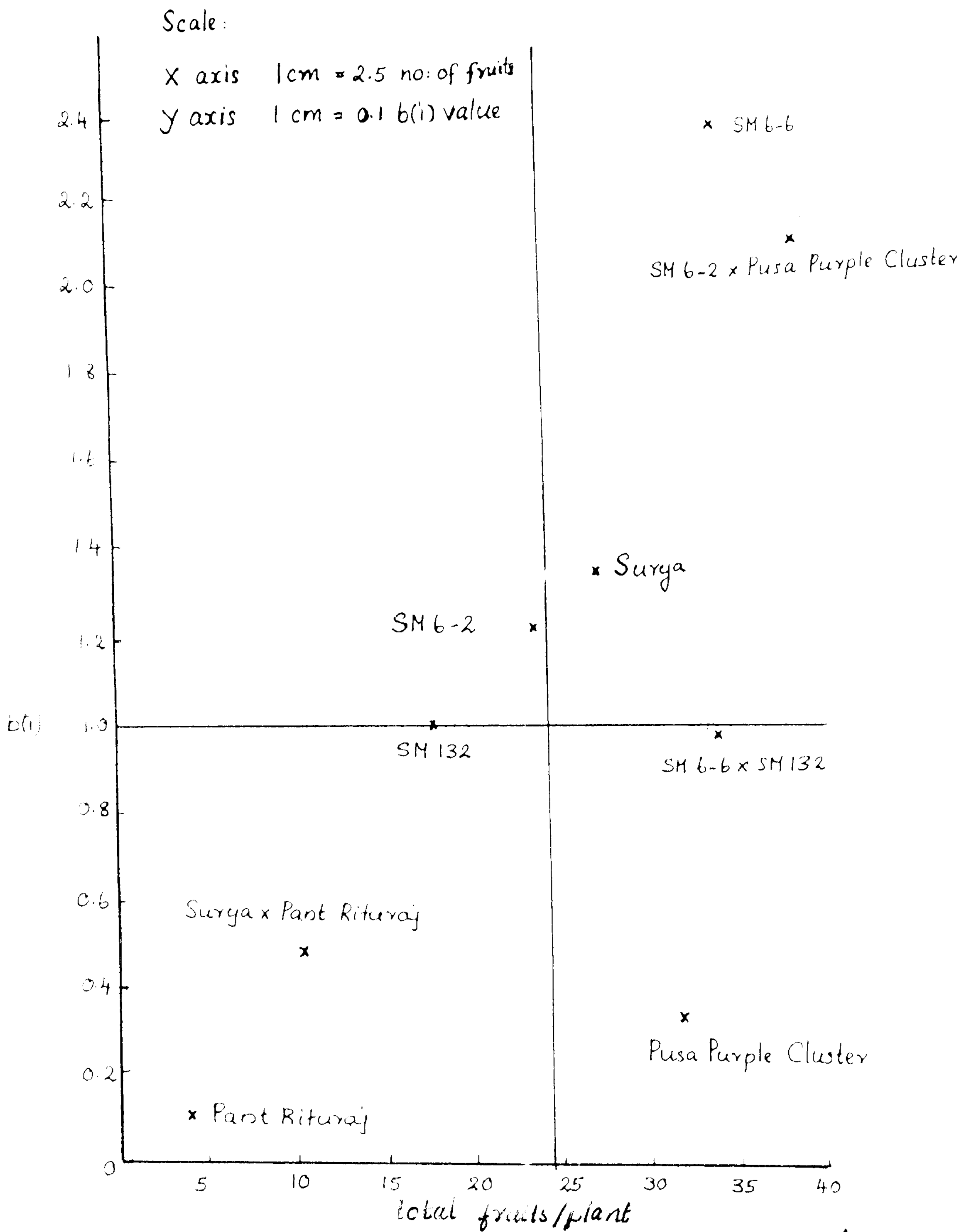


FIG 1: RELATIONSHIP OF TOTAL FRUITS/PLANT AND STABILITY OF 3 F1 HYBRIDS AND 6 PARENTS OF BRINJAL

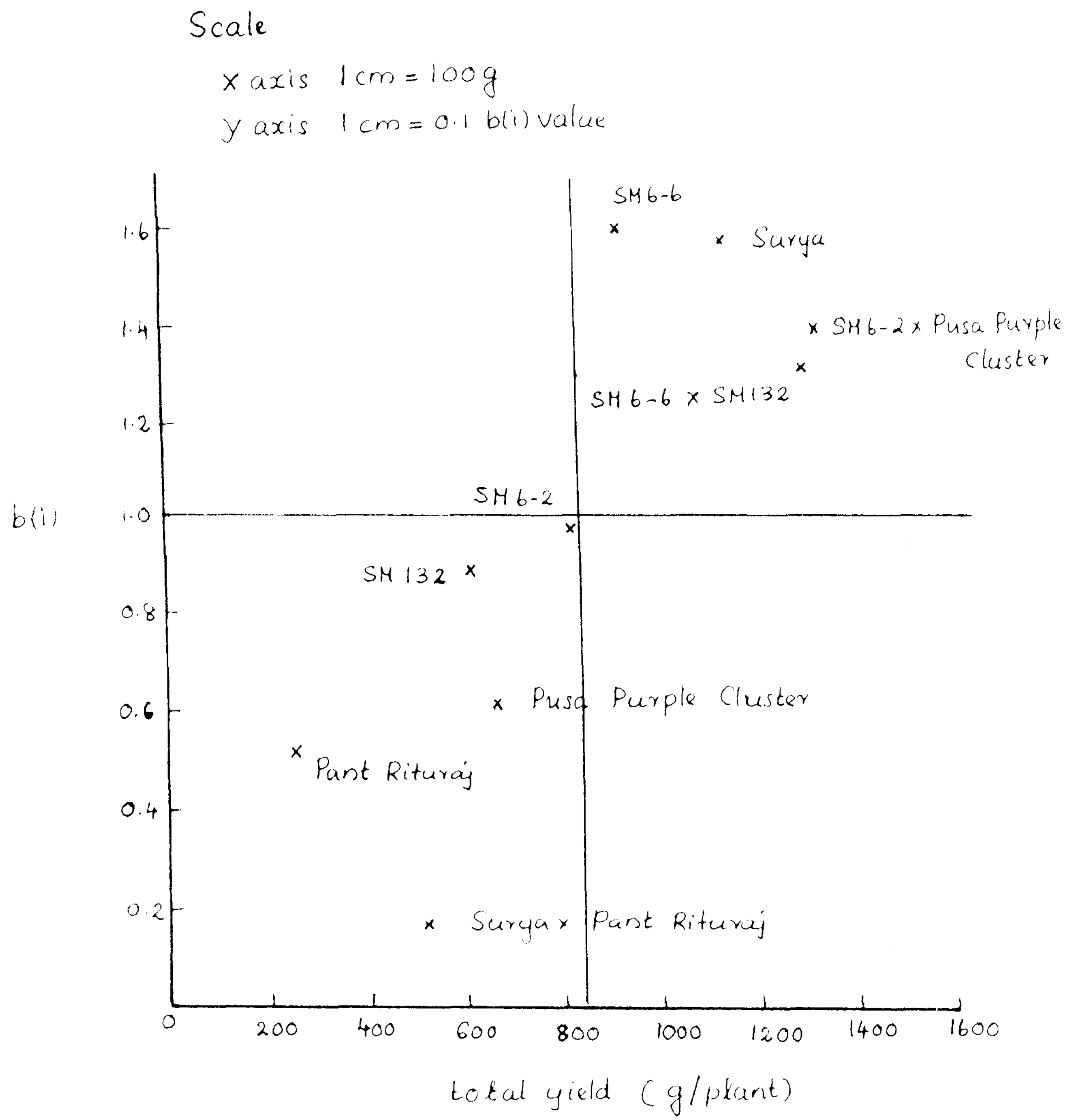


FIG 2 RELATIONSHIP OF TOTAL YIELD/PLANT AND STABILITY OF 3 F1 HYBRIDS AND 6 PARENTS OF BRINJAL

Percentage of productive flowers

Considering grand mean over all environments Pusa Purple Cluster had the highest percentage of productive flowers. Pant Rituraj, Surya x Pant Rituraj were above average stable genotypes. SM 6-2 x Pusa Purple Cluster was the only stable genotypes as indicated by the regression coefficient. Surya, SM 6-6 and SM 6-2 were the below average stable genotypes.

