GENETIC STUDIES IN BRINJAL WITH RELATION TO BACTERIAL WILT RESISTANCE

BY

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THESIS

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for the degree of

DOCTOR OF PHILOSOPHY

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Department of Agricultural Botany

COLLEGE OF AGRICULTURE

Vellayani Trivandrum

1983

DECLARATION

I hereby declare that this thesis entitled "Genetic studies in brinjal with relation to bacterial wilt resistance" is a bona fide record of research work done by me during the course of research and that the thesis has not been previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar titles of any other University or Society.

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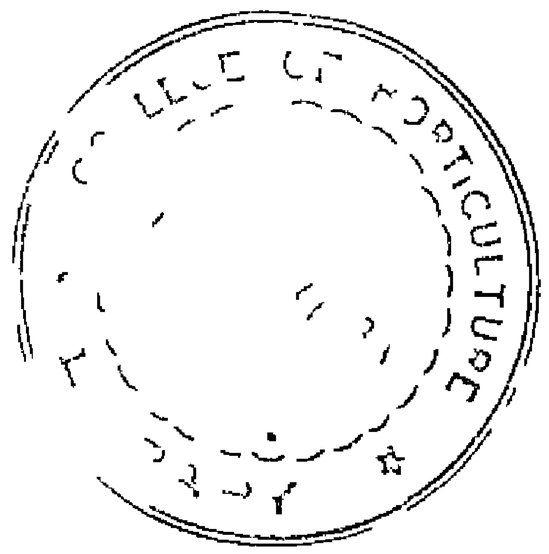

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CERTIFICATE

Certified that this thesis entitled "Genetic studies in brinjal with relation to bacterial wilt resistance" is a record of research work done independently by Shri. R. Gopimony, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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CONTENTS

LIST OF TABLES

LIST OF TABLES (Contd..)

LIST OF TABLES (Contd...)

LIST OF TABLES (Contd..)

LIST OF APPENDICES

LIST OF FIGURES

LIST OF PHOTO PLATES

INTRODUCTION

INTRODUCTION

Brinjal, more commonly known outside India as the egg plant (Solanum melongena L.) is one of the important vegetable crops of the warm, humid tropics. Its unripe fruit is a common and popular vegetable which can be cooked in a variety of ways. From the point of view of nutrition it is comparable with other common vegetables with 1.4 per cent protein, 0.3 per cent fat and 0.3 per cent minerals. It grows throughout the year in India and is available in all seasons. The major factor contributing to the popularity of this crop is the relative easiness of its cultivation.

Brinjal is an ancient crop in India and most likely originated here (Bhaduri, 1951). It is now widely distributed in the tropics and temperate zones. Breeding for locally adapted varieties has resulted in a wide diversity of the germ plasm. Hundreds of varieties varying in size, shape and colour of fruits are known in India, Japan, U.S.A. and U.S.S.R. Throughout the Mediterranean region and the Near East,

varieties of this crop are numerous and diverse in morphology (Franklin and Bernard, 1979).

The most important problem now seen associated with the cultivation of brinjal in the humid tropics is the high incidence of bacterial wilt caused by Pseudomonas solanacearum E.F. Smith. Bozzini (1982) has emphasised the devastating nature of this disease on the various solanaceous crops in the tropics. George David (1975) has reported that the incidence of this dreaded disease in Kerala is as high as 100 per cent in certain improved varieties like 'Arka Kusumkar' and 'Banaras Giant'. None of the remedial or prophylactic measures suggested for the control of this disease is effective under the high acidic condition prevailing in most of the soil types of Kerala.

In 1968, the author initiated a breeding programme to transfer the wilt resistance of the wild brinjal variety Solanum melongena var. insanum Prain to the susceptible cultivated varieties through hybridization and selection. The F_1, F_2 and back cross progenies were grown and studied during the subsequent years (Gopimony and Sreenivasan, 1970; Swaminathan, 1971 and Vijayagopal and Sethumadhavan, 1973). These studies indicated that wilt resistance of the wild variety was governed by a

simple dominant gene and was always associated with some of the undesirable wild characters such as small fruit size, prickly nature and procumbent habit. The hybrids expressed high degree of heterosis. In subsequent generations raised through selfing as well as back crossing, useful recombinants were absent.

In the present study an attempt is made to induce recombinations through gamma irradiation of the F_1 seeds of the cross between the wilt resistant wild variety and the best susceptible cultivar 'Purple Giant', and to widen the spectrum of variation in the segregating generations so as to enable the selection of an economic genotype with bacterial wilt resistance.

The idea of increasing genetic recombinations through induced mutagenesis has been nurtured by plant breeders since Gustafsson (1954) and Gregory (1955) have successfully used this technique as a method in crop breeding. Siddiqui (1971) observed that gamma irradiation could increase recombination in intervarietal crosses of cotton. Radiations were also reported to enhance heritability, genetic advance and selection efficiency in oats (Krull and Frey, 1961) and in rice (Jalilmiah and Yamaguchi, 1965).

Not many attempts have been made to improve brinjal crop through mutation breeding. Reports on hybrid seed irradiation in this crop are still meagre. The present study was therefore undertaken with the following objectives.

1. To evaluate the available germ plasm for identifying the most resistant as well as the most economic types under field conditions for hybridization.

2. To study the sensitivity of the hybrid genotypes to gamma irradiation.

3. To estimate the extent of variability induced by for qualitative and quantitative traits in the genotypes.

4. To explore the possibility of inducing new associations and strengthening the nature of association of yield and resistance characters.

5. To determine the effectiveness of using pollen sterility as a selection index in M_1 generation for selecting F_1M_1 plants to raise the F_2M_2 population.

6. To compare the segregation pattern in the F_2M_2 populations originating from different F_1M_1 sterility groups with that of the control F_2 population.

7. To compare the segregation pattern of control F_2 population under wilt free and wilt infection conditions.

8. To evaluate the different F_3M_3 families along with the control F_3 for wilt resistance and yield.

9. To evaluate the selected mutant recombinant types in F_7M_7 generation for resistance and yield.

To achieve these objectives, special breeding techniques such as hybrid seed irradiation and screening of segregating plant populations under artificial epiphytotic conditions were employed. The methods used for these studies and the results obtained are presented and discussed in the following pages.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The cultivated brinjal plant Solanum melongena Linn. is a species of considerable economic importance in many tropical and subtropical parts of the world. Together with many other Solanum species, its taxonomic relationships are not well understood and most investigations have been limited to studies of morphological characters and evaluation of crossability relationships (Tatebe, 1944, Capinpin et al., 1963, Krishnappa and Chennaveeriah, 1964, Sambandam, 1967, Rao, 1969, Rajasekharan, 1969a, 1969b, 1970 a, b, c, 1971).

I. Origin

Most of the evidences show that brinjal originated in Asia. South West Asia including Arabia, Indo-Burma region, Japan and China have been suggested as probable places of origin by different authors (Hooker, 1885, De Candolle, 1886, Filov, 1940, Coulter, 1942, Bailey, 1947 and Vavilov, 1928, 1931 and 1951). Bhaduri (1951) has supported the view of Filov and Coulter that Indo-Burma region was the centre of origin of this crop since they observed large number of cultivated and wild varieties of brinjal in that area.

The genus Solanum consists of approximately 2000 species out of which about 100 are tuberiferous and the rest non-tuberiferous.

The species of S. melongena has a large number of cultivated and wild forms or races recognised principally according to shape or colour of the fruit. Filov (1940) has classified these various forms in agro-ecological basis. According to Filov the different forms of S. melongena are grouped into five subspecies. He considered that the wild forms of these are found only in India. These forms which are characterised by extremely bitter and inedible fruits have been put under a separate subspecies, S. melongena S sp. agrestis Fil.

After the separation of the new genus Lycinathes from Solanum by Hassler (1917), Santapau (1947) transferred six out of the total 28 Indian Solanum species to the new genus.

Bhaduri (1951) classified the remaining 22 Indian species into two natural groups or sections as (a) species which are non spiny and (b) species which are spiny. Along with other 14 species S. melongena Linn. comes under the group (b). He has also suggested that the nearest ancestors of the cultivated forms of

S. melongena may be (1) wild varieties of S.melongena such as S.melongena var. insanum and S. melongena var. potangii (ii) S. incanum (iii) hybrids of some of the varieties under (i) and S.incanum. But Reayat Khan (1979) has questioned this suggestion by qualifying it as an over simplification of the problem. Based on the fact that S.melongena could produce fertile hybrids with atleast ten different species he believed that this number of successful interspecific crosses involving S.melongena will increase with more such attempts.

Recently Kit Pearce and Lester (1979) have proposed the term "egg plant complex" to denote a group of Solanum species morphologicallysimilar to the cultivated egg plant. They have included S.insanum L. (and other authors), S.melongena L. var. insanum Prain, S.sanctum L., S.album Lour. and S.cumingii Dun. under this group. The internal homogeneity of this group has been confirmed by a number of crossability studies by Pearce (1975) which can be summarised as follows: The production of fertile F_1 hybrids with abundant stainable pollen and normal F_2 generation plants has been obtained only from crosses between species belonging to the "egg plant complex" and not from crosses between members of this complex and other Solanum species.

II. Taxonomic position of Solanum melongena L. var. insanum Prain.

Roxburgh as early as 1832 has described a wild variety of brinjal giving a distinct species status by naming it as S.insanum Roxb. Clarke (1883) has not separated this variety from the parent species S. melongena Linn. Prain (1903) has made mention of a similar variety calling it S. melongena var. insanum and described it as a very prickly herb with quite round fruits. He considered this form to be feral by reversion and does not represent truly wild stock. Gamble (1915) mentioned of S.melongena var. insanum Prain (S. insanum Wild.) and has given identical description as Prain, the mature fruit being a globose yellow berry under one inch in diameter. According to Bhaduri (1951), taking crossability as an index of measuring affinities between allied plants, S. melongena var. insanum Prain is related to the cultivated types of S. melongena. He has considered it as one of the nearest ancestors of the cultivated forms of S. melongena. The other probable ancestors listed out are S. melongena var. potangi, S. incanum L. and hybrids among these. All these species occur naturally in India.

Choudhary (1967) has classified S. melongena var. insanum as a distinct variety under S. melongena along with esculentum (egg shaped fruits), serpentinum (long narrow fruits) and deperssum (dwarf early varieties).

Deb (1979) has distinguished insanum by its solitary flowers, small rounded fruits and the nature of the petal lobes and petal tip from a closely resembling variety incanum.

III. Floral biology

Pal and Singh (1943) have classified the flowers of egg plant with regard to position of the stigma in relation to anther tip into long styled, true short styled and pseudo short styled based on the measurement of style and indicated that only the long styled and pseudo-short styled flowers normally produced fruits while the short styled ones were seldom fertile.

Krishnamoorthy and Subramoniam (1953) have classified the flower types in brinjal into four groups as follows:

1.	Short styled	Style is rudimentary
2.	Pseudo short styled	Stigma comes upto half way of the anther length.
3.	Long styled	Stigma comes well above the anther tip.
4.	Medium styled	Stigma comes upto the anther tip.

They have also found that under natural conditions 27 per cent of flowers set fruit and 93 per cent of these came from long styled flowers.

Sambandam (1964) has reported that in egg plants the natural crossing was from 0.7 per cent to 15.0 per cent of which an average of 4.4 per cent was intra plant crossings and an average of 6.7 per cent was inter plant crossings.

Prasad and Prakash (1968) have conducted a detailed experiment involving four different varieties to study the floral biology of brinjal. They have found that all the varieties had flowers of three different style lengths namely short, medium and long depending on whether the position of stigma was far below, on par with or clearly above the level of the tip of anthers respectively. They have also noted that anthers dehisced usually 15 - 20 minutes after the flower had opened. The period of effective receptivity ranged from a day prior to flower opening till four days after opening. Pollination was by force of gravity, action of wind or by insects.

Gopimony (1968) has reported that under Vellayani conditions the time of flower opening and dehiscence of

anthers were simultaneous and vary between 7 and 10 AM depending on weather conditions.

Chadha and Saimbhi (1977) have studied the varietal variation in flower types in 29 brinjal varieties and have reported that all the varieties bear flower cluster along with solitary flower. The number of flowers in a cluster vary from 2 to 25.

Flanklin and Bernard (1979) have observed that flowers were borne singly or in clusters of upto seven. The first flower in each cluster was normal and subsequent flowers often have abnormal, shortened stigmas, which were seldom fertile. But in clustered types they were found to bear as many as three or four fruits in a cluster.

Reayat Khan (1979) in his review article on brinjal plant has stated that the floral condition of andromonoecy with brachystyly (heterostyly) is very common in this crop.

IV. Crossability studies

a. Interspecific

Comparatively few reports have been known in the past with regard to breeding behaviour of non-tuber bearing Solanum species. But recently many hybridization works

especially at interspecific level have been undertaken in this group by many workers of which the most exhaustive one has been reported by Narasimha Rao (1979). He has reviewed the results of 12 years crossability studies involving ten species including the cultivar Pusa Purple Long and the wild Solanum melongena var. insanum. Of the 90 possible combinations including reciprocals, in 47 there was no fruit set, in four there was only parthenocarpic fruits and in 39 combinations seed set achieved. Among the 39 combinations where F_1 seeds could be obtained only 24 crosses gave normal F_1 plants whereas 12 produced seeds which appeared normal but did not germinate, one produced shrunken seeds and two produced seedlings which died before transplantation.

The results of the different crosses involving S. melongena var. insanum in the above work are listed below:

Sl. No.	Cross combination	Performance of F_1
1.	S.melongena (Pusa Purple Long) x S. melongena var. insanum	Normal seeds which grew well.
2.	S.incanum x S.melongena var. insanum	"
3.	S.integrifolium x S.melongena var. insanum. S.melongena	"

Sl. No.	Cross combination	Performance of F_1
4.	S.gilo x S.melongena var. insanum	Normal seeds but did not grow
5.	S.indicum x S.melongena var. insanum.	Normal seeds which grew well
6.	S.zuccagnianum x S.melongena var. insanum	"
7.	S.xanthocarpum x S.melongena var. insanum	"
8.	S.khasanum x S. melongena var. insanum	Cross unsuccessful
9.	S.sisymbrifolium x S.melongena var. insanum	"

Narasimha Rao (1979) has reported in detail the presence of crossability barriers which permitted crosses of many combinations to be made only in one direction. He has reported that the cross between S.melongena x S. indicum was successful only when S.indicum was taken as female parent. It was also noted that this cytoplasmic effect was continued even upto F_2 and BC_1 generations without any modifications. This was explained as due to unaccommodative nature of the cytoplasm of S. melongena to particular genes or gene complexes of S.indicum while the cytoplasm of S. indicum was tolerative to the genotypes of S.melongena. He further explained the

general barriers to crossability in Solanum species as follows:-

1. There was no stylar incompatibility noticed in any of the 90 cross combinations studied.

2. Where shrunken seeds are produced it was assumed as collapse of embryo in early stages of development (somatoplastic sterility).

3. Partial incompatibility barriers may be the cause for reciprocal differences in crossability.

Such reciprocal differences with regard to crossability in Solanum species were reported by Sarvayya (1936), Bhaduri (1951), Nasrallah and Hopp (1963), Krishnappa and Chennaveeriah (1965), Babu Rao (1965), Rajasekharan (1968) and Rangaswamy and Kadambavanasundaram (1974).

b. Intergeneric

Only very few crosses were attempted at intergeneric level involving Solanum and none of them has been successful. Miva et al. (1958) have tried the following five intergeneric crosses involving Solanum.

S. integrifolium x Petunia violaceae

S. esculentum x Lycopersicon esculentum

Lycopersicon esculentum x S. melongena

Capsicum annuum x S. melongena

Capsium annuum x S. integrifolium

These crosses were possible only by hormonal treatments and in all the cases the F_1s were sterile.

Wann and Johnsen (1963) have attempted intergeneric hybridization involving species of Solanum and Lycopersicon and attributed somatoplastic sterility for the failure of the cross.

A cross between S. pseudocapsicum and Capsicum annuum was attempted by Krishnappa and Chennaveeriah (1964) but found unsuccessful.

c. Intra specific

Reports on intervarietal crosses in Solanum melongena are many, majority of which in connection with the study of heterosis. But here, only those crosses involving taxonomically approved varieties of S.melongena are reviewed since a lot of confusion still exists in the usage of varietal names of the cultivated brinjal.

Swaminathan and Mittal (1949) and Bhaduri (1951) have obtained fertile hybrids from the crosses among S.melongena var. insanum, S. melongena var. potangi and S. melongena (cultivar). Argikar (1952) has crossed a

new variety of S. melongena var. bulsarensis var. Argikar (S. macrocarpon L.) with few of the cultivated Gujarat varieties of S. melongena but failed to get fruit set.

Anon. (1956) has effected a successful cross between S. melongena var. Wayanad Giant amd S. melongena (cultivar) and obtained fertile hybrids.

Rai (1959) obtained fertile hybrids from the cross between S. melongena var. insanum and S. melongena (cultivar).

Magoon et al. (1962) obtained fertile hybrids from the crosses among S. melongena var. insanum, S. melongena var. potangi and S. melongena (cultivar).

Rajkicicer and Pal (1964) have obtained fertile hybrids from the cross between S. melongena (Purple Long) Ssp. occidentale var. bulgaricum x S. melongena (white variety) Ssp. subspontaneum var. liucoum.

Krishnappa and Chennaveeriah (1964) have crossed different strains of S. indicum in all possible combinations and obtained results varying from cross unsuccessful to highly fertile hyorids. They have also found that certain races of S. melongena failed to cross each other and set fruit.

V. Combining ability, heterosis and heritability

Even though the production of hybrids in egg plant has a long past history with the earliest recorded artificial hybridization by Bailey and Munson (1892) in U.S.A. systematic genetic studies on this crop through controlled crossing experiments started only during the middle of this century.

From the study of certain intervarietal crosses of Solanum melongena Pal and Singh (1946) have found that majority of hybrids exhibited heterosis with respect to germination, height, spread, height and spread value, number of branches, earliness of flowering, number of fruits per plant, fruit size and yield.

Venketaramani (1946) has reported hybrid vigour in height, spread, earliness and yield.

Sambandam has given a detailed review of studies on heterosis in egg plant in 1962.

Mishra (1962) has reported the manifestation of conspicuous heterosis in yield, height, spread and number of branches in 13 F_1 hybrids as compared with better parent.

Sambandam (1964) has reported the existence of considerable hybrid vigour in reciprocal crosses studied in two American varieties of brinjal.

Thakur et al. (1968) have reported that the degree of heterosis in total yield varied from 62 to 241.50 per cent. Among four varieties involved in the study Wayanad Giant was the highest yielding variety with the lowest combining ability. Reciprocal differences were observed in some combinations.

Choudhury and Kalda (1968) have reported 80 to 100 per cent higher yield in the hybrids compared to better parent in a cross between Pusa Purple Long and Hyderpur.

Viswanathan (1973) has reported 100 per cent yield increase in the F_1 hybrid of the cross Muktakeshi x Banaras Giant over the better parent.

Oganesyan (1976) has studied the yielding ability of F_1 hybrids over the parents in many intervarietal crosses in brinjal and concluded that the degree of heterosis in yield decreased with increase in the difference in parental yield.

Singh et al. (1977) have reported high degree of heterosis in F_1 over better parent for plant height, days to flowering, fruit length and width and yield per plant from a 7 x 7 egg plant diallel excluding reciprocals. They have also reported considerable

inbreeding depression in the F_2 for all traits measured.

Srivastava and Bajpai (1977) have conducted an half diallel cross experiment to study the combining ability in egg plant and reported that additive genetic variance was higher than non-additive for number of days to flowering and plant height, while the opposite was found for number of branches and plant spread. General and specific combining ability effects were significant for all characters except number of days to flowering.

From a 9 x 9 diallel cross experiment in brinjal Dharmagowda et al. (1979) found that Muktakesi had the highest yield per plant and Arka Kusumkar had the highest number of fruits per plant and good general combining ability for that character and yield. Arka Shirish had the densest fruit and had significant general combining ability effects for that character.

From a detailed study on the genetic divergence in egg plant Dhankhar et al. (1980) have reported that fruit yield, per cent of long, medium and pseudoshort styled flowers together contributed 44.70 per cent of the total diversity in normal crop.

Borikar et al. (1981) have conducted diallel analysis in brinjal and reported that additive genetic effects predominated for yield per plant, plant height and number of branches per plant. Yield per plant was also influenced by non-additive effects. Heritability was moderate for yield per plant but high for plant height and number of branches per plant.

VI. Inheritance studies

a. Pigmentation

Halstead (1918) has noted that purple fruit pigmentation could be formed either dependently or independently of light. He has also reported that the purple colour is dominant to white. As regards to other types when striped fruit groups were crossed with white sorts, the F_1 was slightly striped and when the striped variety was crossed with purple the F_1 was solid purple and only a small fraction of striped fruited plants appeared in F_2 indicating its recessiveness. When long white was crossed with dwarf purple all the fruits in the F_1 were purple but in F_2 four types were secured namely purple, pink, green and white in the ratio 9:3:3:1 suggesting two factors governing the colour. Tatebe (1944) reporting the inheritance of fruit colour

has stated that the purple colour was dominant over green variegated and that green variegated in turn was dominant over white. Pal and Singh (1946) and Janick and Tspoloski (1963) have reported that F_1 of a cross between purple and green was intermediate.

Sambandam (1967) reported that purple, purple striped and white skins of egg plant fruits constituted one allelomorphic series and green striped, light green striped, green and white flesh colours constituted another allelomorphic series. He has given a guide chart for colour combinations in hybrid egg plants.

Tigimellar et al. (1968) have suggested three independent complementary factors for anthocyanin development in the corolla, hypocotyl and fruit. They have also suggested the presence of at least two genes which affected colour intensity. A dominant gene R inhibited the fruit pigmentation in certain genetic back grounds.

Choudhuri (1977) proposed a simple dominant recessive relationship between green stripe and white colour based on his studies on West African egg plant varieties.

Wanjari and Khapre (1977) suggested that purple hypocotyl and purple stem were dominant over green and were monogenically inherited.

b. Fruit shape

Tatebe (1943) has reported that in crosses between round and long fruited egg plants the F_1 hybrids were approximately the geometric mean of the fruits of the two parents in size.

Khan and Ramzan (1953) estimated five pairs of genes to be governing the fruit shape.

Capinpin et al. (1963) have reported that F_1 hybrids were intermediate between the parents in fruit shape.

Swamy Rao (1970) has found that the F_1 of a cross between elongated and round fruit shapes was elongated and in F_2 the elongated and round appeared in 3:1 ratio.

c. Other qualitative characters

Hagivara and Iida (1938) have shown that the presence of spines on the stem and leaf and oblong shape of the fruits of S. integrifolium were dominant in a cross with S. melongena.

Khan and Ramzan (1953) have shown that spiny condition was monogenically dominant over smoothness.

Janick and Topoleski (1963) reported that pubescent leaf surface was dominant to glabrous nature.

Capinpin et al. (1963) have reported that spiny stem was dominant over non spiny stem and the character was monogenically inherited.

Empig and Sumaong (1964) have reported that clusterness was partially dominant over the solitary fruiting habit.

Anon. (1967) has reported that crosses of upright and decumbent plants have indicated that decumbent habit is controlled by a single recessive gene.

Baha-Eldin et al. (1968) have reported partial dominance of tall over dwarf, early flowering over late flowering and round fruit over long fruit.

Swamy Rao (1970) has reported that clustered fruiting habit was dominant over non-clustered habit and monogenically controlled.

Vijayagopal and Sethumadhavan (1973) have found that the spineness and resistance to Pseudomonas solanacearum were under monogenic control with dominant nature.

d. Quantitative characters

Goto (1964) conducted a series of genetic studies in egg plant and reported that the minimum number of genes governing shape and weight of fruit and period from sowing to flowering were calculated as 5, 9, and 4 respectively.

Lal et al. (1971) have studied the variation in agronomic traits through a seven-variety diallel of brinjal and calculated the number of effective factors governing important characters such as fruit length, number of fruits per plant, plant height and days to flowering. They have also reported that weight of fruits per plant was governed by dominant gene action.

From a diallel analysis of economic traits in brinjal Peter and Singh (1973) have found that the number of primary branches and number of days to flowering were governed by over dominant gene action, the weight of fruits per plant by dominant gene action, the height of plant by additive gene action with some over dominance and the number of flowers per inflorescence, number of long plus medium styled flowers, length of fruits and equatorial perimeter of fruit by additive gene action.

Vijayagopal and Sethumadhavan (1973) have studied the F_2 generation of intervarietal hybrids of brinjal and

reported that the plant height, spread, number of branches, number of fruits, fruit length and protein content were under polygenic control.

Gill et al. (1976) have concluded from a half diallel cross involving six varieties of brinjal that additive effects were more important than dominance effects for most of the characters in most crosses. Some significant gene interaction effects were observed. Heritability was high for all characters except the number of branches per plant.

