# EFFICIENCY OF FOUR METHODS OF SELECTION IN BRINJAL IMPROVEMENT IN RELATION TO RESISTANCE TO BACTERIAL WILT

By

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**THESIS**

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## DECLARATION

I hereby declare that this thesis entitled "Efficiency of four methods of selection in brinjal improvement in relation to resistance to bacterial wilt" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Asha Sankar.

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Vellanikkara,

9-6- 1984.

## CERTIFICATE

Certified that this thesis entitled "Efficiency of four methods of selection in brinjal improvement in relation to resistance to bacterial wilt" is a record of research work done independently by Miss Asha Sankar, M. 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.

Vellanikkara,
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Chairman,
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## CERTIFICATE

We, the undersigned members of the Advisory Committee of Miss Asha Sankar, M, a candidate for the degree of Master of Science in Horticulture agree that the thesis entitled "Efficiency of four methods of selection in brinjal improvement in relation to resistance to bacterial wilt" may be submitted by Asha Sankar, M. in partial fulfilment of the requirement for the degree.

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# Introduction

# INTRODUCTION

Brinjal (*Solanum melongena* L) is an important fruit vegetable cultivated throughout the tropics. One of the serious problems that limits its cultivation is the incidence of bacterial wilt caused by *Pseudomonas solanacearum* E.F. Smith. It is particularly serious in the acidic soils of Kerala. Chemical control measures have proved ineffective to control the disease. Any attempt to evolve resistant lines would be highly desirable. Wilt resistant lines were reported from Japan, South Africa and Puerto-Rico. SM-6, a brinjal line from Kerala Agricultural University showed considerable degree of resistance to wilt. The line is promising for many economic characters. The line exhibited considerable variability for morphological characters and those associated with earliness and productivity. Practising selection on the existing variability in SM-6 would be highly beneficial. Simple methods of selection like mass, single plant, pure line and single seed descent methods of selection could improve economic characters along with resistance to wilt.

Studies at the Department of Olericulture, Kerala Agricultural University indicated the presence of transgressive seggregant(s) within SM-6 which were grouped into eleven distinct types. The present work

is intended to improve upon the above eleven types for earliness and yield keeping resistance to bacterial wilt intact. The specific objectives of the study were:

1. To study the relative efficiency of four methods of selection - mass, single plant, pure line and single seed descent to improve level of productivity and resistance to bacterial wilt.
2. To estimate genetic gain and other parameters of vegetative characters, earliness, yield and their components as affected by four selection methods.
3. To select out promising plant types for desirable horticultural characteristics and resistance to wilt within the eleven genetic groups identified earlier.

The data collected in the present study are analysed and presented in Chapter IV and discussion made in Chapter V.

# Review of Literature

## REVIEW OF LITERATURE

The genetic diversity existing in a population provides the basis for any crop improvement programme. Most of the variability existing in the plant population for various characters could be fixed in one cycle of selection (Chaudhary, 1968). Selection procedures like mass, pure line, pedigree, bulk, recurrent selection and more recently single seed descent have been used to advantage in various crop plants.

### A. Relative efficiency of different methods of selection

#### 1. Mass selection.

The success obtained through mass selection depends on heritability, size of population, intensity of selection, linkage relationships and variability of characters (Chaudhary, 1968). Higher the selection intensity in mass selection better would be the success. Singh and Singh (1976) in their study of comparing various selection procedures, observed that, mass selection could be used to exploit both additive and dominance variance. Swarup (1977) stated that mass selection was effective to improve highly heritable characters, but was not useful in the case of polygenic characters. To overcome the disadvantages of mass selection, Swarup (1977) suggested mass pedigree method which would be effective to drift the population to a maximum adaptive

peak at which the selected population would attain equilibrium.

Chaubey (1979) found mass selection advantageous for improving characters like yield. However as the total genetic variability became restricted, the scope of improvement through mass selection became limited.

2. Pure line selection.

Johannsen (1903) provided a scientific basis for selection in self pollinated crops, when he advocated the pure line theory. According to Allard (1960) with 'n' heterozygous gene pairs, the proportion of completely homozygous plants after 'm' generations of self fertilization was given by:

$$\left(\frac{2^m-1}{2^m}\right)^n$$

Chaudhary (1968) reported that pure line selection has special significance in the improvement of self-pollinated crops. In cross pollinated crops, it could not be used with same ease and success. He also stated that no new genotypes would be created by pure line selection. But mixed populations from farmer's field and unimproved varieties could be used to isolate superior pure lines and then release them as varieties.

3. Single seed descent.

In principle, single seed descent is a modification of bulk method of breeding. The method was modified by

Grafius (1965) when it was designed to preserve total range of variation throughout the propagation period and to minimise the effects of natural selection in changing the genotypic array in the original population.

According to Brim (1966), when additive type of epistasis was of significance in the inheritance of economic characters, this method was as inefficient as when genotypic variance was mostly additive. His report also established the fact that only less effort was made to obtain homozygous types for simply inherited characters which were discontinuous/discrete in expression. Boerma and Cooper (1975) reported that single seed descent allowed rapid generation advance of materials in early seggregating generations. They also reported that single seed descent required the least overall selection effort.

Muchlbaner et al. (1981) compared single seed descent and bulk population breeding methods in a hypothetical crop which had seven chromosomes, each with six loci and with various amounts of linkage. In the 6th inbred generation, additive genetic variance was less in bulk population than with single seed descent. This difference was attributed to losses in genetic variability in the bulk population during generation advance. Fecundity affected the genetic variability in the bulk population breeding method.

Hill (1971) compared pure line selection, recurrent selection to an inbred tester and reciprocal recurrent selection, for a case with two alleles at one locus. With complete dominance, reciprocal recurrent selection was more effective than pure line selection. With partial dominance, reciprocal recurrent selection was found equal to pure line selection. Recurrent selection was found suitable to improve characters by pooling of additive genetic variance (Swarup, 1977).

B. Improvement of solanaceous crops through different selection methods

Pierce and Currence (1959) studied the efficiency of single plant selections for earliness, yield and fruit size in a tomato cross. Their observations indicated that considerable gain in fruit size was obtained in one generation of selection. Days to maturity, however, showed little response to selection. This was due to presence of a relatively small amount of genetic variation. A significant increase was obtained in yield/plant. Selection for either of the characters, yield and earliness gave a general improvement. Singh et al. (1974) reported that selection could be beneficial to improve yield and its components in brinjal.