Incidence of wilt

Based on grand mean over the four seasons percentage of wilt ranged from 6.26 to 77.64. Lowest (%) of wilt was observed in SM 6-2 and the highest (%) in Pant Rituraj. Stable genotypes were SM 6-2, Pusa Purple Cluster, SM 6-6 and SM 6-6 x SM 132.

**D. Inheritance of resistance to bacterial wilt**

Two parental lines Surya (resistant) and Pant Rituraj (susceptible) were used to study inheritance of resistance to bacterial wilt in brinjal. These were crossed to generate $F_1$, $F_2$, $BC_1$ and $BC_2$. The plants, wilted and remained resistant were counted and data presented in Table 26.

All the $F_1$ plants wilted indicating dominance of susceptibility or recessive nature of resistance. In the $F_2$ generation

Table 26. Inheritance of resistance to bacterial wilt

| Cross | Generations | Observed number of plants | | | Expected ratio | $\chi^2$ | Probability |
|---|---|---|---|---|---|---|---|
| | | Resis-tant | Susce-ptible | Total | | | |
| Surya x Pant Rituraj | $P_1$ | 50 | 0 | 50 | | | |
| | $P_2$ | 0 | 50 | 50 | | | |
| | $F_1$ | 0 | 50 | 50 | | | |
| | $F_2$ | 67 | 183 | 250 | 1:3 | 0.432 | 0.50-0.70 |
| | $BC_1$ | 119 | 131 | 250 | 1:1 | 0.576 | 0.30-0.50 |
| | $BC_2$ | 0 | 250 | 250 | 0:1 | | |

250 plants segregated into 183 susceptible and 67 resistant. This fitted well in a 3:1 ratio ($\chi^2$ = 0.432, P = 0.50-0.70) in the $BC_1$ ($F_1$ x resistant Surya) 250 plants segregated into 119 resistant and 131 susceptible which fitted in the ratio of 1:1 ($\chi^2$ = 0.576, P = 0.30-0.50). In the $BC_2$ all the plants wilted.

# Discussion

# DISCUSSION

Brinjal (Solanum melongena L.) is a popular vegetable in India. It is grown in all the states and a wide range of variation is observed in the country. Preference of this vegetable depends on size, shape, colour and spininess of fruits, which also varies with location and with individuals. Several varieties differing in fruit characteristics are available. Successful cultivation of brinjal is limited by non availability of high yielding varieties/hybrids and incidence of serious diseases. The most devastating disease in brinjal is the bacterial wilt caused by Pseudomonas solanacearum. This problem is more so in the warm humid weather and acidic soil conditions as prevailing in Kerala. This hinders cultivation of the popular high yielding varieties/hybrids in the state as these are highly prone to the pathogen. This calls for a need based study to circumvent the disease. Hybrids, heterotic for yield and resistant to bacterial wilt with acceptable quality are a great boon to brinjal growers especially in the wilt prone areas. At present such information are rather scanty in brinjal.

Evaluating varieties and hybrids resistant to bacterial wilt over several seasons would reveal their phenotypic stability. This is important in regions where the environmental conditions change considerably. Assessment of performance of genotypes over different environments reveals information on G x E interaction for yield and related characters which in turn paves the way for identification of phenotypically stable varieties/hybrids which can be recommended for year round cultivation. This would also bring out genotypes, suitable for low, medium and high yielding environments.

Mode of gene action governing wilt resistance is of immense use in the choice of appropriate breeding methods for incorporating resistance either from cultivated or wild species into commercially popular varieties.

With the above objectives in mind, experiments were laid out to identify wilt resistant brinjal hybrids, heterotic for yield, of good quality and phenotypically stable. Inheritance of wilt resistance was also studied.

The materials consisted of three isogenic lines of brinjal, SM 6-2, SM 6-6 and Surya, two varieties, Pant Rituraj and Pusa Purple Cluster and one accession (SM 132), high yielding and resistant to bacterial wilt.

**General analysis of variance for different characters**

General analysis of variance clearly indicated significant differences among parental lines and hybrids. The genotypes differed significantly for total fruits/plant, average fruit weight, fruiting period and incidence of wilt (%). In the first season, genotypes differed significantly for days to flower, days to first fruitset, primary branches/plant, total fruits/plant, average fruit weight, fruiting period, % of productive flowers and incidence of wilt (%). During the second season, the genotypes differed significantly for plant height (120 DAS), total fruits/plant, total yield/plant, average fruit weight, fruiting period, % of productive flowers and incidence of wilt (%). Significant difference was observed in the third season for all the characters under study. Genotypes differed significantly during the fourth season for all characters except primary branches/plant and % of productive flowers.

Pooled analysis of variance over environments showed significant differences among environments. Varieties differed significantly for plant height (120 DAS), total fruits/plant, total yield/plant, average fruit weight, fruiting period, % of productive flowers and incidence of wilt (%). Genotype x environment interaction was significant for all characters except days to flower and days to first fruitset.

A perusal of performance of the varieties and hybrids showed that, the white long fruited, SM 6-6 was the earliest to flower and set fruits. The variety took 44 days to set fruit after transplanting. Varietal differences in earliness have also been reported earlier by many workers (Salehuzzaman, 1981 and Kandaswamy _et al_. (1983).

With respect to index to earliness, which gives a more meaningful idea of earlier yield, the popular variety, Surya ranked first. This is due to the fact that Surya outyielded all other varieties and hybrids in the early yield from first five harvests. Despite early flowering and fruitset, total early yield in first five harvests was low in SM 6-6. This is in contrast to the earlier findings of Geetha (1989) in which SM 6-6 gave the total early yield. The present higher early yield in Surya could be attributed to the better management than the normal management given by Geetha (1989) in her studies.

With respect to total yield/plant, the hybrid SM 6-6 x SM 132 gave the highest yield in first and third seasons. SM 6-2 x Pusa Purple Cluster gave the highest yield in second and Surya x Pant Rituraj in the fourth season. The highest mean yield, however, was given by the hybrid SM 6-2 x Pusa Purple Cluster (1326.20 g/plant). This indicated significant role of genotype x environment interaction in the yielding ability of hybrids. One important finding in the study is that all the hybrids were superior to their parents in yield during all the four seasons. In earlier studies, significant differences were observed in yield among varieties (Dutta, 1988).

The difference in performance of varieties and hybrids in varying environments could be due to their difference in adaptability and response to changes in environments. This indicates scope for breeding for adaptability to different conditions like stress due to drought, heat, salt, pollution etc.

The present findings on wilt resistance observed in the parents are as observed by Ushamani (1987) and Geetha (1989) in Surya and SM 6-2.

Maximum wilt incidences (90%) observed in Pant Rituraj under Vellanikkara conditions are similar to the results obtained in the All India Co-ordinated Vegetable Improvement Project during 1988 and 1989 (AICVIP, 1990). The hybrids were not superior in respect of wilt resistance. In the earlier studies, hybrids were reported resistant only when both the parents were resistant (Geetha, 1989).

Varietal differences observed in the present study for plant height, fruits/plant, fruit weight, fruiting period and productive flowers were similar to the findings of Sheela, 1982; Shankar, (1984) and Rashid et al. (1988). The observed variability in the present study is quite rational as there exists diversity in brinjal genotypes for plant height, leaf size, fruit size, shape, colour, spininess etc. in different regions of the country.

**Heterosis in brinjal**

Heterosis breeding was extensively explored and utilized to boost up yield in a number of economically important crops. Prevalence of heterosis has practical implication, if heterosis is explored on rather extensive scale and high heterotic crosses were easily and quickly separated out. Exploitation of heterosis therefore presents immense potential for the improvement of this crop. In the present study, 3 hybrids and 6 parents were evaluated in a field trial for few characters including fruit yield and its components. Heterosis was observed for plant height, earliness, branches, fruits/plant, fruit yield, fruit weight and fruiting period.

SM 6-2 x Pusa Purple Cluster exhibited significant relative heterosis in the first and third seasons for plant height at 90 days after sowing. The crosses with maximum heterobeltiosis for height were SM 6-2 x Pusa Purple Cluster in the first and third seasons and SM 6-6 x SM 132 in the second season. Significant standard heterosis was shown by SM 6-2 x Pusa Purple Cluster in the first and fourth seasons. During the second season, standard heterosis was maximum in SM 6-6 x SM 132 (30.43%).