Dharmegowda et al. (1979) have conducted a 9 x 9 diallel cross in brinjal for genic analysis of yield and its components. They have found that among the six characters studied, five were partially dominant and number of seeds per fruit was over dominant. Narrow-sense heritability estimates were 63.48 per cent and 67.48 per cent for number of fruits per plant and number of seeds per fruit respectively.

Joarder et al. (1981) have reported the inheritance of some quantitative characters in egg plant. Dominance effects were more important than additive effects for most of the characters. Duplicate epistasis was seen for all the characters. F_2 means showed high inbreeding depression.

VII. Bacterial wilt resistance

After a detailed survey of the incidence of bacterial wilt disease caused by Pseudomonas solanacearum, Kelman (1953) has admitted that it is one of the important diseases in temperate, sub-tropical and tropical regions of the world. In India the disease is serious in parts of Karnataka, Kerala, Orissa, Maharashtra, Madhya Pradesh, Bihar and West Bengal (Rao, 1972; Anon., 1974) and yield losses upto 62.5 per cent were observed (Das and Chattopadhyaya, 1955).

a. Studies on the casual organism and disease development

Jones et al. (1926) have observed that bacterial wilt disease is favoured by high temperatures and limited to within areas and during seasons in which such temperatures are prevalent.

Husain and Kelman (1958) have found that the degree of resistance of different strains was almost proportional to the amount of polysaccharides produced by each strain.

French and Sequeira (1970) have collected 42 strains of Pseudomonas solanacearum from solanaceous and Musaceous hosts in North and South America and compared them on the bases of size, shape, colouration and slime deposition in isolate colonies grown on a tetrazolium medium and

melonin formation in a tyrosine medium. The results indicated similarity as well as differences between isolates from different regions in pathogenicity, colony characteristics and host range. All Peruvian Amazon basin isolates had identical pathogenic potential on various hosts and could be distinguished from central American isolates on basis of colony morphology.

Shekhawat et al. (1978) have studied the distribution of bacterial wilt and races and biotypes of pathogen in India and reported that the causal organism Pseudomonas solanacearum E.F. Smith was endemic in India throughout the West Coast, Central and Deccan plateau of Karnataka, Western Maharashtra and Madhya pradesh, in the eastern plains of Assam, West Bengal, Orissa and Chotta Nagpur plateau on potato, tomato, brinjal, chillies and wild Datura, the incidence being 10 to 50 per cent. In the North Western, Eastern and Southern hills, it was also endemic but affected only the potato, incidence being 5 to 30 per cent. The disease was more widespread in heavy and acidic soil (pH 3.5 to 6.9) than in light and neutral (pH 6.5 to 7.5) to alkaline (pH 7.5 to 8.5) soils.

Wallis and Truter (1978) have studied the histopathology of tomato plants infected with Pseudomonas solanacearum with emphasis in ultra structure

through electron microscopy and revealed that initially only small diameter cells adjacent to large vessels were invaded, the vessels remaining bacterium free. Some of these cells were stimulated to form tyloses which bulged into the vessels, bacteria migrated into the tyloses many of which were ruptured 48 to 72 hour after inoculation liberating the organism and non cellular materials into the vessels. At this time plants began to show the first signs of wilting. Within vessels bacterial multiplication and spread was rapid and was accompanied by accumulation of large amounts of fine gramular material identified as bacterial extracellular polysaccharides and this is considered as the major cause for the sudden wilting of the plant.

Nesmith and Jenkins (1979) have developed a new selective medium for the isolation and quantification of Pseudomonas solanacearum from soil. The basal medium was derived by modification of the standard T.T.C. medium and the final selective medium was prepared by adding antimicrobial compounds at the time of use.

b. Screening techniques

Winstead and Kelman (1952) suggested the following method for scoring the disease. The symptom was graded as follows:

0 = No symptom

1 = One leaf wilted

2 = 2 to 3 leaves wilted

3 = All leaves except the top 2 to 3 leaves wilted

4 = All leaves wilted

5 = Dead

The number of plants in each symptom category was multiplied by the corresponding numerical grade and the products added. The summation was converted to a disease index value by dividing by the maximum numerical grades for the given number of plants and multiplied by 100. They have also suggested two inoculation techniques, one by cutting the lateral roots with a scalpel on one side of the plant and pouring 10 ml of the standardized suspension over the injured roots and second by 'stem puncturing' method in which an injury is made with a needle on the second leaf axil of a seedling two weeks after transplanting and putting a small piece of sterile cotton wool dipped in the bacterial culture over the injury.

Kelman (1954) has standardized the isolation technique for Pseudomonas solanacearum from diseased plant material through culturing on T.T.C. agar medium (Appendix VI).

Rao et al. (1976) have successfully screened a large number of brinjal types by growing them in a naturally wilt infested soil with a susceptible variety alternated with every two rows of the test variety.

c. Resistance sources and breeding methods

Evaluation of brinjal varieties for resistance to wilt has been made in several countries and some resistant varieties are available in Puerto Rico (Nolla, 1931, Roque, 1941), Phillippines (Anonymous, 1962, Empig et al. 1962), Ceylon (Park and Fernand, 1940), South Africa (Wager, 1946), Japan (Kuneida, 1953, Suzuki et al. 1964) and Martinique (Daly, 1972, 1973). In India Sreenivasan et al. (1969) have reported a wild variety Solanum melongena var. insanum Prain to be resistant to bacterial wilt.

Daly (1970, 1972 and 1973) crossed a tolerant Ceylonese variety of brinjal with susceptible cultivars and found that the F_1, F_2 and back cross progenies contained a high proportion of tolerant plants. He has further reported that homegenous lines were obtained from the above cross through pedigree method of selection. These lines showed less than 15 per cent of bacterial

wilt 75 days after planting. The tolerant line L-17 yielded 47 t per hectare in a three month season.

Gopimony and Sreenivasan (1970) have reported that the hybrids of a cross between cultivated brinjal varieties and a wild variety S. melongena var. insanum were completely resistant to bacterial wilt.

From the genetic analysis of the segregation pattern for wilt resistance in the BC_1 generation of a back cross breeding programme involving cultivated brinjal varieties and a wild resistant type S.melongena var. insanum, Swaminathan and Sreenivasan (1972) have reported that the character of wilt resistance found in the wild variety was dominant and monogenic in nature. Similar observations were made by Vijayagopal and Sethumadhavan (1973) also from the studies on the F_2 generation of the same cross. They have further reported that the wilt resistant character of the wild parent is closely associated with the small fruit size and hence large fruited resistant segregants were absent in the F_2 population.

Nazir Ahamad Khan (1974) has reported that the egg plant varieties Long Purple, Udipi, Improved Mukthakesi, Purple Long and Pusa Purple Cluster were resistant to

Pseudomonas solanacearum. He has also found two wild species namely Solanum torvum and S.xanthocarpum resistant to bacterial wilt.

Jenkins (1974) has studied the interaction of Ps. solanacearum and Meloidogyne incognita on bacterial wilt incidence in egg plant and reported that the nematodes had no apparent effect on wilt development.

Siddarme Gowda et al. (1974) have screened 12 brinjal varieties against bacterial wilt and reported one variety Gulla to be resistant.

Rao et al. (1976) have screened 19 brinjal cultivars including five wilt resistant types obtained from U.S.A. and Phillippines against bacterial wilt through field evaluation followed by artificial inoculation under glass house conditions. They have found that the so called wilt resistant exotic types were either moderately resistant or moderately susceptible under Indian condition. From this result they have suggested the existance of pathogenic strains of Ps. solanacearum with varying virulence in different parts of the world.

In a recent publication on egg plant Franklin and Bernard (1979) have listed ten egg plant varieties as resistant to bacterial wilt.

Rao and Anilkumar (1980) reported that the hybrids of a cross between S. melongena (Pusa Purple Long) and S. indicum were found to exhibit resistance under field conditions to wilt, fruit rot, leaf mosaic virus and brinjal fruit borer.

VIII. General effects of ionizing radiation on Solanaceous crops

Nuttali (1968) has reported the response of many garden plants including egg plant and tomato to low doses of gamma irradiation of seeds. He has found that 100 and 300 rads increased the number of flowers prior to the first harvest in Black Beauty egg plants. The early yield has slightly increased in 100 rads treatment. All dosages (100, 300 and 1000 rads) gave more vigorous growth of seedling roots, more flowers and large fruits.

Abdullaev (1974) has observed the effects of gamma irradiation doses varying from 15 to 45 kR applied on tomato seeds and reported that in M_2 chlorophyll mutations were found together with changes in habit and inflorescence structure. The largest number of mutant plants were obtained from 15 to 30 kR doses.

From a study of the effect of chronic radiation treatment on the content of active substance in

Solanum laciniatum Sazabady and Tetenyi (1974) have reported that mutant types with procumbent habit and reduced solasodine content were obtained in the M_2 to M_4 generations.

Dhopte and More (1975) have reported that irradiation of egg plant seeds with gamma rays upto 60 kR have increased the ascorbic acid content of the resulting fruits by 59.61, 8.62 and 76.77 per cent in Long white, Pusa Purple Cluster and Mangrigota respectively. The crude protein content was changed by less than one per cent.

Murty and Abraham (1975) have obtained completely spineless mutants in the M_3 generation by treating the seeds of Solanum khasianum Clark with gamma irradiation. These mutants were fertile and produced fruits profusely.

By irradiating dry seeds of tomato varieties at 5 to 20 kR Polyyanskaya (1975) has obtained three mutants at 5 kR dose and one at 10 kR dose. These mutants differed from the initial variety in having a better flavour, shorter growth period and larger fruits.

Viswanathan (1975) has treated dry seeds of Solanum trilobatum with gamma rays of 5, 10, 15, 20, 25, 30 and 35 kR and found that there was a decrease in

germination with increase in dose. But low doses stimulated germination and seedling growth. In M_1 generation large number of plants exhibited bushy and erect plant types, intensity of spines and high berry yield. He has also found that much variation in alkaloid content was induced by the radiation. The alkaloid was maximum for 10 kR dose. The author has explained this increase in alkaloid content at lower dosages of gamma rays as the consequence of stimulatory effect on the metabolic activity of the plant.

Bharathi Bhatt (1976) has produced mutant tetraploids in Solanum khasianum by 10 kR gamma irradiation and colchicine treatments of dry seeds. The mutants possessed blunt curved spines and gave higher yield of solasodine.

Choi (1976) has induced four male sterile mutants following gamma irradiation of the seeds of four varieties of tomato. Each mutant was determined by a single recessive gene and none were allelic. Ovule fertility varied widely among the male sterile mutants.

Zagorcheva (1976) has produced a triploid form of tomato with 20 kR dose on dry seeds. Its vegetative organs and flowers were large and the pollen was sterile.

At 30 kR a short anther mutant was obtained which was controlled by a recessive gene. This was the result of a translocation between two non-homologous chromosomes.

By treating dry seeds of Solanum viarum with EMS and gamma rays Dnyansagar and Pingle (1977) have produced many mutants varying in height, branching, leaf size, leaf weight, berry size and solasodine content. They have also found that solasodine content was directly related to the total quantity of photosynthetic tissue. The best mutant contained about three per cent solasodine.

Katiyar (1977) has induced desynaptic behaviour in a variant isolated from erectly oriented fruited variety of Capsicum annuum following 20 kR gamma irradiation of dry seeds. The phenomenon has led to the production of numerous interesting meiotic anomalies such as macronuclei, miniatures, polyspory and genetic imbalance.

Rangaswamy and Sayed (1977) have studied the effect of gamma rays on the egg plant variety Annamalai and found dwarf plants bearing small fruits in the M_2 population.

IX. Effects of ionising radiation on polygenic traits

Gregory (1955) has estimated the total genetic variance of the quantitative traits among the x-ray irradiated progenies of peanut and noted that irradiation has increased the genetic variance four times that of control progenies. He has further reported in 1956 that normal appearing plants in an irradiated population may be variously mutated with many small changes which form the basis for artifical and natural selection.

Oka *et al.* (1958) have irradiated two purelines of rice varieties with 6 kR and 120 kR of x-rays. They have found that the mean value of heading date and plant height of the population did not differ much though the variability increased due to irradiation. The induced mutations of polygenes brought about symmetrical increase of variability in the high and low direction.

Rawling *et al.* (1958) have studied the effect of seed irradiation with thermal neutron and x-rays on genetic variance of plant height, maturity, yield and seed weight of two varieties of soybean and found that the genetic variance in the irradiated population increased five times compared to the control.

Daly (1960) has investigated the effect of three doses of gamma irradiation at the time of flowering in *Arabidopsis thaliana* and found that the M_1 mean shifted to late flowering with increased variance. In M_2 generation the mean did not differ but the variance increased. The response to selection was equal in irradiated and non-irradiated population.

Working with *Trifolium subterraneum* Brock and Lattur (1961) have found that random mutations would increase the variance of the quantitative character and shift the mean away from the direction of previous selection.

Krull and Frey (1961) have compared the genetic variability of seed size and heading dates in the irradiated populations of pure as well as hybrid varieties of oat. The results from the selection experiments and the heritability percentage have indicated that the variability created by radiation was equally as heritable as that due to hybridization.

Working with bread wheat Bhatia and Swaminathan (1962) have reported that the mean of the irradiated population tended to go down when no selection has been

applied. The variance was enhanced and was found to be more in M_3 population than in M_2.

Yamaguchi (1962) has studied the effect of gamma irradiation in rice and found that the irradiation increased the amount of genetic variations in seed size and the mean values remained the same as in unirradiated ones.

Jalilmiah and Yamaguchi (1965 a, b) have studied the effect of gamma irradiation on the quantitative characters of pure varieties of rice and their hybrids. There was marked response for plant yield in the hybrids than in the parental varieties. The increase in genetic variance as a consequence of irradiation was significant in the hybrids than in the parents. High yielding lines were detected in the irradiated hybrid population.

Gregory (1966) has reviewed the effect of irradiation on the quantitative traits with fitness and non-fitness characters.

Brock (1967) has also reviewed the works on quantitative variation in Arabidopsis thaliana induced by ionising radiations.

Goud (1967) has investigated the induction of polygenic mutations in the agronomic traits of hexaploid

wheat and noted that the variance of quantitative characters and the response to selection increased due to irradiation.

Webber and Fehr (1967) compared the quantitative characters of soybean in lines resulting from hybridization with lines of pure seeds. High genetic recombinations were obtained in hybridization alone. Lower seed yield was obtained in the irradiated population due to adverse effect of neutron irradiation on fertility.

Daly (1973) studying the effects of fast neutrons and gamma rays on Arabiodopsis thaliana, has reported that quantitatively inherited variations are primarily from chromosomal alterations rather than point mutations.

Rangaswamy (1980) studying the induction of variability through mutagenesis of the intraspecific hybrid in sesamum has reported that germination, survival and fertility were reduced in the M_1 generation under mutagenic treatments. There was no difference between parents and hybrids in this respect. In the M_2 and M_3 decrease in mean for many quantitative traits, was noticed both in the parents and hybrid progenies. But capsule girth increased in M_3. There was no significant difference between parents and hybrid progenies in GCV.

Micro mutational spectrum for the combination of the eight economic characters was high with treated population of the hybrid followed by that of the varieties and untreated hybrid.

X. Irradiation of hybrids

The idea of irradiating hybrid seeds to increase recombination rate and adding more variability to the segregating population is of recent origin and the major works in this line were done during sixties and seventies.

It was Gregory (1961) who first suggested that mutagen treatment of hybrid seeds would produce extra variability and thus greater chance for success in selection in peanuts. Krull and Frey (1961) immediately supported this new idea.

From the study of differences in the radio sensitivity of some inbreds and hybrids in Maize, Notani (1961) has reported comparatively more radio resistance by hybrid seeds in maize than the seeds of inbred lines. Saric (1961) has supported this view from his experiences in the same crop.

Jalilmiah and Yamaguchi (1965 a, b) have suggested the possibility of selecting more desirable variants by

irradiation of hybrid seeds in comparison to irradiation of seeds of pure varieties in rice.

Dommergues et al. (1966) have found that segregating seed materials gave numerous somatic changes compared to purelines even without irradiation.

Broertjis (1967) has stressed the fact that the genetic construction of the cultivar used for irradiation was of utmost importance for the yield of somatic mutations. Cultivars that were heterozygous for several colour genes were found to mutate easily.

Joshua et al. (1967) have observed the hybrids of Norin-6 x Ptb-10 to be more sensitive than the parents to gamma irradiation.

Boyle (1968) has found that the hybrids of Agropyron species were strikingly and consistantly more resistant to higher doses of irradiation than their parents.

In mutation studies involving F_1 seeds of Gossypium and gamma rays and fission neutrons, Constantin (1968) has reported loss of marker loci in many F_1M_1 plants.

Swaminathan et al. (1970) have subjected F_1 plants of Japonica x Indica crosses to X-irradiation

and found that the different gene combinations differed significantly for their response to radiation effect on recombination frequencies.

Siddiqui (1971) has undertaken studies to determine the effects of irradiation in inducing interchange in the hybrids of cotton species and it was found that the range of distribution of plot means was invariably wider in the treated populations for almost all the characters when compared with their respective controls. Data on coefficient of genetic variability showed increased values in the irradiated diploid and tetraploid crosses, but the magnitude of variability was attributed to micromutations, enhanced recombination frequency and release of hidden genetic variability.

Alekseenko (1976) has reported that seed set was increased nine fold in crosses of Solanum laciniatum with S. aviculare var. brisbanense by using pollen which has been gamma irradiated with 5 kR dose. A marked increase in seed set was obtained in crosses of S. laciniatum with S. aviculare var. avienlare and S. abutiloides by using pollen treated with ultra violet rays. Haploids of S. laciniatum were obtained in the progeny of S.laciniatum x S.aviculare var. brisbanense.

Milkoveski et al. (1976) have obtained the largest number of useful mutants under the dose of 10 kR for varieties and 30 kR for hybrids involving four varieties and interspecific hybrids of cotton.

Peter (1976) has studied the role of irradiation with gamma rays in hybrids of cotton and reported that the mean values were reduced for yield of seed cotton, lint, boll weight and seed index.

Emery and Wynne (1976) have studied the response of selection for pod yield in the hybrid peanut population after irradiation, both prior to and after hybridization.

Virk et al. (1978) have revealed in their study with pure breeding lines of wheat and rice and their hybrids treated with gamma rays, a significant increase in variation in the treated pure breeding and hybrid genotypes. The magnitude of the induced variation in the pure breeding lines of wheat for grain number and grain yield was either equal or greater than by the conventional segregation following hybridization. In rice the two types of variations were almost the same for yield but in the hybrid population the variation was greater for plant height and tiller number.

Burilkov and Vishnevskaya (1979) have evaluated the recombinogenic activity of laser irradiation in one F_1 tomato hybrid heterozygous for marker loci on chromosomes 2 and 6 at different stages of ontogeny like dry seeds, germinating seeds, growing points, flower buds and pollen. They have found that the treatment altered monohybrid segregation ratios in the F_2. For the marker locus, treatment of air dried seeds gave a segregation ratio of 4.7:1 compared with 2.81:1 in the control. Changes were also observed in the crossing over frequency, for the linked loci aw, d and m-z, c.

Seeds of four parental tomato cultivars, their F_1 hybrids and the F_2 were treated with 8 or 15 kR of gamma rays or 0.1 per cent or 0.25 per cent concentration of EMS by Kaushik and Kallan (1979) and found that all M_1s showed a reduction in height and those from parental cultivars showed an increase in early yield followed by treatment with 8 kR. In the M_2 the coefficient of variability was higher in progenies derived from the F_1 than in those from the F_2 or parental cultivars.

Korol et al. (1979) have found a two fold increase in the variation in frequency of crossing over between F_2

heterozygotes after irradiation of seed from the crossing components and F_1 in tomato. Irradiation changed the F_2 segregation ratios for marker loci, the greatest change being observed after irradiation of P_1 (female) and the F_1.

Kvasnikov et al. (1979) have treated F_1 seeds of cucumber varieties with helium-neon laser beams and doses of 1.2, 2.5 and 6 J and raised F_1M_1, F_2M_2 and F_3M_3 generations to compare the highest yielding families from treated and untreated populations. The families obtained from the treated populations were superior in early yield, total yield or fruit weight to the best families of the untreated control.

Reddy and Rao (1979) observed tight linkage between height, maturity and yield in crosses between tropical and temperate sorghums. Hence they suggested irradiation of F_1 plants especially during pre-meiotic stages to improve the recombination potential and to further enhance the variability in the F_2 population.

Rangaswamy (1980) tried mutagensis in intraspecific hybrids in sesamum and compared the F_1M_1, F_2M_2 and F_3M_3 populations with the same segregating populations of untreated control. He has

found a positive shift for mean and a positive skewness for the genotypic variance in the treated progenies for plant height, number of capsules, seed per capsule, yield per plant, 1000 seed weight and oil content. He has also found that the association between number of capsules and the capsule girth with the number of seeds per capsule had strengthened in the treated population.

Zhuchenko *et al.* (1981) have successfully tried to alter the composition of the F_2 population by treating the pollen of F_1 plants with small doses of ultraviolet and gamma radiation. The treatment applied increased recombination between linked markers, maintained the independent inheritance of unlinked loci and increased phenotypic variation in the F_2 in quantitative characters. Forms with useful combinations of characters which were absent in the control were found in the segregating populations after treatment.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigations were undertaken in the Department of Agricultural Botany, College of Agriculture, Vellayani during the period from 1975 to 1981.

A. Materials

The biological materials consisted of 35 cultivars and one wild variety of brinjal (Solanum melongena Linn.) collected from various sources and maintained in the Department. The sources and distinguishing features of these varieties are summarised in Table 1.

Based on the results of evaluation of these varieties, 'Purple Giant', the best yielder under field conditions and the wild variety S. melongena var. insanum Prain, the best resistant were selected for hybridization.

Gamma irradiation of the F_1 seeds was done at the Botany Department, Kerala University, Kariyavattom, Trivandrum utilising 60_{Co} gamma shine unit. The source was operating at a dose rate of 19.3 kR per hour at the time of irradiation.

Table 1. Details of brinjal varieties collected for evaluation

Sl. No.	Name	Source	Distinguishing features
1	Vellayani Local (oblong)	Vellayani	Nonspiny, small purple oblong fruits, clustered.
2	Wayanad Local (green)	Wayanad	Spiny, green long fruits, clustered.
3	Wayanad Local (purple)	Wayanad	Spiny, light purple oblong fruits.
4	Wayanad Local (white)	Wayanad	Spiny, white long fruits, clustered.
5	Pusa Kranthi	IARI, New Delhi	Nonspiny, purple long, highly susceptible to bacterial wilt
6	Pusa Purple Long	"	Nonspiny, purple long fruits, highly susceptible to bacterial wilt.
7	S-553	"	Nonspiny, dark purple globose fruits.
8	S-550	"	Nonspiny, dark purple globose fruits.
9	S-539	"	Nonspiny, dark purple oblong fruits.
10	S-536	"	Nonspiny, dark purple oblong fruits, clustered.
11	S-534	"	Nonspiny, medium purple oblong fruits.
12	S-521	"	Nonspiny, dark purple globose fruits.

Table 1 (contd...)

Sl. No.	Name	Source	Distinguishing features
13	S-513	IARI, New Delhi	Nonspiny, dark purple globose fruit.
14	S-506		Nonspiny, dark purple globose fruits.
15.	S-509	"	Nonspiny, light purple globose fruits.
16.	S-508	"	Nonspiny, light purple globose fruits.
17.	S-507	"	Spiny, purple streaked globose fruits, clustered.
18.	S-506	"	Nonspiny, dark purple globose fruits.
19	S-501	"	Nonspiny, green long with light purple shades.
20	S-493	"	Nonspiny, light purple oblong fruits.
21	S-491	"	Nonspiny light purple oblong.
22	S-490	"	Nonspiny, deep purple oblong clustered.
23	S-250	"	Nonspiny, deep purple globose.
24	S-247-2	"	Nonspiny, deep purple oblong.

Table 1 (Contd...)

Sl. No.	Name	Source	Distinguishing features
25	Pusa Purple Round	IARI, New Delhi	Nonspiny, deep purple round.
26	Pusa Purple Cluster	"	Nonspiny, deep purple oblong, clustered resistant to bacterial wilt.
27	Mangrigota	"	Spiny, deep purple oblong.
28	Annamalai	"	Nonspiny, purple oblong resistant to bacterial wilt.
29	Arka Sheel	"	Nonspiny, deep purple oblong.
30	A-61	"	Nonspiny, purple long.
31	Vijay	"	Nonspiny, purple oblong.
32	White oval	"	Nonspiny, white oval small fruits, clustered.
33	T-2	"	Nonspiny purple long.
34	Vellayani Local (round)	Vellayani	Spiny, mottled green small round fruits, often clustered.
35	S.melongena var. insanum	Vellayani	Highly spiny, wild variety, very small green mottled fruits, often clustered.
36	Purple Giant	Nagercoil	Spiny, very large dark purple round fruit, often clustered.