Casali and Tigchelaar (1975) compared genetic advance in tomato obtained through pedigree selection and single seed descent. They reported that single seed descent was

effective when several characters with differing heritability were under simultaneous selection.

Singh and Singh (1976) reported that in chilli and other solanaceous crops, the concept of pure line selection and progeny selection had been used for genetic upgrading of yield and other economic traits. The estimates of high heritability indicated that considerable improvement could be brought about by methods like mass selection, progeny selection, family selection or reciprocal recurrent selection to exploit both additive and dominance variance.

Pierce (1977) studied the impact of single seed descent in selecting for fruit size, earliness and total yield in tomato. The study revealed that single seed descent method of selection per se produced generally inferior and smaller fruit size and low total yield in progenies as compared with pedigree selection alone or single seed descent followed by one cycle of pedigree selection. The data further suggested that chances of recovering high performance in lines would be reduced in single seed descent method of selection as compared to pedigree selection.

Celin (1981) in her study on the efficiency of selection procedures in tomato improvement, reported that progenies developed through mass selection were superior to those developed through bulking for days to harvest, fruits/plant and total fruit weight/plant. The progenies

developed through pure line selection were superior to bulking for days to fruit set, days to first harvest and marketable fruit weight/plant. The study further revealed that selection response through mass selection was positive for primary branches/plant, while for plant height, selection response through bulk method was positive. The content of total soluble solids averaged 5° brix in progenies developed through mass selection and ranged from 4° to 5°C brix in pure line selection (Celin, 1981).

C. Genetic parameters as guide for crop improvement in brinjal

In any crop improvement programme through selection, we have to consider a set of characters which may have direct or indirect effects on the desired causal factor. Selection of one character invariably would affect a number of associated characters. A knowledge on the genetics and inheritance of characters as well as the inter-relationship among them, would be useful in selecting characters for improvement.

1. Earliness.

Days to flower and days to first harvest denote earliness or otherwise of a brinjal variety. Komochi (1966) made detailed study on the genes controlling early

maturation of $F_1$ hybrids in brinjal wherein, $F_1$S of a diallel cross among six varieties showed heterosis for early yield. He noted that days to flower was positively correlated to number of leaves present before flowering and leaf size and negatively correlated with yield.

Plant characters with high variability had higher scope for improvement through selection. Srivastava and Sachan (1973) conducted variability studies in brinjal at the University Research Farm, Vallabhanagar, Udaipur. They could observe only minimum variability for days to fruiting with a gcv value of 8.49. For more specific conclusions, they estimated the genetic advance as percentage of mean for this trait and obtained value of 6.42. His report was in agreement with the report given by Singh et al. (1974), who also observed low genetic gain for days to flower and days to fruit set, though these characters showed high heritability estimates. This signifies that high heritability was not always an indication of high genetic gain and such characters might be controlled by non-additive gene action including dominance and epistasis. Similar reports confirming the non-additive gene action for days to flower were also given by Gill et al. (1976) and Peter and Singh (1976).

2. Vegetative characters.

Vegetative characters like plant height, plant spread and primary branches/plant have been studied to

derive valid conclusions regarding their inheritance pattern, type of gene action controlling them and other genetic parameters.

Dhesi et al. (1964) observed high heritability for primary branches/plant in brinjal. Eldin (1967) observed partial dominance of tall plants over short. Choudhuri (1972) studied the $F_2$ seggregation ratios in egg plant and observed that plant height was controlled by a single pair of alleles. These results were further confirmed by Peter and Singh (1973) who suggested an over dominant type of gene action for primary branches/plant.

In the variability studies conducted by Srivastava and Sachan (1973) at the University Research Farm, Vallabhanagar, gcv values of 14.65 and 5.88 were obtained for plant height and primary branches/plant respectively while their respective heritability values were 92.12% and 45.69%.

Genotypic, phenotypic and environmental correlations for various characters in brinjal have been worked out by Singh and Khanna (1978). Their report revealed that plant height did not show any correlation with plant spread and branches/plant. A significant positive correlation was observed between plant spread and branches/plant.

3. Yield and its components.

Yield, being a complex character depends on a number of quantitative characters. In brinjal, among the characters

on which total yield depends, percentage of productive flowers prevalent is more important. Heterostyly is prevalent in brinjal, wherein, long and medium styled flowers set fruits while short and pseudostyled flowers do not. Additive gene effects have been indicated for long and medium styled flowers in a study conducted by Peter and Singh (1973). Fruits/plant was observed governed by additive gene action while total fruit weight was controlled by a dominant type of gene action.

A path analysis was conducted by Srivastava and Sachan (1973) to determine the direct and indirect effects of component characters on yield in brinjal. The study revealed that yield/plant had a significant and positive correlation with fruits/plant and a significant negative correlation with weight of 10 fruits. Obviously selection for more fruits/plant would lead to selection for higher yield.

A biometrical approach to partition the observed variability for yield and its components into heritable and non-heritable, was undertaken by Hiremath and Gururaja Rao (1974). The highest gcv was for fruits/plant (65.59) while the lowest was for fruit length (31.48). Heritability estimates were high for all characters while high genetic advance was seen for fruits/plant (84.04) and yield (54.67). Dharmegouda et al. (1979) and Singh and Khanna (1973) reported an additive

type of gene action for both fruits/plant and yield.

Comparitive data for contribution to total genetic diversity in normal and ratoon crops of brinjal indicated that percentage of long, medium and pseudostyled flowers and total fruit yield together contributed to 44.7% and 41.81% of total diversity in normal and ratoon crops respectively (Dhankar et al. 1980).

D. Bacterial wilt resistance in brinjal

Bacterial wilt caused by Pseudomonas solanacearum E.F. Smith is one of the serious diseases that limits the cultivation of solanaceous crops, particularly in the acid soils of Kerala. Varieties resistant to bacterial wilt have been reported by workers as early as 1935. The origin of the disease is lost in antiquity (Buddenhagen and Kelman, 1964).