SM 6-6 x SM 132 exhibited significant standard heterosis for plant height observed 120 days after sowing during first and second seasons. Significant relative heterosis was observed for SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132 and heterobeltiosis for 'SM 6-2 x Pusa Purple Cluster in the third season. In the fourth season SM 6-2 x Pusa Purple Cluster exhibited significant relative heterosis and standard heterosis. Surya x Pant Rituraj also exhibited significant relative heterosis. Plant height is usually indicative of its vegetative vigour which influences the productivity. Heterosis for plant height was reported earlier by Gopinath (1987), Singh and Mital (1988) and Geetha (1989).

Number of days taken by a variety to put forth the first flower is generally indicative of its earliness. All the three hybrids Surya x Pant Rituraj, SM 6-6 x SM 132 and SM 6-2 x Pusa Purple Cluster exhibited significant standard heterosis in the first season. In the third season SM 6-2 x Pusa Purple Cluster showed a significant relative heterosis and during fourth season Surya x Pant Rituraj exhibited significant relative heterosis, heterobeltiosis and standard heterosis. SM 6-6 x SM 132 also showed significant relative heterosis. Heterosis for days to flower was reported by Peter (1971), Vijay and Nath (1978), Dharmegowda et al. (1979) and Singh and Mital (1988).

For days to first fruitset, two hybrids Surya x Pant Rituraj and SM 6-2 x Pusa Purple Cluster showed significant standard heterosis in the first season. SM 6-2 x Pusa Purple Cluster exhibited significant relative heterosis in the third season. During the fourth season, Surya x Pant Rituraj exhibited significant relative heterosis, heterobeltiosis and standard heterosis. Ability of hybrids to set fruits earlier than the parents was reported by Hristakes (1979), Singh (1980), Kandaswamy et al. (1983) and Geetha (1989) also. During the first season Surya x Pant Rituraj showed a significant standard heterosis of -25.78% and SM 6-2 x Pusa Purple Cluster (-34.81%) for earlier harvest. During the third season significant relative heterosis was shown by SM 6-2 x Pusa Purple Cluster (-16.84%). Maximum relative heterosis was shown by Surya x Pant Rituraj and SM 6-6 x SM 132 and significant heterobeltiosis by SM 6-2 x Pusa Purple Cluster in the fourth season. This showed that early fruiting hybrids were early yielders also.

For branches/plant, SM 6-6 x SM 132 showed a significant standard heterosis of 32.43% during the second season. Heterosis for primary branches/plant was reported by Nagai and Kida (1926), Mishra (1961), Thakur et al. (1968), Peter (1971), Narayanan (1984) and Geetha (1989). Branches/plant is often positively correlated with fruits and yield/plant (Srivastava and Sachan, 1974; Khurana et al. (1988), Nainar and Subbiah, 1990). It indicates that factors which favour vegetative growth favour fruit yield also.

SM 6-2 x Pusa Purple Cluster showed a significant relative heterosis, heterobeltiosis and standard heterosis during second season for total fruits/plant. During the third season significant relative heterosis, heterobeltiosis and standard heterosis were exhibited by SM 6-6 x SM 132. In the fourth season, Surya x Pant Rituraj showed a maximum relative heterosis (122.72%) and heterobeltiosis (52.65%). However standard heterosis was maximum in SM 6-2 x Pusa Purple Cluster (120.74%). Heterosis for total fruits/plant was reported by Gangappa (1986), Nualsri _et al._ (1986), Dixit and Gautam (1987), Gopinath (1987), Geetha (1989) and Singh and Rai (1990).

In the first season, SM 6-2 x Pusa Purple Cluster had maximum values of relative heterosis (71.42%) and heterobeltiosis (51.71%) followed by SM 6-6 x SM 132 (49.99% and 24.8%) for total yield/plant. During the second season also, SM 6-2 x Pusa Purple Cluster exhibited significant relative heterosis and heterobeltiosis. SM 6-6 x SM 132 also showed significant relative heterosis. During the third season, SM 6-6 x SM 132 had maximum values of relative heterosis (109.99%), heterobeltiosis (97.88%) and standard heterosis (42.1%). SM 6-2 x Pusa Purple Cluster had 81.16% relative heterosis, and 39.99% heterobeltiosis. During the fourth season, all the three $F_1$s had high values of heterosis. Heterosis for total yield/plant was reported earlier by Narayanan (1984), Gangappa

(1986), Nualsri et al. (1986), Verma et al. (1986), Dixit and Gautam (1987), Gopinath (1987), Seethapathy (1987), Rashid et al. (1988) and Singh and Rai (1990). The seasonal variation in hybrids in the manifestation of heterosis could be due to their differential response to varying environments.

Significant relative heterosis was exhibited by all the three hybrids for fruit weight in the second season. SM 6-6 x SM 132 showed significant heterobeltiosis and standard heterosis. During the third and fourth season significant relative heterosis was shown by SMM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132. SM 6-6 x SM 132 and Surya x Pant Rituraj exhibited significant standard heterosis in the fourth season. Heterosis for average fruit weight was reported earlier by Silvetti and Brunelli (1970), Vijay and Nath (1978), Joarder et al. (1981), Dixit and Gautam (1987) and Geetha (1989).

During the third season, SM 6-2 x Pusa Purple Cluster showed a significant relative heterosis of 33.35% for period of fruiting. Significant relative heterosis was observed for Surya x Pant Rituraj and SM 6-6 x SM 132 in the fourth season. This could be due to the ability of hybrids to remain longer in productive stage with consequent higher yield. This is in accordance with the reports of Mishra (1961), Quagliotti (1962) and Peter and Rai (1976).

## Phenotypic stability in brinjal

Phenotypic stability is measured by three parameters, viz. mean performance over environments, linear regression and deviation from regression function. In the final selection of cultivars, it is usually considered necessary to identify genotypes performing better under high, medium and low yielding environments.

The data for various traits were analysed for phenotypic stability using Eberhart and Russell (1966) model. For all observed characters, seasons differed significantly among themselves. Genotypes differed significantly for plant height (120 DAS), total fruits/plant, total yield/plant and fruiting period. Genotype x environment interaction was significant for average fruit weight, (%) of productive flowers and incidence of wilt (%). For plant height (90 DAS), days to first harvest and primary branches/plant, only environments differed among themselves, but not genotypes.

While considering total fruits/plant the stable genotypes were Surya and SM 6-6 x SM 132. SM 6-2 x Pusa Purple Cluster and SM 6-6 were above average stable genotypes which reflects that they are suited to high yielding environments. Pusa Purple Cluster was a below average stable genotype. This indicates that it is suited to low yielding environments. When total yield/plant was considered, Surya, SM 6-6, SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132 were above average stable. While assessing the fruiting period stable genotypes were SM 132, SM 6-2, SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132. Surya and SM 6-6 were above average stable.

For average fruit weight, (%) productive flowers and (%) wilt incidence, the mean squares due to genotypes and environments were highly significant indicating diversity among the genotypes and the environments. The mean square due to genotype-environment (G x E) interaction was also highly significant indicating differential response of genotypes in different environments. This highly significant interaction indicates that the genotypes interacted considerably with the environmental conditions of different seasons. Similar results were reported earlier by Singh (1978). For average fruit weight Surya x Pant Rituraj was a stable genotype; Pant Rituraj was above average stable and Surya, SM 6-6 and SM 132 were below average stable. Regarding (%) productive flowers, the stable genotype was Pusa Purple Cluster. Surya, SM 6-6 and SM 6-2 were below average stable. For incidence of wilt stable genotypes were SM 6-2, Pusa Purple Cluster, SM 6-6 and SM 6-6 x SM 132. Phenotypic stability for brinjal varieties have been reported earlier by Ushamani (1987), Khurana *et al.* (1987), **Sidhu (1989) and Vadivel and Bappu (1989)**. But information on phenotypic stability of brinjal hybrids is new.

**Inheritance of resistance to bacterial wilt**

In the present study, an attempt was made to study inheritance of resistance to bacterial wilt. Two varieties Surya (resistant) and Pant Rituraj (susceptible) were used to develop six generations of $P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$. All the $F_1$s were susceptible indicating recessive nature of resistance. Recessive nature of wilt resistance was reported earlier by Dutta and Kishun (1982), Manjunath and Dutta (1987) and KAU (1989).

