REALISED SELECTION RESPONSES UNDER FOUR METHODS OF SELECTION IN THIRD AND FOURTH CYCLES IN A SET OF BRINJAL LINES

BY

JESSY KUTTY, P. C.

THESIS

submitted in partial fulfilment of
the requirement for the degree

Master of Science in Horticulture

Faculty of Agriculture
Kerala Agricultural University

Department of Olericulture
COLLEGE OF HORTICULTURE
Vellanikkara - Trichur

1985

DECLARATION

I hereby declare that the thesis entitled "Realised selection responses under four methods of selection in third and fourth cycles in a set of brinjal lines" 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.

Vellanikkara,

-- -- 1985.

JESSYKUTTY, P.C.

CERTIFICATE

Certified that this thesis entitled "Realised selection responses under four methods of selection in third and fourth cycles in a set of brinjal lines" is a record of research work done independently by Miss. Jessykutty, P.C. 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,

-- -- 1985.

Dr. K.V. Peter,
Chairman,
Advisory Committee,
Professor of Horticulture.

CERTIFICATE

We, the undersigned members of the Advisory Committee of Miss. Jessykutty, P.C., a candidate for the degree of Master of Science in Horticulture agree that the thesis entitled "Realised selection responses under four methods of selection in third and fourth cycles in a set of brinjal lines" may be submitted by Miss. Jessykutty, P.C. in partial fulfilment of the requirement for the degree.

Dr. K.V. Peter,
Chairman.

Dr. R. Vikraman Nair,
Member.

Sri. V.K.G. Unnithan,
Member.

Sri. T.R. Gopalakrishnan,
Member.

ACKNOWLEDGEMENTS

I wish to express my most sincere sense of indebtedness and gratitude to Dr. K.V. Peter, Professor of Horticulture and Head of the Department of Olericulture for the invaluable help rendered during the course of the investigation, both as Chairman of my Advisory Committee and as the inspiring force contributing critical suggestions.

I wish to place on record, my thanks to Dr. R. Vikraman Nair, Professor of Agronomy (KADP) and Sri. T.R. Gopalakrishnan, Assistant Professor, Department of Olericulture for the advices they have rendered to me during the preparation of the manuscript of this thesis.

My profound sense of gratitude is expressed to Shri. V.K.G. Unnithan, Professor, Department of Agricultural Statistics for the whole hearted co-operation extended to me in the statistical analysis of the data.

I am very much indebted to the staff of Department of Olericulture, for the help they have rendered to me at all stages of the investigation.

I am grateful to Dr. P.C. Sivaraman Nair, Director of Research and to Dr. P.K. Gopalakrishnan, Associate Dean, College of Horticulture, Vellanikkara for providing necessary facilities for the conduct of this work.

I also wish to thank those many friends who have without hesitation given freely of their help at all stages of the work.

My thanks are also due to Sri. V.M. Sulaiman, for neatly typing out the manuscript.

The award of the fellowship by the Kerala Agricultural University is gratefully acknowledged.

JESSYKUTTY, P.C.

CONTENTS

LIST OF TABLES

Table No.

LIST OF PLATES

LIST OF FIGURE

Introduction

INTRODUCTION

Brinjal (*Solanum melongena* L.) is one of the most important vegetables in the warm humid tropics. It is popular throughout the tropics for its relatively easier method of culture. 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. We can double the economic gain if varieties that are resistant to the disease are evolved, thereby avoiding both the loss from disease and the cost of sprays and other ways of controlling the disease. Any attempt to evolve resistant lines would then, be highly desirable. SM 6, a brinjal line from Kerala Agricultural University showed considerable degree of resistance to wilt. The line is promising for many economic traits. The line exhibited considerable variability for morphological characters and those associated with earliness and productivity.

Studies conducted at the Department of Olericulture, Kerala Agricultural University, indicated the presence of transgressive segregant(s) within SM 6 which were grouped into eleven distinct types. Simple methods of selection like mass, single plant, pure line and single seed descent methods of selection were found to improve economic characters along with resistance to wilt. The present work is intended to improve further the above eleven types for earliness and yield, keeping resistance to bacterial wilt intact. The specific objectives of the study were:

1. To estimate realised selection responses under four methods of selection - mass, single plant, pure line and single seed descent - in the improvement of productive characters and resistance to bacterial wilt.
2. To identify early lines in each of the eleven groups and progress the progenies based on earliness and total yield.
3. To ascribe definite advantage of one method over other, among the four methods of selection to identify early and higher yielding lines keeping bacterial wilt resistance intact.

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

Review of Literature

REVIEW OF LITERATURE

The improvement of commercial varieties of any agricultural crop depends on the skill of the plant breeders to produce new seedlings of outstanding merit and on the efficiency of the programme for selecting good performers from the larger total number of plants raised. The usual procedure is to conduct field trials for several seasons, rejecting each year (for an annual crop) a proportion of the poorer performers until only the best remains (Finney, 1958). Most of the variability existing in the population for various chafacters can be fixed in one cycle of selection (Chaudhary, 1982). 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 (Asha Sankar, 1984).

A. Relative efficiency of different methods of selection.

1. Mass selection

In a study to determine the relative effectiveness of recurrent selection, selection-while-inbreeding and mass selection, Bilbro (1961) reported that from the stand point of time and labour required, mass selection was the most efficient method. Frey (1967) reported that in a heterogeneous and segregating oat population subjected to mass selection technique, the mean yield of the final mass selected population increased by nine per cent after five consecutive generations of mass selection. The results of a study conducted by Redden and Jensen (1974) to compare the responses of two cycles of mass selection under two mating systems, showed that mass selection with concurrent random mating could be a useful breeding strategy in self pollinated crops. Singh and Singh (1976) compared various selection procedures and 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. Mishra et al. (1978) reported that neither mass selection nor single seed descent was effective after one generation of selection for characters with low heritability like yield and seed number. Chaubey (1979) found mass selection advantageous to improve crop yield. The scope of improvement through mass selection becomes limited as the total genetic variability becomes restricted. Nayak and Patnaik (1979) suggested a modified method of mass selection which would permit a gradual but fuller exploitation of the variability of germplasm complexes to achieve high levels of productivity. Kauffmann and Dudley (1979) reported mass selection to be as effective as half sib family selection to increase protein content in corn. Choo and Kannenberg (1979) reported that a fewer and only minor genes were lost during mass selection. They also reported that under the complete dominance model the rate of increase in gene frequency was slow in mass selection.

2. Single plant selection

Selection on a single plant basis at F_2 is generally ineffective and is the best suited for characters of high heritability like plant height and disease resistance, with selection for yield and other characters that are much influenced by environment postponed until later generations (Valentine, 1979). It was demonstrated (Sneep, 1977) that without positive selection for yield during the early generations, the expected frequency of high yielding genotypes decreases at an alarming rate, and in these circumstances delayed selection for yield seriously limits genetic advance. On the basis of a study on the reliability of single plant selection for yield in F_2, McGinnis and Shebeski (1968) concluded that selection of well tillered vigorous F_2 plants would increase the general yielding capacity of the F_3 lines and would consequently be advantageous to a breeding programme. Chebib et al. (1973) concluded that the efficiency of single plant selection for eleven characters including grain yield in wheat could be doubled by close planted sowing of uniform sized seeds relative to wider spaced stands sown with unsorted seeds. Valentine (1979) reported that the efficiency of single plant selection for yield may be improved via selection for yield components of higher broad sense heritability at the individual plant level. He also stated that the uniformity of sowing may also improve the efficiency of single plant selection.

3. Pure line selection

Pure line selection in relation to other breeding procedures, may be defined as selection with maximum inbreeding (Andrus, 1963). He stated that pure line selection is advantageous at the beginning of a breeding programme to establish parental lines of known genetic content. It is also advantageous at the end of a breeding cycle to provide sufficient uniformity of type, and in special breeding methods like production of F_1 hybrid varieties. According to him one basic weakness of pure line selection lies in the too rapid advance towards a homozygous genotype with the result that insufficient opportunity occurs for genetic recombinations and for the operation of natural selection. Chaudhary (1982) 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 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.

4. Single seed descent

In principle, single seed descent is a modification of bulk method of breeding. This 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. Empig and Fehr (1971) reported that single seed descent was the method least influenced by natural selection. Tee and Oualset (1975) reported that the single seed descent and bulk population methods were generally comparable except for the important competition effect. In a system of rapid generation turn over where only a few seeds per plant are produced, the bulk population method can be applied more efficiently than single seed descent but when competition effects are important, single seed descent becomes the preferred method. Boerma and Cooper (1975) reported that this method allowed rapid generation advance of materials in early segregating generations. They also reported that single seed descent required the lowest overall selection effort. According to Roy (1976) under single seed descent the loss of weak competitors was slower than it might have been under natural selection in the field.

In a study to compare the relative efficiency of single seed descent and bulk population breeding methods for maintaining genetic variation and selection opportunities, Haddad and Muchlbauer (1981) reported that SSD maintained more genetic variation in 15 of 21 comparisons of characters, that were made. Genetic variances were significantly higher with SSD for plant height, days to maturity and yield. According to them the SSD method is an efficient cost-saving method of advancing populations. Muchlbauer 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 sixth imbred generation, additive genetic variance was less in bulk population than in 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. According to Cooper (1982) single seed descent has the advantage over the other pedigree method in more rapid generation turnover, less space requirement, sampling of a larger number of F_2 plants per cross and yield testing only after the inter lines genetic variation is fixed. According to him the limitations of this procedure, were no early generation selection and no or limited sampling of within F_2 genetic variability. Using this procedure, five varieties tracing to one cross and two F_2 plants have been released.

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. Suzuki et al. (1964) employed a method of open pollinated single plant selection for the selection of wilt resistant egg plant lines. By this method they expected to release promising candidate strains of new varieties of egg plants having high degree of bacterial wilt resistance and superior commercial characters. 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. In a study on the genetics of some characters in brinjal, Mital *et al.* (1976) reported that selection of valuable segregants resulting from the accumulation of additive genetic component, could most effectively be carried out on the basis of fruit weight and yield/plant. Mishra and Roy (1976) also reported that in brinjal there is scope for the improvement of characters like yield/plant, fruits/plant and average fruit weight by selection as well as their utilization in advance breeding programme. 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 to 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.

Singh and Khanna (1979) reported that rapid improvement through selection could be made in brinjal for traits like fruit diameter and plant height. Singh *et al.* (1979) reported breeding methods such as biparental mating followed by reciprocal recurrent selection could be used in brinjal to provide greater improvement. Singh and Singh (1980a) also indicated the possibility of success for selection for characters like fruit girth, fruits/plant and yield/plant, in brinjal.

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. Ten single seed descent tomato lines evaluated during the 1981-82 dry season out yielded the highest yielding check (13.8 t/ha). CL 9-0-0-1-3 was the highest yielder (23.7 t/ha), (AVRDC, 1982).

Sheela et al. (1982) reported that pure line selection and single plant selection were equally effective to improve fruit weight/plant in brinjal. Single plant selection was more effective to improve fruits/plant.

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 effect 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 to select characters for improvement.

1. Earliness

Days to flower and days to first fruit 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_1S 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 oonclusions, they estimated the genetic advance as percentage of mean for this trait and obtained a value of 6.42. His report was in agreement with the report given by Singh _et al_. (1974) and Singh and Singh (1980a) who also obtained a low genetic gain for days to flower and days to fruit set, though these characters showed high heritability estimates. This signifies that high heritability estimates 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); Peter and Singh (1976) and Singh _et al_. (1979). In a study on heterosis and development of hybrid variety in brinjal, Vijay and Nath (1978) reported that heterosis was manifested over the better parent for fruit yield and days to flower.

2. Vegetative characters

Vegetative characters like plant height, plant spread and primary branches/plant serve as an index of general plant vigour and are indirect components of fruit yield. These characters 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 segregation 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) 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 per cent and 45.69 per cent. 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.

Singh and Singh (1980b) reported high heritability for plant height and fruit length. In a correlation and path coefficient analysis study in 90 F_2 populations of brinjal they reported that fruit yield showed positive association with plant height. This was in contrast with the findings of Singh and Singh (1981) who observed a negative correlation between yield and plant height. Mak and Vijiarungam (1980) reported that there was positive correlation between yield and primary branches. Borikar et al. (1981) reported that additive genetic effects predominated for yield/plant, plant height and branches/plant. They also stated that heritability was high for plant height and branches/plant.