1. Races and strains of the pathogen.

Okabe and Goto (1961) conducted detailed studies on the strains of Pseudomonas solanacearum. They found that the isolates obtained from various solanaceous hosts in Japan could be separated into 40 groups based on biochemical property, serological reactions and sensitivity to virulent phages. In general, the in vitro determined groups were not the same as groups designated as pathotypes with evaluation of pathogenicity based on

artificial inoculations using a series or differential hosts like tomato, tobacco and brinjal. They further recognised three types of strains.

1. Strains specialised in pathogenecity, (2) Strains specialised in pathogenecity and other physiological and morphological characters, (3) Strains specialised in bacteriological characters only.

Buddenhagen et al. (1962) separated the isolates of Pseudomonas solanacearum into three races based on their pathogenecity reaction - Race-1 was found to attack tobacco, tomato, brinjal and certain diploid bananas. Race-2 was pathogenic on triploid bananas and Heliconia spp. Race-3 was pathogenic to potato and tomato but weakly on other solanaceous crops.

Buddenhagen et al. (1966) studied the comparitive carbohydrate catabolism in different pathogenic strains of Pseudomonas solanacearum. The three strains used in the study was 'T' strain of Race-1 and 'B' and 'SFR' of Race-2. 'T' strain was found different from the other two strains. The two strains of Race-2 were similar metabolitically.

Morton et al. (1966) investigated the serological relationships of Race-1, 2 and 3 of P. solanacearum and observed that Races-2 and 3 have more agglutinins in common than either has with Race-1.

Keshwal and Joshi (1976) undertook studies to know the

occurrence of different strains/races of Pseudomonas solanacearum on different hosts. Ten isolates were put into test. It was found that the isolate A 12/74 was equally infective on all solanaceous hosts but not on Ajeratum where as the isolate G 5/73 could infect this host but not solanaceous hosts except tomato and brinjal. T 24/69 was found to be the most infective isolate.

In an attempt to study the variation in Pseudomonas solanacearum Rath and Addy (1977) used 10 selected isolates from wilted tomato plants and the prepared culture was inoculated on tomato, chillies and potato. There was not much difference between the isolates on tomato while none of the isolates were found pathogenic on potato and chillies. Though morphologically alike, the isolates exhibited variations in respect of biochemical characters like gelatin liquefaction, action on litmus etc.

2. Additional hosts of the pathogen.

Apart from the hosts mentioned above, Pseudomonas solanacearum infects a large number of plants and weeds like groundnut, sesamum, petunia and zinnia (Ramadevi and Menon, 1979).

3. Factors effecting severity of the disease.

a. Environmental factors

Disease development is more rapid with increasing soil

temperatures from 26.7° to 37.8°C (Vaughan, 1944). He observed no wilt development in tomatoes when soil temperature was 21.1°C. Gallegly and Walker (1949) reported that high moisture levels in soil affected the disease by enhancing the survival of bacteria in the soil, by increasing capacity for infection and by quickening disease development after infection. Thus the effect of periodic drying of the soil in bacterial viability appears to be a major factor in the absence of wilt.

b. Plant age and inoculation technique

Winstead and Kelman (1952) evaluated certain factors contributing to bacterial wilt incidence. Their study revealed that in susceptible lines age had no marked effect, while in resistant lines susceptibility decreased with increase in age of plants from four to eight weeks. In a study conducted by Jenkins and Nesmith (1976), to assess the severity of wilt in tomato and brinjal as influenced by age of plant and inoculation technique, it was seen that the resistant varieties of tomato, Venus and Saturn and the brinjal variety Kopek survived bacterial wilt better in the field, if transplanted, when seedlings were about eight weeks old. When stem inoculated the above cultivars were found highly susceptible. They exhibited resistance when inoculated by root wounding.

c. Plant stand density

Winstead and Kelman (1952) could observe no significant difference in disease readings among any of t. plant population groups ranging from 45 to 450 plants/flat.

d. Other factors

Lucas et al. (1954) observed high incidence of wilt in soils infected with Meloidogyne incognita. Kelman and Cowling (1965) reported high wilt incidence at pH 3.5.

Goth et al. (1983) used eight isolates of Pseudomonas solanacearum (Race-1) from diverse geographic locations to study the bacterial wilt resistance of selected tomato lines. Bacterial resistance was broken down when root knot nematode larvae were added at a rate of 100/10 cm pot at the time of inoculation with bacterial isolates. These results suggested that Meloidogyne incognita should be considered as a factor in the development of bacterial wilt resistant tomato germplasm.

4. Evaluation of brinjal varieties for resistance.

Davidson (1935) observed that Puerto Rican brinjal varieties Camuy and Long Green were resistant to bacterial wilt. The variety was found superior in quality with just one per cent infection, when grown on infected land.

Trials conducted at Botanical Research Station, Durban, by Wager (1946) have shown that the varieties Natale and Kopek showed high degree of resistance to bacterial wilt. Empig et al. (1962), at a trial conducted in Philippines observed that the indigenous variety La Union was wilt resistant.

Daly (1970) made crosses between SM-164, a Ceylonese variety tolerant to bacterial wilt and a few susceptible varieties like Florida Market and Barbentane Purple. The $F_1$, $F_2$ and back cross progenies contained a high proportion of tolerant plants. Daly (1973) further developed promising lines L-17 and L-19 by crossing the tolerant cultivar SM-164 with susceptible ones like Florida Market. Dikil and Studentsova (1975) observed varieties like Half long 42 and Cylindrical 55 resistant to wilt and they were used to produce promising hybrids. Lum and Wong (1976) could control bacterial wilt incidence in tomato considerably when susceptible tomato scions were grafted to resistant brinjal root stocks like Sabah and Hitam Bulat. The grafts were found totally compatible and disease incidence was reduced to 10% in fields.

Rao et al. (1976) at the Indian Institute of Horticultural Research, Bangalore observed Dingras Multiple Purple and Sinampiro from Pholippines and Pusa Purple Cluster from IARI, New Delhi to be wilt resistant.

Grubben (1977) reported resistance to bacterial wilt in Japanese cultivar Nihon Nassu. Gill et al. (1978) observed resistance to bacterial wilt under green house and field conditions in Pusa Purple Cluster.