B. Methods

I. Evaluation of germ plasm

Selfed seeds obtained from the 36 varieties were used for evaluation of productivity, genetic variability and field resistance against bacterial wilt caused by Pseudomonas solanacearum E.F. Smith. The experimental field chosen was naturally and heavily infested with bacterial wilt. The incidence of wilt was 91 per cent in a susceptible variety 'Pusa Kranthi' grown in this plot in the previous season. The trial was laid out in a 36 x 3 RBD with 12 plants in each plot of 4 x 3 meter planted at one meter spacing. A border row of 'Pusa Kranthi' was grown around each plot to counter the border effect and to enhance the disease infection. The agronomic practices followed for raising the crop were as per package of practices recommendations for brinjal (Anon., 1975).

Weekly observations were taken on the number of plants wilted in each plot till the last harvest done on the 75th day of first flowering. When all the leaves of a plant were affected by the wilt it is counted as wilted and the cause is confirmed by observing the presence of bacterial ooze from the cut end of the collar region.

Five plants were selected at random per plot in each of the three replications from all varieties which survived infection to retain at least five plants in a plot. The mean values of these five plants in respect of the following characters were estimated and statistically analysed.

1. Height of plants

The measurements were taken from the ground level to the top most bud leaf of each plant with a meter scale to the nearest centimeter on the 60th day of flowering.

2. Number of branches

This observation was also taken on the 60th day of flowering. While counting the total number of branches the primary, secondary and tertiary ones were taken into account.

3. Number of leaves

This observation was also taken on the 60th day of flowering. Total number of opened leaves as on the date of observation was taken and recorded.

4. Days to flowering

The number of days from the date of transplanting to the date of opening of the first flower were taken as days to flowering.

5. Number of short styled flowers

This observation was taken on 21st day of flowering, which was observed to be the middle of the peak period of flowering. Those flowers which were having rudimentary styles reaching only half the length of the anthers were counted and recorded as on the date of observation. These flowers were marked by tying a coloured thread around the pedicel of each flower to estimate the fruit set.

6. Number of medium and long styled flowers

This observation was also taken on the 21st day of flowering. Those flowers which were having styles either reaching the level or protruding clearly above the level of anther tips were counted and recorded as on the date of observation. These flowers were also marked by tying coloured thread around the pedicel of each flower to estimate the fruit set.

7. Number of fruits

This observation was taken on the 30th day of flowering when the first harvest of fruits was done. All the fruits including the one day old ones as seen on the date of observation were counted and recorded.

8. Fruit set

This was estimated as per cent of fruits set over the total number of flowers present as on the 21st day of flowering which have been marked with coloured threads. The fruits with coloured threads around their stalks were counted separately on the 30th day of flowering and the data used for estimating fruit set.

9. Diameter of fruit

The equatorial diameter of round fruits and the diameter at the middle length of long and oblong fruits were measured to the nearest half centimeter with the help of a scale and two square boards. This observation was taken on five largest fruits harvested on the 30th day of flowering and mean taken as observation for a plant.

10. Length of fruit

The length of fruit was measured as the distance from the base of the persistant calyx to the tip of the fruit body with the help of a plastic thread and scale to the nearest half centimeter. This observation was taken on the largest five fruits harvested on the 30th day of flowering from each plant and the mean was taken as observation of a plant.

11. Weight of fruit

The total weight of the largest five fruits harvested from each plant on the 30th day of flowering was taken to the nearest ten gram. The mean weight was calculated and recorded as the observation of a plant.

12. Total fruit yield

The total weight of fruits from four harvests done at biweekly interval from the 30th day of flowering, was taken to the nearest 10 g. and recorded for each plant.

II. Screening against bacterial wilt

The 12 brinjal varieties which survived fully in the preliminary evaluation were subjected to screening under artificial infection in an experiment with 10 plants in each plot in single rows, replicated thrice and planted at one meter spacing. A border row of 'Pusa Kranthi' was grown around each plot to counter border effect and to enhance the disease infection. Severe artificial wilt infestation was produced by (a) applying 500 g of sick soil collected from the root zone of recently wilted brinjal plants (b) dipping roots of seedlings immediately before transplanting in fresh bacterial ooze collected from recently wilted brinjal plants and (c) inoculating the seedlings with sterile distilled water suspension of

bacteria (containing about 1 x 10^9 cells per ml) prepared from 48 hour old cultures grown on TTC agar medium (Kelman, 1954) devoid of tetrazolium salt (Appendix VI) by 'stem puncture' method (Winstead and Kelman, 1952) two weeks after transplanting. Weekly observations were made after transplanting and number of wilted plants were recorded in each variety. The number of plants out of 10 which wilted till the end of sixth week of transplanting in each plot was recorded and the data were subjected to statistical analysis (Appendix VII).

III. Production of F_1 seeds

A population of 25 plants each of the two selected varieties namely S. melongena var. insanum and 'Purple Giant' were grown in a wilt free area under high dose (10 kg per plant) of organic manure to ward off the incidence of wilt as far as possible. The other agronomic practices followed were as per package of practices recommended for brinjal (Anon., 1975). Crossing was done on 125 flowers in each variety using pollen from the other. Hand emasculation was done in the evening. The emasculated and protected flowers were pollinated in the early morning (7 to 9 AM) of the next day. The F_1

seeds were extracted from the crossed fruits with the wild variety insanum as female parent.

IV. Irradiation of F_1 seeds

The hybrid seeds obtained from the cross insanum x Purple Giant were uniformly dried so that the moisture content of the seeds was approximately 12 per cent. Sixteen samples of 400 seeds each were exposed to gamma rays at doses 5, 10, 15, 20, 25, 30, 35 and 40 kR in duplicate samples. One lot was used as reserve seeds and sown into a reserve nursery. Another sample of 400 seeds was used as the control.

V. Studies on the first generation

The first generation consisted of the F_1, F_1M_1 (from gamma irradiated hybrid seeds) and the two parental varieties.

a. Nursery

Nursery was raised in pots with four replications. Hundred seeds were sown in each pot. Weekly observations on germination and survival were taken for five weeks. The emergence of radicle was taken as the criterion for germination in the nursery pots. The number of seedlings remained alive after the post emergence mortality were

counted as survival and expressed as per cent on germination. There was no seedling available in 40 kR exposure.

b. Main field

On the 36th day of sowing, the seedlings were transplanted to the main field in 10 x 4 RBD with 30 plants in each plot of 6 x 5 meter at one meter spacing. An additional single row of the F_1 control plants were grown all around the experimental field to counter the border effect. Reserve seedlings from 35 kR treatment were also used for planting the main field experiment since the available seedlings of that treatment from the main nursery were insufficient to plant the experiment. The agronomic practices followed were as per package of practices recommended for brinjal (Anon; 1975). The ten varieties/treatments included in the experiment were as follows:-

Parents

1. Solanum melongena var. insanum (Female parent-P_1)
2. Purple Giant (Male parent - P_2)

Hybrids

3. F_1 control (P_1 x P_2)
4. F_1M_1 (P_1 x P_2) exposed to 5 kR

5. F_1M_1 (P_1 x P_2) exposed to 10 kR
6. F_1M_1 (P_1 x P_2) exposed to 15 kR
7. F_1M_1 (P_1 x P_2) exposed to 20 kR
8. F_1M_1 (P_1 x P_2) exposed to 25 kR
9. F_1M_1 (P_1 x P_2) exposed to 30 kR
10. F_1M_1 (P_1 x P_2) exposed to 35 kR

The following observations were made.

1. Plant height

2. Spread of the plant

Measurement was taken in the direction where there was maximum spread of the plant with a metalic tape to the nearest centimeter. This was taken on the 60th day of flowering.

3. Number of branches

4. Plant type

The plant type was determined by observing the angle of divergence of the primary branches with reference to the main stem with a protractor. Plants with an angle of divergence between 15° and 40° were counted as erect, between 41° and 65° as semi erect and between 66° and 90° as procumbent. This observation was taken on the 60th day of flowering.

5. Number of fruits

6. Diameter of fruit

7. Pollen sterility

For assessing pollen sterility five mature flower buds produced during the first week of flowering from each plant were used. Pollen grains from these five flowers were stained in a 1:1 glycerine acetocarmine solution. The well stained and properly filled pollen grains were counted as fertile and the others as sterile. In each slide ten microscopic fields were scored and the data recorded. Sterility of each plant was estimated as percentage of the number of sterile pollen grains to the total number of pollen grains recorded.

8. Number of seeds per fruit

Seeds were extracted from each of the selfed fruits collected from the selected F_1M_1 plants (Table 16) belonging to the three different sterility groups and the number of seeds were counted and recorded.

9. Number of visible mutants

Any visible change from the morphological features of the control F_1 plants was considered as a mutant

and their number in each plot was recorded.

Fifteen plants were selected at random from each plot. Data on the characters 1 to 7 were recorded on these plants. Pollen sterility was recorded on all the 30 plants in each plot. Based on pollen sterility the plants in each treatment were grouped into different sterility classes. Seeds were collected from selected plants representing low, medium and high sterility classes. The details of the F_1M_1 plants selected are given in Table 16.

c. Raising bulk population of F_1M_1 for scoring visible mutants

A bulk population of 200 F_1M_1 plants from the 25 kR exposure, which gave the maximum seed germination on the 21st day of sowing was raised separately to isolate variants appearing in the first generation itself.

VI. Studies on the second generation

F_1M_1 plants were carried to F_2M_2 generation based on the pollen sterility. Each F_1M_1 plant was assessed and assigned to one of the following three sterility groups. F_1M_1 plants were grouped into sterility types irrespective of the dose of gamma rays.

1. Low sterility group (less than 20 per cent)
2. Medium sterility group (40 to 60 per cent)
3. High sterility group (more than 80 per cent)

The first formed fruits from the selfed flowers of apparently normal looking plants belonging to each of the above three groups were collected and seeds extracted for growing the second generation. The details of the F_1M_1 plants selected and the number of seeds extracted from each fruit are given in Table 16. The seeds extracted from fruits of all plants belonging to a sterility group were mixed and random samples were selected for growing the F_2M_2 populations. Seed samples were also collected from the normal control F_1 plants for raising the control F_2 population.

Selfed seeds from the various visible mutants appeared among the F_1M_1 generation were grown into F_2 M_2 families for studying the segregation pattern of the particular mutant character. Three such families with 60 plants under each were raised and studied.

a. <u>Segregation pattern and genetic variability</u>

A trial was laid out in a wilt disease free area under high dose (10 kg per plant) of organic manures to

ward off the incidence of bacterial wilt to the extent possible. A 6 x 6 RBD with 40 plants in each plot of 8 x 5 meter with one meter spacing was laid out. An additional single row of the F_2 control plants were grown all around the experimental field to counter the border effect. The six treatments were as follows:

1. Solanum melongena var. insanum (Female parent - P_1)
2. 'Purple Giant' (Male parent - P_2)
3. Control F_2 (P_1 x P_2)
4. F_2M_2 from low sterility group of F_1M_1 (F_2M_2 L.S.)
5. F_2M_2 from medium sterility group of F_1M_1 (F_2M_2 M.S.)
6. F_2M_2 from high sterility group of F_1M_1 (F_2M_2 H.S.)

Observations on the following 13 characters were taken on all the 40 plants in each plot to study the segregation pattern. The mean values of characters 3 to 13 were used for the study of genetic variability.

1. Plant type
2. Colour of fruit

The fruit colour of each plant was ascribed to any one of the following four types appeared in the second generation.

(i) Mottled purple (A mixture of the mottled green of the wild parent and purple of the cultivar parent).

(ii) Purple (similar to the cultivar parent)

(iii) Mottled green (similar to the wild parent)

(iv) White (the pure white colour appeared as in the back ground of the mottled green in the wild parent)

3. Height of plant

4. Number of branches

5. Number of leaves

6. Number of spines per leaf

The number of spines on five leaves taken at random from each plant was counted and the mean taken as the observation of the plant.

7. Number of short styled flowers

8. Number of long and medium styled flowers

9. Number of fruits

10. Equatorial diameter of fruit

11. Length of fruit

12. Spread of the plant

13. Total leaf area

The leaf area was computed by measuring the length and breadth of five leaves taken at random from each plant to the nearest half centimeter and using the equation $a = l \times b/1.5$ where a = area in sq.cm, l = length in cm, b = breadth in cm (Gopimony, 1968).

The mean multiplied by the total number of leaves and expressed as total leaf area in sq.m.

b. Segregation pattern in control F_2 population under wilt free and wilt infestation conditions

A population of 120 control F_2 plants was grown under severe artificial wilt infestation conditions created as per procedure described earlier for studying the segregation pattern in the surviving population under disease stress conditions as that in undisturbed normal F_2 population. Four important characters namely plant type, fruit colour, equatorial diameter of fruit and wilt incidence were observed and data recorded.

VII. Studies on the third generation

Ten F_3M_3 families were grown from the 10 large fruited (diameter above 6 cm in round fruits and length above 6 cm in long fruits) induced recombinants in the F_2M_2 population along with a control F_3 population derived from the F_2 control plant with the largest fruit and the two parents. The experiment was laid out in a 13 x 3 RBD with 20 plants in each plot of 5 x 4 meter at one meter spacing. A single

row of 'Pusa Kranthi', was grown around each plot to counter the border effect and to enhance the disease infection. The plants were grown under severe artificial wilt infection conditions. The number of wilted plants in each plot was estimated. The following 10 characters were recorded on ten plants selected at random from among the surviving plants in each plot. The data were statistically analysed for estimation of genetic variability and association of characters.

1. Height of plants
2. Number of branches
3. Number of spines per leaf
4. Number of leaves
5. Number of short styled flowers
6. Number of long and medium styled flowers
7. Number of fruits
8. Equatorial diameter of fruit
9. Spread of the plant
10. Total leaf area (sq.m)

VIII. Evaluation of selected mutant types in F_7M_7 generation

Individual plants with large fruit size and bacterial wilt resistance were carried through F_4M_4 and F_5M_5 to the F_6M_6 generation employing the pedigree

selection method. Eleven F_6M_6 induced recombinants were selected and their F_7M_7 progeny were evaluated in a trial along with the parents and a highly susceptible check variety 'Pusa Kranthi'. The trial was laid out in a field which was naturally and heavily infested with bacterial wilt. The experimental material was grown in single lines of 10 plants each. An additional row of 'Pusa Kranthi' was grown all around the experimental field to counter the border effect and also to enhance the wilt infection. Severe epiphytotic condition was created by the three techniques described earlier. Observations on plant type, spiny nature, fruit colour, equatorial diameter of fruit, length of fruit, fruit yield and wilt incidence were recorded and presented

IX. Statistical methods applied

The following parameters were calculated from the data obtained in the first three generations:

$$\bar{x} = \frac{\sum x_i}{n}, \quad s^2 = \frac{x_i^2 - (\sum x_i)^2/n}{n-1}$$

where $\bar{x}$ = Mean of the variables

x_i = Variables

n = number of observations

s^2 = Variance

The data for individual characters were analysed by the analysis of variance method to find out the differences among the varieties or progenies employing the method of Panse and Sukatme (1957).

ANOVA

Source	df	MS.	F
Replications	r-1	$S_e^2 + v\ S_r^2$	..
Progenies/ Varieties	v-1	$S_e^2 + r\ S_g^2 = M_v$	$\frac{M_v}{M_e}$
Error	(r-1) (v-1)	$S_e^2 = M_e$	..
Total	rv-1		

where r = Number of replications

v = Number of progenies/varieties

S_e^2 = Error variance

S_g^2 = Genotypic variance

S_r^2 = Replication variance

Different genetic parameters were estimated from the various components in the analysis of variance as suggested by Burton (1952).

1. Genotypic variance = $\frac{M_v - M_e}{r}$

where M_v = Progeny mean square

M_e = Error mean square

r = replications

2. Phenotypic variance = $\frac{M_v - M_e}{r} + M_e$

3. Genotypic coefficient of variation = $S_g/\bar{x}$

where S_g = Genotypic standard deviation

$\bar{x}$ = Mean

4. Heritability in the broad sense (Burton and Devane, 1953)

$$h^2 = \frac{S_g^2}{S_p^2}$$

where S_g^2 = Genotypic variance

S_p^2 = Phenotypic variance

5. Genetic advance from selection (Allard, 1960)

$$GA = k\, h^2\, S_p$$

where k = Selection differential at 5 per cent selection intensity = 2.06

h^2 = heritability estimates

S_p = Phenotypic standard deviation

6. Correlation coefficient = $r_{xy} = \frac{Cov.x}{\sqrt{(Var.x)(Var.y)}}$

ABBREVIATIONS USED IN THE TEXT

kR	=	Kilo Roentgen
SI	=	*Solanum melongena* var. *insanum* (Female parent of the hybrid)
PG	=	Purple Giant (Male parent of the hybrid)
F_1M_1	=	First generation of mutated hybrid
F_2M_2	=	Second generation of mutated hybrid
F_2M_2 (L.S.)	=	F_2M_2 derived from F_1M_1 plants belonging to low pollen sterility group
F_2M_2 (M.S.)	=	F_2M_2 derived from F_1M_1 plants belonging to medium pollen sterility group
F_2M_2 (H.S.)	=	F_2M_2 derived from F_1M_1 plants belonging to high pollen sterility group.
F_3M_3	=	Third generation of mutated hybrid
RBD	=	Randomized Block Design
GCV	=	Genotypic Coefficient of Variation
PCV	=	Phenotypic Coefficient of Variation

h^2	=	heritability in the broad sense
GA	=	Genetic advance
r	=	Correlation coefficient
SE	=	Standard Error
SEd	=	Standard error difference
TTC	=	Triphenyl tetrazolium chloride

RESULTS

RESULTS

I. Evaluation of germ plasm

The distinguishing features of the 36 brinjal varieties evaluated are given in Table 1. The analysis of variance could be done only for 27 varieties, since more than 50 per cent of the experimental plants of nine varieties were lost due to bacterial wilt, the details of which have been given in Table 4. The mean data for 13 characters studied on the 27 varieties are presented in Table 2. The analysis of variance (Appendix I) indicated that there were significant differences among the varieties for all the 13 characters studies. The data revealed the significant superiority of Purple Giant (Photo Plate No. 2) over the other varieties in equatorial diameter of fruit (12 cm), weight of single fruit (626.67 g) and total fruit yield (7330 g per plant).

Genetic parameters such as the mean, phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance are presented in Table 3. Their values revealed large differences among the characters studied. PCV ranged from 12.5 to 98.85 per cent and GCV from 10.63 to 98.20 per cent. Days to flower recorded the

Plate No.1

The wilt resistant wild brinjal variety - *Solanum melongena* var. *insanum* Prain.

Plate No.2

The wilt susceptible cultivar type of brinjal - 'Purple Giant'.

Table 2. Mean data on the 13 characters observed on 27 brinjal varieties

Sl. No.	Name of the variety	No. of long and medium styled flowers	No. of short styled flowers	Height (cm)	No. of fruits	No. of leaves	Fruit* set (per cent)	No. of branches
		1	2	3	4	5	6	7
1.	Vellayani Local (oblong)	22.33	14.33	101.33	21.33	92.00	73.09	12.00
2.	Wayanad Local (green)	10.33	6.00	112.67	3.67	193.67	37.03	16.00
3.	Wayanad Local (purple)	6.33	2.67	115.33	2.33	151.67	45.31	17.00
4.	Wayanad Local (white)	8.67	3.00	150.67	1.00	240.67	19.95	22.00
5.	S-550	4.00	1.00	114.00	3.00	194.67	75.00	20.67
6.	S-539	11.00	3.67	83.67	6.00	274.33	45.65	30.33
7.	S-536	20.00	3.67	85.33	15.00	272.33	53.68	37.00
8.	S-534	6.00	4.00	94.33	4.67	193.67	61.49	16.33
9.	S-513	7.33	1.00	103.33	2.67	183.00	39.98	20.33
10.	S-512	8.67	1.33	108.33	3.33	204.33	45.11	30.00
11.	S-509	9.67	3.33	103.33	3.33	312.33	30.89	41.66
12.	S-508	5.67	1.67	83.00	1.33	169.67	48.93	23.00
13.	S-507	20.33	2.00	81.33	20.00	352.00	90.00	34.00
14.	S-506	13.33	4.00	121.67	4.00	299.67	34.82	25.67
15.	S-501	20.67	10.00	140.33	11.67	281.67	47.29	30.67
16.	S-491	9.67	11.67	99.67	5.00	210.33	56.23	30.33
17.	S-490	5.67	3.33	118.33	5.33	266.33	81.14	33.00

Table 2 (contd...)

Sl. No.	Name of the variety	Weight of single fruit (g)	Diameter of fruit (cm)	Length of fruit (cm)	Days to flower	Total fruit yield (g)	No. of plants wilted per plot
		8	9	10	11	12	13
1.	Vellayani Local (oblong)	62.33	3.50	11.00	41.67	1315.33	0
2.	Wayanad Local (green)	53.67	3.17	12.00	43.67	195.00	4
3.	Wayanad Local (purple)	77.33	3.00	13.00	43.00	210.67	0
4.	Wayanad Local (white)	56.33	3.00	13.00	44.67	56.33	0
5.	S-550	62.67	5.00	7.33	43.33	189.33	2.33
6.	S-539	41.67	3.33	12.33	45.33	249.66	2
7.	S-536	68.67	4.33	11.33	47.67	1045.00	2
8.	S-534	225.67	7.33	12.33	46.00	1045.00	4
9.	S-573	205.00	8.00	11.00	41.00	545.00	4.33
10.	S-512	62.67	4.67	8.33	38.33	207.67	3
11.	S-509	66.00	5.00	8.33	45.33	261.33	4.67
12.	S-508	61.33	4.67	8.00	48.00	82.00	4.33
13.	S-507	71.00	5.33	7.33	45.67	1436.00	0
14.	S-506	245.00	9.33	8.00	44.67	973.33	2
15.	S-501	94.33	4.00	11.69	37.67	1086.67	0
16.	S-491	119.00	4.50	16.00	36.00	597.00	3
17.	S-490	72.33	6.00	9.67	44.00	385.33	4

Table 2 (contd...)

Sl. No.	Name of the variety	No. of long and medium styled flowers	No. of short styled flowers	Height (cm)	No. of fruits	No. of leaves	Fruit set (per cent)	No. of branches
		1	2	3	4	5	6	7
18.	Pusa Purple Cluster	49.33	2.67	102.33	49.33	116.66	90.00	17.33
19.	Mangsigota	8.33	2.33	71.33	5.33	376.00	83.77	40.33
20.	Annamalai	19.67	6.67	71.33	18.33	223.00	80.63	13.67
21.	Arka Sheel	4.33	4.00	126.67	3.33	144.33	65.00	19.67
22.	A-61	14.00	10.67	72.33	6.67	353.67	48.40	39.67
23.	Vijay	12.67	2.67	114.33	3.00	262.00	30.99	32.33
24.	White Oval	30.67	1.33	68.00	26.00	313.00	70.57	40.33
25.	Vellayani Local (round)	18.67	6.00	73.67	14.00	307.33	90.00	32.33
26.	S.melongena var. insanum	14.33	0.00	21.33	16.67	261.00	70.00	36.00
27.	Purple Giant	10.93	28.67	69.67	11.67	148.67	65.68	8.00
	C.D. (0.05)	10.93	5.69	13.08	10.71	20:20	32.86	2.98

(Mean squares are given in Appendix I)

Table 2 (contd...)