3. Yield and its components

Selection based on the performance for fruit yield, a polygenically controlled character, is usually not very effective, but the one based on its component characters could be more efficient. Correlations are helpful to determine the component characters of a complex entity like yield. In brinjal among the characters on which total yield depends, percentage of productive flowers present is more important. Meterostyly is observed 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). 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 ten fruits. Obviously selection for more fruits/plant would lead to selection for higher yield. A biometrical approach to partition of the observed variability for yield and its components into heritable and non-heritable, was undertaken by Hiremath and 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 (94.04) and yield (54.67). Mishra and Roy (1976) reported high heritability values and high percentage of genetic advance for yield/plant, fruits/plant and average fruit weight. Mital et al. (1976) observed yield/plant to be genetically a complex character with presence of over dominance. They stated that fruit weight proved to be genetically more stable than any other component of yield and thus could be effectively used in component breeding. Bhutani *et al.* (1977) reported that marketable fruits/plant and the total fruits/plant had high genetic coefficients of variation and high estimates of heritability and genetic advance. Dharmegowda *et al.* (1979) reported that the narrow sense heritability estimates were 63.48 per cent and 67.48 per cent for fruits/plant and seeds/fruit respectively. Singh *et al.* (1979) observed a negative association for branches/plant and fruit yield. Singh and Singh (1980a) reported high gcv, heritability and genetic advance for fruit girth, fruits/plant and yield/plant and indicated the possibility of success for selection for these characters. A path coefficient analysis conducted by them revealed that fruit girth and fruits/branch were the major factors contributing to yield and that selection should be focussed primarily on these traits. Salehuzzaman and Joarden (1980) reported that fruit weight, fruit volume and fruits/plant showed high phenotypic and genotypic coefficients of variation associated with high heritability and genetic gain. Mak and Vijiarungam (1980) stated that yield/plant was positively correlated with fruits/plant, mean fruit weight, mean fruit length, primary branches/plant and seeds/fruit. According to Borikar *et al.* (1981)

additive genetic effects predominanted for yield/plant and that yield/plant was also influenced by non-additive effects. Heritability was moderate for yield/plant. Singh and Singh (1981) reported that fruit girth showed the greatest direct effect on yield/plant followed by fruit length and fruit weight.

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).

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 properties, 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 of differential hosts like tomato, tobacco and brinjal. They further recognized three types of strains (1) strains specialised in pathogenicity (2) strains specialised in pathogenicity and other physiological and morphological characters only. Hayward (1964) also described Pseudomonas solanacearum as a complex species consisting of several races differing in host range and pathogenicity.

Buddenhagen et al. (1966) studied the comparative carbohydrate catabolism in different pathogenic strains of Pseudomonas solanacearum. The three strains used in the study were '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 Pseudomonas solanacearum and observed that Races 2 and 3 have more agglutinins in common than either has with Race 1.

Keshwal and Joshi (1976) studied the occurrence of different strains/races of Pseudomonas solanacearum on different hosts. Then isolates were put into test. It was found that the isolate A 12/74 was equally infective on all solanaceous hosts but not on a Ageratum, whereas 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 liquifaction and action on litmus. In a study on the strains of Pseudomonas solanacearum affecting Solanaceae in the Americas, Martin et al. (1982) reported that of 85 strains of Pseudomonas solanacearum from 10 countries in the Americas and from four solanaceous hosts, 28 strains were biotype I, 52 were biotype II and 5 were biotype III. They selected 30 representative strains which were pathogenic on all three hosts by a soil infestation method. Biotype II had more pathogenic strains than biotype I under glass house conditions. Only one strain of biotype III from tomato, affected potatoes.

2. Additional hosts of the pathogen

Keshwal *et al.* (1977) reported that *Pseudomonas solanacearum* could infect ajwain (*Trachyspermum ammi* L.) and fennel (*Foeniculum vulgare* Mill) and cause bacterial wilt.

3. Factors affecting severity of the disease

(a) Environmental factors

Disease development is more rapid with increasing soil temperatures from 26.7°C to 37.8°C (Vaugham, 1944). He observed no wilt development in tomatoes when soil temperature was 21.1°C. Earle (1900) reported that an increase in the moisture content of the infested soils resulted in an increased infection by *Pseudomonas solanacearum*, although Nakata (1927) found that there was a "detrimental" moisture content of the soil which would kill the organism. Infection may occur at soil temperature as low as 55°F but symptoms of bacterial wilt ordinarily do not become apparent at temperatures of 55° to 60°F. The rate of development of the disease increases from 70°F to as high as 110°F soil temperature (Vaugham, 1944). He also reported that a constant, but not necessarily a good supply of soil moisture appeared to be essential for the growth of

Pseudomonas solanacearum. 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 the capacity for infection and by quickening disease development after infection. Thus the effect of periodic drying of the soil on bacterial viability, appears to be a major factor for the absence of wilt.

6. Age of plant and inoculation technique

Winstead and Kelman (1952) evaluated 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 plant 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 the above cultivars were stem inoculated, they were found highly susceptible. They exhibited resistance reaction when inoculated by root wounding.

C. Plant stand density

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

D. Other factors

Nakata (1927) reported that in Japan Phytomonas solanacearum grows only in soils with a reaction between pH 6.0 and 8.1 but Eddins (1936) was able to obtain growth in culture on agars having reactions between pH 4.25 and 8.71. He also found that the organism was present in Florida soils having reactions as low as pH 4.32. He was able to control the disease however, by treating soils with sufficient sulfur to reduce the pH to 3.5 to 4.0. Lucus 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. Mukherjee and Mukhopadhyay (1982) reported that the virulence of the bacterium was related to the age of the culture of bacteria, after its isolation from the host plant. In a study to find out the effect of root exudates of brinjal on Pseudomonas solanacearum, they found that the root exudates of the susceptible variety (Pusa Purple Long) enhanced the population of the bacterium whereas that of the resistant variety, Pusa Purple Cluster showed very little enhancement of the population.

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 wilt 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 the Botanical Research Station, Durban by Wager (1946) showed that the varieties Matale and Kopek showed a 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. Suzuki *et al.* (1964) reported a brinjal line, Taiwan-Naga to be a population composed of immune individuals. In the breeding works they used Taiwan-Naga and OTB-1 as resistant parents. 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 backcross 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. Dutta and Kishun (1974) reported, that local collections from Bihar, SM 6 (Ceylon) Muktakeshi and Kerala collections showed good potential of bacterial wilt resistance. Lum and Wong (1976) could control bacterial wilt incidence in tomato considerably when susceptible tomato scions were grafted on resistant brinjal rootstocks like Sahah and Hitam Butal. The grafts were found totally compatible and disease incidence was reduced to 10 per cent in fields. Rao <u>et al</u>. (1976) at Indian Institute of Horticultural Research, Bangalore, observed Dingras Multiple Purple and Sinampiro from Philippines and Pusa Purple Cluster from Indian Agricultural Research Institute, New Delhi to be wilt resistant. Grubben (1977) reported resistance to bacterial wilt in Japanese cultivar Nehan Nassu. Gill *et al.* (1978) observed resistance to bacterial wilt under green house and field conditions in Pusa Purple Cluster.

Sitaramaih *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 per cent plants wilted
2. Highly resistant	-	1 -10 per cent plants wilted
3. Moderately resistant	-	11 -50 per cent plants wilted
4. Moderately susceptible	-	51 -70 per cent plants wilted
5. Highly susceptible	-	71-100 per cent plants wilted

They reported Pusa Purple Round, Vijai Hybrid Banaras Giant Green and Pusa Purple Cluster to be highly resistant. Gopimony *et al.* (1982) reported that the mutants obtained by irradiating the F_1 seeds of Purple Giant, *Solanum melongena* var *insanum* were resistant to *Pseudomonas solanacearum*. Experiments conducted at the Department of Olericulture, Kerala Agricultural University, Trichur showed that the brinjal line SM 6 was resistant to bacterial wilt disease and was accepted as a source of resistance in the All India Co-ordinated Vegetable Improvement Research Programme (K.A.U., 1981). The brinjal lines SM 1, SM 6, SM 48, SM 56, SM 70, SM 72 and SM 74 and one line of Solanum texanum were also found to be resistant to bacterial wilt (K.A.U., 1982). Goth et al. (1983a) tested four lines of brinjal SM 6, Classic 465, Black Magic 462 and Deuoky for disease reaction to several isolates of Pseudomonas 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 melongena var insanum. Gopimony and Sreenivasan (1970) made crosses between

Solanum melongena var *insanum* 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 melongena* var *insanum* as a possible source for wilt resistance was also reported by Vijayagopal and Sethumadhavan (1973). *Solanum texanum* was reported to be resistant (K.A.U., 1982).

6. Mechanism of resistance to bacterial wilt

Gallegly and Walker (1949) observed that resistant factors in host plants were associated with light dependent 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

Pseudomonads. Gopimony and Sreenivasan (1970) observed a significant increase in dry matter content, starch, protein and total alkaloids in the resistant brinjal hybrids. Mukherjee and Mukhopadhyay (1982) noticed that the root exudates of the resistant brinjal variety Pusa Purple Cluster showed very little enhancement of the bacterial population while that of the susceptible varieties greatly enhanced the population of the bacterium.

7. Inheritance of resistance

Kelman (1953) reported that the resistance to *Pseudomonas solanacearum* in groundnuts, tobacco and egg plant had all the appearance of being horizontal. Suzuki *et al.* (1964) suggested that the bacterial wilt resistance exhibited in the brinjal varieties, Taiwan Naga and OTB 1 was hereditary and should be a quantitative character controlled by a number of genes. Hybridisation studies conducted by Swaminathan and Sreenivasan (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 hybrids were resistant since it had the dominant gene for resistance. Studies on the F_2 generation of the cross between *Solanum melongena* L var. *Pusa Dutta* and *Solanum melongena* var. *insanum* were carried out by Vijaygopal 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 per cent and H^2(b) estimate of 53 per cent with a degree of dominance of 75 per cent 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 study was conducted at the College of Horticulture, Kerala Agricultural University, Vellanikkara, during August - February, 1983-1984 and March - September, 1984. The experimental area enjoys a typical warm humid tropical climate 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 materials for making selections and evaluating for bacterial wilt resistance under field conditions. The 11 groupings consisted of all possible combinations of the three characters namely, prickleness (prickly/non prickly), colour of fruit (white/purple/green) and shape of fruit (long/oval)(Table 3.1). Each of the 11 genetic groups was improved through four methods of selection - mass, pure line, single plant and single seed descent by Asha Sankar (1984) and were in the third cycles of continuous selection.

Sheela (1982) identified four lines SM 45, SM 56, SM 71 and SM 74 to be resistant to bacterial wilt. These

Table 3.1 Morphological description of the eleven genetic groups under selection

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

lines along with the forty-four genetic assemblages were also grown for evaluation and comparison.

B. Experimental methods

The studies were conducted in three parts.

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

Eleven genetic groupings under each of the four different methods of selection - mass selection, single plant selection, pure line selection and single seed descent - constituting a total of 44 genetic assemblages formed the materials for the study. These assemblages were the continuation of the materials selected by Asha Sankar (1984) through the same methods of selection.

The criteria for selecting elite plant types were earliness and higher yield associated with bacterial wilt resistance.

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

Mass selection - Observations were made on all the plant in each group for fruits/plant and total fruit yield. The intensity of selection followed was five per cent and plant 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 elite plant selected as for pure line selection.

Part 2. Evaluation of progenies developed through four methods of selection and estimation of realised selection response and efficiency of four methods of selection along with resistance to bacterial wilt.

The 44 lines were sown in raised beds during August, 1982. When the seedlings were 10 to 15 cm height, they were transplanted to main field at a spacing of 75 x 45 cm in a Compact Family Block Design with three replications. There were 20 plants/progeny/replication. Observations were recorded on earliness, vegetative characters, productive characters and their components as detailed below:

Earliness

Days to first fruit set

Days to first harvest

Vegetative characters

Plant height (cm)

Primary branches/plant

Productive characters

Fruits/plant

Average fruit weight (g)

Yield/plant (g)

Economic pickings

The data were analysed as in a Compact Family Block Design, considering methods of selection 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 as in a randomised block design between genetic groups within each selection method. Estimation of genotypic coefficient of variation (gcv), phenotypic coefficient of variation (pcv) was done separately for each method of selection as per Burton (1952).

$$\text{gcv} = \frac{\sigma g \times 100}{\text{Mean of the character}}$$

$$\text{pcv} = \frac{\sigma p \times 100}{\text{Mean of the character}}$$

where

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

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

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

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

Heritability in the broad sense was calculated as suggested by Allard (1960).

$$h^2 b = \frac{\sigma^2 g}{\sigma^2 p}$$

Expected selection response = $i\, h^2 \sigma p$

where

i = a constant (at 5% intensity of selection i = 2.06)

h^2 = heritability (broad sense)

σp = phenotypic standard deviation

Expected genetic advance as percentage of mean = (Genetic gain)

$$\frac{\text{genetic advance} \times 100}{\text{Arithmetic mean of the character}}$$

Realised selection response 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 selection response was calculated for different characters.

Realised selection response under mass selection	= Mean performance under mass selection-overall mean
Realised selection response under single plant selection	= Mean performance under single plant selection - overall mean
Realised selection response under pure line selection	= Mean performance under pure line selection - overall mean
Realised selection response under single seed descent	= Mean performance under single seed descent - overall mean

Efficiency of the four methods of selection among one another

Efficiency of the four methods of selection among one another was calculated as indicated below:

Efficiency of mass selection over single plant selection

$$= \frac{\text{Selection response through mass selection}}{\text{Selection response through single plant selection}}$$

Likewise the relative efficiency among all combinations of four methods of selection were estimated.