Sitaramaiah et al. (1981) screened 22 cultivars of brinjal against bacterial wilt. The wilted vs healthy plants were recorded regularly and a disease score was made as per the following standards:

1. Immune - 0% plants wilted
2. Highly resistant - 1 to 10% plants wilted
3. Moderately resistant - 11 to 50% plants wilted
4. Moderately susceptible - 51 to 70% plants wilted
5. Highly susceptible - 71 to 100% plants wilted

Goth et al. (1983) tested four lines of brinjal, SM-6, Classic 465, Black Magic 462 and Deuoky for disease reaction to seven isolates of P. solanacearum belonging to Race-1 and Race-3. The line SM-6 was found resistant to TFP-13, 126408-1 and W-82. The isolates TFP-13 and 126408-1 belonged to Race-1 and W-82 to Race-3. They also observed that SM-6 is susceptible to isolates K-60, TFP-12 and Tifton 80-1. It showed tolerant reaction to isolate A-21.

5. Related species of Solanum resistant to bacterial wilt

Buddenhagen (1960) observed Solanum torvum to be wilt resistant. Sreenivasan et al. (1969) observed

resistance to bacterial wilt in the popular brinjal cultivar, Purple Long Datta and in the wild type Solanum meloncena var. inermum. Gopimoni and Sreenivasan (1970) made crosses between Solanum meloncena var. inermum and three cultivated brinjal varieties. All the $F_1$ hybrids showed a high degree of resistance and exhibited heterosis for many characters. The potentiality of Solanum meloncena var. inermum as a possible source for wilt resistance was also reported by Vijayagopal and Sethumadhavan (1973).

6. Mechanism of resistance to bacterial wilt

Gallegly and Walker (1949) observed that resistant factors in host plants were associated with light dependant processes. Akai and Kuneida (1955) suggested a resistance mechanism based on the presence of a few inhibitory substances in the leaves of resistant brinjal varieties. Qualitative differences in phenolic compounds between resistant and susceptible brinjal varieties were also noted. Maine (1958) observed that resistant varieties became susceptible when reducing agents were applied.

Maine and Kelman (1961) observed that polyphenol oxidase activity was much greater in infected than in healthy stem tissues. Hence they suggested that polyphenol oxidase may be involved directly or indirectly

in resistance of host plants to pathogenic micro-organisms including Pseudomonas. Gopimony and Srinivasan (1970) observed a significant increase in dry matter content, starch, protein and total alkaloids in the resistant brinjal hybrids.

7. Inheritance of resistance.

Hybridisation studies conducted by Swaminathan and Srinivasan (1971) showed that resistance to bacterial wilt was monogenically controlled and was transmitted to the $F_1$ and back cross progenies completely. The donor parent Solanum melongena var insanum carried the dominant gene for resistance. The $F_1$ hybrid was resistant since it had the dominant gene for resistance.

Studies in the $F_2$ generation of the cross between Solanum melongena L. var. Pusa Datta and Solanum melongena var. insanum were carried out by Vijayagopal and Sethumadhavan (1973) to find out the mode of inheritance of characters with special reference to wilt resistance. The resistance was found to be monogenically inherited and resistance was dominant over susceptibility.

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 a resistant and susceptible cultivar.

A heritability (narrow sense) estimate of 42% and $h^2(b)$ estimate of 53% with a degree of dominance of 75% were observed. A diallel analysis conducted in the same study indicated that general combining ability was more important than specific combining ability and that inheritance to resistance was due to additive gene action.

# Materials and Methods

## MATERIALS AND METHODS

The present studies were conducted at the College of Horticulture, Kerala Agricultural University, Vellanikkara during June-December, 1982 and January-May, 1983. The experimental area is warm and humid and the soil is moderately acidic (pH 5.1). There was high incidence of bacterial wilt in this area when solanaceous crops were grown.

### A. Experimental materials

Eleven genetic groups based on fruit colour, shape and presence/absence of prickles within the brinjal line SM-6 formed the basic material for making selections and evaluating for bacterial wilt resistance under field conditions.

The source, pedigree and morphological description of the 11 genetic groups are given in Table 3.1. Each of the 11 genetic groups were improved through four methods of selection - mass, pure line, single plant and single seed descent. The selections were done in two succeeding cycles, one during June-December, 1982 and another during January-May, 1983.

### B. Experimental methods

The studies were conducted in three parts.

Part 1. Identifying elite plant types in each of the 11 genetic groups.

Out of the 11 genetic groups identified by Sheela (1982)

within the line SM-6, a total of 44 lines were developed through mass, single plant, pure line and single seed descent methods of selection. The criteria for selecting elite plant types were:

Fruits/plant and

total fruit yield/plant

Procedure adopted for each of the four methods of selection was as follows:

Mass selection - Observations were made on all the plants in each group for fruits/plant and total fruit yield. The intensity of selection followed was five per cent and plants falling in the upper five per cent limits in each group were selected, fruits collected, seeds extracted and bulked.

Single plant selection - The most promising elite plant within each group was selected, fruits harvested, seeds extracted and progressed.

Pure line selection - In each group considering all the plants, the most promising elite plant was identified. The plant was selfed to develop progenies through pure line selection.

Single seed descent - The largest sized single seed was collected from each of the fruits borne in the most promising and elite plant selected for pure line selection.

**Part 2. Evaluation of progenies developed through four methods of selection and estimation of realised genetic gain for economic characters along with resistance to bacterial wilt.**

The 44 lines were sown in raised beds during June, 1982. When the seedlings were 10 to 15 cm height, they were transplanted to main field at a spacing of 60 x 60 cm in a Compact Family Block Design with three replications. There were 10 plants/progeny/replication. Observations were recorded on earliness, vegetative characters, productive characters and their components as detailed below:

Earliness:

- Days to flower
- Days to harvest

Vegetative characters:

- Plant height (cm)
- Primary branches/plant

Productive characters:

- Percentage of productive flowers
- Fruits/plant
- Average fruit weight
- Yield/plant

The data were analysed in a Compact Family Block Design, considering methods of selections in main plots and genetic groups in sub plots. An analysis of variance between methods of selection was carried out to test

whether the four selection methods differed significantly or not in improving various economic characters. This was followed by an analysis of variance between genetic groups within each selection method. Those selection methods with homogeneous error mean squares were pooled and a pooled analysis of variance was conducted (Panse and Sukhatme, 1978). The analysis of selection methods were kept separate for characters whose error mean squares were heterogenous.