Sl. No.	Name of the variety	Weight of single fruit (g)	Diameter of fruits (cm)	Length of fruit (cm)	Days to flower	Total fruit yield (g)	No. of plants wilted per plot
		8	9	10	11	12	13
18.	Pusa Purple Cluster	46.33	4.00	10.33	43.00	2304.00	0
19.	Mangrigota	122.00	3.83	14.67	40.00	646.67	3.67
20.	Annamalai	85.33	5.00	14.67	37.67	1558.00	0
21.	Arka Sheel	98.33	4.00	16.67	47.00	310.33	0
22.	A-61	112.33	4.00	15.67	38.00	750.67	0
23.	Vijay	217.67	7.00	16.67	37.67	652.00	1.67
24.	White Oval	95.67	6.33	9.33	41.67	2489.33	0
25.	Vellayani Local (round)	12.33	4.00	4.00	46.00	174.00	0
26.	S. melongena var. insanum	13.90	2.00	2.50	45.33	63.33	0
27.	Purple Giant	626.67	12.00	13.33	61.33	7330.00	3.67
	C.D. (0.05)	18.45	0.70	1.14	4.80	895.21	1.75

* Transformed figures

(Mean squares given in Appendix I)

Table 3. Genetic parameters of 12 quantitative characters in the brinjal germ plasm

	Characters	Mean	PCV (per cent)	GCV (per cent)	h^2 (per cent)	GA (Expressed as per cent of mean)
1.	Height (cm)	96.58	28.56	27.34	92.00	53.91
2.	No. of branches	26.70	36.44	35.81	96.51	72.42
3.	No. of leaves	237.30	32.00	31.58	97.36	64.20
4.	Days to flower	43.85	12.50	10.63	71.72	18.56
5.	No. of short styled flowers	7.69	84.26	71.13	71.28	123.73
6.	No. of medium and long styled flowers	13.80	80.60	64.50	64.05	106.37
7.	No. of fruits	12.44	95.01	79.18	69.43	135.92
8.	Percentage of fruit set	58.12	44.07	27.44	38.78	35.20
9.	Diameter of fruit (cm)	5.04	43.32	42.46	96.02	85.87
10.	Length of fruit (cm)	11.02	33.30	32.70	96.44	66.17
11.	Weight of single fruit (g)	121.41	98.64	98.20	99.12	201.38
12.	Total fruit yield (g)	1513.89	98.85	92.07	86.69	176.47
13.	No. of plants wilted plot	2.25	71.80	53.78	56.32	83.54

Table 4. List of brinjal varieties in which incidence of wilt was more than 50 per cent in the preliminary evaluation of germ plasm

Sl. No.	Name of the variety	Percent of wilting
1.	Pusa Kranthi	77.78
2.	Pusa Purple Long	58.33
3.	S-553	86.11
4.	S-521	66.67
5.	S-493	58.33
6.	S-250	61.11
7.	S-247-2	69.44
8.	Pusa Purple Round	77.78
9.	T_2	58.33

lowest PCV and GCV (12.50 and 10.63 per cent). Higher PCV and GCV were observed for weight of single fruit (98.64 and 98.20 per cent) and total fruit yield (98.85 and 92.07 per cent).

Heritability estimates in the present study varied from 38.78 to 99.12 per cent. Among the 13 characters studied, percentage of fruit set had the lowest heritability (38.78 per cent) followed by number of plants wilted (56.32 per cent) and number of medium and short styled flowers (64.05 per cent). High heritability values were observed for diameter of fruits (96.02 per cent) length of fruits (96.44 per cent), weight of single fruits (99.12 per cent), plant weight (92.0 per cent), number of leaves (97.36 per cent) and number of branches (96.51 per cent).

The expected genetic advance expressed as per cent of mean revealed large differences among various characters studied. It ranged from 18.56 per cent (days to flower) to 201.38 per cent (weight of single fruit). Highest GA was observed for weight of single fruit (201.38 per cent) followed by total fruit yield (176.47 per cent), number of fruits (135.92 per cent) number of short styled flowers (123.73 per cent) and number of medium and long styled flowers (106.37 per cent). When heritability and genetic

advance were together considered the diameter of fruit was also foundto occupy a higher position along with the characters listed immediately above.

II. Screening against bacterial wilt

The results are presented in Tables 5 to 7. From the preliminary soreening trial done on the 36 varieties collected, the natural incidence of wilt was found to be nil in twelve varieties. Only these were subjected to artificial screening against wilt. Among these twelve varieties subjected to artificial screening against wilt, the percentage of wilting ranged from 0.00 to 96.67 (Table 6). The nil incidence of wilt was observed in only one variety namely Solanum melongena var. insanum (Photo plate No. 1). On comparing the mean number of plants wilted per plot (Table 7) the varieties Annamalai, Vellayani Local (oblong) and Wayanad Local (purple) were found to be on par and significantly superior in resistance to S-507, S-5,01and Arka Seel. Other varieties were intermediate in resistance.

The weekly observations on wilting in the screening trial (Table 6) showed that maximum number of plants have wilted during the first week of transplanting irrespective of varietal difference. But in the preliminary evaluation

Table 5. The stage and number of plants wilted in the preliminary evaluation of germ plasm

Days after transplanting	Number of plants wilted	Per cent on total plants wilted
7	37	10.08
14	0	0.00
21	52	14.17
28	88	23.98
35	74	20.16
42	29	7.91
49	21	5.72
56	52	14.17
63	14	3.81

Table 6. Number of plants wilted in each week in the artificial screening trial

Name of the variety	Time of wilting after transplanting							
	I week	II week	III week	IV week	V week	VI week	Total	Per cent
Vellayani Local (oblong)	4	2	2	1	4	3	16	53.33
Wayanad Local (purple)	6	8	3	-	3	-	20	66.67
Wayanad Local (white)	7	11	5	-	-	-	23	76.67
S-507	9	14	2	-	2	2	29	96.67
S-501	17	7	-	-	3	-	27	90.00
Pusa Purple Cluster	8	8	4	-	3	-	23	76.67
Annamalai	9	3	-	-	-	2	14	46.67
Arka Seel	18	6	2	-	-	2	28	93.33
A-61	14	6	1	-	-	4	25	83.33
White Oval	13	8	-	-	-	2	23	76.67
Vellayani Local (round)	10	9	2	-	1	-	22	73.33
Solanum melongena var. *insanum*	Nil	Nil	Nil	Nil	Nil	Nil	-	-

Table 7. Mean number of plants wilted per plot in the artificial screening trial

Variety	Mean
Vellayani Local (oblong)	5.33
Wayanad Local (purple)	6.66
Wayanad Local (white)	7.66
S-507	9.66
S-501	9.00
Pusa Purple Cluster	7.66
Annamalai	4.66
Arka Seel	9.33
A-61	8.33
White Oval	7.66
Vellayani Local (round)	7.33
Solanum melongena var. *insanum*	0.00
C.D. (0.05)	2.584

Mean squares are given in Appendix VII

trial conducted on the available germ plasm under field conditions the maximum number of plants have wilted during the fourth and fifth week of transplanting (Table 5).

III. Production of F_1 seeds

Of the 125 flowers each of 'Purple Giant' and S. melongena var. insanum pollinated (Table 8) with pollen from the other variety, fruit set was obtained only when S. melongena var. insanum was taken as the female parent. All the flowers of 'Purple Giant' which were pollinated with pollen of the wild S. melongena var. insanum have shed on the third day of crossing. There was 51.20 per cent fruit set in S. melongena var. insanum pollinated with pollen from 'Purple Giant'. The average seed set in this successful cross combination was 403 per fruit. The average fruit set on selfing in 'Purple Giant' and S. melongena var. insanum was 60 and 73.33 per cent respectively.

IV. Studies on first generation

The results are presented in Tables 9 to 16 and graphically represented in Figures 1 to 4. The analysis of variance (Appendices II and III) indicated that there was significant differences among the treatments for all the characters studied.

Table 8. The fruit set and seed set in crossing and selfing done on the selected parents

I. Cross combination	No. of flowers crossed or selfed	No. of fruit set	Per cent of fruit set	Average seed set per fruit
1. Purple Giant X *S. melongena* var. *insanum*	125	Nil	-	-
2. *S. melongena* var. *insanum* X Purple Giant	125	64	51.20	403
II. Selfing				
1. Purple Giant	15	9	60.00	3050
2. *S. melongena* var. *insanum*	15	11	73.33	433

a. Germination and seedling survival

Germination in the nursery pots started from fifth day of sowing and progressed steadily upto 21st day (Table 10). There onwards a sharp decline in the number of seedlings was observed in the 35 and 40 kR exposures. On the 21st day of sowing the total seeds germinated in the control F_1 was 81.50 per cent whereas it was only 32.75 and 19.25 per cent in 35 kR and 40 kR exposures respectively (Table 10). In the other treated hybrids this varied from 54.00 (in 30 kR) to 74.00 (in 25 kR) per cent. By the 35th day of sowing when 98.77 per cent of seedlings survived in the control all the seedlings withered off in 40 kR exposure. In 35 kR exposure also the survival of seedlings was very low (18.32 per cent). In the other exposures the survival was round about 98 per cent except in 25 kR where it was only 88.24 per cent.

b. Main field observations

1. Height

As regards plant height at maturity, control F_1 and 5 to 30 kR exposures were on par expressing the round about mid parental values (42.43 to 58.63 cm). But a significant increase in plant height was observed in 10 kR treatment

Table 9. Effect of mutagen on the hybrids in the first generation

Varieties/ Treatments	Germination per cent on 21st day of sowing			Survival per cent on 35th day of sowing (Per cent on germination		
	Mean+	Per cent on better parent	Per cent on control	Mean+	Per cent on better parent	Per cent on control
Parents						
PG	59.15	-	-	83.29	100.00	-
SI	59.99	100.00	-	81.71	-	-
Hybrids						
Control	65.75	111.16	100.00	83.01	99.66	100.00
5 kR	51.51	87.08	78.34	83.14	99.82	100.16
10 kR	53.20	89.94	80.91	84.54	101.50	101.84
15 kR	62.84	106.24	95.57	80.81	97.02	97.35
20 kR	56.47	95.47	85.88	82.28	98.79	99.12
25 kR	57.80	97.72	87.91	82.86	99.48	99.82
30 kR	47.34	80.03	72.00	83.19	99.88	100.22
35 kR	34.60	58.49	52.62	25.55	30.67	30.78
40 kR	25.63	43.33	38.98	No plants	No plants	No plants
SEd	6.05**			4.15**		
CD	12.36			8.48		

** Significant at 0.01 level of probability

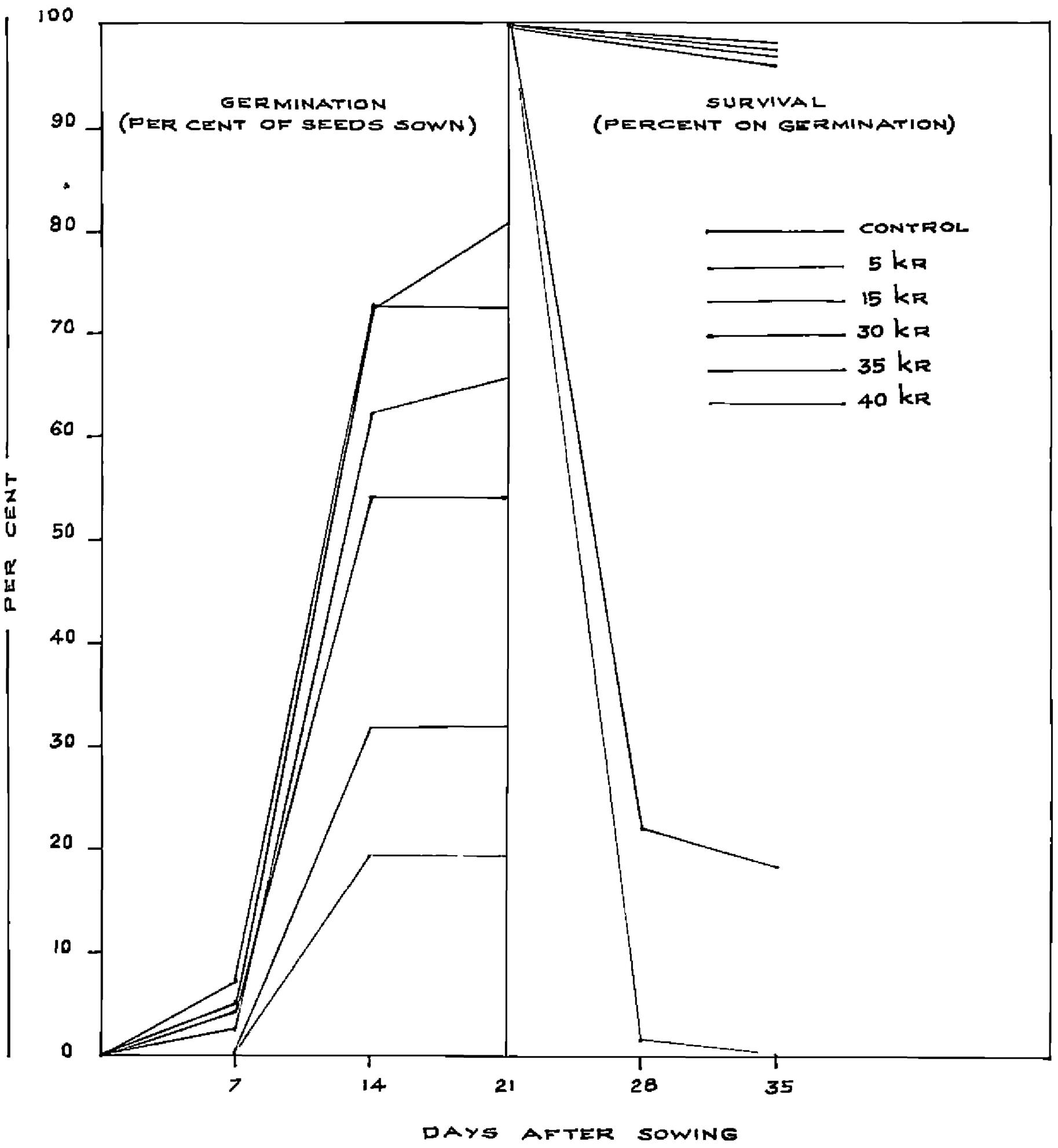
\+ Transformed values

Table 10. Effect of mutagen on the hybrids in the first generation

Varieties/ Treatments	Germination (per cent*)			Survival (per cent on germination*)	
	7th day	14th day	21st day	28th day	35th day
Parents					
PG	20.75	70.00	73.50	99.52	98.13
SI	1.50	64.00	74.50	100.00	99.38
Hybrids					
Control	5.75	72.00	81.50	99.39	98.77
5 kR	3.25	63.00	66.25	98.49	98.11
10 kR	6.50	64.00	64.00	98.83	98.83
15 kR	7.00	73.75	73.75	97.97	97.29
20 kR	3.25	69.00	69.00	98.19	98.19
25 kR	4.25	71.00	74.00	98.94	88.24
30 kR	4.25	54.00	54.00	99.53	98.15
35 kR	0.00	32.75	32.75	22.90	18.32
40 kR	0.00	19.25	19.25	1.32	0.00

* True values

FIG 1 EFFECT OF MUTAGEN ON GERMINATION AND SEEDLING SURVIVAL IN THE FIRST GENERATION



(58.63 cm) and drastic reduction was noted in 35 kR treatment (33.69 cm) (Table 11).

2. Spread of the plant

In this character the control F_1 and 5 to 30 kR exposures were on par (79.3 to 89.24 cm) but they were having a significantly increased spread over the cultivar parent Purple Giant (52.15 cm). There was significant reduction in spread in 35 kR (57.43 cm) when compared to other treatments except the parents (Table 11).

3. Number of branches

There was no significant difference between the control and exposed hybrids in this character (Table 12). They all expressed the low branching character of the cultivar parent (13.70). The wild parent produced a significantly higher number of branches (37.15) when compared to all the hybrids and the cultivar parent (13.70 to 15.74).

4. Plant type

The plants in the control and exposed hybrids upto 25 kR were of semi-erect type expressing a round about mid parental value (50.78° to 56.47°) for the angle of divergence of the primary branches from the main stem.

FIG 1 EFFECT OF MUTAGEN ON GERMINATION AND SEEDLING SURVIVAL IN THE FIRST GENERATION

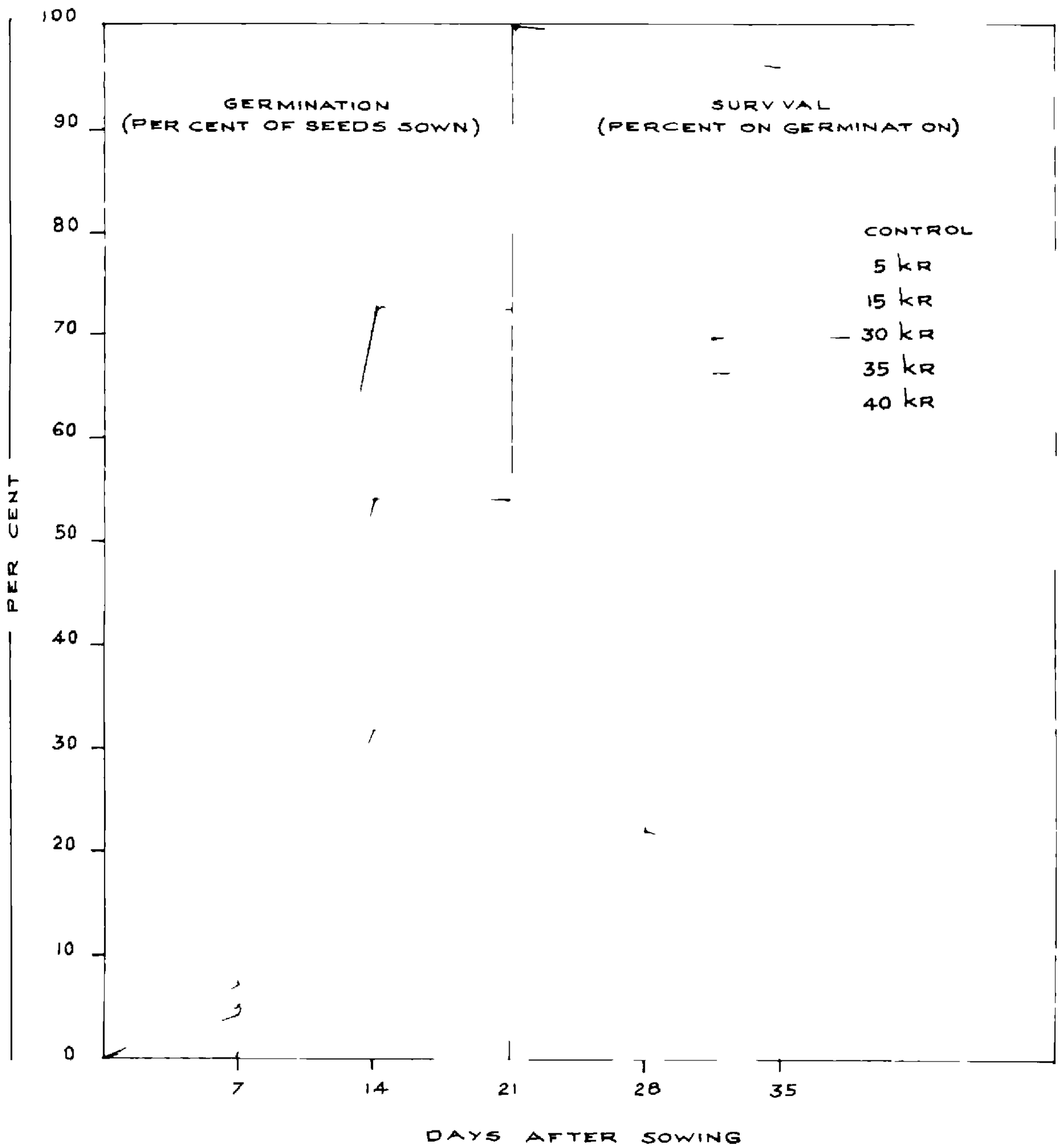


FIG 2 EFFECT OF MUTAGEN ON THE HYBRIDS IN THE FIRST GENERATION

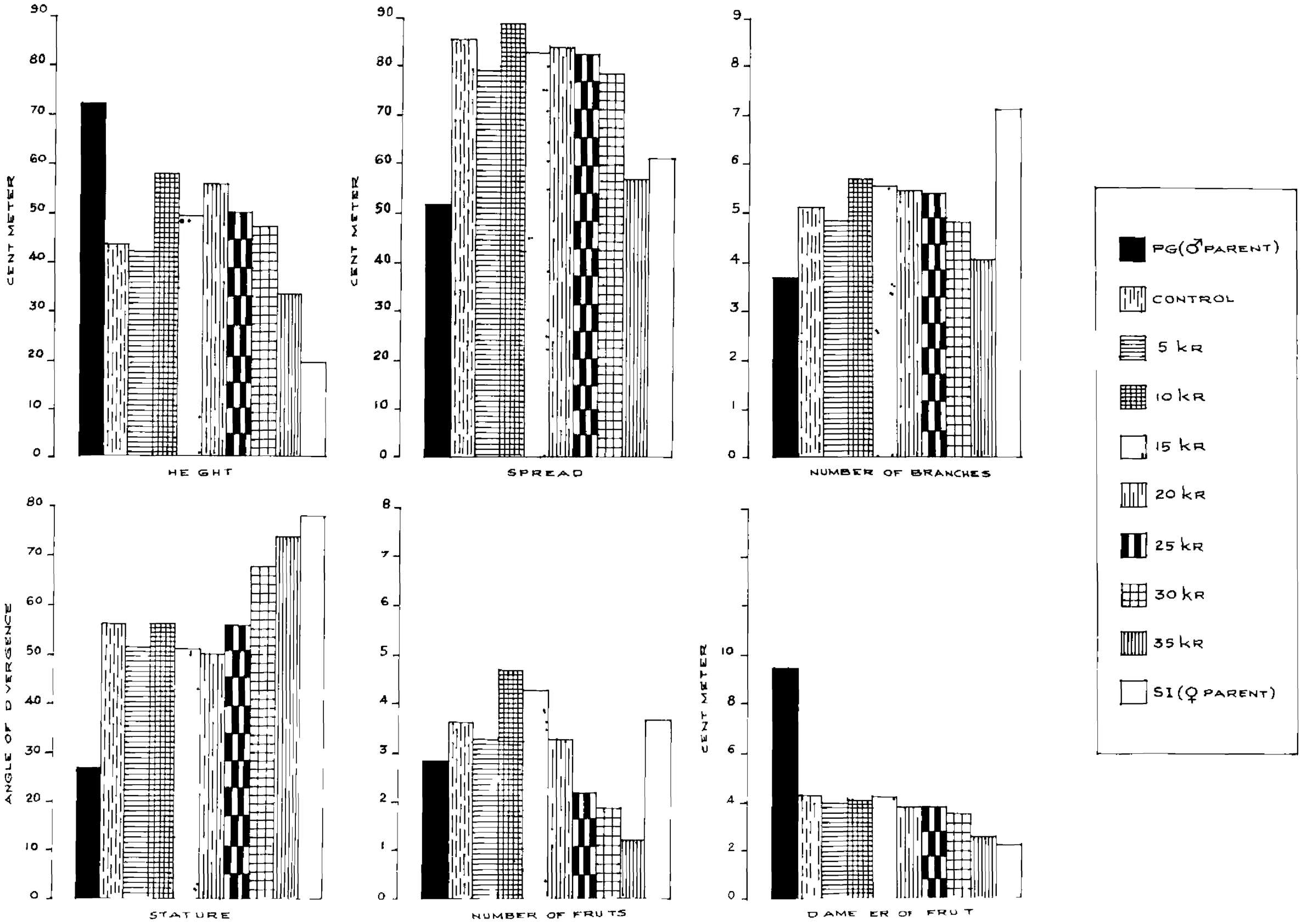


Table 11. Effect of mutagen on the hybrids in the first generation

Varieties/ Treatments	Height (cm)			Spread (cm)		
	Mean	Per cent on better parent	Per cent on control	Mean	Per cent on better parent	Per cent on control
Parents						
PG	72.18	100.00	-	52.15	-	-
SI	19.13	-	-	61.80	100.00	-
Hybrids						
Control	43.18	58.44	100.00	86.14	139.38	100.00
5 kR	42.43	58.78	98.26	79.30	128.32	92.06
10 kR	58.63	81.23	135.78	89.24	144.40	103.60
15 kR	49.57	68.67	114.80	83.58	135.24	97.03
20 kR	56.06	77.67	129.83	84.42	136.60	98.00
25 kR	50.12	69.44	116.07	83.68	135.40	97.14
30 kR	47.27	65.49	109.47	79.83	129.17	92.67
35 kR	33.69	46.67	78.02	57.43	92.93	66.67
SEd	4.55**			9.62**		
CD	9.33			19.75		

** Significant at 0.01 level of probability

Table 12. Effect of mutagen on the hybrids in the first generation

Varieties/ Treatments	Number of branches			Plant type (Angle of divergence)		
	Mean	Per cent on better parent	Per cent on control	Mean	Per cent on better parent	Per cent on control
Parents						
PG	13.70	-	-	27.50	-	-
SI	37.15	100.00	-	78.99	100.00	-
Hybrids						
Control	15.12	40.70	100.00	56.09	79.01	100.00
5 kR	14.89	40.08	98.48	51.64	65.38	92.07
10 kR	15.74	42.37	104.10	56.47	71.49	100.08
15 kR	15.50	41.72	102.51	51.61	65.34	92.01
20 kR	15.42	41.51	101.98	50.78	64.29	90.53
25 kR	15.45	41.59	102.18	56.26	71.22	100.30
30 kR	14.81	39.86	97.95	68.16	86.29	121.52
35 kR	14.00	37.68	92.59	74.38	94.16	132.61
SEd	6.49**			5.20**		
CD	11.00			10.68		

** Significant at 0.01 level of probability

But the plants in 30 and 35 kR exposures were showing more procumbent habit (68.16° to 74.38°) similar to the wild parent (78.99°) (Table 12).