In $F_2$, the population segregated into a ratio of 3 susceptible and 1 resistant indicating monogenic nature of resistance. This was further confirmed in $BC_1$ and $BC_2$ generations where the population segregated fitting into ratios of 1:1 and 0:1 respectively. This susceptible nature of resistance observed in the present finding is against the earlier reports of Swaminathan and Sreenivasan (1971), Vijayagopal and Sethumadhavan (1973), Gopimony (1983) and Gopinath and Madalageri (1986) who observed dominant nature of inheritance of bacterial wilt in brinjal. The difference in the present study could be attributed to difference in sources of resistance.

# Summary

# SUMMARY

Present studies "Evaluation of $F_1$ hybrids resistant to bacterial wilt and inheritance of resistance in brinjal (Solanum melongena L.) were conducted at the vegetable research plots of Kerala Agricultural University, Vellanikkara during February 1990 to July 1991, with the objective of identifying bacterial wilt resistant and stable $F_1$ hybrids heterotic for yield and component characters and to understand the inheritance of wilt resistance in brinjal. The materials comprised of six lines of brinjal and three $F_1$ hybrids. The three $F_1$ hybrids were evaluated for four seasons, along with their parents during April-September (1990), June (1990)-January (1991), October (1990)-April (1991) and February-June (1991). General and pooled analysis of variance were done to know the varietal difference. The extent of $F_1$ heterosis over midparent, better parent and over Surya (SM 6-7) were estimated. Phenotypic stability analysis was done to select stable genotypes suited to different environments. Inheritance of resistance to bacterial wilt was studied using the cross between the resistant Surya and the susceptible Pant Rituraj.

The genotypes differed significantly for majority of the characters in all the four seasons. Significant difference was observed for total fruits/plant, average fruit weight, fruiting period and incidence of wilt (%) in all the four seasons. In the first season,

genotypes differed significantly for days to flower, days to first fruitset, primary branches/plant, total fruits/plant, average fruit weight, fruiting period, % of productive flowers and incidence of wilt (%). During the second season, the genotypes differed significantly for plant height at 120 DAS, total fruits/plant, total yield/plant, average fruit weight, fruiting period, and % of productive flowers. During the third season, significant difference was observed among genotypes for all the characters studied. Genotypes differed significantly in the fourth season for all characters except primary branches/plant and % of productive flowers.

Pooled analysis of variance over environments showed significant difference among environments. Varieties differed significantly for plant height (120 DAS), total fruits/plant, total yield/plant, average fruit weight, fruiting period, % of productive flowers and incidence of wilt (%).

SM 6-6 was the earliest variety to set fruit after transplanting. However, index to earliness was highest in Surya. SM 6-6 x SM 132 gave the highest yield in first and 3rd seasons, SM 6-2 x Pusa Purple Cluster in the second and Surya x Pant Rituraj in the 4th season. Highest mean yield was given by the hybrid SM 6-2 x Pusa Purple Cluster. Genotype x environment interaction played significant role in the yielding ability of hybrids. All the 3 hybrids were superior to their parents in yield during all the 4 seasons. The hybrids were not superior in respect of their wilt resistance. Varietal differences were observed in the present study for plant height, fruits/plant, fruit weight, fruiting period and productive flowers.

Two hybrids namely SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132 exhibited heterosis for plant height at 90 DAS. All the three hybrids exhibited significant heterosis for plant height at 120 DAS. In the first 3 seasons, SM 6-6 x SM 132 exhibited significant heterosis. In the 3rd and 4th seasons SM 6-2 x Pusa Purple Cluster and in the fourth season Surya x Pant Rituraj exhibited significant heterosis for plant height. Heterosis was also observed for days to flower, days to first fruitset, and days to first harvest. SM 6-6 x SM 132 exhibited heterosis for primary branches/plant during the second season. For total fruits/plant, relative heterosis, heterobeltiosis and standard heterosis were exhibited by SM 6-2 x Pusa Purple Cluster in the second season and SM 6-6 x SM 132 in the 3rd season. During 4th season, maximum relative heterosis, and heterobeltiosis were shown by Surya x Pant Rituraj and standard heterosis by SM 6-2 x Pusa Purple Cluster. For total yield/plant, SM 6-2 x Pusa Purple Cluster exhibited maximum relative heterosis (71.42%) and heterobeltiosis (51.71%) followed by SM 6-6 x SM 132 (49.99% and 24.8%) in the first season. During second season singificcant relative heterosis was shown by SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132. SM 6-2 x Pusa Purple Cluster also exhibited significant heterobeltiosis. During the third season SM 6-6 x SM 132 showed maximum values of relative heterosis, heterobeltiosis and standard heterosis. SM 6-2 x Pusa Purple Cluster showed relative heterosis and heterobeltiosis. During the 4th season, all the 3 hybrids exhibited heterosis. Heterosis was also observed for average fruit weight and fruiting period.

Phenotypic stability analysis indicated that all the three hybrids - Surya x Pant Rituraj, SM 6-6 x SM 132 and SM 6-2 x Pusa Purple Cluster were phenotypically stable.

Study of inheritance of resistance to bacterial wilt revealed that resistance to bacterial wilt was inherited in a monogenic and recessive manner.

Considering yield and disease resistance two hybrids namely SM 6-2 x Pusa Purple Cluster and SM 6-6 x SM 132 were found promising. Hence these hybrids may be tested multilocationally.

# References

## REFERENCES


AICVIP 1990. All India Coord. Veg. Improv. Proj. Progr. Rept. 1988-'89 and 1989-'90. KAU, Vellanikkara.

*Akiba, F., Ribeiro, R., Del, D., Robbs, C.F., Sudo, S. and Kimura, O. 1972. Resistance to bacterial wilt in the egg plant variety Nikon Nassu. Arquivos da Universidade Federal Rural Riode Janeiro [illegible] (cf. Hort. Abstr. 45; 1069) (German)

*Andronicescu, D., Talpalaru, E. and Enachescu, G. 1962. The manifestation of the effect of heterosis in the $F_1$ of different tomato hybrid combinations. Lucrar Sti. Inst. Cercet. Hort. - Vit. Boneasa-Bucuresti. 6:87-89.

*Anonymous 1962. Bacterial wilt resistant egg plant varieties. Mon. Bull. U. P. Coll. Agri. Laguna. 27(6):1-4.

*Anonymous 1963. Indian Council of Agricultural Research - Annual Report 3:1-14, 89-100, 163-176, 249-265 (cf. Pl. Br. Abstr. 35, 5839).

*Anonymous 1974. Scientific report of Central Potato Research Institute for the triennium 1971-1973:120-125.

Anonymous 1980. Research Report of the Kerala Agricultural University for the year 1979-80. Vellanikkara. p.401.

Anonymous 1981. Research Report of the Kerala Agricultural University for the year 1980-81, Vellanikkara. p.146.

Anonymous 1982. Research Report of the Kerala Agricultural University for the year 1981-82, Vellanikkara. p.273.

*Bailey, L.H. 1892. The behaviour of some egg plant crosses. Cornell Agric. Exp. Sta. Bull. 26:20.

*Bailey, L.H. and Munson, W.M. 1891. Experience with egg plants New York (Cornell) Sta. Bull. **26**:20.

Baksh, S. 1979. Cytogenetic studies on the $F_1$ hybrid Solanum incanum L. x S. melongena L. var. Giant of Banaras. Euphytica **28**:793-800.

Balamohan, T.N., Subbiah, R. and Shanmugavelu, K.G. 1983. Studies on heterosis in brinjal (Solanum melongena L.). (In) Pre-congress scientific meeting on genetics and improvement of heterotic systems. Tamil Nadu Agricultural University, Coimbatore.

*Bayla, S. 1918. Hybridisation of egg plant. Philipp. Agric. and For. **7**:66-71.

Belkhindi, G. and Madalageri, B.B. 1986. Studies on resistance to bacterial wilt (Pseudomonas solanacearum E.F. Smith) in brinjal (Solanum melongena L.). Mysore J. Agric. Sci. **21**(4):23.

Bell, A.A. 1981. Biochemical mechanism of disease resistance. Ann. Rev. Plant Physiol. **32**:21-81.