In addition to the general analysis of variance the following genetic parameters were also estimated.

Genotypic coefficient of variation (gcv) (Burton, 1952) = $\frac{\sigma g \times 100}{\text{Arithmetic mean}}$

where $\sigma g = \sqrt{\sigma^2 g}$ = genotypic standard deviation

$\sigma^2 g$ was estimated as

$$\sigma^2 g = \frac{\text{Mean squares due to genotypes} - \text{Error mean squares}}{\text{No. of replications}}$$

The gcv was calculated for each method of selection.

Phenotypic co-efficient of variation (pcv)(Burton, 1952) = $\frac{\sigma p \times 100}{\text{Arithmetic mean}}$

where $\sigma p = \sqrt{\sigma^2 p}$ = phenotypic standard deviation

The $\sigma^2 p$ was estimated as

$$\sigma^2 p = \sigma^2 g + \sigma^2 e$$

The pcv was estimated for each method of selection separately.

Heritability in the broad sense ($h^2 b$) (Allard, 1960) = $\frac{\sigma^2 g}{\sigma^2 p}$

where $\sigma^2 g$ was genotypic

variance and $\sigma^2_p$ was phenotypic variance

Expected genetic advance at 5% intensity of selection =

$$ih^2\sigma_p$$

where i = a constant at 5% intensity of selection = 2.06

$h^2$ = heritability in broad sense

$\sigma_p$ = phenotypic standard deviation.

Expected genetic advance as percentage of mean =

$$\frac{\text{genetic advance} \times 100}{\text{arithmetic mean}}$$

Realised genetic gain for various characters under different methods of selection.

The mean performance of different selection methods were compared with the overall mean performance of the whole population and the realised genetic gain was calculated for different characters.

| | |
|---|---|
| Realised genetic gain under mass selection | Mean performance under mass selection - overall mean |
| Realised genetic gain under single plant selection | Mean performance under single plant selection- overall mean |
| Realised genetic gain under pure line selection | Mean performance under pure line selection - overall mean |
| Realised genetic gain under single seed descent | Mean performance under single seed descent - overall mean |

Relative efficiency of different methods of selection

The superiority of one selection method over the

other was assessed by comparing their relative realised genetic gain.

Evaluation of genotypes for resistance to bacterial wilt

Evaluation for resistance to bacterial wilt was done by counting the number of plants wilted during the two growth stages - juvenile stage and bearing stage. The incidence of bacterial wilt was confirmed through ooze test for each of the wilted plants. The lines were grouped into highly susceptible, moderately susceptible, moderately resistant, highly resistant and immune as per Sitaramaiah et al. (1981).

Part 3. Repeated evaluation of progenies developed through four methods of selection.

The 44 lines were further developed as in Part 1 through four methods of selection in the 11 genetic groups, based on pure line from pure line, mass from mass and so on. The progenies thus evolved were sown in raised bed during January 1983. The seedlings, 10 to 15 cm height, were transplanted to main field at a spacing of 45 x 60 cms. The design, experiment, observations taken and statistic analysis were same and similar as in Part 2.

Table 3.1. Morphological description of the eleven genetic groups under selection

| Genetic group | Prickly/Non prickly | Fruit colour | Fruit shape |
|---|---|---|---|
| SM-6-4 | Non prickly | Green | Long |
| SM-6-2 | Non prickly | Purple | Long |
| SM-6-6 | Non prickly | White | Long |
| SM-6-11 | Non prickly | White | Oval |
| SM-6-9 | Non prickly | Green | Oval |
| SM-6-7 | Non prickly | Purple | Oval |
| SM-6-10 | Prickly | White | Oval |
| SM-6-8 | Prickly | Green | Oval |
| SM-6-3 | Prickly | Green | Long |
| SM-6-5 | Prickly | White | Long |
| SM-6-1 | Prickly | Purple | Long |

# Experimental Results

## RESULTS

Data collected in the present studies were statistically analysed and presented under the following heads:

A. Somatic analysis of progenies developed through mass, single plant, pure line and single seed descent selection methods for economic characters.

B. Assessing the relative efficiency of four methods of selection.

C. Evaluation of genetic groups for economic characters.

D. Evaluation for resistance to bacterial wilt.

### A. Somatic analysis of progenies developed through mass, single plant, pure line and single seed descent selection methods for economic characters

Forty four lines of the brinjal line SM-6, consisting of 11 genetic groups, each developed through four methods of selection, were studied for genetic differences, if any, for characters - plant height, primary branches/plant, days to fruit set, days to first harvest, percentage of productive flowers, fruits/plant, average fruit weight and total yield/plant (Tables 4.1A and 4.1B).

The methods of selection differed significantly among themselves for days to fruit set, days to harvest,

percentage of productive flowers, average fruit weight, fruits/plant and yield/plant in the first cycle of selection. Similar observations were recorded in the second cycle, except for vegetative characters (plant height and primary branches/plant) where significant differences were observed among the selection methods. The 11 genetic groups differed significantly among themselves for all the characters under study in two consecutive cycles of selection except average fruit weight, where no significant difference was observed under mass and pure line selections in the first cycle (Tables 4.1A and 4.1B).

Plant height ranged from 50.5 cm in SM-6-1 to 110.6 cm in SM-6-6 in the first cycle while the range narrowed slightly in the second cycle (60 cm - 102.4 cm) (Table 4.2). Primary branches/plant ranged from one to six in both the cycles.

Among productive characters, fruits/plant ranged from three in SM-6-3 to 19 in SM-6-2, SM-6-4 and SM-6-5 in the first cycle. The range slightly widened in the second cycle to four fruits/plant in SM-6-10 to 23 fruits/plant in SM-6-2. Yield/plant varied from 200 g in SM-6-3, SM-6-6, SM-6-10 and SM-6-11 to 1.71 kg in SM-6-4 in the first cycle. Yield/plant ranged from 50 g in SM-6-5 to 1.9 kg in SM-6-7 during the second cycle.