5. Number of fruits

The number of fruits produced by the control F_1 (3.65), 5 kR (3.36) and 20 kR (3.34) exposed plants was not significantly different from that of the var. insanum (3.70). The 10 kR (4.73) and 15 kR (4.26) exposures showed positive heterosis over the better parent (SI). The number of fruits in 25 kR was on par with the cultivar parent (2.89). But 30 and 35 kR exposures expressed significant reduction in fruit set compared to all other treatments (1.93 and 1.17 respectively) (Table 13).

6. Diameter of fruit

In this important commercial character the control F_1 and 5 to 25 kR exposures produced fruits of less than intermediate size (4.03 to 4.24 cm) while higher exposures (20 kR to 35 kR) showed more drastic reduction in fruit size (2.5 to 3.81 cm) (Table 13).

7. Pollen sterility

The results are summarised in Table 14 and the frequency distribution of plants under different sterility classes are given in Table 15 which is graphically

Table 13. Effect of mutagen on the hybrids in the first generation

Varieties/ Treatments	Number of fruits			Diameter of fruit (cm)		
	Mean	Per cent on better parent	Per cent on control	Mean	Per cent on better parent	Per cent on control
Parents						
PG	2.89	-	-	9.58	100.00	-
SI	3.70	100.00	-	2.25	-	-
Hybrids						
Control	3.65	98.65	100.00	4.19	43.74	100.00
5 kR	3.36	90.81	92.05	4.03	42.07	96.18
10 kR	4.73	127.84	129.59	4.13	43.11	98.57
15 kR	4.26	115.13	116.71	4.24	44.26	101.19
20 kR	3.34	90.27	91.51	3.81	39.77	90.93
25 kR	2.19	59.19	60.00	3.80	39.67	90.69
30 kR	1.93	52.16	52.88	3.35	34.97	79.95
35 kR	1.17	31.62	32.05	2.50	26.10	59.67
SEd	0.67**			0.83**		
CD	1.37			0.54		

** Significant at 0.01 level of probability

Table 14. Effect of mutagen on the hybrids in the first generation

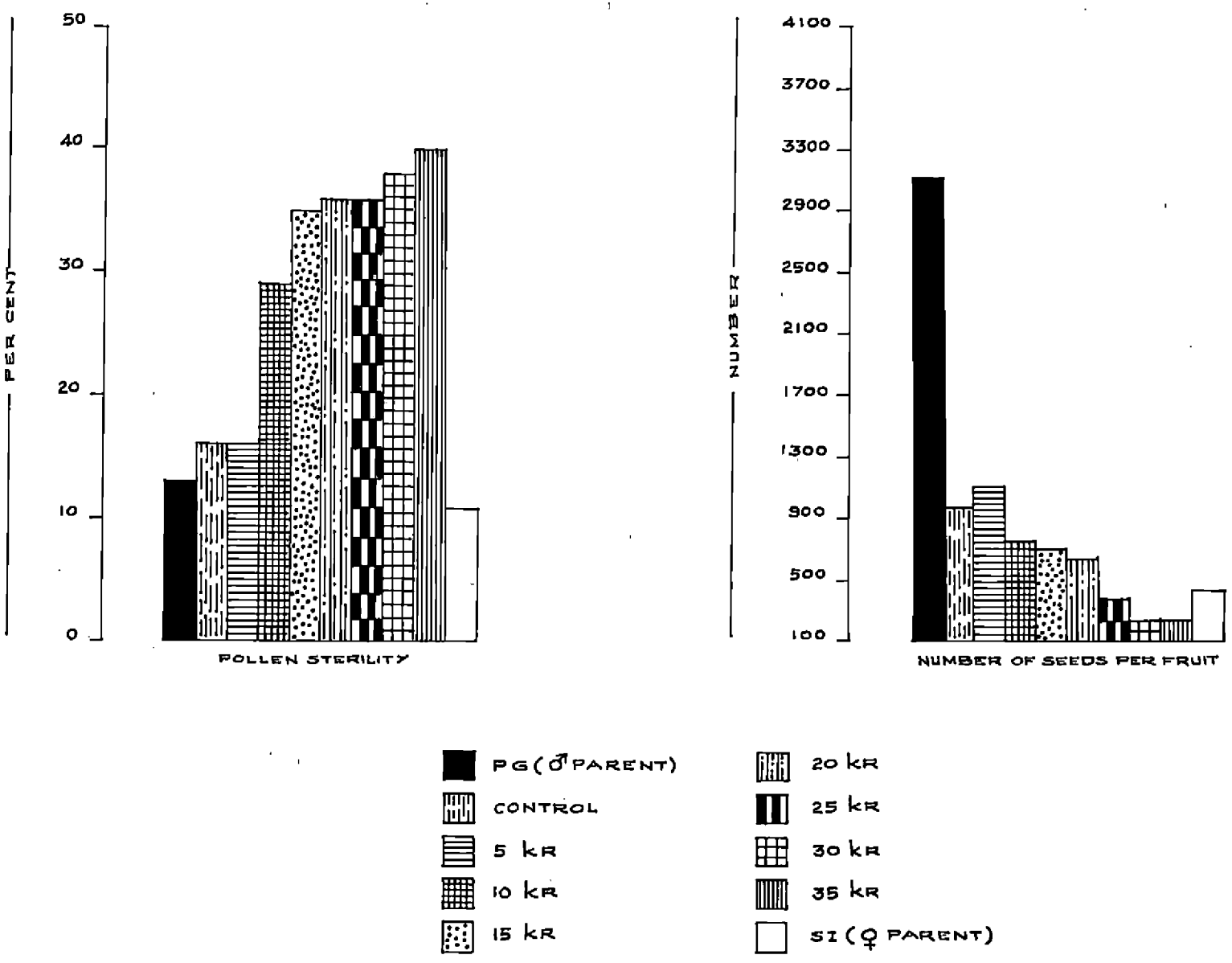
Varieties/ Treatments	Pollen sterility (per cent)			Number of seeds/fruit		
	Mean+	Per cent on better parent	Per cent on control	Mean*	Per cent on better parent	Per cent on control
Parents						
PG	13.19	100.00	-	3150.00	100.00	-
SI	11.46	-	-	405.00	-	-
Hybrids						
Control	16.52	125.25	100.00	981.80	31.14	100.00
5 kR	16.31	123.65	98.73	1100.00	34.92	112.64
10 kR	29.21	221.46	176.82	748.00	23.75	76.19
15 KR	35.66	265.81	212.23	728.90	23.14	74.24
20 KR	36.84	279.30	223.00	635.70	20.18	64.75
25 KR	36.31	275.28	219.79	384.00	12.19	39.11
30 KR	38.18	289.46	231.11	221.80	7.04	22.59
35 KR	40.33	305.76	244.13	210.00	6.67	21.39
SEd	0.85**					
CD	1.74					

** Significant at 0.01 level of probability

+ Transformed values

* Based on the number of seeds extracted from the fruits listed in Table 16.

FIG. 3. EFFECT OF MUTAGEN ON THE HYBRIDS IN THE FIRST GENERATION.



represented in Fig. 4. The mean pollen sterility was found to be progressively increasing with the increased exposures. While all the plants belonging to both parents showed pollen sterility below 11 per cent, only 10 per cent of the F_1 plants derived from 35 kR exposure belonged to that sterility group. Upto 10 kR exposures no plants showed sterility above 70 per cent. From 15 kR to 30 kR exposures 4 to 24 per cent of plants showed very high pollen sterility varying from 81 to 100 per cent. But the F_1 plants derived from 35 kR exposures showed a more or less uniform sterility distribution varying from 0 to 80 per cent among the population (Table 15).

8. Number of seeds per fruit

The results are summarised in Table 14 and the details of the number of seeds extracted from individual fruits obtained from the three different sterility groups are given in Table 16. A progressive decrease in the number of seeds per fruit can be observed with the increase in exposure rate (Table 14). A similar trend was noted in seed set with the increase in pollen sterility level. While the plants belonging to the lowest sterility group (0 to 10) gave a seed set of 1297.13 per fruit the mean seed set per fruit in the highest sterility group (91 to 100 per cent) was only 267.67 (Table 16).

Table 15. Effect of mutagen on hybrids in the first generation - Percentage of plants under different sterility classes

Varieties/ Treatments	Classes of pollen sterility (per cent)									
	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Parents										
PG	100	-	-	-	-	-	-	-	-	-
SI	100	-	-	-	-	-	-	-	-	-
Hybrids										
Control	88	6	6	-	-	-	-	-	-	-
5 kR	69	23	4	4	-	-	-	-	-	-
10 kR	46	4	17	-	21	8	4	-	-	-
15 kR	35	11	4	15	11	8	-	8	4	4
20 kR	7	22	19	7	11	19	7	4	4	-
25 kR	26	16	6	9	6	13	6	9	6	3
30 kR	11	6	2	11	11	9	6	20	13	11
35 kR	10	20	-	10	10	20	20	10	-	-

FIG 4 EFFECT OF MUTAGEN ON POLLEN STERILITY IN THE FIRST GENERATION

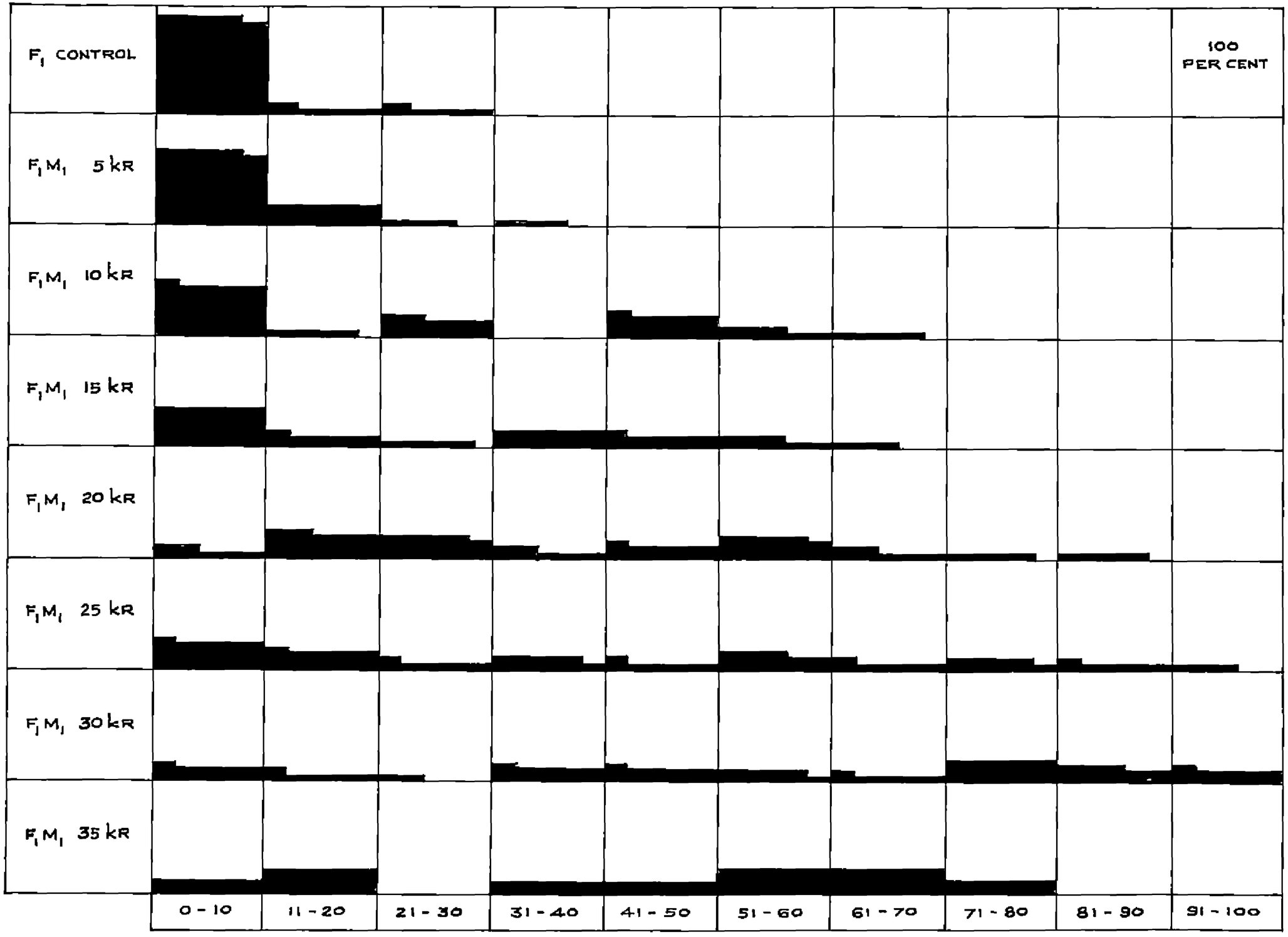


Table 16. Number of seeds per fruit from parents and hybrids in the first generation

Identify of the parent plant	Pollen sterility classes					
	Low		Medium		High	
	0-10 per cent	11-20 per cent	41-50 per cent	51-60 per cent	81-90 per cent	91-100 per cent
PG	3150 (Mean of 10 fruits)	-	-	-	-	-
SI	405 (Mean of 10 fruits)	-	-	-	-	-
Control F_1	981.80 (Mean of 10 fruits)	-	-	-	-	-
5 kR-I-29*	820	-	-	-	-	-
" III-1	978	-	-	-	-	-
" I-20	1502	-	-	-	-	-
10 kR-I-15	-	748	-	-	-	-
15 kR-II-26	-	-	420	-	-	-
" I-20	-	640	-	-	-	-
" II-22	-	-	-	-	1180	-
" IV-10	-	712	-	-	-	-
" IV-9	-	750	-	-	-	-
" II-10	-	700	-	-	-	-
" II-20	-	700	-	-	-	-
20 kR-I-12	-	-	-	728	-	-
" II-18	-	-	-	210	-	-

Table 16 (contd...)

Identity of the parent plant	Pollen sterility classes					
	Low		Medium		High	
	0-10 per cent	11-20 per cent	41-50 per cent	51-60 per cent	81-90 per cent	91-100 per cent
20 kR-II-12	-	-	-	380	-	-
" III-2	-	-	-	750	-	-
" I-2	-	-	-	470	-	-
" II-4	-	502	-	-	-	-
" III-12	-	-	-	1410	-	-
25 kR-I-23	-	-	546	-	-	-
" I-30	-	-	-	-	500	-
II-5	-	-	-	-	330	-
" II-24	-	-	-	-	-	150
" III-5	-	-	-	-	400	-
30 kR-II-12	-	-	-	-	-	450
" I-20	-	-	485	-	-	-
" II-8	-	-	-	-	200	-
" II-30	-	-	-	-	-	38
" II-12	-	-	-	-	-	268
" II-4	-	-	-	-	-	300
" III-18	-	-	-	485	-	-
" IV-14	-	-	-	-	70	-
" IV-17	-	-	-	-	-	400
35 kR-I-9	-	-	-	-	210	-
Mean	1297.13	979.00	483.70	633.30	412.86	267.67

* Exposure - Replication - plant number

9. Appearance of visible mutants

The results are summarised in Table 17. The only visible mutant appeared in the first generation was on the colour of fruits. Any variation from the normal F_1 fruit colour namely mottled purple was considered as a visible fruit colour mutant. Three different fruit colour mutants namely mottled green, purple and white appeared in the main experiment as well as in the bulk plot raised from F_1 seeds exposed to 25 kR (Photo plate No. 4). Among the seven different exposures varying from 5 kR to 35 kR tried, maximum number (15) of visible mutants appeared in 25 kR exposure. Among the 190 bulk F_1M_1 plants raised from hybrid seeds exposed to 25 kR, 30 colour mutants appeared. Among the total 69 fruit colour mutants appeared 38 were of mottled green, 26 purple and five white.

V. Studies on second generation

a. Segregation patterns

The results are presented in Tables 18 to 30 and graphically represented in Figures 5 to 8. The analysis of variance given in Appendix IV indicated significant differences among the treatments for all the characters studied except the number of flowers per plant.

Plate No.3

The fruits of the parents and hybrid of the cross S.melongena var.insanum (SI) X 'Purple Giant (PG).

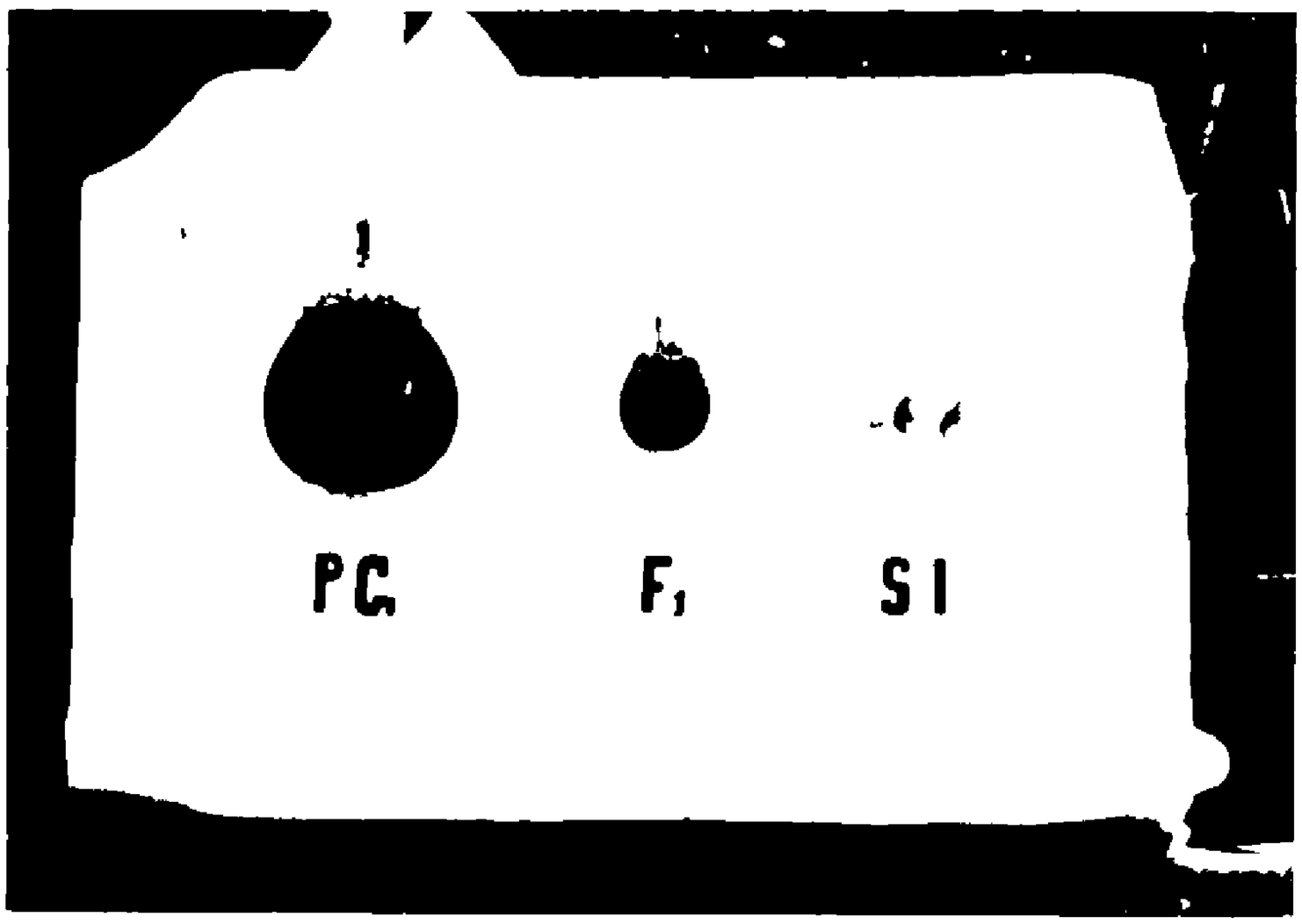


Plate No.4

The visible mutants in fruit colour appeared in the first generation (F_1M_1)

(i) Purple
(ii) Green mottled
(iii) Green mottled
(iv) White
(v) Purple
(vi) Purple
(vii) Purple

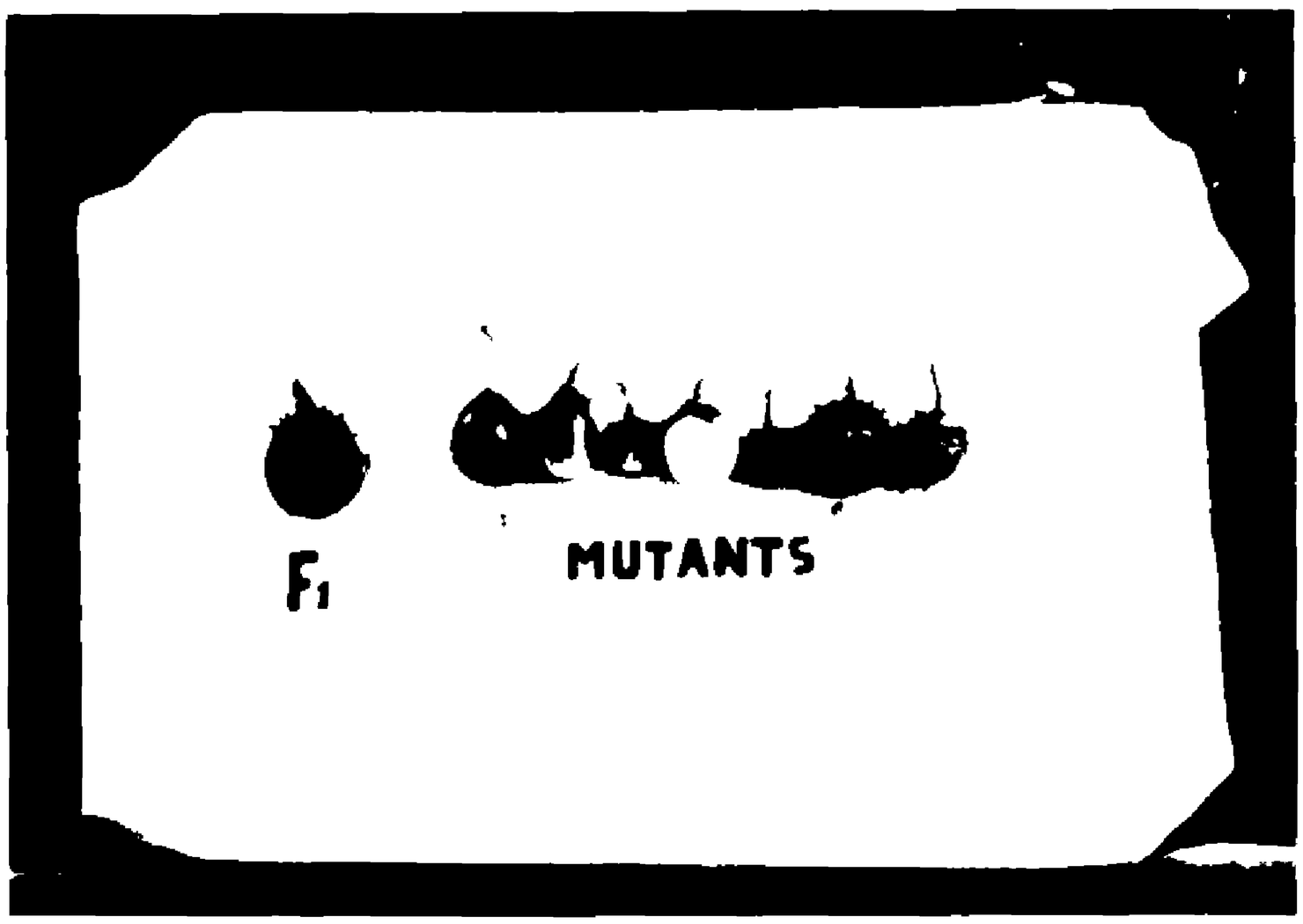


Table 17. Number of fruit colour mutants appeared in the first generation

Treatment		Total No. of plants	Normal plants (mottled purple)	Fruit colour mutants			Total mutants
				mottled green	Purple	white	
F_1M_1	control	120	120	-	-	-	-
F_1M_1	5 kR	120	118	-	2	-	2
F_1M_1	10 kR	120	120	-	-	-	-
F_1M_1	15 kR	120	120	-	-	-	-
F_1M_1	20 kR	120	116	4	-	-	4
F_1M_1	25 kR	120	105	8	6	1	15
F_1M_1	30 kR	120	110	8	2	-	10
F_1M_1	35 kR	120	112	4	4	-	8
Bulk F_1M_1 (25 kR)		190	160	14	12	4	30
Total		1150	1081	38	26	5	69

1. Plant type

The results are presented in Table 18. The erect, semi-erect and procumbent types appeared in the control F_2 population in approximately 1:2:1 ratio where the χ^2 value was not significant indicating a close fit of the expected ratio over the observed values. F_2M_2 population derived from low sterility group of F_1M_1 has also behaved similarly whereas F_2M_2s from medium and high sterility groups of F_1M_1 have shown significant variation from the segregation of control F_2 population. The difference was mainly in the reduction of erect types and an increase of semi-erect types (Table 18).