Berry, S.Z., Uddin, M.R., Gould, W.A., Bisges, A.D. and Dyer, G.D. 1988. Stability for fruit yield, soluble solids and citric acid of 8 machine harvested processing tomato cultivars in Northern Ohio. J. Amer. Soc. Hort. Sci. **113**(4):604-608.

Bhaduri, P.N. 1951. Inter relationship of non-tuberiferous species of Solanum with some consideration on the origin of brinjal (Solanum melongena L.). Indian J. Genet. Pl. Breed. **11**: 75-82.

Bhutani, R.D., Kalloo, Singh, G.P. and Sidhu, A.S. 1980. Heterosis and combining ability in brinjal (Solanum melongena L). J. Res. Haryana Agric. Univ. **10**:476-484.

*Biswas, C.K. 1964. Heterosis and combining ability in brinjal (Solanum melongena L.) in West Pakistan. Post Graduate Res. Ayub. Agric. Res. Inst. A retrospect. 1964. pp.300-302 (cf. Pl. Breed. Abstr. 35:5862)

Briggle, L.W. 1963. Heterosis in wheat - a review. Crop Sci. **3**: 407-412.

Buddenhagen, I., Sequeira, L. and Kelman, A. 1962. Designation of races in Pseudomonas solanacearum (Abstr) Phytopath, **52**:726.

*Burton, G.W. 1952. Quantitative inheritance in grasses. Proc. 6th Inst. Grassld. Congr. **1**:277-283.

*Capinpin, J.M. and Alviar, M.A. 1949. Heterosis in egg plant. Philipp. Agric. **33**:126-141 (cf. Hort. Abstr. 21, 1725(b).

*Cariappa, K.A. 1961. Studies on certain aspects of floral biology and the effect of gibberellic acid and 2,4-D on fruitset in brinjal (Solanum melongena L.). M.Sc.(Ag.) Dissertation. Tamil Nadu Agric. Univ., Coimbatore.

Chadha, M.L. and Hegde, R.K. 1989. Combining ability studies in brinjal. Indian J. Hort. **46**(1):44-52.

Chadha, M.L. and Sidhu, A.S. 1982. Studies on hybrid vigour in brinjal. Indian J. Hort. **39**:233-236.

Cheah, C.H., Kwan, K.H., Nurmala, M.D., and Noor 1981. Genetics of brinjal (Solanum melongena L.) (In) Fourth International SABRAO Congress, 4-8 May 1981 at University Kebangsaan Malaysia and Federal Hotel, Kuala Lumpur. 20.

Cherepova, O.M. 1976. Testing varieties and hybrids of egg plant in Tombov Province. Pl. Breed. Abstr. **46**(6):5865.

*Chong, L.L., Molle, E. and Konstantinova, M. 1984. Study of the effects of genotype, environment and their interaction in some subperiods of biological earliness in tomato. Genetika i Seleitsiva **17**:263-265.

Chupp, C. and Sherf, A.F. 1960. Vegetable diseases and their control. The Ronald Press Co., New York. 695.

Coulter, F.C. 1942. Story of garden vegetables. IX. Eggplant and its travel from ancient India. Seed World, **52**(1):36-37.

Daly, P. 1970. Search for an eggplant variety tolerant to Pseudomonas solanacearum (In) Proceedings of 7th Annual meeting CFCS, Martinique-Guadeloupe 113-132. (cf. Hort. Abstr. 42:9328.

Daly, P. 1973. Obtaining a new egg plant variety which is tolerant to Pseudomonas solanacearum. Agron. Trop. **28**(1):23-27.

Daly, P.M.J. 1972. Research carried out at IRAT Martinique with a view to breeding an aubergine variety tolerant of Pseudomonas solanacearum. Agronomic Tropicale. **27**(4):462-472.

Das, C.R. and Chattopadhyay, S.B. 1955. Bacterial wilt of egg plant. Indian Phytopath. **8**:130-135.

Daskaloff, C. 1941. The study of heterosis in egg plant and the possibility of its practical utilization. Pl. Breed. Abstr. **12**:1224.

Davidson, H.F. 1935. Bacterial wilt of solanaceous crops. Trop. Agric. **85**:257-259.

Dhankar, B.S., Mehrotra, N. and Singh, K. 1980. Heterosis in relation to yield components and fruit and shoot borer (Leucinodes orbonalis Con.) in brinjal Solanum melongena L.). Genet. Agric. **34**:215-220.

Dharmegowda, M.V., Hiremath, K.G. and Goud, J.V. 1979. Genetic analysis of yield and its components in brinjal (Solanum melongena L.). Mysore J. Agric. Sci. **13**:151-155.

Dixit, J., Bhutani, R.D. and Dudi, B.S. 1982. Heterosis and combining ability in egg plant. Indian J. Agric. Sci. **52**:444-447.

Dixit, J. and Gautam, N.C. 1987. Studies on hybrid vigour in egg-plant (Solanum melongena L.). Indian J. Hort. **44**:74-77.

Dutt, G.K.G. 1970. Studies on heterosis in brinjal (Solanum melongena L.). South Indian Hort. **18**:54.

Dutta, O.P. 1988. Performance of brinjal lines resistant to bacterial wilt. ICAR Annual Report of IIHR Bangalore. p.30.

Dutta, O.P. and Kishun, R. 1982. Part B. Breeding brinjal for yield, quality and resistance to bacterial wilt Pseudomonas solanacearum. ICAR Annual Report of IIHR, Bangalore. pp.35-36.

Eberhart, S.A. and Russell, W.A. 1966. Stability parameters for comparing varieties. Crop Sci. **6**:36-40.

*Empig, L.T. and Sumaong, J.T. 1964. Incorporation of genes controlling clustered fruiting habit into five Philippinal eggplant varieties. Philipp. Agric. **48**:113-127.

*Filov, A.I. 1940. An agro-ecological classification of eggplants and study of their characters. C. R. Doklady. Acad. Sci. USSR. **26**:223-231.

*Frydrych, J. 1964. Biology and flowering in the eggplant (Solanum melongena L.). Bull. Vyzkumny Ustav Zelinarsky Olomoue **8**:27-37 (cf. Pl. Breed. Abstr. 35: 7604) (Russian)

Gallegly, M.E. and Walker, J.C. 1949. Reaction of environmental factors to bacterial wilt of tomato. Phytopathology **39**: 936-945.

Gangappa, B. 1986. Studies on resistance to bacterial wilt (Pseudomonas solanacearum E.F. Smith) in brinjal (Solanum melongena L.). M.Sc.(Hort.) thesis, Univ. Agric. Sci., Bangalore.

Gangappa, B. and Madalageri, B.B. 1986. Studies on resistance to bacterial wilt (Pseudomonas solanacearum E.F. Smith) in brinjal (Solanum melongena L.). Mysore J. Agric. Sci. **21**(4):23.

Gangopadhyay, S. 1984. Advances in vegetable diseases. Associated Publishing Company, New Delhi. pp.644.

Geetha, P.T. 1989. Heterosis and genetic analysis involving isogenic lines in brinjal resistant to bacterial wilt. M.Sc.(Hort.) thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Gopalakrishnan, T.R. and Gopalakrishnan, P.K. 1985. Relative susceptibility of brinjal lines to bacterial wilt. Agric. Res. J. Kerala. **23**:209-211.

Gopimony, R. 1983. Genetic studies in brinjal with relation to bacterial wilt resistance. Ph.D. thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Gopimony, R. and George, M.K. 1979. Screening brinjal varieties for wilt resistance. Agric. Res. J. Kerala. **17**:7-10.

Gopimony, R. and Nair, N.K. 1983. Breeding for bacterial wilt resistance in egg plant. (In) National Seminar on breeding Crop plants for resistance to pest and disease. Tamil Nadu Agricultural University, Coimbatore:16.

Gopimony, R. and Sreenivasan, K. 1970. Studies on brinjal hybridization. 1. Features of $F_1$ hybrids between cultivated and wild brinjal. Agric. Res. J. Kerala. **8**:101-105.

Gopinath, G. 1987. Studies on the inheritance of bacterial wilt (Pseudomonas solanacearum E.F.Smith) resistance and characters of agronomic importance in brinjal. Mysore J. Agric. Sci. **21**:257.

Gopinath, G. and Madalageri, B.B. 1986. Bacterial wilt (Pseudomonas solanacearum E.F. Smith) resistance in egg plant. Veg. Sci. **13**(2):189-195.