The highest variability (gcv) was observed for total yield/plant (23.44 and 22.05 in the first and second cycles of selection respectively). High heritability ($h^2b$) values were observed for yield and its components, the values being 0.99 for average fruit weight and yield in both the cycles and 0.96 and 0.99 for fruits/plant in the first and second cycles respectively.

High heritability associated with high variability was noted for yield/plant (gcv = 23.44 and $h^2b$ = 0.99 in the first cycle and gcv = 22.05 and $h^2b$ = 0.99 in the second cycle). In the second cycle, fruits/plant had considerable variability (gcv = 22.05) coupled with high heritability ($h^2b$ = 0.99). Genetic advance as percentage of mean was comparatively higher for yield/plant (47.85 and 45.32 in the first and second cycles respectively).

B. Assessing the relative efficiency of four methods of selection

The four methods of selection mass, single plant, pure line and single seed descent were critically examined to judge their relative effectiveness to upgrade the base population in two consecutive cycles of selection (Table 4.3). Progenies developed through single plant selection set fruit the earliest (39.82 days after transplanting and 32.80 days after transplanting

and 32.80 days after transplanting in the first and second cycles of selection respectively). Total fruit yield/plant was also the highest in progenies developed through single plant selection (886.76 g/plant and 1115.64 g/plant in the first and second cycles of selection respectively). In both the cycles progenies developed through pure line selection and single seed descent were inferior as compared to the overall mean for all productive characters (Fig. 1 and Fig. 2).

Efficiency of selection methods was also judged in terms of improving the genetic parameters of the progenies (Table 4.4). Genetic advance as percentage of mean was the highest for total yield/plant in progenies developed through single plant selection (20.07 and 23.28 in the first and second cycles of selection respectively). Closely related productive characters - percentage of productive flowers and fruits/plant also had higher values of genetic advance as percentage of mean in progenies developed through single plant selection (21.59 and 15.13 respectively in the first cycle and 19.47 and 22.70 respectively in the second cycle).

Heritability values ($h^2b$) for total yield/plant were also higher for progenies developed through single plant selection (0.74 and 0.85 in the first and second cycles respectively) followed by mass selection (0.69 and 0.67 in the first and second cycles of selection

respectively). Heritability values for yield components like percentage of productive flowers (0.78 and 0.71 in the first and second cycles respectively), fruits/plant (0.75 and 0.88 in the first and second cycles respectively) and average fruit weight (0.73 and 0.74 in the first and second cycles respectively) were also higher in progenies developed through single plant selection.

Realised genetic gain as compared to the overall mean under the four methods of selection was also estimated for the characters under study (Table 4.5). Realised genetic gain for yield/plant was considerable in progenies developed through single plant selection in the first (+175.91 g over and above the overall mean) and second (+198.74 g over and above the overall mean) cycles of selection.

C. Evaluation of genetic groups for economic characters

The pooled genetic groups exhibited significant differences among themselves for primary branches/plant, days to fruit set, days to harvest, percentage of productive flowers, fruits/plant and yield in two consecutive cycles of selection (Table 4.1A). For average fruit weight no significant difference was observed among the 11 genetic groups under mass and pure line methods of selection in the first cycle. In

the second cycle, the groups differed significantly for this trait under all the four selection methods (Table 4.1B). The mean performances of the 11 genetic groups for distinct characters, were used to identify elite genetic group(s). The genetic group SM-6-2 yielded better in mass (969.17 g/plant), single plant (1003.33 g/plant), pure line (640.67 g/plant) and single seed descent (670 g/plant) methods of selection (Tables 4.6a, 4.6b, 4.6c and 4.6d). In the second cycle, SM-6-1 yielded better under pure line selection (815.33 g/plant). The genetic group SM-6-2 had more fruits/plant under all the four selection methods in the first cycle (Tables 4.6a, 4.6b, 4.6c and 4.6d). In the second cycle SM-6-4 performed the best under single plant selection (15.57 fruit/plant). The performance of the genetic group SM-6-11 was found inferior for production characters including total yield/plant under mass (627.50 g/plant and 972.00 g/plant in the first and second cycles of selection respectively), single plant (710.67 g/plant and 933.33 g/plant in the first and second cycles of selection respectively), pure line (489.33 g/plant and 641.00 g/plant in the first and second cycles of selection respectively) and single seed descent (457.67 g/plant and 665.33 g/plant in the first and second cycles of selection respectively) methods of selection alike.

D. Evaluation for resistance to bacterial wilt

Information regarding incidence of wilt in the 11 genetic groups under four methods of selection in two consecutive cycles are provided in Fig. 3 and Fig. 4. The mean wilt incidence of the base population got reduced from 4.4% in the first cycle to 2.86% in the second cycle. Incidence of wilt in the 11 genetic groups under four methods of selection were noted in two growth stages, one at juvenile stage and another during adult stage (Tables 4.7a and 4.7b). In the first cycle complete plant immunity (0% wilt incidence) was observed under all the selection methods in SM-6-1, SM-6-4 and SM-6-9. Single seed descent conferred immunity to SM-6-2 and SM-6-6, while SM-6-3 was found immune under mass, single plant and pure line methods of selection. Maximum wilt incidence was noted in the genetic group SM-6-8 under mass (20%), single plant (20%), pure line (16.67%) and single seed descent (13.33%) methods of selection. In the second cycle, wilt incidence was very low with SM-6-4, SM-6-11, SM-6-9, SM-6-8 and SM-6-1 showing complete immunity (0% wilt incidence) under four methods of selection alike. Single seed descent was found effective where it gave complete immunity to nine out of 11 genetic groups. SM-6-10 and SM-6-3 were the only lines which gave a wilt incidence of 3.33% and 6.67% respectively under

single seed descent. Wilt incidence was comparatively higher in progenies developed through mass and pure line selection while single plant selections performed moderately. In the second cycle also maximum wilt incidence was observed in lines SM-6-5 (20%, 10%, 13.33% and 6.67% under mass, single plant, pure line and single seed descent methods of selection respectively) and SM-6-10 (13.33%, 6.67%, 13.33% and 3.33% under mass, single plant, pure line and single seed descent methods of selection respectively).