2. Fruit colour

The results are presented in Table 19. In the control F_2 population the four different fruit colours namely mottled purple, mottled green, purple and white appeared in the ratio 8.20: 2.60:2.80:1 which has a closest fit with the dihybrid ratio of 9:3:3:1. The frequencies of these four fruit colour types appeared in the three different F_2M_2 populations also fitted very well with the segregation pattern found in the control F_2.

Among the 20 plants grown from the F_1M_1 mottled green mutant, two were white fruited. All the 30 plants

Table 18. Segregation of plant type in the second generation

(Range in parents and classes: PG: 15-30°, SI: 65-90°, Erect: 15-40°, Semi erect: 41-65°, Procumbent: 66°-90°)

Populations	Number of plants under each class (per cent in parentheses)			Total	χ^2 value against control
	Erect	Semi-erect	Procumbent		
F_2 (Control)	61 (26.30)	119 (51.30)	52 (22.40)	232	0.854 (against 1:2:1)
F_2M_2 (L.S.)	57 (24.40)	116 (49.50)	61 (26.10)	234	1.86
F_2M_2 (M.S.)	9 (4.10)	173 (78.60)	38 (17.30)	220	75.91**
F_2M_2 (H.S.)	11 (5.30)	166 (79.40)	32 (15.30)	209	72.11**

Test at P. 0.05 = 5.991, at P. 0.01 = 9.210

** Significant at 0.01 level of probability

Table 19. Segregation of fruit colour in the second generation

(Fruit colour of parents - PG: Deep purple, SI: Green mottled)

Populations	Number of plants under each class (per cent in parentheses)					Total χ^2 value against control
	Mottled purple	Mottled green	Purple	White		
F_2 (Control)	41 (56.20)	13 (17.80)	14 (19.20)	5 (6.80)	73	0.084 (against 9:3:3:1)
F_2M_2 (L.S.)	48 (58.50	15 (18.30)	15 (18.30)	4 (4.90)	82	5.92
F_2M_2 (M.S.)	46 (54.10)	16 (18.80)	19 (22.40)	4 (4.70)	85	1.13
F_2M_2 (H.S.)	56 (65.10)	14 (16.30)	9 (10.50)	7 (8.10)	86	4.95
F_2M_2 from F_1M_1 mottled green mutants	-	18	-	2	20	Not tested
F_2M_2 from F_1M_1 purple mutants	-	-	30	-	30	"
F_2M_2 from F_1M_1 white mutants	-	-	-	56	56	"

Test at P. 0.05 = 7.815

raised from the F_1M_1 purple mutants and 56 plants raised from F_1M_1 white mutants were found to breed true for the fruit colour.

3. Plant height

The results are presented in Table 20. The segregation pattern for this character was found to be significantly different between the F_2 control and F_2M_2 populations. The difference was mainly in the proportion of positive transgressors. In F_2 control approximately one fourth of the plants were positive transgressors whereas in F_2M_2s the medium tall types dominated.

4. Number of spines per leaf

The results are presented in Table 21. In this character also the segregation pattern of F_2M_2s differed significantly from that of the control F_2. The major difference was in the proportion of highly spiny plants which was higher among the irradiated populations when compared to the control F_2. Positive transgressors appeared only very sparsely in all the treatments.

5. Number of branches

The results are presented in Table 22. There was no significant difference in the segregation pattern of this character among the different populations studied.

Table 20. Segregation of height (cm) in the second generation

(Range in parents and classes: PG: 22-52 cm, SI: 11-27 cm, Dwarf: 11-24 cm, Medium tall: 25-38 cm, Tall: 39-52 cm, + ive transgressors $>$ 52 cm)

Populations	Number of plants under each class (per cent in parentheses)				Total	χ^2 value against control
	Dwarf	Medium	Tall	+ive transgressors		
F_2 (Control)	15 (6.50)	74 (31.90)	86 (37.10)	57 (24.50)	232	-
F_2M_2 (L.S.)	16 (6.80)	116 (49.60)	86 (36.80)	16 (6.80)	234	52.92**
F_2M_2 (M.S.)	29 (13.20)	122 (55.40)	55 (25.00)	14 (6.40)	220	91.95**
F_2M_2 (H.S.)	15 (7.20)	112 (53.60)	57 (27.30)	25 (11.90)	209	49.93**

Test at P. 0.05 = 7.815, at P. 0.01 = 11.345

** Significant at 0.01 level of probability

Table 21. Segregation of number of spines on leaf in the second generation

(Range in parents and classes: PG: 8-20, SI: 10-28, Low: 8-14, Medium: 15-21, High: 22-28, + ive transgressors: >28)

Population	Number of plants under each class (per cent in parentheses)				Total	χ^2 value against control
	Low	Medium	High	+ive transgressors		
F_2 (Control)	155 (66.80)	71 (30.60)	5 (2.10)	1 (0.50)	232	-
F_2M_2 (L.S.)	157 (67.10)	58 (24.80)	19 (8.10)	Nil	234	42.22**
F_2M_2 (M.S.)	142 (64.50)	54 (24.60)	22 (10)	2 (0.90)	220	66.79**
F_2M_2 (H.S.)	141 (67.40)	47 (22.50)	19 (9.20)	2 (0.90)	209	52.50**

Test at P. 0.05 = 7.815, at 0.01 = 11.345

** Significant at 0.01 level of probability

Table 22. Segregation of number of branches in the second generation

(Range in parents and classes: PG: 4-9, SI: 35-42, Low: 4-16, Medium: 17-29, High: 30-43)

Populations	Number of plants under each class (per cent in parentheses)			Total	χ^2 value against control
	Low	Medium	High		
F_2 (Control)	226 (97.40)	6 (2.60)	Nil	232	-
F_2M_2 (L.S.)	233 (99.60)	1 (0.40)	Nil	234	4.28
F_2M_2 (M.S.)	220 (100)	Nil	Nil	220	0.17
F_2M_2 (H.S.)	209 (100)	Nil	Nil	209	0.18

Test at P. 0.05 = 5.991, at P. 0.01 = 9.210

Among the total 232 F_2 control plants observed 226 were of low branching type like the cultivar parent. Among the F_2M_2 s almost all the plants were of low branching type.

6. Number of leaves

The results are presented in Table 23. In both F_2 control and F_2M_2, 40 to 60 per cent of plants were of positive transgressor type. But the segregation pattern of this character in F_2M_2 (M.S.) and F_2M_2 (H.S.) populations significantly differed from that of the F_2 control population. The difference was mainly in the increased proportion of positive transgressors in F_2M_2 (M.S.) and F_2M_2 (H.S.) populations.

7. Number of short styled flowers

The results are presented in Table 24. The unimorphic character (absence of short styled flowers) of the wild parent appeared in large proportions (34.9 to 47.6 per cent) in all treatments. The F_2M_2 populations differed significantly from the control F_2 populations in the segregation pattern of this character. The difference was mainly in the increase of positive transgressors in F_2M_2 (L.S.)(6.9 per cent) and decrease in the proportion of 'high group' in F_2M_2 (M.S.) (4.8 per cent) and also the decrease in the proportion of unimorphic types in F_2M_2 (H.S.) (34.9 per cent).

Table 23. Segregation of number of leaves in the second generation

(Range in parents and classes: PG: 16-50, SI: 40-90, Low: 16-40, Medium: 41-65, High: 66-90, + ive transgressors: >90)

Populations	Number of plants under each class (per cent in parentheses)				Total	χ^2 value against control
	Low	Medium	High	+ive transgressors		
F_2 (Control)	38 (16.40)	39 (16.80)	54 (23.30)	101 (43.50)	232	-
F_2M_2 (L.S.)	28 (12.00)	51 (21.80)	61 (26.00)	94 (40.20)	234	6.44
F_2M_2 (M.S.)	11 (5.00)	29 (13.20)	62 (28.20)	118 (53.60)	220	27.49**
F_2M_2 (H.S.)	7 (3.40)	31 (14.80)	46 (22.00)	125 (59.80)	209	30.21**

Test at P. 0.05 = 7.815, at 0.01 = 11.345

** Significant at 0.01 level of probability

Table 24. Segregation of number of short styled flowers in the second generation

(Range in parents and classes: PG: 1-5, SI: 0 (unimorphic) Medium: 1-3, High: 3-5, + ive transgressors > 5)

Populations	Number of plants under each class (per cent in parentheses)				Total	χ^2 value against control
	Unimorphic	Medium	High	+ive transgressors		
F_2 control	72 (42.30)	71 (41.80)	26 (15.30)	1 (0.60)	170	-
F_2M_2 (L.S.)	82 (40.60)	86 (42.60)	20 (9.90)	14 (6.90)	202	142.16**
F_2M_2 (M.S.)	89 (47.60)	84 (44.90)	9 (4.80)	5 (2.70)	187	28.92**
F_2M_2 (H.S.)	58 (34.90)	77 (46.40)	26 (15.70)	5 (3.00)	166	19.60**

Test at P. 0.05 = 7.815, at P. 0.01 = 11.345

** Significant at 0.01 level of probability

8. Number of long and medium styled flowers

The results are presented in Table 25. Unimorphic type (absence of medium and long styled flowers) appeared in all the four treatments in small proportions (2.4 to 7.4 per cent). Positive transgressors were absent in F_2M_2 (M.S.) and F_2M_2 (H.S.) populations. The difference in segregation pattern between the control F_2 and F_2M_2s was not very pronounced except in the increased proportion of 'low' class in the F_2M_2 (M.S.) (76.5 per cent) and F_2M_2 (H.S.) (77.7 per cent) groups.

9. Number of fruits

The results are presented in Table 26. There was not much difference in the segregation pattern of this character among the different populations studied. But the F_2M_2 (H.S.) population differed slightly from the control population in having an increased proportion of positive transgressors (6.9 per cent) and medium class (21.8 per cent).

10. Diameter of fruit

The results are presented in Table 27. The segregation pattern of this important commercial character which determines the fruit size was uniform in all the

Table 25. Segregation of number of long and medium styled flowers in the second generation

(Range in parents and classes: PG: 2-13, SI: 2-9, Unimorphic: 0, Low: 2-5, Medium: 6-9, High 10.13, +ive transgressors >13)

Populations	Number of plants under each class (per cent in parentheses)					Total	χ^2 value against control
	Unimorphic	Low	Medium	High	+ive transgressors		
F_2(Control)	9 (5.40)	116 (68.20)	30 (17.60)	7 (4.10)	8 (4.70)	170	-
F_2M_2(L.S.)	15 (7.40)	133 (65.80)	44 (21.80)	9 (4.50)	1 (0.50)	202	11.53*
F_2M_2(M.S.)	6 (3.20)	143 (76.50)	35 (18.70)	3 (1.60)	Nil	187	15.19**
F_2M_2(H.S.)	4 (2.40)	129 (77.70)	27 (16.30)	6 (3.60)	Nil	166	12.89**

Test at P. 0.05 = 9.488, at 0.01 = 13.277

* Significant at 0.05 level of probability

** Significant at 0.01 level of probability

Table 26. Segregation of number of fruits in the second generation

(Range in parents and classes: PG: 1-6, SI: 1-5, Low: 1-2, Medium: 3-4, High: 5-6, +ive transgressors > 6)

Populations	Number of plants under each class (per cent in parenthese)				Total	χ^2 value against control
	Low	Medium	High	+ive transgressors		
F_2 control	58 (77.30)	11 (14.70)	4 (5.30)	2 (2.70)	75	-
F_2M_2 (L.S.)	61 (70.10)	18 (20.70)	8 (9.20)	Nil	87	7.49
F_2M_2 (M.S.)	81 (76.40)	17 (16.00)	6 (5.70)	2 (1.90)	106	0.415
F_2 M_2 (H.S.)	59 (67.80)	19 (21.80)	3 (3.50)	6 (6.90)	87	10.485*

Test at P. 0.05 = 7.815, at 0.01 = 11.345

* Significant at 0.05 level of probability

Table 27. Segregation of the diameter (cm) of fruit in the second generation

(Range in parents and classes: PG: 8-13 cm, SI: 2-2.5 cm, Low: 2-5 cm, Medium: 6-9 cm, High: 10-13 cm)

Populations	Number of plants under each class (per cent in parentheses			Total	χ^2 value against control
	Low	Medium	High		
F_2 (Control)	75 (100)	Nil	Nil	75	-
F_2M_2 (L.S.)	87 (100)	Nil	Nil	87	-
F_2M_2 (M.S.)	98 (92.5)	8 (7 5)	Nil	106	64.604**
F_2M_2 (H.S.)	87 (100)	Nil	Nil	87	-

Test at P. 0.05, = 3, 841, at 0.01 = 6.635

** Significant at 0.01 level of probability

treatments except F_2M_2 (M.S.) where eight plants produced fruits having an equatorial diameter ranging from six to nine centimeters. These plants were selected for carrying over to F_3M_3 families. One more such large fruited plant was selected from the bulk F_2M_2 plants raised from the visible mutants appeared in the F_1M_1 populations.

11. Length of fruits

The results are presented in Table 28. The eight plants in the F_2M_2 (M.S.) population which showed a significantly higher equatorial diameter for their fruits were again marked for their superior length also. Among the 87 plants scored for the fruit length in F_2M_2 (H.S.) population there was one plant which produced long fruits (8 to 10 cm) instead of the usual round fruits produced by the parents and all other hybrids. This plant was also selected for carrying over to F_3M_3 generation.

12. Spread of plant

The results are presented in Table 29. The important feature in the segregation of this character was the appearance of both positive and negative transgressors in all the four treatments. Only the F_2M_2 (L.S.) and F_2M_2 (M.S.) differed significantly from the control and the difference was mainly in the increased proportion of the 'low' class (25.2 and 23.2 per cent) and slight decrease in the 'high' class (19.7 and 21.0 per cent).

Table 28. Segregation of length (cm) of fruit in the second generation

(Range in parents and classes: PG: 8-10 cm, SI: 2-2.5 cm, Low: 2-4 cm, Medium: 5-7 cm, High: 8-10 cm)

Populations	Number of plants under each class (per cent in parentheses)			Total	χ^2 value against control
	Low	Medium	High		
F_2 (Control)	75 (100)	Nil	Nil	75	-
F_2M_2 (L.S.)	87 (100)	Nil	Nil	87	-
F_2M_2 (M.S.)	98 (92.50)	8 (7.5)	Nil	106	49.604**
F_2M_2 (H.S.)	86 (98.80)	Nil	1 (1.20)	87	1.01

Test at P. 0.05, = 5.99, at 0.01 = 9.21

** Significant at 0.01 level of probability

Table 29. Segregation of the spread of plant (cm) in the second generation

(Range in parents and classes: PG: 23-115 cm, SI: 23-100 cm, Low: 23-53 cm, Medium: 54-84 cm, High: 85-115 cm, +ive transgressors > 115 cm, -ive transgressors: < 23 cm)

Populations	Number of plants under each class (per cent in parentheses)					Total	χ^2 value against control
	Low	Medium	High	+ive transgressers	-ive transgressers		
F_2 (control)	45 (19.40)	124 (53.40)	60 (25.90)	2 (0.90)	1 (0.40)	232	-
F_2M_2(L.S.)	59 (25.20)	122 (52.10)	46 (19.70)	2 (0.90)	5 (2.10)	234	23.432**
F_2M_2(M.S.)	51 (23.20)	117 (53.20)	46 (21.00)	4 (1.70)	2 (0.90)	220	12.371*
F_2M_2(H.S.)	37 (17.70)	116 (55.50)	51 (24.40)	4 (1.90)	1 (0.50)	209	3.341