Evaluation of genotypes for resistance to bacterial wilt

Evaluation for resistance to bacterial wilt was done by counting the number of plants wilted. 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 Sitaramaih *et al*. (1981).

The four resistant genotypes identified by Sheela (1982), were grown separately but adjacent to the main experiment in a Randomised Block Design with five replications. Observations taken were the same as for the main experiment. The data were analysed in RBD and appropriate comparisons with the forty-four progenies were made.

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

Among the forty-four genetic assemblages, 12 lines which were found to be highly susceptible to bacterial wilt coupled with low yield in the third cycle of selection, were eliminated. The remaining 32 lines were advanced through specific and corresponding method of selection.

The progenies thus evolved were grown in the field during March - September, 1984 at a spacing of 75 x 60 cm. The design of the experiment, observations taken and statistical analysis were same as in Part 2.

Experimental Results

EXPERIMENTAL RESULTS

Data collected in the present study were statistically analysed and presented under the following heads.

A. Evaluation of the genetic groups developed in third and fourth cycles through mass, single plant, pure line and single seed descent selection methods.

B. Comparison of different selection methods and assessing their relative efficiency.

C. Evaluation of the four resistant lines and comparison with the eleven genetic groups.

A. Evaluation of the genetic groups developed in third and fourth cycles through mass, single plant, pure line and single seed descent selection methods

Forty-four lines of the brinjal line SM 6 consisting of eleven genetic groups, each developed in third and fourth cycles through four methods of selection, were critically studied for genetic differences, if any, for plant height, primary branches/plant, days to fruit set, days to harvest, fruits/plant, average fruit weight, total yield/plant and number of economic pickings. The genetic groups exhibited significant differences among themselves for days to fruit set, plant height, fruits/plant, yield/plant and average fruit weight under four methods of selection in both cycles of selection (Tables 4.2a to 4.2h). No significant difference was observed among the lines for primary branches/plant under mass selection and single plant selection in the third cycle of selection and under single plant selection in the fourth cycle of selection. No significant difference was also observed among the lines for days to first harvest and number of economic pickings in the fourth cycle of selection under pure line selection method.

1. Evaluation for earliness

In third cycle of selection, the genetic group SM 6-3 was the earliest under mass selection (fruit set 33 days after transplanting) while under single plant selection SM 6-5 was the earliest (29 days) (Tables 4.2a and 4.2c). Under pure line and single seed descent methods SM 6-6 was the earliest both in third and fourth cycles of selection (40 days and 34 days after transplanting under pure line selection and 38 days and 32 days after transplanting under single seed descent in the third and fourth cycles of selection respectively)(Tables 4.2c and 4.2g). In the fourth cycle under single plant selection, genetic groups SM 6-1, SM 6-2, SM 6-3 and SM 6-4 were found to be early and there was no significant difference among these lines for days to fruit set (Table 4.2b). Under pure line selection, lines SM 6-6 and SM 6-8 were the earliest (40 days and 39 days respectively) in the third cycle of selection, while in the fourth cycle of selection in addition to the above two, genotypes SM 6-4 and SM 6-10 fruited early (Table 4.2e). Under single seed descent, SM 6-2, SM 6-6, SM 6-7, SM 6-10 and SM 6-11 were early (39 days, 38 days, 39 days, 40 days and 38 days respectively) in the third cycle while in the fourth cycle SM 6-6 was the earliest line (32 days)(Table 4.2g).

First fruit harvest was early in the lines SM 6-3, SM 6-6, SM 6-9 and SM 6-10 (58 days, 60 days, 60 days and 60 days respectively) in the third cycle of selection under mass selection, while in the fourth cycle, SM 6-6 and SM 6-8 were the earliest (50 days and 53 days respectively)(Table 4.2a). SM 6-6 was the earliest line for days to first harvest under four methods of selection in both cycles of selection (Tables 4.2a, 4.2c,, 4.2e and 4.2g).

2. Evaluation for vegetative characters

The line SM 6-1 was the tallest (plant height

93.6 cm, 94.73 cm, 85.78 cm and 104.30 cm under mass, single plant, pure line and single seed descent methods respectively), while the line SM 6-10 was the shortest (48.66 cm, 48.31 cm, 66.24 cm and 49.45 cm under mass, single plant, pure line and single seed descent methods respectively) in the third cycle of selection. In the fourth cycle plant height varied widely among the progenies under the two methods of selection (Tables 4.2a, 4.2c, 4.2e and 4.2g). There was no significant difference among the lines to primary branches/plant under mass selection in the third cycle and under single plant selection in both the cycles (Tables 4.2a and 4.2c). The line SM 6-1 had the highest primary branches/plant (4.27) under pure line selection and single seed descent (5.05) in the third cycle, while in the fourth cycle, line SM 6-7 had the highest number under pure line and single seed descent (5.67 and 5.27)(Tables 4.2e and 4.2g).

3. Evaluation for productive characters

The line SM 6-2 produced the highest yield/plant under mass selection and single plant selection in both cycles of selection (1.25 kg and 1.44 kg under mass selection and 1.3 kg and 1.62 kg under single plant selection in the third and fourth cycles of selection respectively)(Tables 4.2b and 4.2d)(Plate I). Under pure line selection SM 6-1 yielded the highest in both the cycles of selection (0.98 kg/plant and 1.02 kg/plant in the third and fourth cycles respectively)(Table 4.2f)(Plate II). Under single seed descent the genetic groups SM 6-4 and SM 6-6 produced the highest yield/plant in the third and fourth cycles of selection (0.84 kg for SM 6-4 and SM 6-6 in the third cycle and 0.95 kg for SM 6-4 and 0.91 kg for SM 6-6 in the fourth cycle of selection (Table 4.2h)(Plates III and IV). SM 6-6 had the highest number of fruits/plant under all methods of selection in both cycles of selection (Tables 4.2b, 4.2d, 4.2f and 4.2h). SM 6-2 produced the highest number of fruits/plant in both cycles of selection under single plant selection (13.88 and 17.7 in the third and fourth cycles respectively)(Table 4.2d). The performance of the line SM 6-11 was inferior for productive characters including total yield/plant under single plant selection (0.74 kg and 0.85 kg in the third and fourth cycles of selection respectively) and under pure line selection (0.66 kg and 0.85 kg in the third and fourth cycles respectively) (Tables 4.2d and 4.2f)(Plate V). Under the mass selection the lowest yield was recorded in the genetic group SM 6-3 (0.66 kg/plant and 0.69 kg/plant in the third and fourth cycles of selection respectively (Table 4.2b)(Plate VI). Under single seed descent, the genetic group SM 6-5 yielded poorly in the third cycle (0.56 kg/plant) while the line SM 6-3 had the lowest yield in the fourth cycle of selection (0.73 kg/plant)(Table 4.2h). Fruits/plant also was the lowest in the genetic group SM 6-3 in both cycles of selection under mass and single seed descent selection methods (Table 4.2b and 4.2h). Fruits/plant was the lowest also in SM 6-11 under mass and single plant selection methods (Table 4.2b and 4.2d). Under pure line selection method, the lowest number of fruits/plant was produced by the genetic group SM 6-8 in both cycles of selection (Table 4.2f). Economic pickings/plant was the highest for the genetic group SM 6-6 under single plant and single seed descent in both cycles of selection (4.04 and 4.75 under single plant and 3.06 and 3.55 under single seed descent in the third and fourth cycles of selection respectively)(Tables 4.2d and 4.2h). The highest average fruit weight was observed in the genetic groups SM 6-2 under mass,

Table 4.2a. Mean performance of eleven genetic groups improved through mass selection for earliness and vegetative characters.

Genetic groups	Days to first fruit set		Days to first harvest		Plant height (cm)		Primary branches/ plant	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	40.01	37.81	68.81	61.70	93.60	55.33	3.97	3.00
SM 6- 2	40.26	33.11	65.08	53.62	95.07	74.83	4.87	3.17
SM 6- 3	32.76	35.48	58.21	55.59	101.85	92.00	4.00	2.67
SM 6- 4	41.88	32.71	62.87	56.97	75.83	62.33	3.93	3.17
SM 6- 5	42.48	—	67.58	—	68.70	—	2.76	—
SM 6- 6	39.63	30.07	59.69	50.28	56.99	56.17	3.82	3.17
SM 6- 7	40.51	36.88	65.44	60.85	93.80	59.67	3.83	3.00
SM 6- 8	41.69	33.19	65.92	53.22	75.42	47.00	3.03	2.67
SM 6- 9	38.23	37.17	59.59	57.90	87.56	51.00	3.89	2.50
SM 6-10	41.64	—	60.46	—	48.66	—	2.86	—
SM 6-11	38.08	34.21	61.49	54.89	67.75	48.67	3.57	4.67
Sem	+0.761	+0.70	+0.841	+0.98	+5.58	+3.19	+0.378	+0.40
CD ($p = 0.05$)	2.25	2.10	2.67	2.23	16.52	9.56	NS	1.19

Table 4.2b. Mean performance of eleven genetic groups improved through mass selection for productive characters

Genetic groups	Fruits/plant		Yield/plant (g)		Economic pickings		Average fruit weight (g)	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	11.11	11.95	996.72	1025.93	3.31	2.94	86.54	87.32
SM 6- 2	14.10	16.03	1254.67	1437.51	4.07	3.56	85.69	92.80
SM 6- 3	9.47	9.34	659.34	689.45	2.48	2.68	80.61	74.34
SM 6- 4	10.67	15.77	1005.89	1275.20	3.44	4.02	80.16	84.14
SM 6- 5	10.89	--	762.11	--	2.97	--	81.38	--
SM 6- 6	11.98	18.24	1033.11	1389.38	3.36	4.17	77.00	74.44
SM 6- 7	12.01	12.87	916.61	1015.97	3.56	3.98	86.99	76.18
SM 6- 8	9.97	11.16	920.67	1047.63	3.11	3.04	79.37	83.58
SM 6- 9	11.41	11.36	777.62	809.83	3.20	2.90	82.25	77.49
SM 6-10	8.23	--	865.67	--	2.79	--	75.11	--
SM 6-11	10.53	10.73	920.11	986.55	3.01	3.33	77.08	88.92
Sem	±0.85	±0.59	±22.61	±52.05	±0.12	±0.07	±0.99	±1.56
CD (p = 0.05)	2.51	1.76	66.41	156.16	0.34	0.21	2.91	4.69

Table 4.2c. Mean performance of eleven genetic groups improved through single plant selection for earliness and vegetative characters

Genetic groups	Days to first fruit set		Days to first harvest		Plant height (cm)		Primary branches/ plant	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	39.55	33.27	67.09	54.15	94.73	62.17	3.17	3.67
SM 6- 2	34.03	33.24	60.14	53.88	88.10	60.17	3.22	3.83
SM 6- 3	36.44	33.31	59.13	54.00	78.83	58.67	3.66	3.83
SM 6- 4	34.92	32.15	59.94	53.33	80.52	63.17	2.92	4.17
SM 6- 5	29.49	—	54.99	—	59.62	—	2.96	—
SM 6- 6	32.28	31.27	58.62	52.33	56.28	63.67	4.12	2.83
SM 6- 7	39.60	35.75	66.93	60.51	86.13	60.00	4.41	4.00
SM 6- 8	34.24	35.08	57.90	57.33	72.50	47.33	3.78	3.83
SM 6- 9	37.55	38.76	62.60	59.50	78.83	53.67	3.24	3.50
SM 6-10	39.74	—	68.36	—	48.31	—	3.59	—
SM 6-11	37.69	35.12	61.71	55.87	63.37	58.17	3.27	3.67
Sem	±0.50	±0.81	±0.67	±0.78	±5.13	±1.63	±0.33	±0.32
CD(p=0.05)	1.48	2.42	1.98	2.35	15.13	4.88	N.S	N.S

Table 4.2d. Mean performance of eleven genetic groups improved through single plant selection for productive characters

Genetic groups	Fruits/plant		Yield/plant (g)		Economic pickings		Average ffuit weight (g)	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	11.40	13.86	961.28	1284.46	3.47	3.29	85.55	94.14
SM 6- 2	13.88	17.70	1295.56	1616.05	3.71	4.39	88.63	86.48
SM 6- 3	10.85	12.88	1026.22	1431.70	2.71	3.60	90.89	114.98
SM 6- 4	11.87	15.95	1031.28	1362.23	3.48	3.97	80.52	83.78
SM 6- 5	8.92	—	885.78	—	2.67	—	86.20	—
SM 6- 6	14.17	18.60	1171.06	1416.41	4.04	4.75	78.79	76.95
SM 6- 7	12.19	14.90	975.06	1186.92	3.26	3.26	87.45	87.78
SM 6- 8	8.52	10.60	745.65	935.58	3.21	3.04	74.75	79.59
SM 6- 9	11.15	12.90	885.75	975.38	2.95	2.94	75.12	74.30
SM 6-10	9.06	—	783.67	—	2.48	—	79.44	—
SM 6-11	8.55	10.65	736.78	848.52	2.62	2.87	79.88	83.50
Sem	±0.34	±0.49	±23.82	±45.86	±9.46	±0.23	±0.90	±2.23
CD (p = 0.05)	0.99	1.48	70.28	137.59	0.279	0.68	2.65	6.68