Gopinath, G., Madalageri, B.B. and Somasekar, C. 1987. Genetics of fruit characters in egg plant Solanum melongena L. Mysore J. Agric. Sci. **21**:329-331.

Goth, R.W., Peter, K.V. and Webb, R.E. 1983. Bacterial wilt: Pseudomonas solanacearum resistance in pepper and egg plant. Phytopathology **73**:808 (Abstract A 329)

*Goto, K. 1952. Studies on heterosis in egg plants. (Preliminary Report). Jap. J. Breed. **1**:196.

Gowda, T.K.S., Shetty, K.S., Balasubramanya, R.H., Setty, K.P.V. and Patil, R.B. 1974. Studies on the bacterial wilt of solanaceous crops caused by Pseudomonas solanacearum E.F. Smith in the wilt sick soil. Mysore J. Agric. Sci. **8**(4):560-566.

*Graham, R.M. and Yap, T.G. 1976. Studies on bacterial wilt. I. Inheritance of resistance to Pseudomonas solanacearum in tomato. Malaysian Agric. Res. **57**:1-8.

*Halsted, B.D. 1901. Experiments in crossing egg plants. N. J. Agric. Expt. Stat. Ann. Rep. **22**:398-400.

*Hani, M.B., Khalf-Allah, A.M. and El-Shal, M.A. 1977. Estimation of heterosis in egg plant (Solanum melongena L.). Alexandria J. Agric. Res. **25**:465-471 (cf. Pl. Breed. Abstr. 48, 10254.

Hayes, J.K., Immer, F.R. and Smith, D.C. 1965. Methods of plant breeding 2nd ed. Mc Graw Hill Book Company Inc., New York. pp.329-332.

*Hayward, A.C. 1964. Characteristics of Pseudomonas solanacearum. J. Appl. Bact. **27**:265-277.

*Hristakes, D.A. 1979. Evaluation of varieties and hybrids of egg plant in the green house. Geoigike Ereuna **3**(4):370-375.

Jessykutty, P.C. 1985. Realised selection responses under four methods of selection in third and fourth cycles in a set of brinjal lines. M.Sc. thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

*Joarder, O.I., Islam, Q.N., Salehuzzaman, M. and Alam, M.S. 1981. Inheritance of some quantitative characters in egg plant (Solanum melongena L.). Genetica Polonica. **22**:91-102. (cf. Pl. Breed. Abstr. 52, 894).

*Kakizaki, Y. 1938. Hybrid vigour in eggplant and its practical utilization. J. Hered. **21**:253-258.

Kalloo and Pandey, S.C. 1979. Phenotypic stability in tomato. Haryana Agric. Univ. J. Res. **9**:303-307.

Kandasamy, P., Singh, N., Kalda, T.S., Sirohi, P.S. and Choudhary, B. 1983. Heterosis and combining ability in eggplant. Indian J. Agric. Sci. **53**:201-206.

Kerala Agricultural University 1989. Package of Practices Recommendations. Directorate of Extension, Kerala Agricultural University, Trichur, Kerala. pp.214-215.

*Kelman, A. 1953. The bacterial wilt caused by Pseudomonas solanacearum. N. Carolina Agric. Expt. Sta. Tech. Bull. 99:911.

Kelman, A. and Cowling, E.B. 1965. Cellulose of Pseudomonas solanacearum in relation to pathogenesis. Phytopathology **55**: 148-158.

Kelman, A. and Winstead 1960. Resistance to bacterial wilt in eggplant in North Carolina. Plant Dis. Reptr. **44**:432-434.

Keshwal, R.L. and Joshi, L.K. 1976. Variation in Pseudomonas solanacearum. Indian J. Microbiol. **16**:94-97.

Khan, N.A.A. 1974. Studies on Pseudomonas solanacearum E.F. Smith causing wilt of brinjal, potato and tomato in Mysore State. Mysore J. Agric. Sci. **8**(3):477-478.

Khurana, S.C., Kalloo, G., Singh, C.B. and Thakral, K.K. 1988. Correlation and path analysis in eggplant (Solanum melongena). Indian J. Agric. Sci. **58**(10):799-800.

Khurana, S.C., Singh, G.R., Thakral, K.K., Kalloo, Pandita, M.L. and Pandey, U.C. 1987. Phenotypic stability for fruit yield in brinjal. Haryana Agric. Univ. J. Res. **17**(2): 189-191.

*Konstantinova, M., Daskaloff, C.H. and Molle, E. 1984. Reaction of the genotype for the character "Pericarp thickness" in tomato cultivars grown at different environment. New era in tomato breeding. Synopses, IXth meeting, EUCARPIA Tomato Working Group, Wageningen, Netherland.

Krishnamoorthy, S. and Subramoniam, D. 1953. Some investigations on the type of flowers in Solanum melongena L. Indian J. Hort. **11**:63-67.

*Kuc, J. 1968. Phenolic compounds and disease resistance in plants (In) Runneckles, V.C. (ed) Phenolics in normal and diseased fruits and vegetables. Plant Phenolic group of North Americal Symposium Proceedings. Imperial Tobacco Co. Montreal: 63-81.

Kuneida, K. 1953. Studies on bacterial wilt of eggplants. I. Varietal differences of hosts in reaction to the casual bacteria. Ann. Phytopath. Soc. Japan. **17**:133-136.

*Kuriyama, T. 1975. Testing methods for breeding disease resistant vegetables in Japan. JARQ, **9**(2):96-100.

Lal, S., Verma, G. and Pathak, M.M. 1973. Hybrid vigour for yield and yield component in brinjal (Solanum melongena L.). Indian J. Hort. **31**:52-55.

Lantican, R.M. and Others. 1963. Heterosis in Solanum melongena L. Philipp. Agric. **47**:117-129.

Li, H.P., Goth, R.W. and Barksdale, T.H. 1988. Evaluation of resistance to bacterial wilt in eggplant. Plant Disease **72**(5):437-439.

Madalageri, B.B., Sulladmath, U.V. and Belkhindi, G.B. 1983. Wilt resistant high yielding hybrid brinjal. Curr. Res. **12**: 108-109.

Manjunath, K.N. and Dutta, O.P. 1987. Genetics of bacterial wilt (Pseudomonas solanacearum E.F. Smith) resistance in brinjal (Solanum melongena L.). ICAR Annual Report of IIHR, Bangalore. p.126.

*Mew, T.W. and Ho, W.C. 1976. Varietal resistance to bacterial wilt in tomato. Pl. Dis. Rep. **60**:264-268.

Mishra, G.M. 1961. Investigations on hybrid vigour in brinjal. Indian J. Hort. **18**:305-317.

Mishra, G.M. 1962. Preliminary pollen studies in 4 varieties of brinjal and their $F_1$ hybrids. Sci. Cult. **28**:439-440.

Mishra, G.M. 1966. Preliminary chemical studies in four varieties of brinjal (Solanum melongena L.) and their $F_1$ hybrids. Sci. Cult. **32**:545-546.

Mishra, G.M. and Choudhury, B. 1975. Investigation on physiological aspects of heterosis in brinjal (Solanum melongena L.). I. Rate of growth and size of embryo. Veg. Sci. **2**:21-28.

Mishra, R. 1977. Hybrid vigour in brinjal (Solanum melongena L.). Madras Agric. J. **64**(10):663-665.

Mital, R.K. Singh, S.N. and Singh, H.N. 1972. Genetics of some characters in brinjal (Solanum melongena L.). Veg. Sci. **11**:79-87.

Mochizuki, H. and Yamakawa, K. 1979. Potential utilization of bacterial wilt resistant Solanum species as rootstocks for commercial eggplant production. Bulletin of the Vegetable and Ornamental Crops Research Station. **6**:11-18.

Mochizuki, H. and Yamakawa, K. 1979. Resistance of selected egg plant cultivars and related wild Solanum species to bacterial wilt Pseudomonas solanacearum. Bulletin of the Vegetable and Ornamental Crops Research Station. **6**:19-27.

Monteiro, M.S.R. and Costa, C.P.P. 1977. Heterotic behaviour and phenotypic stability in hybrids of egg plant (Solanum melongena L.). Pl. Breed. Abstr. **47**(11):10888.

Mukherjee, R. and Mukhopadhyay, S. 1982. Effect of root exudates of brinjal on Pseudomonas solanacearum. Veg. Sci. **9**(2): 122.