Test at P. 0.05 = 9.488 at 0.01 = 13.277

** Significant at 0.01 level of probability

* Significant at 0.05 level of probability

FIG 5 SEGREGATION PATTERN IN TREATED AND CONTROL F_2 POPULATIONS

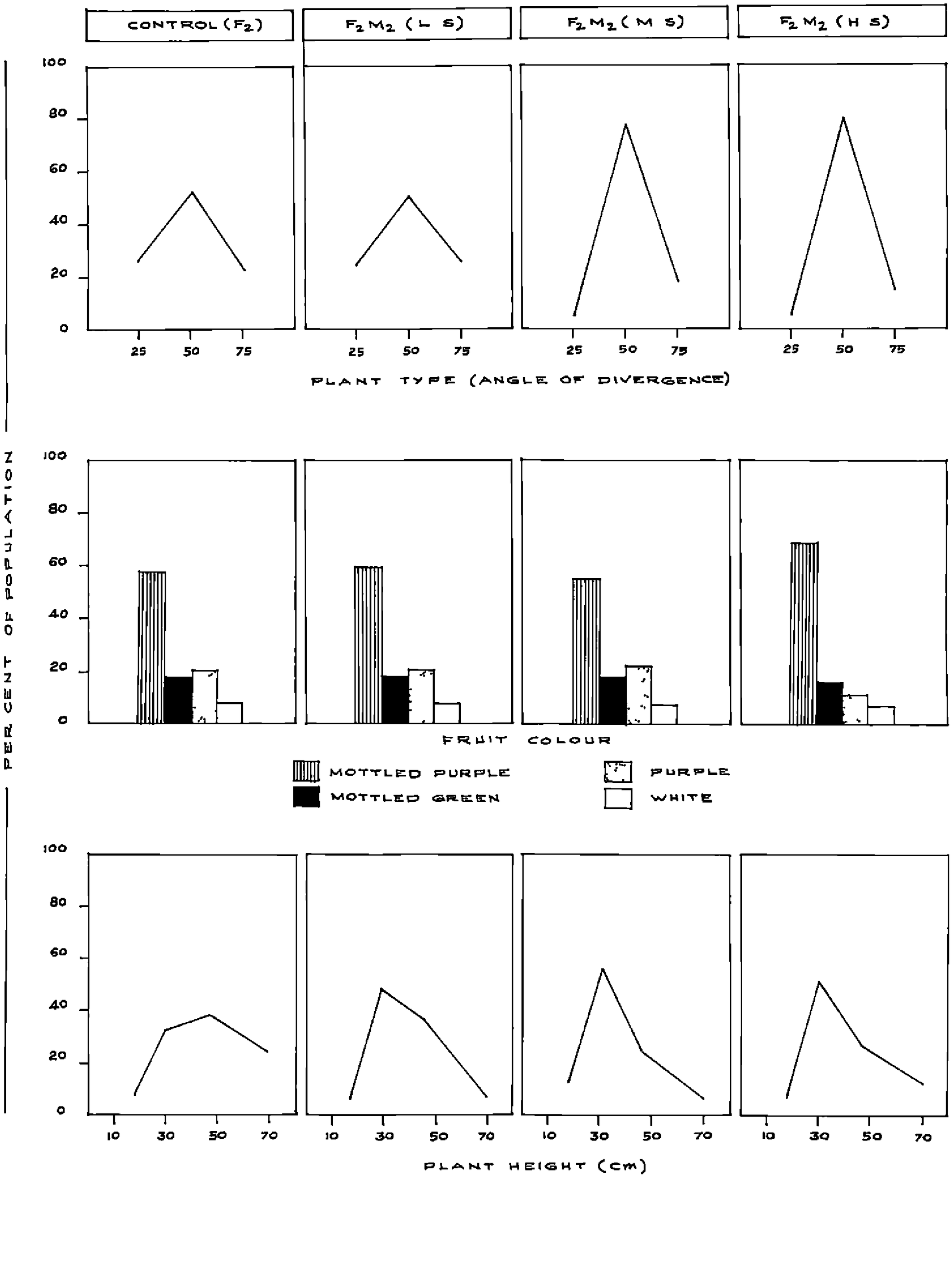


FIG 6 SEGREGATION PATTERN IN TREATED AND CONTROL F_2 POPULATIONS

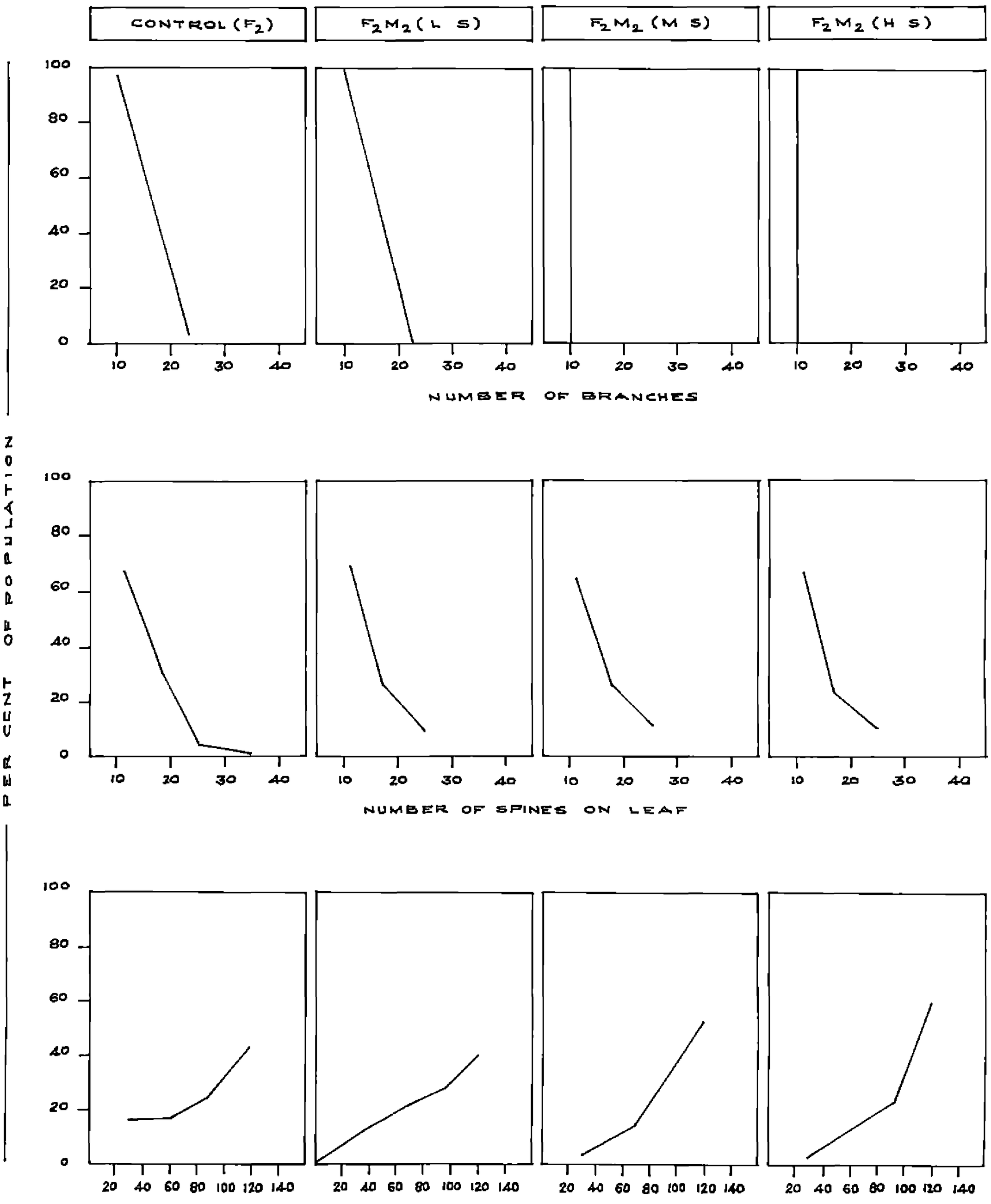


FIG 7 SEGREGATION PATTERNS IN TREATED AND CONTROL F_2 POPULATIONS

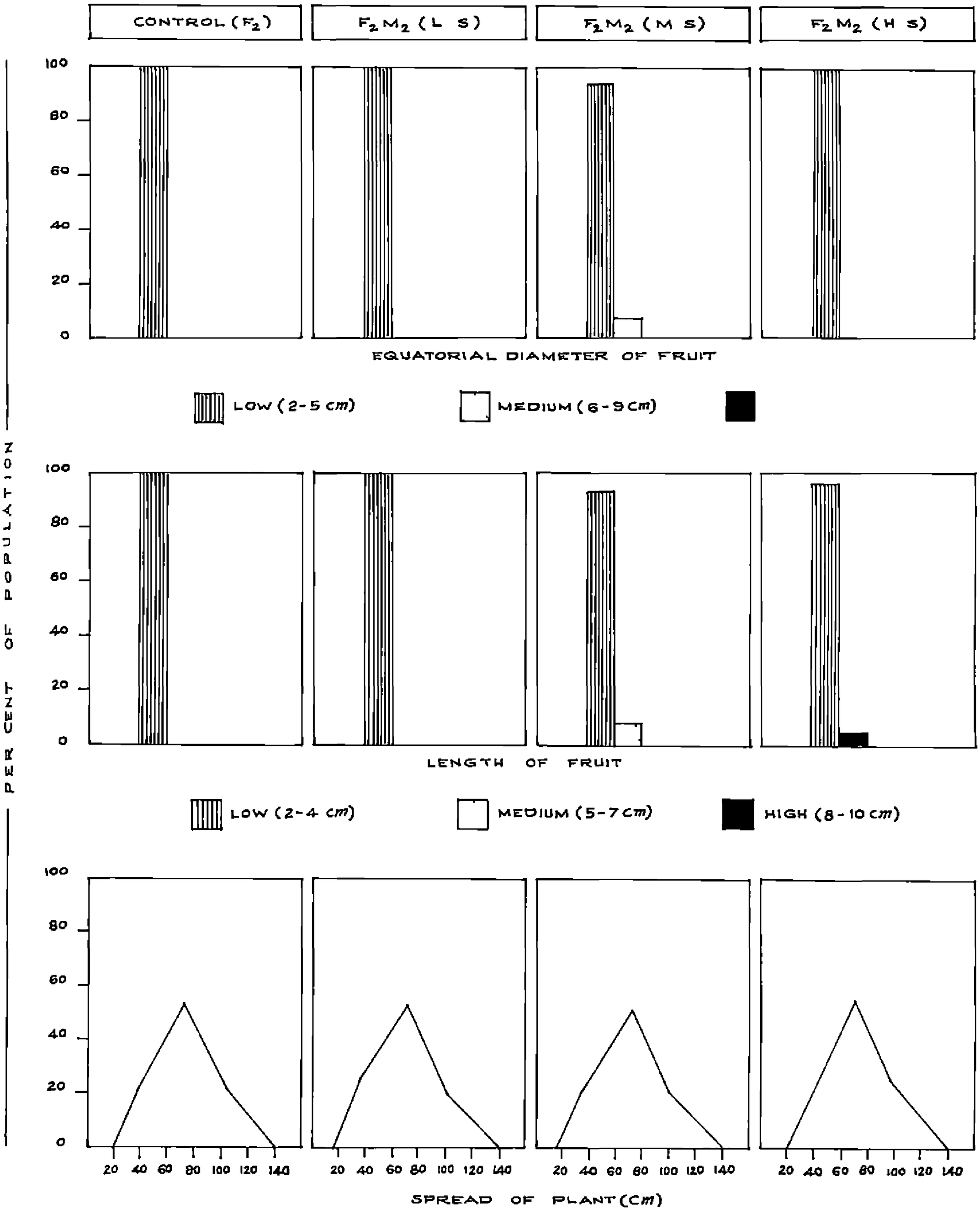
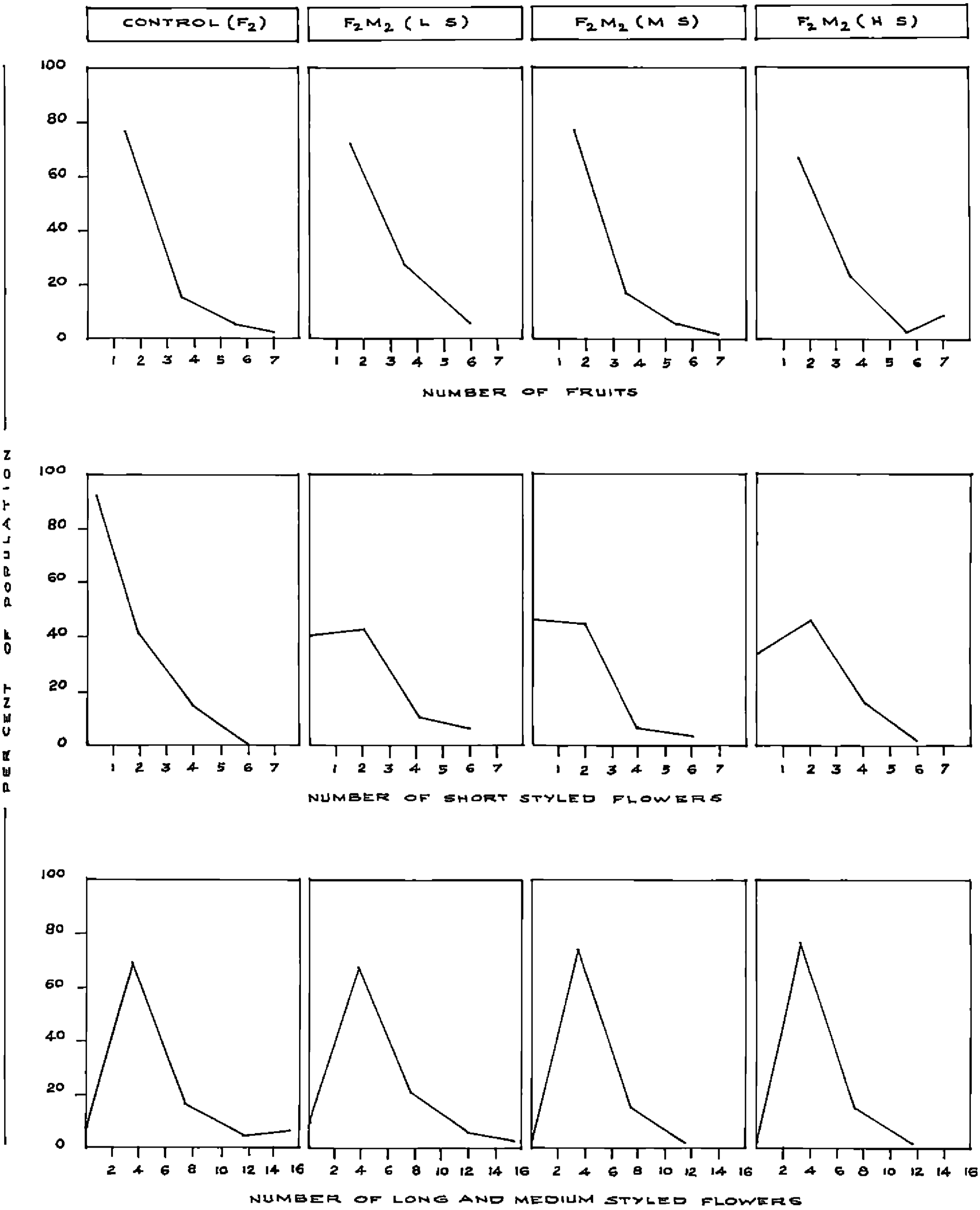


FIG 8 SEGREGATION PATTERN IN TREATED AND CONTROL F_2 POPULATIONS



13. Total leaf area

The results are presented in Table 30. In total leaf area also both positive and negative transgressors appeared in all the treatments. There was significant difference between the control F_2 and the F_2M_2s in the segregation pattern of this character. The proportion of plants belonging to the 'high' class in the F_2M_2s (20.9 to 23.4 per cent) was almost double that of the control F_2 (10.9 per cent).

b. Segregation in F_2 control populations under wilt free and wilt infestation conditions

The results are presented in Tables 31 to 33 and graphically represented in Figure 9.

1. Plant type

The segregation pattern of the erect, semi-erect and procumbent types in F_2 control under artificial wilt infestation was found to be significantly different from that of the F_2 control under wilt free conditions. The 1:2:1 ratio under wilt free conditions was found to have changed into 1:3.31:2.15 in the surving F_2 control population under artificial wilt infestation condition (Table 31).

2. Fruit colour

The 9:3:3:1 ratio of mottled purple, mottled green,

FIG 9 SEGREGATION PATTERN IN F_2 (CONTROL) POPULATIONS UNDER WILT FREE AND ARTIFICIAL WILT INFECTION CONDITIONS

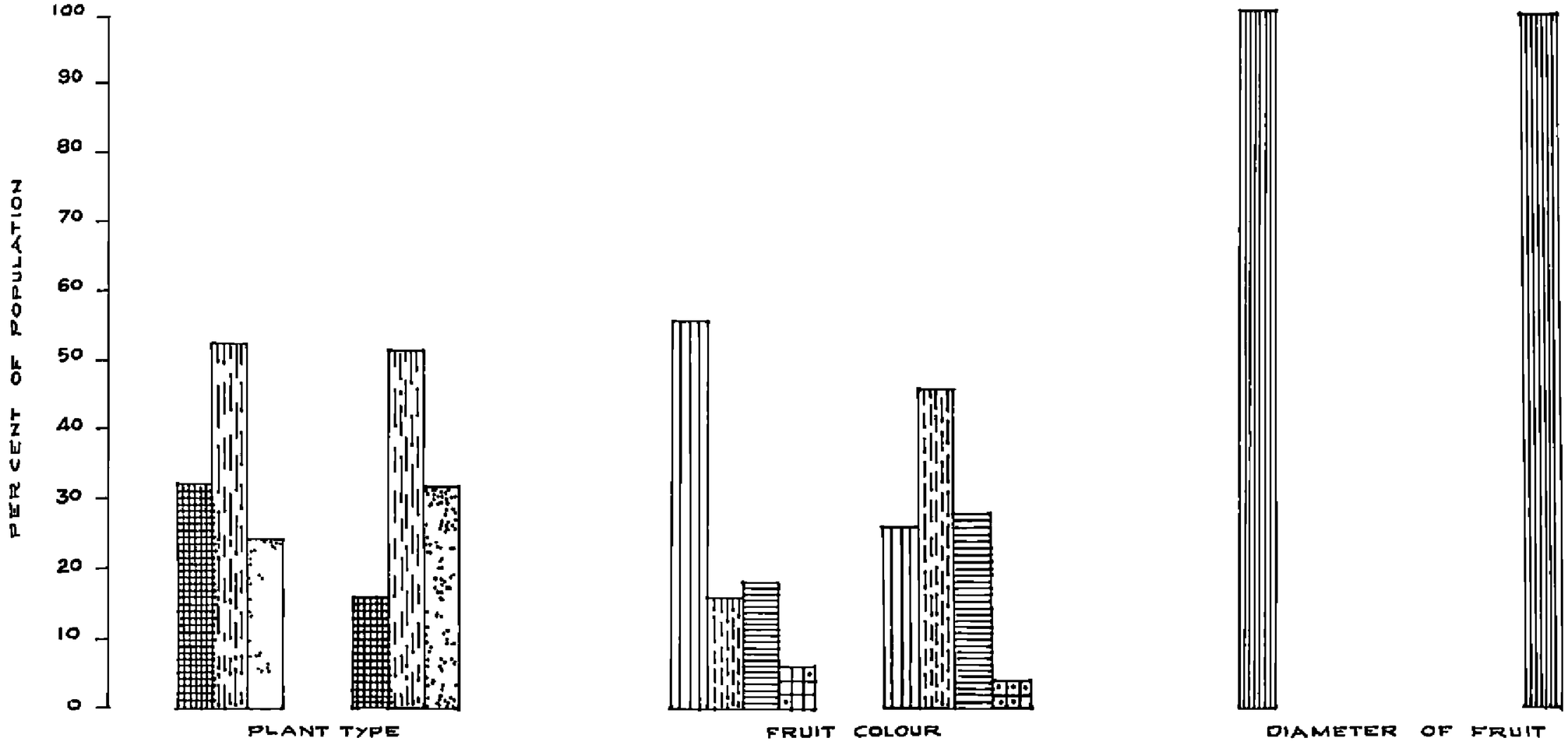
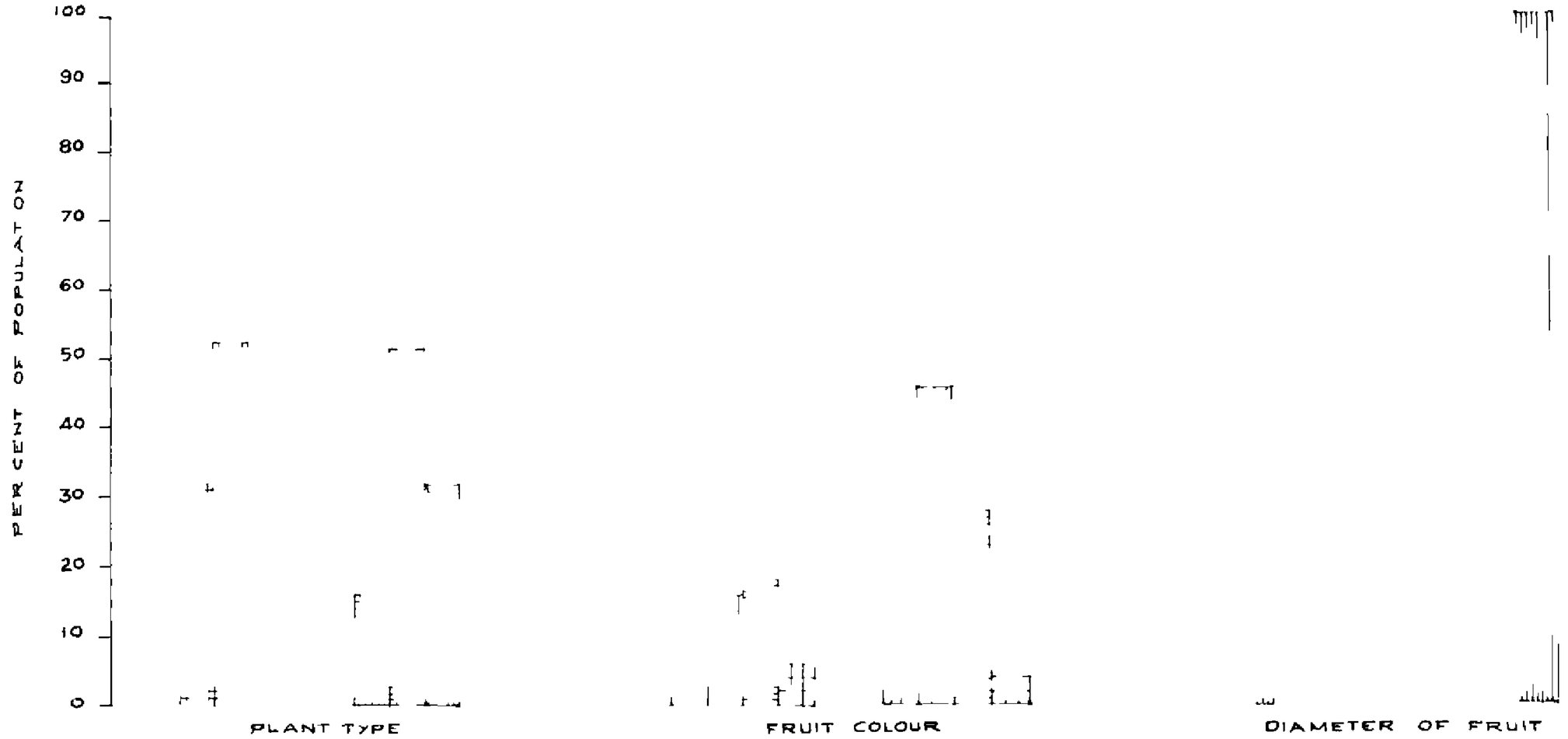


FIG 9 SEGREGATION PATTERN IN F_2 (CONTROL) POPULATIONS UNDER WILT FREE AND ARTIFICIAL WILT INFECTION CONDITIONS



RED COLOUR INDICATES POPULATION UNDER ARTIFICIAL WILT INFECTION

BLUE COLOUR INDICATES POPULATION UNDER WILT FREE CONDITION

ERECT
SEMI ERECT
PROCUMBENT

MOTTLED PURPLE
MOTTLED GREEN
PURPLE
WHITE

LOW

Table 30. Segregation of total leaf area (sq.m) in the second generation

(Range in parents and classes: PG: 0.16-0.75 sq.m, SI: 0.13-0.46 sq.m, Low: 0.13-0.33 sq.m, Medium: 0.34-0.54 sq.m, High: 0.55-0.75 sq.m, +ive transgressors >0.75 sq.m, -ive transgressors: < 0.13 sq.m)

Populations	Number of plants under each class (per cent in parentheses)					Total	χ^2 value against control
	Low	Medium	High	+ive transgressers	-ive transgressers		
F_2(Control)	43 (18.50)	43 (18.50)	25 (10.90)	114 (49.10)	7 (3.00)	232	-
F_2 M_2(L.S.)	43 (18.40)	57 (24.40)	50 (21.30)	80 (24.20)	4 (1.70)	234	40.57**
F_2M_2 (M.S.)	19 (8.60)	47 (21.40)	46 (20.90)	106 (48.20)	2 (0.90)	220	41.38**
F_2M_2 (H.S.)	10 (4.80)	46 (22.00)	49 (23.40)	102 (48.80)	2 (1.00)	209	40.21**

Test at P. 0.05 = 9.49, at 0.01 = 13.28

** Significant at 0.01 level of probability

Table 31. Segregation of plant type in control F_2 populations under wilt free and artificial wilt infestation conditions

Populations	Number of plants under each class (per cent in parentheses)			No. of plants wilted	Total plants	χ^2 value
	Erect	Semi-erect	Procumbent			
F_2 control under wilt free conditions	61 (26.30)	119 (51.30)	52 (22.40)	Nil	232	0.853 (against (1:2:1)
F_2 control under artificial wilt infestation conditions	13 (15.67)	42 (50.60)	28 (33.73)	37	120	13.03** (against control)

Test at P. 0.05 = 5.99, at 0.01 = 9.21

** Significant at 0.01 level of probability

purple and white fruited plants in the F_2 control population under wilt free conditions was found to have changed into 9.50:17:10:1 in the F_2 control population under artificial wilt infestation conditions (Table 32).

3. Equatorial diameter of fruit

The results (Table 33) showed that the two populations behaved the same way in the expression of this character. The plants under wilt free as well as wilt infestation conditions have produced only small sized fruits (2' to 5 cm).

c. Variability studies

The analysis of variance given in Appendix IV has shown that there was significant difference among the treatments for all the characters studied except number of short styled flowers and long and medium styled flowers. The mean, standard error and coefficient of variation for the various characters studied are presented in Tables 34 to 43.

1. Plant height

The results are presented in Table 34. Significant reduction in height was noted in the treated populations compared to the control. The variability was found to be higher in F_2M_2 populations derived from low sterility

Table 32. Segregation of fruit colour in control F_2 populations under wilt free and artificial wilt infestation conditions

Populations	Number of plants undereach class (per cent in parentheses				No.of plants wilted	Total plants	χ^2 value
	Mottled purple	Mottled green	Purple	White			
F_2 control under wilt free conditions	41 (56.20)	13 (17.80)	14 (19.20)	5 (6.80)	Nil	73	0.084 (against 9:3:3:1)
F_2 control under artificial wilt infestation conditions	19 (25.33)	34 (45.33)	20 (26.67)	2 (2.67)	37	112	48.48** (against control)

Test at P. 0.05 = 7.815, at P. 0.01 = 11.345

** Significant at 0.01 level of probability

Table 33. Segregation of diameter (cm) of fruits in control F_2 populations under wilt free and artificial wilt infestation conditions

Populations	Number of plants under each class (per cent in parentheses)			No.of plants wilted	Total	χ^2 value
	Low (2 to 5 cm)	Medium (6 to 9 cm)	High (10 to 13 cm)			
F_2 control under wilt free condition	75 (100)	Nil	Nil	Nil	75	-
F_2 control under wilt infested condition	75 (100)	Nil	Nil	37	112	-

Table 34. Variations for quantitative traits in the second and third generations

1. Plant Height (cm)

Generation	Treatments	Mean	±	SE	Per cent on control	CV per cent
	Parents					
	SI	17.83	±	0.78	-	10.77
	PG	31.83	±	2.84	-	21.93
Second	Hybrids					
	F_2 control	46.60	±	1.73	100.00	9.10
	F_2M_2 (L.S.)	37.08	±	1.64	79.57	11.27
	F_2M_2 (M.S.)	32.78	±	0.97	70.34	7.57
	F_2M_2 (H.S.)	34.64	±	1.67	74.33	12.12
	SEd	2.22**				
	CD	6.20				
Third	F_3 control	25.57	±	0.19	100.00	1.35
	F_3M_3 family-1	27.17	±	0.99	106.26	6.71
	" 2	47.67	±	1.85	186.43	7.82
	" 3	74.59	±	4.39	291.71	10.51
	" 4	59.94	±	2.27	234.42	7.23
	" 5	59.81	±	2.77	233.87	8.21
	" 6	72.33	±	0.82	282.87	2.23
	" 7	68.33	±	4.19	267.23	11.11
	" 8	27.26	±	1.01	106.61	6.57
	" 9	28.30	±	0.62	110.68	4.51
	" 10	52.25	±	4.56	204.34	15.23
	SEd	4.57**				
	CD	12.51				

** Significant at 0.01 level of probability

(11.27 per cent) and high sterility (12.12 per cent) groups of F_1M_1 whereas it was lower in F_2M_2 (7.57per cent) when compared to control F_2 (9.10 per cent).

2. Number of branches

The results are presented in Table 35. Significant reduction in the mean number of branches was noted in the treated populations in comparison to control. Variability was highest in F_2M_2 (L.S.) (17.35 per cent) followed by control F_2 (16.21 per cent) and F_2M_2 (M.S.) (12.27 per cent). It was lowest in F_2M_2 (H.S.) (8.51 per cent).

3. Number of spines per leaf

The results are presented in Table 36. There was not much difference in this character among the treatments except that F_2M_2 (M.S.) plants produced more spiny leaves (15.61 spines per leaf) than the other treatments which were on par (12.67 to 13.67 spines per leaf). Variability was found to be highest in the F_2M_2 (H.S.) plants (15.12 per cent) and lowest in F_2M_2 (L.S.) (8.51 per cent).

4. Number of leaves

The results are presented in Table 37. There was significant reduction in the mean number of leaves in the treated plants (82.8 to 86.1 leaves per plant) compared

Table 35. Variations for quantitative traits in second and third generations

2. Number of branches

Generation	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	33.47	± 3.34	-	13.43
	PG	7.51	± 0.82	-	22.34
Second	F_2 control	10.13	± 0.66	100.00	16.21
	F_2M_2 (L.S.)	7.01	± 0.49	69.20	17.35
	F_2M_2 (M.S.)	6.51	± 0.33	64.26	12.27
	F_2M_2 (H.S.)	6.81	± 0.23	67.23	8.51
	SEd	0.58**			
	CD	1 .61			
Third	F_3 control	9.63	± 0.45	100.00	8.22
	F_3M_3 family-1	6.53	± 0.23	67.81	6.10
	" 2	8.43	± 0.68	87.54	14.05
	" 3	8.38	± 0.46	87.02	10.11
	" 4	9.39	± 0.69	97.51	13.70
	" 5	9.63	± 0.36	100.00	6.12
	" 6	7.53	± 0.30	78.19	7.35
	" 7	8.37	± 0.41	86.92	8.30
	" 8	13.91	± 0.24	144.44	3.21
	" 9	6.73	± 0.78	69.89	20.11
	" 10	9.36	± 0.41	97.20	8.80
	SEd	2.44	Not Significant.		

** Significant at 0.01 level of Probability

Table 36. Variations for quantitative traits in second and third generations

3. Number of spines/leaf

Generations	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	18.61	± 0.61	-	14.32
	PG	12.12	± 1.31	-	19.57
Second	Hybrids				
	F_2 control	12.67	± 0.58	100.00	11.10
	F_2M_2 (L.S.)	13.49	± 0.44	106.47	8.51
	F_2M_2 (M.S.)	15.61	± 0.75	123.20	12.50
	F_2M_2 (H.S.)	13.67	± 0.85	107.89	15.12
	SEd	1.02*			
	CD	2.845			
Third	F_3 control	10.97	± 0.10	100.00	2.31
	F_3M_3 family- 1	13.00	± 2.53	118.51	34.75
	" 2	13.87	± 1.60	126.44	20.11
	" 3	11.35	± 0.58	103.46	9.23
	" 4	14.40	± 1.29	131.27	15.21
	" 5	14.58	± 0.80	132.91	10.11
	" 6	8.90	± 1.05	81.13	20.23
	" 7	12.17	± 0.69	110.94	10.56
	" 8	19.40	± 1.79	176.85	16.10
	" 9	13.10	± 0.76	119.42	10.10
	" 10	8.75	± 1.84	79.76	36.25
	SEd	2.21**			
	CD	6.18			

** Significant at 0.01 level of probability

* Significant at 0.05 level of probability

Table 37. Variations for quantitative traits in second and third generations

4. Number of leaves

Generation	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	64.37	± 4.61	-	22.31
	PG	35.41	± 7.57	-	23.01
Second	Hybrids				
	F_2 control	100.07	± 3.93	100.00	10.01
	F_2M_2 (L.S.)	84.45	± 7.58	84.39	22.00
	F_2M_2 (M.S.)	82.80	± 2.16	82.74	6.11
	F_2M_2 (H.S.)	86.12	± 5.80	86.06	16.24
	SEd	6.97**			
	CD	10.43			
Third	F_3 control	150.00	± 10.78	100.00	21.81
	F_3M_3 Family-1	102.17	± 8.87	68.11	15.76
	F_3M_3 " 2	82.83	± 6.94	55.22	14.60
	" 3	100.44	± 8.53	66.96	12.21
	" 4	120.87	± 7.04	80.58	10.32
	" 5	105.25	± 5.44	70.17	9.51
	" 6	76.14	± 5.28	50.76	12.62
	" 7	102.54	± 4.53	68.36	8.72
	" 8	183.19	± 24.86	122.13	23.81
	" 9	106.90	± 1.91	71.27	3.82
	" 10	123.47	± 6.95	82.31	10.11
	SEd	14.63**			
	CD	40.96			

** Significant at 0.01 level of probability

to control (100.07 leaves per plant). But the F_2M_2s irrespective of their origin were on par in this character. Variability was highest in F_2M_2 (L.S.) (22.0 per cent) and lowest in F_2M_2 (M.S.) (6.11 per cent).