Table 4.2e. Mean performance of eleven genetic groups improved through pure line selection for earliness and vegetative characters

Genetic groups	Days to first fruit set		Days to first harvest		Plant height (cm)		Primary branches/ plant	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	45.93	41.15	68.32	60.10	85.78	63.00	4.27	4.33
SM 6- 3	43.22	37.14	66.38	60.95	77.43	73.83	2.70	3.83
SM 6- 4	42.32	35.11	62.12	58.17	90.09	67.00	4.40	6.00
SM 6- 5	44.81	--	69.28	--	69.27	--	3.63	--
SM 6- 6	40.36	34.14	59.32	58.37	72.08	67.50	3.93	4.67
SM 6- 7	42.20	37.23	65.06	60.87	96.23	66.17	4.32	5.67
SM 6- 8	38.66	29.32	60.47	53.26	71.32	67.83	3.56	5.50
SM 6- 9	43.52	38.78	66.31	60.21	91.22	75.83	4.17	6.00
SM 6-10	45.03	--	69.32	--	66.24	--	3.50	--
SM 6-11	42.14	32.45	64.87	58.50	66.04	61.83	3.46	4.67
Sem	±0.92	±1.95	±0.81	±1.71	±4.48	±2.75	±0.32	±0.45
CD ($p = 0.05$)	2.72	5.90	2.41	N.S.	13.32	8.34	0.96	1.35

Table 4.2f. Mean performance of eleven genetic groups improved through pure line selection for productive characters

Genetic groups	Fruits/plant		Yield/plant (g)		Economic pickings		Average fruit weight (g)	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	12.49	13.33	974.97	1025.38	3.53	2.85	78.36	79.39
SM 6- 3	9.83	10.35	769.31	791.03	3.18	2.66	75.44	81.17
SM 6- 4	9.68	11.59	816.42	876.42	2.78	2.65	65.09	71.15
SM 6- 5	8.11	--	786.38	--	2.44	--	74.13	--
SM 6- 6	12.24	14.21	812.45	958.28	3.18	3.29	64.60	68.65
SM 6- 7	9.70	10.38	855.07	867.90	3.27	3.17	73.58	78.33
SM 6- 8	8.28	8.83	706.93	739.88	2.23	3.48	75.39	78.38
SM 6- 9	9.83	10.86	753.88	810.21	2.65	3.28	70.68	76.35
SM 6-10	8.63	--	711.72	--	2.96	--	67.90	--
SM 6-11	10.36	13.09	662.64	851.93	2.82	2.86	66.78	71.73
Sem	±0.33	±0.86	±13.03	±47.89	±0.13	±0.28	±0.78	±1.87
CD (p = 0.05)	0.97	2.62	38.71	145.12	0.38	N.S.	2.33	5.67

Table 4.2g. Mean performance of eleven genetic groups improved through single seed descent for earliness and vegetative characters

Genetic groups	Days to first fruit set		Days to first harvest		Plant height (cm)		Primary branches/ plant	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	41.08	—	67.12	—	104.30	—	5.05	—
SM 6- 2	39.42	34.82	62.08	61.39	79.26	73.83	3.45	4.60
SM 6- 3	42.35	34.60	73.21	57.87	92.07	78.24	4.00	3.83
SM 6- 4	40.64	35.09	65.98	60.33	105.48	79.63	4.02	4.05
SM 6- 5	44.59	—	70.28	—	98.22	—	4.80	—
SM 6- 6	37.62	32.36	62.14	56.64	72.99	76.00	3.46	5.82
SM 6- 7	39.19	35.40	64.79	59.81	75.27	80.82	3.54	5.27
SM 6- 8	44.70	35.19	70.75	61.66	91.98	84.33	3.27	5.17
SM 6- 9	40.59	—	66.54	—	78.65	—	3.18	—
SM 6-10	39.92	—	70.51	—	49.45	—	3.05	—
SM 6-11	38.29	—	62.85	—	70.18	—	2.86	—
Sem	±0.81	±0.51	±0.91	±0.72	±4.03	±0.76	±0.42	±0.24
CD (p = 0.05)	2.39	1.61	2.68	2.38	11.88	4.43	1.23	0.77

Table 4.2h. Mean performance of eleven genetic groups improved through single seed descent for productive characters

Genetic groups	Fruits/plant		Yield/plant (g)		Economic pickings		Average fruit weight(g)	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
SM 6- 1	9.45	—	774.21	—	3.19	—	74.89	—
SM 6- 2	11.04	11.51	777.67	782.68	3.33	3.30	72.01	73.86
SM 6- 3	8.11	9.67	732.62	731.65	2.50	2.96	74.65	78.42
SM 6- 4	9.88	11.32	842.81	949.54	3.17	3.15	70.80	74.35
SM 6- 5	7.90	—	559.00	—	2.47	—	67.39	—
SM 6- 6	10.40	12.53	847.56	911.87	3.06	3.55	66.14	68.44
SM 6- 7	9.79	10.44	789.55	815.97	3.25	2.99	76.14	77.19
SM 6- 8	10.11	10.92	773.89	842.09	3.47	3.17	76.15	76.77
SM 6- 9	8.72	—	743.95	—	2.64	—	71.90	—
SM 6-10	7.16	—	647.56	—	2.49	—	65.30	—
SM 6-11	6.76	—	670.43	—	2.11	—	68.94	—
Sem	±0.46	±0.41	±13.71	±18.03	±0.15	±0.05	±1.05	±1.09
CD (p = 0.05)	1.33	1.28	40.45	56.79	0.43	0.16	3.11	3.43

SM 6-3 under single plant, SM 6-1 under pure line and SM 6-3, SM 6-7 and SM 6-8 under single seed descent method in both cycles of selection (Tables 4.2b, 4.2d, 4.2f and 4.2h).

4. Evaluation for resistance to bacterial wilt

The genetic group SM 6-4 was found to be immune (0% wilt incidence) to bacterial wilt under mass and pure line method and was highly resistant (10% wilt incidence) under single plant selection in the third cycle of selection. Under single seed descent it was moderately resistant (36.67% wilt incidence)(Table 4.3a). In the fourth cycle of selection this line was found to be highly resistant under all methods of selection (Table 4.3b). The genetic groups SM 6-2, SM 6-7 and SM 6-8 were also highly resistant under all methods of selection in the third cycle of selection, while the lines SM 6-10 and SM 6-5 were highly susceptible under all methods of selection (Table 4.3a). Maximum wilt incidence was noted in the line SM 6-5 (85%, 78.33%, 65% and 55% under mass, single plant, pure line and single seed descent respectively) and also in the line SM 6-10 (80%, 68.33%, 70% and 71.67% under mass, single plant, pure line and single seed descent respectively).

Table 4.3a. Evaluation of progenies for resistance to bacterial wilt in the third cycle of selection

Genotype	Total No.	Total no. of plants wilted				Percentage				Score			
		Mass	SP	PL	SSD	Mass	SP	PL	SSD	Mass	SP	PL	SSD
SM 6- 4	60	0	6	0	22	0.00	10.00	0.00	36.67	1	2	1	4
SM 6- 2	60	4	5	-	5	6.67	8.33	-	8.33	2	2	-	2
SM 6- 6	60	20	12	6	11	33.33	20.00	10.00	18.33	4	3	2	3
SM 6- 9	60	6	7	13	32	10.00	11.67	21.67	53.33	2	3	3	4
SM 6- 7	60	5	6	4	6	8.33	10.00	6.67	10.00	2	2	2	2
SM 6-10	60	48	41	42	43	80.00	68.33	70.00	71.67	5	4	4	5
SM 6- 3	60	19	20	5	6	31.67	33.33	8.33	10.00	3	3	2	2
SM 6- 8	60	6	5	4	2	10.00	8.33	6.67	3.33	2	2	2	2
SM 6- 5	60	51	47	39	33	85.00	78.33	65.00	55.00	5	5	4	4
SM 6- 1	60	24	11	5	12	40.00	18.33	8.33	20.00	3	3	2	3
SM 6-11	60	6	13	13	32	10.00	21.67	21.67	53.33	2	3	3	4

Table 4.3b. Evaluation of progenies for resistance to bacterial wilt in the fourth cycle of selection

Genotype	Total no.	Total no. of planted wilted				Percentage				Score			
		Mass	SP	PL	SSD	Mass	SP	PL	SSD	Mass	SP	PL	SSD
SM 6- 4	60	4	2	5	4	6.67	3.33	8.33	6.67	2	2	2	2
SM 6- 2	60	4	3	-	6	6.67	5.00	--	10.00	2	2	-	2
SM 6- 6	60	8	3	4	5	13.33	5.00	6.67	8.33	3	2	2	2
SM 6- 9	60	6	6	9	-	10.00	10.00	15.00	--	2	2	3	-
SM 6- 7	60	0	0	2	4	0.00	0.00	3.33	6.67	1	1	2	2
SM 6- 3	60	12	10	7	5	20.00	16.67	11.67	8.33	3	3	3	2
SM 6- 8	60	6	3	5	2	10.00	5.00	8.33	3.33	2	2	2	2
SM 6- 1	60	13	9	10	-	21.67	15.00	16.67	--	3	3	3	-
SM 6-11	60	15	5	8	-	25.00	8.33	13.33	--	3	2	3	-

In the fourth cycle of selection, the line SM 6-7 was immune to wilt under mass and single plant while it was highly resistant under pure line and single seed descent methods (3.33% and 6.67% wilt incidence respectively)(Table 4.3b). SM 6-2, SM 6-4 and SM 6-8 were highly resistant under all methods of selection in the fourth cycle of selection (Plates I, III, VIII respectively). In the fourth cycle maximum wilt incidence was noted in the line SM 6-3 (20%, 16.67%, 11.67% and 8.33% under mass, single plant, pure line and single seed descent method respectively) and in the line SM 6-1 (21.67%, 15% and 16.67% under mass, single plant and pure line methods respectively).

B. Comparison of different selection methods and assessing their relative efficiencies

The four selection methods, mass, single plant, pure line and single seed descent were critically examined to evaluate their relative effectiveness to upgrade the base population. The four methods of selection differed significantly among themselves to develop variability for earliness, productive characters and vegetative characters in the two cycles of selection except for primary branches/plant, where no significant difference was observed among the different selection methods in the third cycle of selection (Tables 4.4a and 4.4b).

Progenies developed through single plant selection set fruit the earliest in the two cycles of selection (36 days and 33 days after transplanting in the third and fourth cycles of selection respectively). Progenies developed through pure line selection and single seed descent were late in both cycles of selection (Table 4.4a).

Total fruits/plant and total yield/plant were the highest for the progenies developed through single plant selection in both cycles of selection (10.67 and 920.26 g/plant and 14.6 and 1266.30 g/plant in the third and fourth cycles respectively (Table 4.4b). Number of economic pickings and average fruit weight were also the highest for progenies developed through single plant selection (Table 4.4b).

Progenies developed through pure line selection and single seed descent method were inferior for earliness and productive characters in both cycles of selection. Progenies developed through single seed descent possessed the highest plant height while primary branches/plant were the highest for progenies developed through pure line selection in both cycles of selection (Table 4.4a).

Efficiency of selection methods was also evaluated in terms of improving the genetic parameters of the progenies. Genetic advance as percentage of mean was the highest for total yield/plant (62.53) in progenies developed through single seed descent method in the fourth cycle of selection (Table 4.5d). Genetic advance as percentage of mean for total yield/plant were also higher for progenies developed through single plant selection (36.44 and 40.99 in the third and fourth cycles respectively) and mass selection (34.24 and 44.09 in the third and fourth cycles respectively)(Tables 4.5a and 4.5b).

Heritability values (h^2b) for total yield/plant were the highest for progenies developed through single plant selection (0.95 and 0.91 in the third and fourth cycles respectively)(Table 4.5b). Heritability values for fruits/plant, (0.92 and 0.91 in the third and fourth cycles respectively) economic pickings/plant (0.90 and 0.73 in the third and fourth cycles respectively) and average fruit weight (0.92 and 0.90 in the third and fourth cycles respectively), were also higher in progenies developed through single plant selection. The highest heritability value for yield/plant (0.99) was observed in the progenies developed through single seed descent method in the fourth cycle of selection (Table 4.5d).