# Discussion

# DISCUSSION

The practice of selecting desirable individuals from a variable population is an ancient art (Allard, 1960). Three phenotypically discernible responses which could be achieved through selection are changes in the proportion of previously existing genotypes accompanied by a shift in population mean, appearance of new genotype(s) and changes in the variability of the population (Allard, 1960). In the present study, four methods of selection - mass, single plant, pure line and single seed descent were utilised to exploit the genetic variability in the brinjal line SM-6, keeping basic resistance to bacterial wilt intact.

## A. Genetic basis of selection

The basic principles underlying selection are that selection could act only on heritable differences and that selection acts only on the variability that is already in existence. The different methods of selection practised in the present study aimed to locate desirable transgressive seggregant(s) in the population which were grouped into eleven distinct types based on fruit shape, fruit colour and presence/absence of prickles. Variability existing for various plant characters among individual plants of a population could be fixed in one cycle of selection (Choudhary, 1968). In the present

study the variability existing in the population for earliness, vegetative characters and productive characters were exploited in two consecutive cycles of selection. Linkage of a character for which selection is being practised, with an undesirable character might create problems while a desirable linkage might bring in improvement in the linked character as well (Choudhary, 1968). In brinjal for upgrading yield through selection, selection for more fruits/plant was found beneficial (Srivastava and Sachan, 1973). In the present study closely related productive characters- fruits/plant and total yield/plant were taken as criteria for selecting elite progenies.

B. Relative efficiency of four selection methods to improve economic characters

The study revealed that among the four methods of selection practised, progenies developed through single plant selection and mass selection performed better for productive characters (Table 5.1). According to Choudhary (1968) mass selection and closely related procedures are more successful in cross pollinated crops than pure line selection. Obviously, brinjal being an often cross pollinated crop, pure line selection was found rather ineffective. Choudhary (1968) opined that success through mass selection depended on the heritability of

character under selection. Characters showing high heritability like fruits/plant ($h^2b$ = 0.96 and $h^2b$ = 0.99 in the first and second cycles of selection) and fruit yield/plant ($h^2b$ = 0.99 in both the cycles of selection) could be developed better through mass and single plant methods of selection. Celin (1981) in her study on the efficiency of selection procedures in tomato improvement reported that progenies developed through mass selection were superior to those developed through bulking for days to harvest, fruits/plant and total fruit weight/plant. The present study also revealed that realised genetic advance was positive for progenies developed through mass and single plant selections.

Brim (1968) suggested that when additive type of variance was significant, the single seed descent method of selection was found ineffective. In the present study, progenies developed through single seed descent method of selection were inferior for fruits/plant and total yield/plant. Casali and Figchelaer (1975) reported that single seed descent method of selection was effective only when several characters with differing heritability values were under simultaneous selection.

C. Estimation of genetic parameters

Information on heritability, variability and their components are highly desirable to any plant improvement

programme. High heritability was noted for primary branches/plant in the first ($h^2b$ = 0.87) and second ($h^2b$ = 0.96) cycles of selection. Singh et al. (1974) also observed high heritability for primary branches/plant in a study conducted with 24 lines of brinjal obtained through selection. The character was found to have low genetic gain (9.6). In the present study primary branches/plant had low genetic (4.15) in the first cycle of selection. It is inferred that this character might be governed by a non-additive type of gene action. The non-additive type of gene action for primary branches/plant was suggested by Peter and Singh (1973).

Days to fruit set had high heritability values ($h^2b$ = 0.88 and $h^2b$ = 0.81) in the first and second cycles of selection respectively. Genetic advance was low (6.34 and 6.38 in the first and second cycles of selection respectively). Similar observations were made for days to harvest. This observation did agree with the report of Srivastava and Sachan (1973) who observed low genetic gain (6.42). This signified that high heritability was not always an indication of high genetic gain and such characters were seldom improved by selection.

High heritability ($h^2b$ = 0.96, 0.99 in the first and second cycles of selection respectively) was observed for fruits/plant and total yield/plant ($h^2b$ = 0.99 in both the cycles of selection). The genetic gain was

also comparitively higher for fruits/plant (21.37 and 46.2 in the first and second cycles of selection respectively) and total yield/plant (47.85 and 45.32 in the first and second cycles of selection respectively). High estimates of genetic gain were observed for fruits/plant (84.04) and yield (54.67) by Dharmegowda *et al.* (1979). Selection of more fruits/plant led to selection for higher yield (Srivastava and Sachan, 1973).

D. Relative performance of eleven genetic groups progressed through four methods of selection

The eleven genetic groups exhibited significant differences among themselves for plant height, primary branches/plant, days to fruit set, days to harvest, fruits/plant and yield/plant. The genetic groups SM-6-1, SM-6-2 and SM-6-4 were promising for fruits/plant and yield/plant. The genetic group SM-6-1 exhibited immunity to bacterial wilt in both the cycles of selection. The group SM-6-1 was characterised by long, purple, non-prickly fruits and was promising for economic characters and resistance to bacterial wilt. SM-6-1 yielded 0.91 kg/plant in the basic selection (Sheela, 1982).

E. Evaluation for resistance to bacterial wilt

The resistance of the basic population of SM-6 to bacterial wilt was confirmed through multilocational trials and through artificial inoculation (Table 5.2).

Goth et al. (1983) inoculated seedlings of SM-6 with seven virulent isolates of Pseudomonas solanacearum belonging to Race 1 and Race 3. SM-6 was found resistant to TFP-13 (Race 1), 126408-1 (Race 1) and K-82 (Race 3). It showed tolerant reaction to isolate A-21 but was susceptible to isolates K-60 (Race 1), TFP-12 (Race 1) and Tifton-80-1 (Race 1). Preliminary observations on incidence of bacterial wilt made at Kerala Agricultural University with 25 popular varieties indicated yield losses from nil to 100% (Kerala Agricultural University, 1979). The existance of different pathogenic races of Pseudomonas solanacearum as reported by Buddenhagen et al. (1962) further complicated the breeding effort. Attempts were made to develop multi isolate resistant lines in SM-6 with desirable horticultural characteristics.

The relative efficiency of different selection methods to improve level of resistance was also worked out. Progenies developed through single seed descent method of selection exhibited greater resistance to wilt. When screened under field conditions SM-6-1 exhibited complete immunity (score-1) under all the four methods of selection.