* Nagai, K. and Kida, S. 1926. Experiments of hybridisation of various strains of Solanum melongena L. Japan J. Genet. **4**:10-30 (cf. Biol. Abstr. 3, 4571).

Nainar, P., Subbiah, R. and Irulappan, I. 1990. Association analysis in brinjal (Solanum melongena L.). South Indian Hort. **38**(3):137-138.

Narayanan, K.K. 1984. Evaluation of intervarietal hybrids of brinjal for yield and resistance to bacterial wilt. M.Sc.(Ag.) thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Narayanan, K.K. and Nair, V.G. 1983. Evaluation of brinjal varieties for resistance to bacterial wilt. Agric. Res. J. Kerala. **21**(2):58-60.

Nolla, J.A.B. 1931. Studies on the bacterial wilt of the Solanaceae in Puerto Rico. Puerto Rico. Dep. Agric. J. **15**:287-308.

Nualsri, C., Dhanasobhon, C. and Srinives, P. 1986. A study on the inheritance of some economically important characters in 4 cultivars of eggplants (Solanum melongena var. esculenta Nees). II. Gene actions controlling the characters. Kasetsart J. **20**:239-248.

Odland, M.L. and Noll, C.J. 1948. Hybrid vigour and combining ability in eggplants. Proc. Amer. Soc. Hort. Sci. **51**: 417-422.

Oganesyan, A.A. 1971. Heterosis for earliness in first generation eggplant hybrids. Referativnyi zhurnal **2**:47-49 (cf. Pl. Breed. Abstr. 42, 9327)

Ognyanova, A. 1970. A study of earliness in four tomato crosses II Early yield. Genet. Pl. Breed. Sofia **3**:435-450.

*Olalde, M.E., Gomez, O. and Prado, L. 1983. Effect of genotype - environment interaction in 18 tomato varieties. Centro Agricola **10**:115-126.

*Omidiji, M.O. 1976. Evidence concerning the hybrid origin of the local garden egg (Solanum melongena L.). Nigerian J. Sci. **10**($\frac{1}{2}$):123-135.

Ostle, B. 1966. Statistics in Research I. B.H. Oxford. pp.363-370.

Ozaki, K. and Kimura, T. 1989. Methods for evaluating the resistance of Solanum plants to bacterial wilt caused by Pseudomonas solanacearum. Bulletin of the Chugoka National Agricultural Experiment Station. **4**:103-117.

Pal, B.P. and Singh, H.B. 1943. Floral characters and fruit formation in egg plant. Indian J. Genet. Pl. Breed. **3**:45-58.

Pal, B.P. and Singh, H. 1946. Studies in hybrid vigour II Notes on the manifestation of hybrid vigour in the brinjal and bittergourd. Indian J. Genet. **6**:19-33.

Panse, V.G. and Sukhatme, P.V. 1954. Statistical methods for agricultural workers. 3rd ed: ICAR, New Delhi. pp.70-73.

Panse, V.G. and Sukhatme, P.V. 1967. Statistical Methods for Agricultural Workers, ICAR, New Delhi, pp.347.

Park, M. and Fernande, M. 1940. A variety of brinjal (Solanum melongena L.) resitant to bacterial wilt. Trop. Agric. **94**:19-21.

Patil, R.B. and Shinde, S.R. 1984. Heterosis in eggplant. J. Maharashtra Agric. Univ. **9**:289-292.

Perkins, J.M. and Jinks, J.L. 1968. Environmental and genotype-environmental components of variability III. Multiple lines and cross. Heredity **23**:339-356.

Peter, K.V. 1971. Studies on heterosis in brinjal (Solanum melongena L.) and analysis of genetic components. M.Sc.(Ag.) thesis, U.P. Agric. Univ. Uttarpradesh.

Peter, K.V. and Rai, B. 1976. Combining ability, heterosis and analysis of phenotypic variation in brinjal. Indian J. Agric. Sci. **44**(6):393-399.

Peter, K.V. and Rai, B. 1976. Stability parameters and G x E interaction in tomato. Indian J. Agric. Sci. **46**:395-398.

Poysa, V.W., Garton, R., Courtney, W.H., Metcalf, J.G. and Muchmer, J. 1986. Genotype-environment interactions in processing tomatoes in Ontario. J. Amer. Soc. Hort. Sci. **III**(2):293-297.

Quagliotti, L. 1962. Some aspects of heterostylism in Solanum melongena L. Sementielette **8**:30-38 (cf. Hort. Abstr. **33**, 1010).

Rajput, J.C., Palve, S.B., Jamadagni, B.M. and Salvi, M.J. 1984. Heterosis in brinjal (Solanum melongena L.). Agric. Sci. Digest India. **4**:215-217.

Ram, D., Singh, S.N., Chauhan, V.S. and Singh, N.D. 1981. Heterosis in brinjal. Haryana J. Hort. Sci. **10**:201-206.

Raman, K.R. 1964. Further studies on hybrid vigour in brinjal. Madras Agric. J. **51**:79-81.

Rao, G.R. and Anilkumar. 1980. Some observations on interspecific hybrid of Solanum melongena L. Proc. Indian Acad. Sci. (Plant Sci.) **89**(2):117-126.

Rao, M.V.B. 1972. Bacterial wilt due to Pseudomonas solanacearum (In) Bacterial diseases of plants in India. Notes edited by P.N. Patel, Prepared IARI, New Delhi.

Rao, M.V.B. and Sohi, H.S. 1977. Control of bacterial wilt. Indian Hort. **22**(1):11-13.

Rao, M.V.B., Sohi, H. and Vijay, O.P. 1976. Reaction of some varieties of brinjal (Solanum melongena L.) to Pseudomonas solanacearum Sm. Veg. Sci. **3**(1):61-64.

Rao, T.K.B. 1934. Partial sterility in the first generation plants of crosses between wild varieties of common eggplant. Curr. Sci. **2**(8):258-286.

Rashid, M.A., Mondal, S.N., Ahmed, M.S., Ahmad, S. and Sen, D.K. 1988. Genetic variability, combining ability estimates and hybrid vigour in egg plant (Solanum melongena L.). Thai J. Agric. Sci. **21**(1):51-61.

Rogue, A. 1941. Egg plants resistant to bacterial wilt. Puerto Rico Univ. Agric. Expt. Sta. Ann. Rept. for 1939-40, 47-48.

Salehuzzaman, M. 1981. Investigations on hybrid vigour in Solanum melongena L. SABRAO J. **13**:25-31. (cf. Pl. Breed. Abstr. 52, 8009).

*Salehuzzaman, M. and Alam, M.S. 1983. Genetic analysis of yield and its components in the eggplants. SABRAO J. **15**: 11-15.

Salimath, S.B. 1981. Diallel analysis of yield and yield components in brinjal. Thesis Abstr. Agric. College Dharwar (cf. Pl. Breed. Abstr. 52, 5342).

Sambandam, C.N. 1962. Heterosis in eggplants. Prospects and problems in commercial production of hybrid seeds. Econ. Bot. **16**:71-76.

Sanguineti, M.C., Coltelli, C. and Conti, S. 1985. Heterosis and combining ability in eggplant (Solanum melongena L.). Genet. Agric. **39**:345.

Scossiroli, R.E., Silvetti, E. and Brunelli, B. 1972. The genetics of products trait in egg plant. Genet. Agric. **26**:321-329.

Seethapathy, P. 1987. Studies on heterosis and combining ability in brinjal (Solanum melongena L.). M.Sc. thesis, Tamil Nadu Agricultural University, Coimbatore.

Shankar, A. 1984. Efficiency of four methods of selection in brinjal improvement in relation to resistance to bacterial wilt. M.Sc. thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Shankaraiah, V. and Rao, R.R. 1990. Studies on heterosis for growth characters and earliness in brinjal. Veg. Sci. **17**(1): 56-62.

Sharma, J.R. 1983. Studies on the adaptability of some tomato varieties in the State of Punjab. Thesis Abstr. **9**:101-102.

Sharma, J.R. and Nandpuri, K.S. 1984. Adaptability of some tomato varieties in Punjab. J. Res. Punjab Agric. Univ. **2**: 180-182.