High variability was noted for yield/plant under mass selection (gcv = 17.17 and 22.84 in the third and fourth cycles respectively) and under single plant selection (gcv = 18.11 and 20.89 in the third and fourth cycles)(Tables 4.5a and 4.5b). Fruits/plant showed wide variability under all selection methods (Tables 4.5a to 4.5d).

Realised genetic gain as compared to the overall mean under the four methods of selection was also estimated for the characters under study (Table 4.6). Realised genetic gain for yield/plant was considerable in progenies developed through single plant selection in the third (+87.96g over and above the overall mean) and fourth (+254.61g over and above the overall mean) cycles of selection.

Efficiency of different selection methods were calculated for the characters under study (Tables 4.7a and 4.7b). The efficiency of single plant selection over mass selection for yield/plant was +1.64 and +3.54 in the third and fourth cycles of selection respectively, while for fruits/plant it was +0.97 and +2.18.

Maximum wilt incidence was observed in the progenies developed through single seed descent method (30.91%) in the third cycle while it was minimum in the progenies developed through pure line selection (21.83%). In the fourth cycle of selection,

Table 4.4a. Comparison of different selection methods for earliness and vegetative characters in two cycles of selection

Methods of selection	Days to first fruit set		Days to first harvest		Plant height (cm)		Primary branches	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
Mass	39.69	33.67	62.51	55.38	77.02	63.43	3.57	2.93
Single plant	36.15	33.33	61.73	55.50	72.41	58.53	3.52	3.73
Pure line	42.79	34.59	65.15	58.32	78.57	66.47	3.80	5.37
Single seed descent	40.89	34.53	67.42	59.26	83.85	79.80	3.72	4.85
'F' test	*	NS	*	*	*	*	NS	*
Sem	±0.20	±0.75	±0.17	±0.58	±1.33	±1.31	±1.39	±0.09
CD (p = 0.05)	0.70	--	0.59	2.02	4.60	4.54	--	0.34

Table 4.4b. Comparison of different selection methods for productive characters and bacterial wilt resistance in two cycles of selection

Methods of selection	Fruits/plant		Yield/plant (g)		Economic pickings		Average fruit weight (g)		Percentage of wilted plants	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
Mass	10.69	13.48	885.79	1083.53	3.12	3.58	80.65	78.54	28.64	12.59
Single plant	10.67	14.60	920.26	1266.30	3.09	3.72	81.86	88.62	26.21	7.59
Pure line	9.91	11.07	784.98	846.70	2.83	3.05	71.20	75.53	21.83	10.42
Single seed descent	8.84	10.98	738.16	850.23	2.84	3.16	71.11	75.04	30.91	7.22
'F' test	*	*	*	*	*	*	*	*		
Sem	±0.10	±0.11	±4.77	±20.64	±0.02	±0.06	±0.22	±0.98		
CD (p = 0.05)	0.35	0.37	16.52	71.44	0.07	0.21	0.78	3.38		

Table 4.5a. Range, mean, genotype coefficient of variation (gcv), phenotype coefficient of variation (pcv), heritability in the broad sense (h^2b), genetic advance and genetic advance as percentage of mean for earliness vegetative characters and productive characters in the third and fourth cycles under mass selection

Characters	Cycles of selection	Range	Mean	gcv	pcv	h^2b	GA	GA as percentage of mean
Earliness								
Days to fruit set	C_3	30.97 - 43.21	39.69 ± 0.201	6.58	7.38	0.80	4.83	12.15
	C_4	29.43 - 39.09	33.67 ± 0.75	7.05	7.88	0.80	4.48	12.98
Days to harvest	C_3	57.40 - 71.09	62.51 ± 0.17	4.67	5.29	0.78	5.33	8.50
	C_4	50.00 - 64.54	55.38 ± 0.58	6.31	7.00	0.81	6.54	11.66
Vegetative characters								
Plant height (cm)	C_3	47.33 - 116.00	77.02 ± 1.33	20.75	23.43	0.78	29.61	38.64
	C_4	55.00 - 98.00	63.43 ± 1.31	28.10	24.83	0.87	27.04	44.49
Primary branches/plant	C_3	2.60 - 5.33	3.57 ± 1.39	12.01	21.44	0.31	0.505	13.69
	C_4	2.00 - 4.50	2.93 ± 0.09	17.98	28.40	0.40	0.725	23.31
Productive characters								
Fruits/plant	C_3	7.73 - 16.17	10.69 ± 0.10	11.53	17.75	0.42	1.68	15.36
	C_4	8.85 - 19.46	13.48 ± 0.11	22.21	23.54	0.89	5.63	43.13
Yield/plant	C_3	627.50 - 1291.67	885.79 ± 4.77	17.17	17.68	0.94	314.80	34.24
	C_4	630.77 - 1540.41	1083.53 ± 20.64	22.83	24.32	0.88	474.10	44.09
Economic pickings	C_3	2.00 - 4.20	3.12 ± 0.02	12.59	14.10	0.78	0.707	22.65
	C_4	2.50 - 4.26	3.58 ± 0.06	16.11	16.64	0.53	0.622	18.29
Average fruit weight(g)	C_3	72.00 - 88.50	80.65 ± 0.22	4.78	5.23	0.84	7.32	9.03
	C_4	73.57 - 93.37	78.54 ± 0.97	8.05	8.70	0.86	12.67	15.42

Table 4.5b. Range, mean, genotypic coefficient of variation (gcv), phenotypic coefficient of variation (pcv), heritability in the broad sense (h^2b), genetic advance and genetic advance as percentage of mean for earliness vegetative characters and productive characters in the third and fourth cycles under single plant selection

Characters	Cycles of selection	Range	Mean	gcv	pcv	h^2b	GA	GA as per centage of mean
Earliness								
Days to fruit set	C_3	28.60 - 40.87	36.15 ± 0.20	9.09	9.41	0.93	6.48	18.01
	C_4	30.00 - 41.44	33.33 ± 0.75	6.06	7.31	0.69	3.54	10.38
Days to harvest	C_3	54.10 - 69.43	61.73 ± 0.17	6.85	7.11	0.93	8.39	13.62
	C_4	52.00 - 61.00	55.50 ± 0.58	4.96	5.53	0.80	5.075	9.12
Vegetative characters								
Plant height (cm)	C_3	45.00 - 98.00	72.41 ± 1.33	17.24	21.02	0.67	21.42	29.01
	C_4	47.00 - 68.00	58.53 ± 1.31	8.41	9.69	0.75	8.76	14.96
Primary branches/plant	C_3	2.60 - 6.00	3.52 ± 1.39	8.12	20.76	0.15	0.22	6.39
	C_4	2.50 - 5.00	3.73 ± 0.09	5.63	15.76	0.11	0.13	3.54
Productive characters								
Fruits/plant	C_3	8.00 - 15.57	10.67 ± 0.10	18.21	18.96	0.92	3.94	35.97
	C_4	9.21 - 19.50	14.60 ± 0.11	19.68	20.57	0.91	5.49	38.59
Yield/plant(g)	C_3	714.00 - 1348.00	920.26 ± 4.77	18.11	18.62	0.95	347.73	36.44
	C_4	814.58 - 1676.45	1266.30 ± 20.64	20.89	21.87	0.91	503.67	40.99
Economic pickings	C_3	2.50 - 4.18	3.09 ± 0.02	15.65	16.50	0.90	0.964	30.60
	C_4	2.54 - 5.00	3.72 ± 0.06	18.69	20.79	0.73	1.112	31.24
Average fruit weight (g)	C_3	70.74 - 92.81	81.86 ± 0.22	6.60	6.86	0.92	10.73	13.01
	C_4	72.53 - 125.45	88.62 ± 0.98	13.71	14.42	0.90	23.21	26.73

Table 4.5c. Range, mean, genotypic coefficient of variation (gcv), phenotypic coefficient of variation (pcv), heritability in the broad sense (h^2b), genetic advance (GA), genetic advance as percentage of mean for earliness vegetative characters, productive characters in the third and fourth cycles under pure line selection

Characters	Cycles of selection	Range	Mean	gcv	pcv	h^2b	GA	GA as percentage of mean
Earliness								
Days to fruit set	C_3	37.33 - 49.67	42.79 ± 0.20	4.68	5.98	0.61	3.22	7.51
	C_4	23.73 - 42.47	34.59 ± 0.75	8.94	13.01	0.47	4.49	12.59
Days to harvest	C_3	58.00 - 70.87	65.15 ± 0.17	5.28	5.71	0.86	6.59	10.12
	C_4	54.70 - 64.62	58.32 ± 0.58	3.13	5.92	0.28	2.01	3.41
Vegetative characters								
Plant height (cm)	C_3	55.00 - 102.00	78.57 ± 1.33	13.19	16.48	0.64	17.07	21.73
	C_4	60.00 - 79.00	66.47 ± 1.31	5.84	9.13	0.41	5.24	7.71
Primary branches/plant	C_3	2.00 - 5.00	3.80 ± 1.39	10.96	18.42	0.35	0.504	13.26
	C_4	3.00 - 7.50	5.37 ± 0.09	13.48	20.05	0.67	1.45	27.71
Productive characters								
Fruits/plant	C_3	7.22 - 12.94	9.91 ± 0.10	14.63	15.70	0.87	2.79	28.20
	C_4	8.50 - 15.70	11.07 ± 0.11	13.85	18.96	0.53	2.40	20.73
Yield/plant (g)	C_3	630.81 - 1004.63	784.98 ± 4.77	11.15	11.51	0.94	174.97	22.29
	C_4	710.03 - 1049.36	846.70 ± 20.64	9.04	13.17	0.47	110.34	12.75
Economic pickings	C_3	2.14 - 3.71	2.83 ± 0.02	15.13	16.87	0.78	0.77	27.21
	C_4	2.31 - 3.93	3.05 ± 0.06	4.67	16.83	0.07	0.073	2.41
Average fruit weight (g)	C_3	63.66 - 80.36	71.20 ± 0.22	6.74	7.00	0.93	9.54	13.40
	C_4	65.66 - 86.88	75.53 ± 0.98	5.47	6.94	0.62	6.705	8.86

Table 4.5d. Ranage, mean, genotypic coefficient of variation (gcv), phenotypic coefficient of variation heritability in the broad sense (h^2b), genetic advance and genetic advance as percentage of mean for vegetative characters, earliness and productive characters in the third and fourth cycles under single seed descent

Characters	Cycles of selection	Range	Mean	gcv	pcv	h^2b	GA	GA as percentage of mean
Earliness								
Days to fruit set	C_3	35.33 - 45.97	40.89 ± 0.20	5.33	6.35	0.71	3.79	9.29
	C_4	31.50 - 36.29	34.53 ± 0.75	2.90	3.86	0.56	1.55	4.47
Days to harvest	C_3	60.07 - 75.26	67.42 ± 0.17	5.58	6.04	0.85	7.07	10.57
	C_4	55.65 - 62.78	59.26 ± 0.58	3.09	3.79	0.66	3.07	5.15
Vegetative characters								
Plant height (cm)	C_3	41.10 -112.50	83.85 ± 1.33	19.59	21.30	0.85	31.12	37.29
	C_4	74.00 - 86.00	79.80 ± 1.31	3.65	4.78	0.58	4.52	5.71
Primary branches/plant	C_3	2.00 - 7.00	3.72 ± 1.39	15.29	24.77	0.38	0.720	19.46
	C_4	3.50 - 6.26	4.85 ± 0.09	15.15	17.59	0.75	1.30	27.08
Productive characters								
Fruits/plant	C_3	6.40 - 12.63	8.84 ± 0.10	14.66	17.10	0.74	2.36	26.13
	C_4	9.27 - 13.06	10.98 ± 0.11	8.00	10.23	0.61	1.42	12.83
Yield/plant (g)	C_3	515.67 -873.67	738.16 ± 4.77	11.49	11.93	0.93	169.49	22.85
	C_4	712.57-1004.50	850.23 ±20.64	30.44	30.66	0.99	524.64	62.53
Economic pickings	C_3	2.00 - 3.63	2.84 ± 0.02	14.73	17.36	0.72	0.74	25.69
	C_4	2.87 - 3.69	3.16 ± 0.06	6.65	6.87	0.83	0.38	11.80
Average fruit weight (g)	C_3	61.91 - 76.97	71.11 ± 0.22	5.33	5.91	0.81	7.02	9.86
	C_4	67.38 - 79.69	75.04 ± 0.97	4.56	5.21	0.77	6.19	8.27

Table 4.6 Realised genetic gain under four methods of selection in two consecutive cycles