In the present study, variability existing within the basic population of brinjal line SM-6 for earliness, vegetative characters and productive characters were

exploited through mass, single plant, pure line and single seed descent methods of selection. Being a cross pollinated crop, mass selection and single plant selection were found superior to pure line selection and single seed descent methods to improve horticultural characteristics. The study further confirmed that high heritability was not always an indication of high genetic gain and such characters could not be improved by selection alone. The level of resistance of SM-6 to bacterial wilt was assessed under four methods of selection. Single seed descent was found effective to improve level of resistance. Uniformity for plant characters within the eleven genetic groups has not yet been attained even after two cycles of selection.

Table 5.2. Disease reaction of the basic population of SM-6 to *Pseudomonas solanacearum* under multilocation trials

| Year | Location | Number of plants | Plants wilted | Resistance (%) | Score |
|---|---|---|---|---|---|
| 1979 | Vellanikkara | 25 | 0 | 100 | 1 |
| 1980 | Vellanikkara | 539 | 4 | 99.26 | 2 |
| 1981 | Vellanikkara | 2840 | 8 | 99.72 | 2 |
| 1982 | Vellanikkara | 1100 | 362 | 67.09 | 3 |
| 1982 | Farmer's field, Kizhuparamba | 100 | 70 | 30 | 4 |
| 1982 | Farmer's field, Idukki | 25 | 0 | 100 | 1 |
| 1982 | Farmer's field, Mannarghat | 150 | 0 | 100 | 1 |
| 1982 | Farmer's field, Maraamcoor | 50 | 0 | 100 | 1 |
| 1983 | Regional Agricultural Research Station, Pilicode | 162 | 0 | 100 | 1 |
| 1983 | Agronomic Research Station, Chalakudy | 80 | 27 | 66.25 | 3 |

# Summary

## SUMMARY

1. Eleven genetic groups within the brinjal line SM-6 were progressed through four methods of selection - mass, single plant, pure line and single seed descent. The forty four lines thus obtained were sown during June, 1982 and January, 1983 in two successive cycles of selection.

2. New progenies were studied for earliness, vegetative characters, productive characters and their components. There was significant difference among the selection methods for days to fruitset, days to harvest, percentage of productive flowers, fruits/plant, average fruit weight and total yield/plant.

3. The relative efficiency of the four methods of selection to improve economic characters was critically examined. Progenies developed through single plant selection and mass selection were superior to those developed through pure line and single seed descent methods of selection for earliness and productive characters. Efficiency was also examined in terms of improving genetic parameters of progenies. Genetic advance as percentage of mean was the highest for total yield/plant in progenies developed through single plant selections in both the cycles. Realised genetic gain as compared to the overall mean was positive for progenies developed through mass and single plant

selections for fruits/plant, average fruit weight and yield/plant.

4. The performance of the eleven genetic groups was also evaluated under each selection method. The eleven genetic groups differed significantly among themselves for all the characters under study in both the cycles of selection except for average fruit weight in the first cycle of selection. The genetic groups SM-6-2, SM-6-1 and SM-6-4 were promising for fruits/plant and yield/plant.

5. Simultaneous evaluation for resistance to bacterial wilt under field conditions was also conducted in two consecutive cycles of selection. Among the four selection methods, single seed descent was found effective to raise level of resistance considerably in all the genetic groups. The genetic groups SM-6-1, SM-6-4 and SM-6-9 showed complete plant immunity in both the cycles of selection. The resistance of the basic population of SM-6 to bacterial wilt was also confirmed through multilocational trials and through artificial inoculation.

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# Appendices

Plate No: 1

S.M. 6-1

Plate No: 2

S.M. 6-5


PPL


PWL

Plate NO: 3

S.M.-6-7

Plate NO: 4

S.M.-6-8


NPPOVAL


PGOVAL(m)

Plate NO: 5

S.M_6-10

Plate NO: 6

S.M_6_11


PWOVAL


NPWOVAL

# EFFICIENCY OF FOUR METHODS OF SELECTION IN BRINJAL IMPROVEMENT IN RELATION TO RESISTANCE TO BACTERIAL WILT

By

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## ABSTRACT OF THE THESIS

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## ABSTRACT

Bacterial wilt caused by *Pseudomonas solanacearum* is one of the serious problems that limits its cultivation in Kerala. With the identification of SM-6, a brinjal line from Kerala Agricultural University showing considerable degree of resistance to wilt, the prospect of brinjal cultivation has become brighter under the acidic soil conditions of Kerala. Studies at the Department of Olericulture, Kerala Agricultural University, indicated the presence of transgressive seggregant(s) within SM-6 which were grouped into eleven distinct types. Hence a study was undertaken at the College of Horticulture, Vellanikkara to improve upon the existing eleven types for earliness and yield keeping resistance to wilt intact.

Each of the eleven genetic groups were improved through four methods of selection mass, single plant, pure line and single seed descent. The selections were conducted in two consecutive cycles. The criteria for selecting elite plant types were fruits/plant and total yield/plant. Observations were recorded on earliness, vegetative characters, productive characters and their components.

The relative efficiency of the four methods of selection to improve economic characters was critically examined. Being a cross pollinated crop mass selection and single plant

selection were found superior to pure line selection and single seed descent to improve economic characters.

Genetic information like genotypic co-efficient of variation, phenotypic co-efficient of variation, heritability in the broad sense, genetic advance and genetic advance as percentage of mean was estimated for the progenies developed through four methods of selection. The relative efficiency of the four methods of selection was also examined in terms of improving genetic parameters of progenies. Genetic advance as percentage of mean was highest for progenies developed through single plant selection. Realised genetic gain for economic characters as compared to the overall mean was positive for progenies developed through mass and single plant selections.

The eleven genetic groups were also evaluted under each selection method for the characters under study. The genetic groups [illegible] and [illegible] were promising for fruits/plant and yield/plant.

The level of resistance of [illegible] to bacterial wilt was assessed under four methods of selection. Single seed descent was found effective to improve the level of resistance of [illegible] to bacterial wilt. When screened under field conditions, the genetic groups [illegible], and [illegible] exhibited complete plant immunity under all the four methods of selection, in both the cycles. Multi locational trials and artificial inoculation studies further confirmed the resistance of the basic population of [illegible] to bacterial wilt.