Sheela, K.B. 1982. Cataloguing of brinjal germplasm to isolate line(s) resistant to bacterial wilt. M.Sc. thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Sheela, K.B., Gopalakrishnan, P.K. and Peter, K.V. 1984. Resistance to bacterial wilt in a set of eggplant breeding lines. Indian J. Agric. Sci. **54**(6):457-460.

Shekhawat, G.S., Singh, R. and Kishore, V. 1978. Distribution of bacterial wilt and races and biotypes of pathogen in India. J. Indian Potato Assoc. **5**(3):155-165.

Sidhu, A.S. 1989. Phenotypic stability in brinjal. Indian J. Genet. **49**(1):81-84.

*Silvetti, E. and Brunelli, B. 1970. Analysis of a diallel cross among some egg plant varieties and of their $F_1$ progeny. Genet. Agric. Pavia. **24**:258-268.

Singh, B.P. 1978. Stability studies in brinjal (*Solanum melongena* L.). M.Sc. thesis, P.A.U., Ludhiana.

Singh, B. and Kumar, N. 1988. Studies on hybrid vigour and combining ability in brinjal (*Solanum melongena* L.). Veg. Sci. **15**(1):72-78.

Singh, H. and Kalda, T.S. 1989. Heterosis and genetic architecture of leaf and yield characters in egg plant. Indian J. Hort. **46**(1):53-58.

Singh, H.N., Singh, S.N. and Mital, R.K. 1977. Heterosis in brinjal 1245-1247. U.P. Inst. Agric. Sci. Kanpur (cf. Pl. Breed Abstr. 47, 8145).

Singh, J., Singh, K. and Thakur, M.R. 1968. Hybrid vigour studies in brinjal (*Solanum melongena* L). J. Res. Ludhiana. **5**:490-495.

Singh, N.D. and Mital, R.K. 1988. Genetics of yield and its components in egg plant (*Solanum melongena* L.). Indian J. Agric. Sci. **58**(5):402-403.

Singh, R.D. and Rai, B. 1990. Studies on heterosis and gene action in brinjal (*Solanum melongena* L.). Veg. Sci. **17**(2): 180-185.

Singh, S.N. 1980. Studies on heterosis and perse performance in brinjal. Veg. Sci. **1**:18-27.

Singh, S.N., Singh, N.D. and Hazarika, G.N. 1982. A note on degree dominance and parental mean performance in brinjal (Solanum melongena L.). Haryana J. Hort. Sci. **11**($\frac{1}{2}$): 146-148.

Sitaramaiah, K., Singh, S.K. and Vishwakarma, S.N. 1985. Reaction of brinjal cultivars to bacterial wilt caused by Pseudomonas solanacearum. Indian J. Mycol. Pl. Path. **14**:218-222.

Sitaramaiah, K., Singh, R.S., Vishwakarma, S.N. and Dubey, G.S. 1981. Brinjal cultivars resistant to Pseudomonas solanacearum wilt. Indian Phytopath. **34**(1):113.

Som, M.G. and Maity, T.K. 1986. Brinjal (In) Vegetable Crops In India (ed.) Bose and Som. Naya Prakash, Calcutta. 293-330.

Sreenivasan, K., Gopimony, R., Swaminathan, M. and Kumara Pilla, B. 1969. On the resistance of a wild brinjal variety to bacterial wilt. Agric. Res. J. Kerala. **7**:39-40.

Srivastava, L.S. and Sachan, S.C.P. 1974. Correlation coefficient and path analysis in brinjal. Indian J. Agric. Sci. **43**:673-675.

Stofella, P.J., Bryan, H.H., Howe, T.K., Scolit, J.W., Lacascio, S.J. and Olsen, S.M. 1983. Yield stability differences between fresh market tomato genotypes. Hort Science **18**:599.

*Suzuki, I., Sugahara, Y., Katani, A., Todaka, S. and Shimada, H. 1964. Studies on breeding egg plants and tomato for resistance to bacterial wilt. Investigations on method of evaluating the resistance and on the source of resistance in egg plants and tomatoes. Bull. Hort. Res. St. Hiratsuka. Ser. A. **3**:77-106.

Swaminathan, M. and Sreenivasan, K. 1971. Studies on brinjal hybridization II. Transference of bacterial wilt resistance from a wild brinjal variety to cultivated brinjal varieties. Agric. Res. J. Kerala. **9**(1):11-13.

Tai, G.C.C. 1971. Genotypic stability analysis and its application to potato regional trials. Crop Sci. **11**:184-190.

Thakur, M.R., Singh, K. and Singh, J. 1968. Hybrid vigour studies in brinjal (Solanum melongena L.). J. Res. Punjab Agric. Univ. Ludhiana. **5**:490-495.

Thomas, J. 1987. Heterosis for yield and resistance to bacterial wilt in brinjal. M.Sc.(Ag.) thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Tiwari, R.D. 1966. Studies on hybrid vigour in Solanum melongena L. J. Indian Bot. Sci. **45**:138-139.

Ushamani, P. 1987. Phenotypic stability analysis in a set of bacterial wilt resistant lines of brinjal. M.Sc. thesis, Kerala Agric. Univ., Vellanikkara, Trichur.

Vadivel, E. and Bapu, K.J.R. 1989. Genotype x environment interaction for fruit yield in eggplant (Solanum melongena). South Indian Hort. **37**(3):141-143.

Vaughan, E.K. 1944. Bacterial wilt of tomato caused by Pseudomonas solanacearum. Phytopath. **34**:443-458.

Vavilov, N.I. 1931., Mexico and Central America as the Principal Centre of origin of cultivated plants of the New World. Bulletin of Applied Botany, Genetics and Plant Breeding. **26**:360-651.

Venkataramani, K.S. 1946. Breeding brinjals in Madras. I. Hybrid vigour in brinjals. Proc. Indian Acad. Sci. **23**: Sect. B. 266-273.

Verma, S., Kumar, J.C., Chadha, M.L. 1986. Heterosis studies in brinjal (Solanum melongena L.). Progr. Hort. **18**(3-4): 213-215.

Vijayagopal, P.D. and Sethumadhavan, P. 1974. Studies on the intervarietal hybrids of Solanum melongena. Agric. Res. J. Kerala **11**:43-46.

Vijay, O.P. and Nath, P. 1978. Studies on heterosis and development of hybrid variety in brinjal (Solanum melongena L.). Indian J. Hort. **35**:229-241.

Viswanathan, T.V. 1973. Hybrid vigour in brinjal. Proc. Indian Acad. Sci. **77**:176-180.

Wager, V.A. 1946. Eggplants resistant to bacterial wilt. Farming in South Africa. **21**:410-412.

Winstead, N.N. and Kelman, A. 1952. Inoculation techniques for evaluation of resistance to Pseudomonas solanacearum. Phytopathology **42**:628-634.

Yein, B.R. and Rathiah, Y. 1984. Field incidence of shoot and fruit borer and bacterial wilt in some promising cultivars of brinjal and their yield performance. J. Res. Assam Agric. Univ. **5**(1):104-110.

* Originals not seen

# EVALUATION OF $F_1$ HYBRIDS RESISTANT TO BACTERIAL WILT AND INHERITANCE OF RESISTANCE IN BRINJAL (*Solanum melongena* L.)

By

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## ABSTRACT OF A THESIS

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ABSTRACT

The present studies "Evaluation of $F_1$ hybrids resistant to bacterial wilt and inheritance of resistance in brinjal (Solanum melongena L.) were conducted during February 1990 to July 1991 in the vegetable research plots of Kerala Agricultural University, Vellanikkara.

Evaluation of $F_1$ hybrids over 4 environments revealed that all the 3 hybrids were superior to their parents for yield during all the four seasons. It also indicated significant role of genotype x environment interaction in the yielding ability of the hybrids. Considering wilt resistance the hybrids were not superior to their parents. Varietal difference was observed for plant height, fruits/ plant, fruit weight, fruiting period and productive flowers.

Estimation of heterosis of three $F_1$s over their parents revealed significant heterosis for plant height, days to flower, days to first fruitset, days to harvest, primary branches/plant, total fruits/plant, total yield/plant, average fruit weight and fruiting period.

All the three hybrids viz. Surya x Pant Rituraj, SM 6-6 x SM 132, SM 6-2 x Pusa Purple Cluster were stable.

Study on the nature of inheritance showed that resistance to bacterial wilt is inherited in a recessive and monogenic manner.