Character	Methods of selection							
	Mass		Single plant		Pure line		Single seed	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
Plant height (cm)	-0.94	-3.63	-5.55	-8.53	+0.61	-0.59	+5.89	+12.74
Primary branches/ plant	-0.08	-1.29	-0.13	-0.49	+0.15	+1.15	+0.07	+ 0.63
Days to fruit set	+0.19	+0.36	+3.73	+0.70	-2.91	-0.56	-0.01	-0.50
Days to harvest	+1.69	+1.74	+2.47	+1.62	-0.95	-1.20	-3.22	-2.14
Fruits/plant	+0.66	+0.95	+0.64	+2.07	-0.12	-1.46	-1.19	-1.55
Yield/plant	+53.49	+71.84	+87.96	+254.61	-47.32	-164.99	-94.14	-161.46
Economic pickings	+0.15	+0.20	+0.12	+0.34	-0.14	-0.33	-0.13	-0.22
Average fruit weight	+4.44	-0.89	+5.65	+9.19	-5.01	-3.90	-5.10	-4.39

Table 4.7a. Efficiency of different selection methods over another in improving earliness and vegetative characters in two consecutive cycles

	Days to first fruit set		Days to first harvest		Plant height		primary branches/ plant	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
Efficiency of Mass selection over Single plant selection	+0.05	+0.51	+0.68	+1.07	+0.17	+0.43	+0.62	+2.63
Efficiency of Mass selection over Pure line selection	-0.07	-0.64	-1.78	-1.45	-1.54	+6.15	-0.53	-1.12
Efficiency of Mass selection over Single seed descent	-0.19	-0.72	-0.52	-0.81	-0.16	-0.28	-1.14	-2.05
Efficiency of Single plant selection over Mass	+19.63	+1.94	+1.46	+0.93	+5.90	+2.35	+1.63	+0.38
Efficiency of Single plant selection over Pure line	-1.28	-1.25	-2.60	-1.35	-9.10	+14.46	-0.87	-0.43
Efficiency of Single plant selection over Single seed descent	-3.69	-1.40	-0.78	-0.75	-0.94	-0.67	-1.86	-0.78
Efficiency of Pure line selection over Mass	-15.32	-1.55	-0.56	-0.68	-0.65	+0.16	-1.88	-0.89
Efficiency of pure line selection over Single plant	-0.78	-0.8	-0.38	-0.74	-0.11	+0.07	-1.15	-2.35
Efficiency of Pure line selection over Single seed descent	+2.88	+1.12	+0.30	+0.56	+0.10	-0.05	+2.14	+1.83
Efficiency of Single seed descent over Mass	-5.32	-1.38	-1.91	-1.23	-6.27	-3.51	-0.88	-0.49
Efficiency of Single seed descent over Single plant	-0.27	-0.714	-1.30	-1.32	-1.06	-1.49	-0.54	-1.29
Efficiency of Single seed descent over Pure line	+0.35	+0.89	+3.39	+1.78	+9.66	-21.59	+0.47	+0.55

Table 4.7b. Efficiency of different selection methods over one another in improving productive characters in two consecutive cycles

	Fruits/ plant		Yield/ plant		Economic pickings		Average fruit weight	
	C_3	C_4	C_3	C_4	C_3	C_4	C_3	C_4
Efficiency of Mass selection over Single plant selection	+1.03	+0.46	+0.61	+0.28	+1.25	+0.59	+0.79	+0.09
Efficiency of Mass selection over Pure line	-5.50	-0.65	-1.13	-0.44	-1.07	-0.61	-0.89	+0.22
Efficiency of Mass selection over Single seed descent	-0.55	-0.61	-0.57	-0.44	-1.15	-0.91	-0.87	+0.20
Efficiency of Single plant selection over Mass	+0.97	+2.18	+1.64	+3.54	+0.80	+1.70	+1.27	-10.33
Efficiency of Single plant selection over Pure line	-5.33	-1.42	-1.86	-1.54	-0.86	-1.03	-1.13	- 2.35
Efficiency of Single plant selection over Single seed	-0.54	-1.34	-0.93	-1.58	-0.92	-1.55	-1.11	-2.09
Efficiency of Pure line selection over Mass	-0.18	-1.54	-0.88	-2.30	-0.93	-1.65	-1.13	+4.38
Efficiency of Pure line selection over Single plant	-0.19	-0.71	-0.54	-0.65	-1.16	-0.97	-0.89	-0.42
Efficiency of Pure line selection over Single seed	+0.10	+0.94	+0.50	+1.02	+1.08	+1.50	+0.98	+0.89
Efficiency of Single seed descent over Mass	-1.80	-1.63	-1.76	-2.25	-0.86	-1.10	-1.15	+4.93
Efficiency of Single seed descent over Single plant	-1.86	-0.75	-1.07	-0.63	-1.08	-0.65	-0.90	-0.48
Efficiency of Single seed descent over Pure line	+9.92	+1.06	+1.99	+0.98	+0.93	+0.66	+1.02	+1.13

progenies developed through single seed descent showed the minimum wilt incidence (7.22%) followed by single plant selection (7.59%).

C. Evaluation of the four resistant lines and comparison with the eleven genotypes

Four resistant lines SM 45, SM 56, SM 71, and SM 74 were critically studied for genetic differences, if any for plant height, primary branches/plant, yield/plant, economic pickings and average fruit weight. The lines were significantly different for all the above characters (Table 4.8a). Plant height was the highest for the line SM 74 (98.18 cm) and the lowest for the line SM 71 (75.72 cm). SM 56 was found to be the earliest among the four lines for days to fruit set (37 days after transplanting). The progenies of the line SM 6 set fruit 33 days after transplanting (Table 4.4a). The line SM 56 also produced the highest yield/plant and fruits/plant (1.19 kg/plant and 17.31 respectively). The fruit yield was lower compared to the line SM 6, where a mean yield of 1.28 kg/plant was obtained under single plant selection. Wilt incidence was maximum in the lines SM 45 and SM 71 (46.67%) and the lowest in the line SM 74 (20%)(Table 4.8b). Maximum wilt incidence recorded in the line SM 6 was only 30.91%. The four lines were found moderately resistant while many of the genotypes under SM 6 were highly resistant. The above four lines were late and were low yielders.

Table 4.8a. Mean performance of four brinjal lines resistant to bacterial wilt

Genotype	Days to first fruit set	Days to first harvest	Plant height (cm)	Primary branches/ plant	Fruits/ plant	Yield/ plant (g)	Economic pickings	Average fruit weight(g)
SM 45	43.99	74.28	85.46	4.11	9.93	823.79	2.80	81.53
SM 56	37.32	65.41	82.51	3.53	17.31	1193.07	4.63	64.65
SM 71	48.10	83.97	75.72	4.24	14.49	817.67	4.27	79.85
SM 74	52.31	87.93	98.18	3.61	14.38	590.15	3.28	66.68
Sem	±0.78	±1.23	±1.85	±0.12	±0.78	±55.02	±0.28	±2.30
CD (p = 0.05)	2.29	3.79	5.69	0.38	2.39	169.47	0.87	7.09

Table 4.8b. Evaluation of four brinjal lines for resistance to bacterial wilt

Genotype	Total number of plants	No. of plants wilted	Percentage of wilted plants
SM 45	45	21	46.67
SM 56	45	15	33.33
SM 71	45	21	46.67
SM 74	45	9	20.00

Plate I

SM 6-2

Plate II

SM 6-1


SM6
PIPO


SM6
PIPO

Plate III

SM 6-4

Plate IV

SM 6-6


SM6
PI90


SM6-6
PIWO

Plate V

SM 6-11

Plate VI

SM 6-3


SM6
PIWO


SM6
PIgO

Plate VII

SM 6-7

Plate VIII

SM 6-8


SM6
PIPO


SM6
PI90

Discussion

DISCUSSION

Four methods of generation advance were evaluated for their ability to generate and maintain superior genotypes and genetic variability for economic traits and for their efficiency to keep bacterial wilt resistance intact, in a set of brinjal lines. The methods were mass, single plant, pure line and single seed descent. The present study extended the comparison of selection methods in the third and fourth cycles of selection for further improvement of the lines. 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).

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 were aimed to improve the desirable transgressive segregant(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 (Chaudhary, 1982). In the present study the variability existing in the population for earliness, vegetative characters and productive characters were further exploited in the third and fourth cycles of selection.

In brinjal for upgrading yield through selection, selection for more fruits/plant was beneficial (Srivastava and Sachan, 1973). In the present study related productive characters - fruits/plant and total yield/plant were taken as criteria for selecting elite progenies.

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

The eleven genetic groups exhibited significant differences among themselves for days to fruit set, plant height, fruits/plant, yield/plant and average fruit weight. The genetic groups SM 6-2, SM 6-4, SM 6-6, SM 6-1 and SM 6-7 were promising for fruits/plant and yield/plant. Asha Sankar (1984) also reported the genetic groups SM 6-1, SM 6-2 and SM 6-4 as promising for economic characters in the first and second cycles of selection. The genetic group SM 6-4 was found immune to bacterial wilt. The genetic groups SM 6-2 and SM 6-7 were highly resistant to bacterial wilt. These lines were also reported to be highly resistant to bacterial wilt in the first and second cycles of selection by Asha Sankar (1984). The group SM 6-2 was characterised by long purple, non-prickly fruits and was promising for economic characters and resistance to bacterial wilt. The group SM 6-4 was characterised by long green non-prickly fruits and was also a promising genetic group. The highest yield reported for SM 6-2 in the second cycle of single plant selection was 1.35 kg/plant (Asha Sankar, 1984), while in the fourth cycle of selection it had increased to 1.62 kg/plant.

C. Evaluation for resistance to bacterial wilt

The resistance of the basic population of SM 6 to bacterial wilt was confirmed through field reaction (Table 5.9) Goth et al. (1983a) 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 W 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

Table 5.9 Evaluation of a few selected progenies of SM 6 for field reaction to bacterial wilt

Progenies	No. of plants trans-planted	No. of plants wilted at bearing stage	Percentage of resistant plants
SM 6 Bulk	1652	118	92.86
SM 6-7	1685	121	92.81
SM 6-4	36	1	97.22

(Race 1). Experiments conducted at the Department of Olericulture, Kerala Agricultural University reported SM 6 to be resistant to bacterial wilt (K.A.U., 1982). Sheela _et al_. (1984) reported SM 6-1 to be immune to wilt.

The relative efficiency of different selection methods to improve level of resistance was also worked out. The percentage of wilted plants was reduced considerably in the fourth cycle of selection. Progenies developed through single seed descent and single plant selection methods exhibited greater resistance to wilt. Asha Sankar (1984) reported progenies developed through single seed descent to be highly resistant to wilt.

D. 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 earliness and productive characters. According to Chaudhary (1982) 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.

Andrus (1963) reported that pure line selection is advantageous only at the beginning of a breeding programme and also at the end of a breeding cycle to provide sufficient uniformity of the type. The degree of success of mass selection depends highly upon the heritability of the attribute being selected (Romero and Frey, 1966). In the present study characters showing high heritability like fruits/plant (0.92 and 0.91 in the third and fourth cycles under single plant selection) and yield/plant (0.95 and 0.91 in the third and fourth cycles under single plant selection) could be developed better through mass and single plant selection. Suzuki et al. (1964) adopted single plant selection method successfully for the release of promising new varieties of brinjal having high degree of bacterial wilt resistance and superior commercial characters. 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. Asha Sankar (1984) in her study on the efficiency of selection methods in brinjal improvement in relation to resistance to bacterial wilt also reported positive realised genetic advance for progenies developed through mass and single plant selection.

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 earliness and productive characters. Casali and Tigchelaar (1975) reported that single seed descent method of selection was effective only when several characters with differing heritability values were under simultaneous selection. Asha Sankar (1984) also reported that progenies developed through single seed descent method of selection were inferior for fruits/plant and total yield/plant.

E. Estimation of genetic parameters

The success of phenotypic selection depends on the range of genetic diversity present in the population. The genetic facts are inferred from phenotypic observations with the aid of suitable parameters viz., genetic coefficient of variation, heritability estimates and genetic advance. Realised genetic gain for yield/plant was quite high in progenies developed through single plant selection (+87.96 and +254.61 in the third and fourth cycles of selection respectively). Thus yield/plant showed considerable response to selection. This may be due to the présence of a relatively large amount of variability present in the population (gcv = 18.11 and 20.89 in the third and fourth cycles of selection respectively).

High heritability was noted for yield/plant (0.95 and 0.91 in the third and fourth cycles under single plant selection). Genetic advance as percentage of mean for total yield/plant was also higher in progenies developed through single plant selection (36.44 and 40.99 in the third and fourth cycles under single plant respectively). High heritability was also noted for fruits/plant (0.92 and 0.91 in the third and fourth cycles) and average fruit weight (0.92 and 0.90 in the third and fourth cycles). Hiremath and Rao (1974) also reported high heritability and genetic advance for fruits/plant and yield/plant. Mishra and Roy (1976) reported high heritability values and high percentage of genetic advance for yield/plant, fruits/plant and average fruit weight. Singh and Singh (1980a) also observed high gcv, heritability and genetic advance for yield/plant, fruit girth and fruits/plant and indicated the possibility of success for selection in these characters.

Four brinjal lines SM 45, SM 56, SM 71 and SM 74 were also found moderately resistant to bacterial wilt. But they were late and were low yielders. Sheela (1982) reported these lines to be highly resistant to bacterial wilt.

AN IDEOTYPE OF BRINJAL

Plants of about 100 - 120 cm height

Plants of mechanically sound structure with semi-erect habit.

Determinate growth habit.

Three to four productive branches of semi-erect orientation each carrying seven to ten fruits.

Thick deep green lobed leaves with long petioles.

Flowering - 20 to 30 days after transplanting.

Inflorescence with one or two productive flowers.

Fruits - solitary, each fruit weighing about 150 gms with acceptable colour and shape.

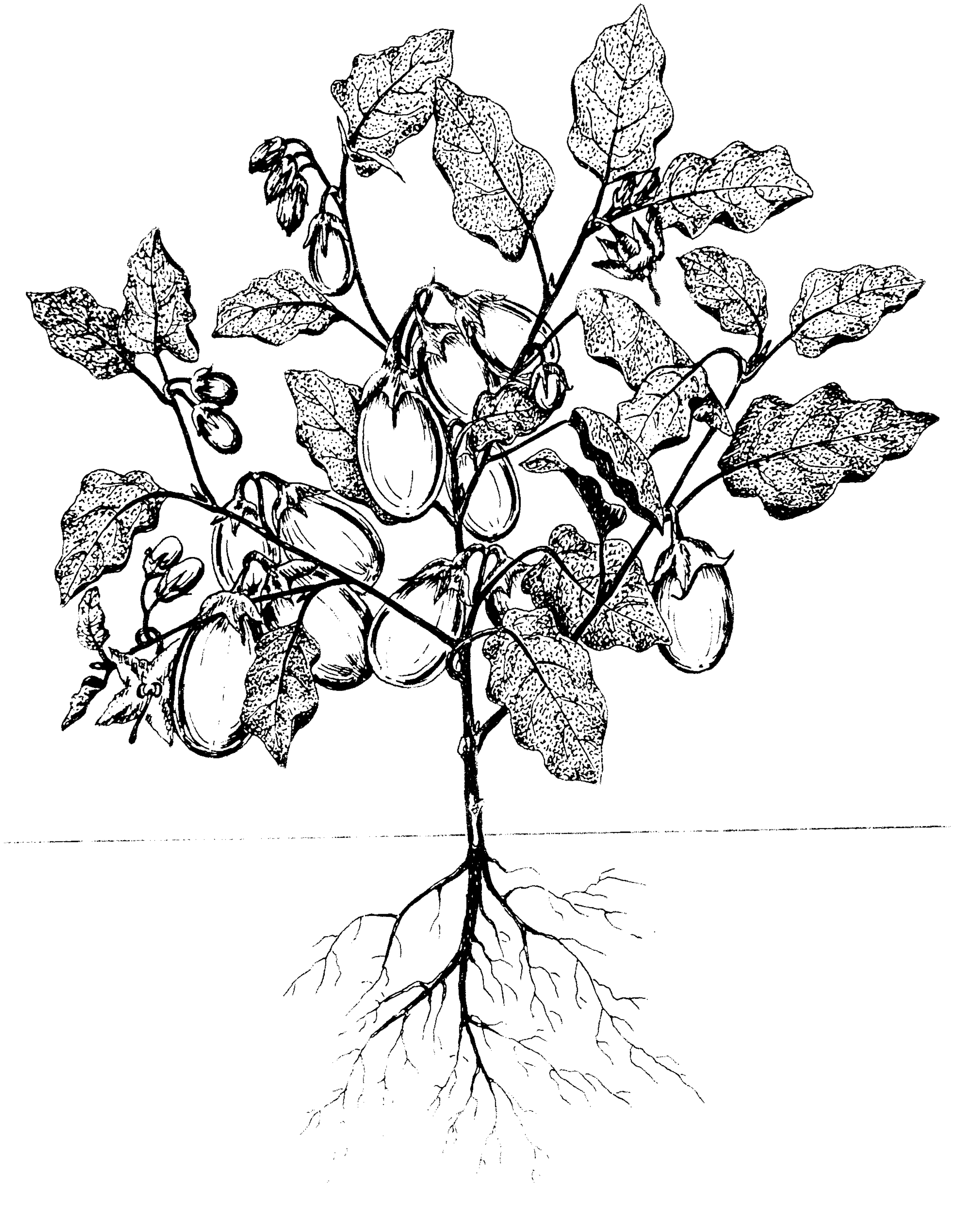
Fruits with more meat and lesser number of seeds.

Fruits having high nutritional value and longer keeping quality.

Plants frost resistant.

Plants resistant to bacterial wilt, nematode attack, phomopsis rot and fruit and shoot borer.

Root system - well developed tap root system.



Summary

SUMMARY

Eleven genetic groups within the brinjal line SM 6 evolved through four methods of selection - mass, single plant, pure line and single seed descent were further improved through the same methods of selection in the third and fourth cycles. The selection procedures were carried out in two consecutive cycles during August - February 1983-1984 and March - September, 1984. The progenies developed through the four selection methods were critically studied for genetic differences, if any, for earliness, vegetative characters and productive characters. The genetic groups exhibited significant differences among themselves for days to fruit set, plant height, fruits/plant, yield/plant and average fruit weight. SM 6-6 was the earliest for days to first harvest under all four methods of selection in both the cycles. The lines SM 6-6, SM 6-2, SM 6-4 and SM 6-1 were promising for fruits/plant and yield/plant.

2. The line SM 6-7 was immune to wilt under mass and single plant selection in the fourth cycle while the lines SM 6-2, SM 6-4 and SM 6-8 were highly resistant under all methods of selection.

3. The four selection methods differed significantly among themselves to develop variability for earliness, productive characters and vegetative characters in the two cycles of selection.

4. The relative efficiency of the four methods of selection was also critically examined. Progenies developed through single plant and mass selection were superior to those developed through single seed descent and pure line selection for earliness and productive characters.

5. The efficiency was also examined in terms of improving the genetic parameters of the progeny. Genetic advance as percentage of mean for yield/plant was higher for progenies developed through single plant in both cycles of selection. Realised genetic gain as compared to the over all mean was positive for progenies developed through mass and single plant selection for earliness and productive characters.

6. The efficiency of single plant selection over mass selection for yield/plant was the highest, +1.64 and +3.54 in the third and fourth cycles of selection respectively.

7. Simultaneous evaluations for resistance to bacterial wilt under field conditions were also conducted in two consecutive cycles of selection.

Progenies developed through single seed descent and single plant selection showed minimum wilt incidence in the fourth cycle of selection.

8. Four brinjal lines SM 45, SM 56, SM 71 and SM 74 were moderately resistant under field conditions. The above lines were late and were low yielders compared to SM 6.

References

REFERENCES

*Akai, S. and Kuneida, K. 1955. Varietal differences of egg plants in relation to the causal bacteria of the wilt disease *Xanthomonas solanacearum*. *Forsch. Geb. Pflanzekrankeiten* **5**: 37-44.

Allard, R.W. 1960. *Principles of plant breeding*. pp. 50-183. John Wiley and Sons Inc., New York and London.

Andrus, C.F. 1963. Plant breeding systems. *Euphytica*. **12**: 205-208.

Asha Sankar, M. 1984. *Efficiency of four methods of selection in brinjal improvement in relation to resistance to bacterial wilt*. M.Sc.(Hort) thesis, College of Horticulture, Kerala Agricultural University, Vellanikkara.

AVRDC. 1982. Tomato Single Seed Descent Trials. *Annual Progress Report*, pp. 36. Asian Vegetable Research and Development Centre, Taiwan.

Bhutani, R.D., Singh, G.P. and Kalloo, 1977. A note of variability studies in brinjal (*Solanum melongena* L.). *Haryana J. Hort. Sci.* **6**(34): 190-192.

Bilbro, J.D. 1961. Comparative effectiveness of three breeding methods in modifying coarseness of cotton fibre. *Crop Sci.* **1**(5): 313-317.

Boerma, H.R. and Cooper, R.L. 1975. Comparison of three selection procedures for yield in Soybeans. *Crop Sci.* **15**(2): 225-229.

Borikar, S.T., Makne, V.G. and Kulkarni, V.G. 1981. Note on diallel analysis in brinjal. *Indian J. agric Sci.* **51**(1): 51-52.

Brim, C.A. 1966. A modified pedigree method of selection in soybean. *Crop Sci.* **6**(2): 220.

Buddenhagen, I.W. 1960. Strains of *Pseudomonas solanacearum* in indigenous hosts in banana plantations of Costa Rica and their relationship to bacterial wilt of bananas. *Phytopathology* **50**(9): 660-664.

Buddenhagen, I.W. and Kelman, A. 1964. Biological and physiological aspects of bacterial wilt caused by *Pseudomonas solanacearum*. *Ann. Rev. Phytopath.* **2** : 203-226.

Buddenhagen, I.W., Kennedy, K.R. and Wag, C.H. 1966. Comparative carbohydrate catabolism in three different pathogenic strains of *Pseudomonas solanacearum*. *Phytopathology* **56**(9): 995-1002.

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

Casali, V.W.D. and Tigchelaar, E.C. 1975. Breeding progress in tomato with pedigree selection and single seed descent. *J. Amer. Soc. Hort. Sci.* **100**: 362-367.

Celin, V.A. 1981. Genetic cataloguing of tomato germplasm towards isolation of line(s) resistant to bacterial wilt. M.Sc. (Hort.) thesis, College of Horticulture, Kerala Agricultural University, Vellanikkara.

Chaubey, C.N. 1979. Mass selection for seed yield in toria. *Indian J. Genet.* **39**(2): 198-200.

Chaudhary, R.C. 1982. *Introduction to plant breeding*. pp. 70-93. Oxford and IBH Publishing Co., New Delhi.

*Chebib, F.S., Helgasan, S.B. and Kattsikes, P.J. 1973. Effect of variation in plant spacing, seed size and genotype on plant-to-plant variability in Wheat. *Z. Pflanzenzüchtg* **69**: 301-332.

Choo, T.M. and Kannenberg, L.W. 1979. Changes in gene frequency during Mass, Modified Ear-to-Row and S_1 selection: A simulation study. *Crop Sci.* **19**(4): 503.

*Choudhuri, H.C. 1972. Genetical studies in some West African *Solanum melongena* L. *Can. J. Genet. Cytol.* **14**(2): 446-449.

Cooper, R.L. 1982. Early generation testing as an alternative to the single seed descent breeding method in Soybeans. *Agron. Abstr. Annual Report.* pp. 62.

*Daly, P. 1970. Search for an egg plant variety tolerant of *Pseudomonas solanacearum*. *7th Ann. meeting CFCS Proc.* pp. 113-132.

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

*Dawidson, H.F. 1935. Bacterial wilt of solanaceous crops. Trop. agric. (4): 257-259.

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(2): 151- 155.

Dhesi, H.S., Nandpuri, K.S. and Dhatiwal, C.S. 1964. Heritability of some characters in eggplant. Indian J. Genet. 24: 286-287.

*Dikil, S.K. and Studentsova, L.I. 1975. Initial material for breeding egg plant. Refertivnyi Z. 68-71.

Dutta, O.P. and Kishun, R. 1974. Breeding brinjal for yield, quality and resistance to bacterial wilt (Pseudomonas solanacearum). In Indian Council of Agricultural Research Annual Report 1982. Indian Institute of Horticultural Research, Hessarghatta, Bangalore.

*Earle, F.S. 1900. Tomatoes Ala. agric. Exp. Stat. Bull. (108): 1-36.

*Eddins, A.H. 1936. Brown rot of Irish potatoes and its control. Fla agric. Exp. Stat. Tech. Bull. 299: 1-44.

*Eldin, S.A. 1967. The inheritance of certain quantitative characters in egg plant. Diss. Abstr. 28: 491.

*Empig, L.T., Calub, A.G., Katigbek, M.M. and Deanon, J.R. 1962. Screening tomato, egg plant and pepper varieties and strains for bacterial wilt resistance. Phillipp. Agric. 46: 936-946.

Empig, L.T. and Fehr, W.R. 1971. Evaluation of methods for generation advance in bulk hybrid soybean populations. Crop Sci. 11: 51-54.

Finney, D.J. 1958. Plant selection for yield improvement. Euphytica. 7: 83-106.

Frey, K.J. 1967. Mass selection for seed width in oat populations. Euphytica. 16: 341-349.

Gallegly, M.E. and Walker, J.C. 1949. Relation of environmental factors to Bacterial wilt of Tomato. Phytopathology 39: 936-945.

Gill, H.S., Arora, R.S. and Pachauri, C. 1976. Inheritance of quantitative characters in egg plant. Indian J. agric. Sci. 4(10): 484-490.

Gill, H.S., Bhagehandani, P.M. and Thakur, M.R. 1978. Pusa Purple Cluster - brinjal with wide adaptability. Indian Hort. 23(1): 13-22.

Gopimony, R. and Sreenivasan, K. 1970. Studies on brinjal hybridisation-I. Features of Fi hybrids between cultivated and wild brinjal. Agric. Res. J. Kerala. 8(2): 101-105.

Gopimony, R., Nair, N.K. and Nair, V.G. 1982. Wilt resistant mutants in egg plant. Mutation Breed Newsl. (20): 8-9.

*Goth, R.W., Peter, K.V. and Webb, R.E. 1983a. Bacterial wilt, Pseudomonas solanacearum resistance in pepper and egg plant lines. Phytopathology. 73(5): 808.

*Goth, R.W., Peter, K.V., Sayne, K.M. and Webb, R.E. 1983b. Effects of root knot nematode on bacterial wilt of tomato. Phytopathology. 73(6): 966.

Grafius, J.E. 1965. Short cuts in plant breeding. Crop Sci. 5(4): 377.

Graham, R.M. and Yap, T.C. 1976. Studies on bacterial wilt. 1. Inheritance of resistance to Pseudomonas solanacearum in tomato. Malayasian agric. Res. 57(1): 1-8.

Grubben, G.J.H. 1977. Tropical vegetables and their genetic resources. pp. 34-36. International Board of Plant Genetic Resources, Rome.

Haddad, N.I. and Muchlbauer, F.J. 1981. Comparison of random bulk population and single seed descent method of lentil breeding. Euphytica 30: 643-651.

Hayward, A.C. 1964. Characteristics of Pseudomonas sclanacearum J. appl. Bact. 27(2): 265-277.

Hiremath, K.G. and Rao, G.M.C. 1974. Genetic variability and correlation studies in Solanum melongena L. Mysore J. agric. Sci. 8: 197-202.

*Jenkins, S.F. and Nesmith, W.C. 1976. Severity of southern wilt of tomato and egg plant as influenced by plant age, inoculation technique and isolate source. Amer. Phytopath. Soc. Proc. 3: 337-338.

Kauffmann, K.D. and Dudley, J.W. 1979. Selection indices for corn grain yield, percent protein and kernel weight. Crop Sci. 19(5):583-589.

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. Cellulase of Pseudomonas solanacearum in relation to pathogenesis. Phytopathology. 55: 148-158.

Kerala Agricultural University, 1981. Cataloguing brinjal germplasm to isolate line(s) resistant to bacterial wilt. Research Report 1981-82. pp. 140-273. Directorate of Research, Kerala Agricultural University, Vellanikkara.

Kerala Agricultural University, 1982. Genetic cataloguing of brinjal germplasm to isolate line(s) resistant to bacterial wilt. Annual Report 1982-83. pp. 140. Kerala Agricultural University, Vellanikkara.

Keshwal, R.L. and Joshi, L.K. 1976. Variation in Pseudomonas solanacearum. Indian J. Micfobiol. 16(2): 94-97.

Keshwal, R.L., Joshi, L.K. Kulkarni, S.N. and Chaubey, P.C. 1977. Bacterial wilt of ajwain tomato and fennel in Madhya Pradesh. Veg. Sci. IV(1): 19-20.

*Komochi, S. 1966. Genes controlling early maturation of F_1 hybrids of egg plant. Japanese J. Breed. 16: 31-38.

Lucas, G.B., Sasser, J.N. and Kelman, A. 1954. The effect of root knot nematode on the expression of Granville wilt resistance in tobacco. Phytopathology. 44(9): 28-33.

*Lum, K.Y. and Wong, H.K. 1976. Control of bacterial wilt of tomatoes in the lowlands through grafting. MARDI Res. Bull. 4(1): 28-33.

*Maine, E.C. 1958. Influence of host components on resistance to Pseudomonas solanacearum, causal agent of bacterial wilt. M.Sc. thesis submitted to University of North Carolina.

*Maine, E.C. and Kelman, A. 1961. The influence of reducing substance on resistance to bacterial wilt in tobacco. Phytopathology. 51(7): 491-492.

Mak, C. and Vijiarungam, A.F. 1980. Variability in bacterial wilt resistance and inter-relationship of some characteristics of brinjal. (Solanum melongena L.). SABRAO J. 12(1): 65-73.

Martin, C., French, E.R. and Nydeggar, V. 1982. Strains of Pseudomonas solanacearum affecting solanaceae in the Americas. Plant Dis. 66: 488-460.

Mc Ginnis, R.C. and Shebeski, L.H. 1968. The reliability of single plant selection for yield in F_2. (In) Finlay, K.W. (Ed.) 3rd Intern. Wheat Genet. Symp. Proc. Canberra. Australia. pp. 109.114.

Mishra, G.M. and Roy, S.N. 1976. Genotypic and phenotypic variability in brinjal. Veg. Sci. III(1): 25-29.

Mishra, M.N., Tiwari, A.S., Seshagiri, A. and Singh, L. 1978. Selection gains in Bengalgram. Indian J. Genet. 38(1): 86-89.

Mital, R.K., Singh, S.N. and Singh, H.N. 1976. Genetics of some characters in brinjal (Solanum melongena L.) Veg. Sci. III(2): 79-87.

*Morton, D.J., Duker, P.D. and Jenkins, S.F. 1966. Serological relationships of races 1,2 and 3 of Pseudomonas solanacearum. Plant Dis. Reptr. 50(4): 275-280.

Muchlbauer, F.J., Burnell, D.G., Bogyo, T.P. and Bogyo,M.T. 1981. Simulated comparisons of single seed descent and bulk population breeding methods. Crop Sci. 21(4): 572-577.

Mukherjee, R. and Mukhopadhyay,S. 1982. Effect of root exudates of brinjal on Pseudomonas solanacearum. Veg. Sci. 9(2): 122-125.

*Nakata, K. 1927. Principles for controlling tobacco wilt. J. Sci. agric. Soc. (Tokyo) 298: 389-411.

Nayak, B.K. and Patnaik, M.C. 1979. The effect of mass selection for yield and its components on variability and correlations in maize. Crop Improv. 6(2): 94-102.

*Okabe, N. and Goto, M. 1961. Studies on Pseudomonas solanacearum XI - Pathotypes in Japan. Shiznoka Fac. agric Rept. 11:25-42.

Peter, K.V. and Singh, R.D. 1973. Diallel analysis of economic traits in brinjal. Indian J. agric. Sci; 43(5): 452-455.

Peter, K.V. and Singh, R.D. 1976. Combining ability, heterosis and analysis of phenotypic variation in brinjal. Indian J. agric. Sci. 44(6): 393-399.

Pierce, L.C. and Currence, T.M. 1959. The efficiency of selecting for earliness, yield and fruit size in a tomato cross. J. Amer. Soc. Hort. Sci. 102(5) 520-522.

Pierce, L.C. 1977. Impact of single seed descent in selecting for fruit size, earliness and total yield in tomato. J. Amer. Soc. Hort. Sci. 102(5): 520-522.

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

Rath, P.K. and Addy, S.K. 1977. Variation in Pseudomonas solanacearum causing bacterial wilt of tomato. Indian Phytopath. 30(4): 502-506.

Redden, R.J. and Jensen, N.F. 1974. Mass selection and mating systems in cereals. Crop Sci. 14(3): 345.

Romero, G.E. and Frey, K.J. 1966. Mass selection for plant height in Oat populations. Crop Sci. 6(3): 283-287.

Roy, N.N. 1976. Inter-genotypic plant competition in wheat under single seed descent breeding. Euphytica. 25: 219-223.

*Salehuzzaman, M. and Joarden, O.I. 1980. Correlation and selection index in egg plant (Solanum melongena L.) Genet. agric. 34(3/4): 193-205.

Sheela, K.B. 1982. Cataloguing of brinjal germplasm to isolate line(s) resistant to bacterial wilt. M.Sc.(Hort.) thesis, College of Horticulture, Kerala Agricultural University, Vellanikkara.

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

Singh, B. and Khanna, K.R. 1978. Correlation studies in egg plant. Indian J. Hort. 35(1): 39.

Singh, B. and Khanna, K.R. 1979. Inheritance of some quantitative characters in brinjal. Indian J. Hort. 36(1): 80-83.

Singh, A. and Singh, H.N. 1976. Genetics of quality components in Chilli. Indian J. Genet. 36(1): 84-95.

Singh, S.N. and Singh, H.N. 1980a. Genetic variability and heritability in brinjal (Solanum melongena L.) Progve. Hort. 12(1): 20-23.

Singh, S.N. and Singh, H.N. 1980b. Association in segregating populations in brinjal. Indian J. Genet. 40(2): 322-327.

Singh, S.N. and Singh, N.D. 1981. Correlation and path analysis in brinjal. Progve. Hort. 13(1): 13-16.

Singh, S.N., Singh, R.D., Chauhan, Y.S. and Katiyar, R.P. 1974. Genetic variability, heritability and genetic advance in brinjal. Progve. Hort. 6(1):15-18.

Singh, S.N., Singh, H.N. and Hazarika, M.H. 1979. Fractional diallel analysis of some quantitative characters in brinjal. Acta. Hort. 93: 307-311.

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

Sneep, J. 1977. Selection for yield in early generations of self-fertilising crops. Euphytica 26: 27-30.

Sreenivasan, R., Gopimony, P., Swaminathan, M. and Pillai, P.K. 1969. On the resistance of wilt brinjal variety to bacterial wilt. Agric. Res. J. Kerala 7(1): 39-40.

Srivastava, L.S. and Sachan, S.C.P. 1973. Correlation coefficient and path analysis in brinjal. Indian J. agric. Sci. 43(7): 673-675.

Suzuki, I., Sugahara, Y., Kotani, A., Todaka, S. and Shimada, H. 1964. Studies on breeding Egg plants and Tomatoes for Resistance to Bacterial wilt. I. Investigations on Method of Evaluating the Resistance and on the source of Resistance in Egg plants and Tomatoes. Bull. Hort. Res. Stn. Hiratsuka. Ser. A. (3): 77-106.

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

Swarup, V. 1977. Breeding procedures for cross pollinated vegetable crops pp. 10-11. ICAR, New Delhi.

Tee, S.T. and Oualset, C.O. 1975. Bulk population in wheat breeding. Comparison of single seed descent and random bulk methods. Euphytica 24: 393-405.

Valentine, J. 1979. The effect of competition and Method of sowing on the efficiency of single plant selection for grain yield, yield components and other characters in spring Barley. J. Plant breed. 83: 193-204.

Vaugham, E.K. 1944. Bacterial wilt of tomato caused by Phytomonas solanacearum. Phytopathology 34: 443-458.

Vijay, O.P. and Nath, Prem. 1978. Studies on heterosis and development of hybrid variety in brinjal (Solanum melongena L.). Indian J. Hort. 35(3).

Vijaygopal, P.D. and Sethumadhavan, P. 1973. Studies on the intervarietal hybrids of solanum melongena L. Agric. Res. J. Kerala. 11(1): 43-46.

*Wager, V.A. 1946. Egg plants resistant to bacterial wilt. Fmg. Soc. Atr. 21: 410-412.

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

* Originals not seen

REALISED SELECTION RESPONSES UNDER FOUR METHODS OF SELECTION IN THIRD AND FOURTH CYCLES IN A SET OF BRINJAL LINES

BY

JESSY KUTTY, P. C.

ABSTRACT OF A THESIS

submitted in partial fulfilment of

the requirement for the degree

Master of Science in Horticulture

Faculty of Agriculture

Kerala Agricultural University

Department of Olericulture

COLLEGE OF HORTICULTURE

Vellanikkara - Trichur

1985

ABSTRACT

Selection methods like mass, single plant, pure line and single seed descent were efficiently used to exploit the genetic variability present in the transgressive segregants of the brinjal line SM 6, keeping the bacterial wilt resistance of the population intact. The present study conducted at the College of Horticulture, Vellanikkara, extended the comparison of the selection methods for further improvement of the eleven genetic groups within the line SM 6 for earliness and productive characters in the third and fourth cycles of selection. The criteria for selecting the elite plant types were fruits/plant and yield/plant. Observations were recorded on earliness, vegetative characters and productive characters.

The eleven genetic groups were evaluated under each selection method for the characters under study. The genetic groups SM 6-2, SM 6-4, SM 6-7 and SM 6-1 were promising for fruits/plant and total yield/plant. Only promising lines were carried forward in the fourth cycle of selection.

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

Genetic information like genotypic coefficient of variation, phenotypic coefficient of variation, heritability in the broad sense, genetic advance and genetic advance as percentage of mean were higher 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 selection methods.

The level of resistance of SM 6 to bacterial wilt, under four methods of selection, was assessed. Single seed descent and single plant selection methods were found effective in the fourth cycle of selection to improve level of resistance of SM 6 to bacterial wilt. When screened under field condition the line SM 6-7 was found immune to bacterial wilt, while the lines SM 6-2 and SM 6-4 were found highly resistant. Four resistant lines SM 45, SM 56, SM 71 and SM 74 were grown for comparison with SM 6. These lines were found moderately resistant and were late and low yielders.