5. Number of short styled flowers

The results are presented in Table 38. The differences in this character among the treatments were not significant. The variability was very high in F_2M_2 (L.S.) (47.13 per cent) and F_2M_2 (M.S.) (41.51 per cent) and comparatively low in F_2 control (16.01 per cent) and F_2M_2 (H.S.) (24.61 per cent).

6. Number of long and medium styled flowers

The results are presented in Table 39. For this character also the difference among the various treatments were not significant, but a progressive reduction in the mean was present among F_2M_2 treatments in accordance with the increase in their sterility level. The variability was highest in F_2M_2 (L.S.) and lowest in F_2M_2 (H.S.) (42.23 and 22.60 per cent respectively).

7. Number of fruits

The results are presented in Table 40. F_2 control plants produced significantly higher number of fruits (1.00) than the F_2M_2 populations (0.49 to 0.63). But the differences

Table 38. Variations for quantitative traits in second and third generations

5. Number of short styled flowers

Generation	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	0.00	± 0.00	-	0.00
	PG	3.41	± 0.31	-	17.81
Second	Hybrids				
	F_2 control	1.60	± 0.11	100.00	16.01
	F_2M_2 (L.S.)	1.56	± 0.30	97.50	47.13
	F_2M_2 (M.S.)	1.13	± 0.19	70.63	41.51
	F_2M_2 (H.S.)	0.91	± 0.09	56.88	24.61
	SEd	0.81	Not significant		
Third	F_3 control	1.00	± 0.10	100.00	17.42
	F_3M_3 Family-1	0.00	± 0.00	000.00	0.00
	" 2	3.33	± 0.51	333.00	26.72
	" 3	2.56	± 0.30	256.00	20.81
	" 4	2.47	± 0.13	247.00	9.97
	" 5	2.58	± 0.18	258.00	12.01
	" 6	2.85	± 0.12	285.00	7.50
	" 7	2.38	± 0.51	238.00	37.71
	" 8	1.67	± 0.32	167.00	34.60
	" 9	0.00	± 0.00	000.00	00.00
	" 10	1.62	± 0.08	162.00	9.23
	SEd	0.41**			
	CD	1.13			

** Significant at 0.01 level of probability

Table 39. Variations for quantitative traits in second and third generations

6. Number of long and medium styled flowers

Generations	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	6.37	± 0.24	-	14.01
	PG	7.51	± 0.34	-	22.37
Second	Hybrids				
	F_2 control	5.02	± 0.81	100.00	39.11
	F_2M_2 (L.S.)	4.67	± 0.79	93.03	42.23
	F_2M_2 (M.S.)	3.04	± 0.48	60.56	39.51
	F_2M_2 (H.S.)	2.40	± 0.21	47.81	22.60
	SEd	1.05	Not significant		
Third	F_3 control	2.90	± 0.25	100.00	15.71
	F_3M_3 Family-1	5.53	± 0.89	190.69	28.82
	" 2	4.33	± 0.32	149.31	13.11
	" 3	3.08	± 0.13	106.21	7.25
	" 4	3.18	± 0.24	109.66	13.81
	" 5	3.39	± 0.33	116.90	17.12
	" 6	3.16	± 0.18	108.97	10.23
	" 7	2.67	± 0.38	92.07	24.41
	" 8	3.26	± 0.08	112.41	4.24
	" 9	3.17	± 0.08	109.31	4.71
	" 10	2.35	± 0.27	81.03	20.55
	SEd	1.017*			
	CD	2.09			

* Significant at 0.05 level of probability

Table 40. Variations for quantitative traits in second and third generations

7. Number of fruits

Genera-tion	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	3.31	± 0.07	-	17.48
	PG	4.56	± 0.13	-	23.51
Second	Hybrids				
	F_2 control	1.00	± 0.25	100.00	62.71
	F_2M_2 (L.S.)	0.53	± 0.07	53.00	32.56
	F_2M_2 (M.S.)	0.63	± 0.07	63.00	27.24
	F_2M_2 (H.S.)	0.49	± 0.09	49.00	45.81
	SEd	0.14**			
	CD	0.41			
Third	F_3 control	2.60	± 0.53	100.00	35.72
	F_3M_3 Family-1	4.13	± 0.41	158.85	17.11
	" 2	2.23	± 0.16	85.77	13.24
	" 3	2.00	± 0.28	76.92	25.48
	" 4	2.42	± 0.10	93.08	7.46
	" 5	2.50	± 0.08	96.15	6.65
	" 6	2.93	± 0.28	112.69	17.71
	" 7	2.79	± 0.29	107.31	18.70
	" 8	2.46	± 0.03	94.62	2.81
	" 9	3.00	± 0.14	115.38	8.20
	" 10	2.23	± 0.06	85.77	4.31
	SEd	0.43**			
	CD	1.21			

** Significant at 0.01 level of probability

among the different F_2M_2 populations were not significant. Very high variability was noted in this character also. The F_2 control showed maximum variability (62.71 per cent) followed by F_2M_2 (H.S.) (45.81 per cent), F_2M_2 (L.S.) (32.56 per cent) and F_2M_2 (M.S.) (27.24 per cent).

8. Equatorial diameter of fruits

The results are presented in Table 41. In this character the F_2M_2 (H.S.) population (3.49 cm) showed significant superiority over F_2 control (3.23 cm) which was on par with other treatments. The variability in this character was minimum except in F_2M_2 (H.S.) where it was 17.01 per cent while the lowest variability of 3.57 per cent was seen in F_2 control.

9. Spread of plant

The results are presented in Table 42. The F_2 control plants showed significantly higher mean spread (74.81 cm) over the F_2M_2 populations (60.54 to 65.15 cm) which were on par. The variability in this character was minimum except in F_2M_2 (L.S.) which was 15.31 per cent.

10. Total leaf area

The results are presented in Table 43. In this character also the F_2 control plants (0.97 sq.m) showed their significant superiority over the F_2M_2 populations

Table 41. Variations for quantitative traits in second and third generations

8. Equatorial diameter of fruit (cm)

Generations	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	2.50	± 0.01	-	2.01
	PG	11.50	± 0.37	-	10.47
Second	**Hybrids**				
	F_2 control	3.23	± 0.04	100.00	3,57
	F_2M_2 (L.S.)	3.38	± 0.09	104.64	7.61
	F_2M_2 (M.S.)	3.31	± 0.13	102.48	10.21
	F_2M_2 (H.S.)	3.49	± 0.24	108.05	17.01
	SEd	0.08**			
	CD	0.22			
Third	F_3 control	4.46	± 0.15	100.00	6.21
	F_3M_3 Family-1	4.50	± 0.08	100.90	3.11
	" 2	6.03	± 0.70	135.20	20.07
	" 3	6.65	± 0.19	149.10	4.96
	" 4	7.13	± 0.36	159.87	8.70
	" 5	7.81	± 0.31	175.11	6.91
	" 6	7.31	± 0.27	163.90	6.29
	" 7	7.37	± 0.23	165.25	5.43
	" 8	6.48	± 0.25	145.29	6.11
	" 9	6.53	± 0.32	146.41	8.58
	" 10	3.90	± 0.24	87.44	10.77
	SEd	0.53*			
	CD	1.48			

* Significant at 0.01 level of probability

Table 42. Variations for quantitative traits in second and third generations

9. Spread of the plant (cm)

Generation	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	65.46	± 3.87	-	15.25
	PG	68.15	± 4.51	-	18.51
Second	Hybrids				
	F_2 control	74.81	± 2.28	100.00	7.71
	F_2M_2 (L.S.)	62.47	± 3.70	83.50	15.31
	F_2M_2 (M.S.)	60.84	± 2.34	81.33	9.20
	F_2M_2 (H.S.)	65.15	± 1.40	87.09	5.57
	SEd	3.86**			
	CD	7.95			
Third	F_3 control	106.46	± 2.63	100.00	4.27
	F_3M_3 Family-1	97.60	± 2.01	91.68	3.57
	" 2	94.33	± 3.08	88.61	5.65
	" 3	91.59	± 3.91	86.03	7.39
	" 4	92.89	± 4.94	87.25	9.12
	" 5	81.33	± 8.58	76.39	18.26
	" 6	72.43	± 4.39	68.63	10.49
	" 7	79.33	± 1.61	74.52	3.52
	" 8	119.06	± 1.95	111.84	2.84
	" 9	69.36	± 0.86	65.15	2.15
	" 10	75.72	± 5.24	71.13	11.97
	SEd	6.76**			
	CD	18.95			

** Significant at 0.01 level of probability

Table 43. Variations for quantitative traits in second and third generations

10. Total leaf area (sq.m)

Generation	Treatments	Mean	± SE	Per cent on control	CV per cent
	Parents				
	SI	0.26	± 0.04	-	10.72
	PG	0.45	± 0.08	-	18.51
Second	Hybrids				
	F_2 control	0.97	± 0.04	100.00	10.20
	F_2M_2 (L.S.)	0.67	± 0.08	69.07	30.37
	F_2M_2 (M.S.)	0.75	± 0.04	77.32	13.75
	F_2M_2 (H.S.)	0.72	± 0.04	74.23	14.81
	SEd	0.073*			
	CD	0.20			
Third	F_3 control	0.80	± 0.07	100.00	16.12
	F_3M_3 Family-1	0.63	± 0.06	78.75	15.87
	" 2	0.84	± 0.08	105.00	16.67
	" 3	1.39	± 0.08	173.75	10.07
	" 4	1.25	± 0.03	156.25	4.80
	" 5	1.02	± 0.08	127.50	13.73
	" 6	0.76	± 0.08	95.00	18.42
	" 7	0.81	± 0.06	101.75	12.35
	" 8	1.21	± 0.06	151.25	8.26
	" 9	0.70	± 0.06	87.50	4.82
	" 10	1.13	± 0.06	141.25	8.85
	SEd	0.097 **			
	CD	0.270			

** Significant at 0.01 level of probability

(0.67 to 0.75 sq.m). The variability ranged from 10.20 per cent(F_2 control) to 30.37 per cent (F_2M_2 (L.S.)).

d. Genetic parameters

The mean, phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance are presented in Table 44. Their values revealed large differences among the characters studied. PCV ranged from 15.11 to 98.80 per cent and GCV from 8.08 to 93.43 per cent. Number of spines per leaf recorded the lowest PCV (15.11 per cent) and GCV (8.08 per cent). Higher PCV and GCV were observed for number of fruits (98.80 and 61.45 per cent) and equatorial diameter of fruits (94.03 and 93.43 per cent).

Heritability estimates varied from 28.31 to 99.00 per cent. Among the eight characters analysed number of spines per leaf had the lowest heritability (28.31 per cent). Higher heritability values were observed for equatorial diameter of fruit (99 per cent), plant height (84.74 per cent), number of branches (76.58 per cent), total leaf area (78.95 per cent) and spread of plant (75.09 per cent).

The expected genetic advance expressed as per cent of mean revealed large differences among various characters

Table 44. Genetic parameters for 8 quantitative characters in the second generation

Characters	Mean	PCV (per cent)	GCV (per cent)	H^2 (per cent)	GA (expressed as per cent of mean
1. Plant height (cm)	37.78	26.07	23.98	84.74	45.51
2. Number of branches	7.62	27.13	23.75	76.58	42.85
3. Number of spines per leaf	13.86	15.11	8.08	28.31	8.79
4. Number of leaves	88.36	28.91	25.48	77.69	46.54
5. Number of fruits	1.66	98.80	61.45	39.18	78.92
6. Equatorial diameter of fruits (cm)	3.35	94.03	93.43	99.00	191.94
7. Spread of the plant (cm)	65.82	20.37	17.65	75.09	31.59
8. Total leaf area (sq.m)	0.78	35.90	30.77	78.95	58.97

studied. It ranged from 8.79 to 191.94 per cent. The highest GA was observed for equatorial diameter of fruit (191.94 per cent) followed by number of fruits (78.92 per cent) total leaf area (58.97 per cent), number of leaves (46.54 per cent), plant height (45.51 per cent) and number of branches (42.85 per cent).

When heritability and genetic advance were together considered the equatorial diameter of fruit (93 and 191.94 per cent) was adjudged the best character followed by total leaf area (78.95 and 58.97 per cent), height (84.74 and 45.57 per cent), number of branches (76.58 and 42.85 per cent) and number of leaves (77.69 and 46.54 per cent).

VI. Studies on the third generation

a. Genetic variability

The analysis of variance given in Appendix V indicated that there were significant differences among the F_3 families raised for all the 10 characters studied except number of branches. The mean, standard error and coefficient of variation for these characters are presented in Tables 34 to 43 (Photo plate Nos. 5 to 9).

1. Plant height

The results are presented in Table 34. Seven F_3M_3 families showed significant superiority in height over

the control F_3 family. The control F_3 and three other F_3M_3 families (F_3M_3 Family Nos. 1, 8 and 9) were of procumbent type, breeding true for that character. The procumbent types in general had low variability with the F_3 control showing the lowest (1.35 per cent). Some of the erect F_3M_3 families (No. 6) were also found to be true breeding with low variability (2.23 per cent).

2. Number of branches

The results are presented in Table 35. There was no significant differemce in the mean number of branches among the various families studied. The variability for this character ranged from 3.21 to 20.11 per cent.

3. Number of spines per leaf

The results are presented in Table 36. The mean number of spines per leaf ranged from 8.75 to 19.40 among the various families. F_3M_3 family No. 10 scored the lowest number of spines (8.75 spines per leaf) followed by family No. 6 (8.90 spines per leaf) and F_3 control (10.97 spines per leaf). In eight F_3M_3 families nonspiny plants appeared which bred true in the succeeding generations. Among total 600 F_3M_3 plants raised there were 22 such nonspiny plants (See Table 47 also).

The variability for this character ranged from 2.31 (F_3 control) to 36.25 (F_3M_3 Family No. 10) per cent.

4. Number of leaves

The results are presented in Table 37. The mean number of leaves among the various families ranged from 76.14 to 183.19 per plant. Majority of the F_3M_3 families recorded a significantly lower leaf number when compared to F_3 control. Only one F_3M_3 family (No.8) showed a higher mean leaf number (183.19 perplant) over the F_3 control (150.00 per plant). The variability for this character ranged from 3.8 (F_3M_3 family No.7) to 23.81 (F_3M_3 family No. 8) per cent.

5. Number of short styled flowers

The results are presented in Table 38. Among the ten F_3M_3 families raised two were found to be unimorphic like the wild parent and bred true for the character. Majority of the other F_3M_3 families showed a significantly higher mean for this character when compared with the control F_3. The variability ranged from 0 (F_3M_3 family No. 1 and 9) to 37.71 (F_3M_3 family No. 7) per cent.

6. Number of long and medium styled flowers

The results are presented in Table 39. F_3M_3 family No. 1 produced significantly higher number of long and medium styled flowers over all other families except

F_3M_3 family No. 2. The variability ranged from 4.24 (F_3M_3 family No. 8) to 28.82 (F_3M_3 family No. 1) per cent.

7. Number of fruits

The results are presented in Table 40. In this character also F_3M_3 family No. 1 was found to be significantly superior to all other families except F_3M_3 family No. 9. The variability ranged from 2.81 (F_3M_3 family No. 8) to 35.72 (F_3control) per cent.

8. Equatorial diameter of fruit

The results are presented in Table 41. All the F_3M_3 families except No. 1 and 10 were found to be significantly superior to F_3M_3 control in this important commercial character. The F_3M_3 family No. 10 was actually a long fruited type and hence the smaller diameter of fruit (Refer Table 26). The largest round fruit was obtained in F_3M_3 family No. 5 followed by F_3M_3 family No. 7 and 6. The variability for this character was comparatively small ranging from 3.11 to 20.07 per cent.

9. Spread of the plant

The results are presented in Table 42. F_3M_3 family No. 8 recorded the highest mean value for this character which was found to be significantly superior to

the other F_3M_3 families but on par with F_3 control. The variability ranged from 2.15 to 18.26 per cent.

10. Total leaf area

The results are presented in Table 43. The highest mean value for this character was recorded by F_3M_3 family No. 3 followed by F_3M_3 family Nos. 4 and 8. The variability for this character ranged from 4.8 to 18.42 per cent.

b. Segregation pattern for four characters

1. Plant type

The results presented in Table 45 have shown that the procumbent types breed true for the character and the semi-erect types segregated into erect semi-erect and procumbent types in approximately 1:2:1 ratio. In F_3M_3 family No. 2, which was free from bacterial wilt, this ratio was found to be fitting closely with the observed values.

2. Fruit colour

The results presented in Table 46 have shown that the mottled purple parents have segregated into mottled purple, mottled green, purple and white in approximately 9:3:3:1 ratio. In two disease free F_3M_3 families namely

Table 45. Segregation of plant type (based on angle of divergence) in the third generation

(Range in parents and classes: PG: 15-30°, SI: 65-90°, Erect: 15-40°, Semi-erect 41-65°, Procumbent: 66-90°)

Family	No. of plants grown	No. of plants wilted	Parental character	Number of plants under each class (per cent in parentheses)		
				Erect	Semi-erect	Procumbent
F_3 control	60	Nil	Procumbent	-	-	60 (100)
F_3M_3 - No. 1	60	Nil	"	-	-	60 (100)
" 2	60	Nil	Semi-erect	14 (23.33)	34 (56.67)	12 (20)
" 3	60	12	"	8 (16.66)	26 (54.17)	14 (29.17)
" 4	60	16	"	10 (22.73)	26 (59.09)	8 (18.18)
" 5	60	16	"	8 (18.18)	26 (59.09)	10 (27.73)
" 6	60	14	"	12 (26.09)	28 (60.87)	6 (13.04)
" 7	60	12	"	14 (19.17)	24 (50.00)	10 (20.83)
" 8	60	12	Procumbent	-	-	48 (100.00)
" 9	60	Nil	"	-	-	60 (100.00)
" 10	60	10	Semi-erect	6 (12.00)	34 (68.00)	10 (20.00)

χ^2 value against 1:2:1 ratio in F_3M_3 family No. 2 = 0.180
Test at P. 0.05 = 5.991, at 0.01 = 9.210

Table 46. Segregation of fruit colour in the third generation

(Fruit colour of original parents: PG: Deep purple, SI: Mottled green)

Family	Total plants grown	Parental character	No. of plants wilted	Number of plants under each class (per cent in parentheses)			
				Mottled purple	Mottled green	Purple	White
F_3 control	60	Mottled green	Nil	-	60 (100.00)	-	-
F_3M_3 No.1	60	White	Nil	-	-	-	60 (100.00)
" 2	60	Mottled purple	Nil	38 (63.33)	10 (16.67)	10 (16.67)	2 (3.33)
" 3	60	Purple	12	-	-	48 (100.00)	-
" 4	60	Mottled purple	16	28 (63.64)	8 (18.18)	8 (18.18)	-
" 5	60	Purple	16	-	-	36 (81.82)	8 (18.18)
" 6	60	Purple	14	-	-	46 (100.00)	-
" 7	60	Mottled purple	12	26 (54.17)	10 (20.83)	12 (25.00)	-
" 8	60	Mottled purple	12	-	34 (70.83)	-	14 (29.17)
" 9	60	Mottled purple	Nil	34 (56.67)	12 (20.00)	10 (16.67)	4 (6.67)
" 10	60	Mottled purple	10	28 (56.00)	10 (20.00)	8 (16.00)	4 (8.00)

X^2 value against 9:3:3:1 in the combined data from F_3M_3 family Nos. 2 and 9 = 0.89
Test at P. 0.05 = 7.815

family Nos. 2 and 9, this ratio was found to be fitting closely with the observed values. The white colour has always bred true while one mottled green bred true and the other segregated into mottled green and white in approximately 3:1 ratio. Similarly one purple has segregated into purple and white and two others have bred true for the purple colour.

3. Equatorial diameter of fruits

The results are presented in Table 47. The F_3 control family which has originated from a small fruited F_2 control plant has produced only plants with fruits below 6 cm diameter. But all the F_3M_3 families except No. 10 produced plants with medium and large sized fruits. The F_3M_3 family No. 10 which was originated from a long fruited mutant from F_2M_2 population of high sterility group (refer Table 28) was found to segregate for long and oblong types in approximately 5:1 ratio.

4. Number of spines per leaf

The results are presented in Table 48. The most important difference in the segregation pattern of this character noted between F_3 control and F_3M_3 families was the appearance of nonspiny types among the population of the latter. But some of these nonspiny types were showing sparsely spiny nature on the calyx of the flower.

Table 47. Segregation of diameter of fruits in the third generation (cm)

(Range in parents and classes: PG: 8-13 cm, SI: 2-2.5 cm, Low: 2-5 cm, Medium: 6-9 cm, High: 10-13 cm)

Family	Total plants grown	No. of plants wilted	Parental character	Number of plants under each class (per cent in parentheses)		
				Low	Medium	High
F_3 control	60	Nil	Low	60 (100.00)	-	-
F_3M_3 Family No.1	60	Nil	Medium	52 (86.67)	8 (13.33)	-
" 2	60	Nil	"	30 (50.00)	22 (36.67)	8 (13.33)
" 3	60	12	"	18 (37.50)	22 (45.83)	8 (16.67)
" 4	60	16	"	14 (31.82)	22 (50.00)	8 (18.18)
" 5	60	16	"	8 (18.18)	26 (59.09)	10 (22.73)
" 6	60	14	"	18 (39.13)	20 (43.48)	8 (17.39)
" 7	60	12	"	10 (20.83)	24 (50.00)	14 (29.17)
" 8	60	12	"	4 (8.33)	44 (91.67)	Nil
" 9	60	Nil	"	8 (13.33)	52 (86.67)	Nil
" 10	60	10	Low (Long fruit)	50 (100.00)	-	-

Table 48. Segregation of number of spines per leaf in the third generation

(Range in parents and classes: PG: 8-20, SI: 10-28, Nonspiny = 0, Very low: 1-7, Low: 8-14, Medium: 15-21, High 22-28, +ive transgressors: > 28)

Family	Total plants grown	No. of plants wilted	Parental character	Number of plants undereach class (per cent in parentheses)					
				Non spiny	Very low	Low	Medium	High	+ive transgressors
F_3 control	60	Nil	Medium	-	-	36 (60)	18 (30)	6 (10)	-
F_3M_3 No. 1	60	Nil	"	4 (6.67)	12 (20)	16 (26.67)	18 (30)	10 (16.66)	-
" 2	60	Nil	High	2 (3.34)	16 (26.67)	18 (30)	8 (13.33)	14 (23.33)	2 (3.33)
" 3	60	12	Low	2 (4.17)	6 (12.50)	32 (66.67)	8 (16.66)	-	-
" 4	60	16	"	2 (4.55)	8 (18.18)	8 (18.18)	18 (40.91)	8 (18.18)	-
" 5	60	16	"	4 (9.09)	6 (13.64)	14 (31.82)	10 (22.73)	10 (22.73)	-
" 6	60	14	"	4 (8.69)	16 (34.78)	24 (52.17)	-	2 (4.35)	-
" 7	60	12	"	2 (4.17)	14 (29.17)	6 (12.50)	22 (45.83)	4 (8.33)	-
" 8	60	12	"	-	-	10 (20.83)	24 (50.00)	10 (20.83)	4 (8.33)
" 9	60	Nil	"	-	4 (6.67)	40 (66.67)	12 (20.00)	4 (6.67)	-
" 10	60	10	Very low	2 (4)	24 (48)	8 (16)	10 (20)	6 (12)	-

c. Genetic parameters

The mean, phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance for the third generation are presented in Table 49. Their values revealed large differences among the characters studied. PCV ranged from 21.26 to 65.59 per cent. Number of spines recorded the lowest PCV (21.26 per cent) whereas the number of fruits recorded the lowest GCV (17.29 per cent). The highest PCV and GCV were observed for number of short styled flowers (65.59 and 59.68 per cent) followed by number of long and medium styled flowers (46.29 and 27.6 per cent) and plant height (40.52 and 38.98 per cent).

Heritability estimates varied from 35.22 to 92.50 per cent. Among the 9 characters analysed number of long and medium styled flowers had the lowest heritability (35.22 per cent). High heritability valuen were observed for plant height (92.5 per cent) number of spines (92.48 per cent) number of leaves (90.91 per cent) and equatorial diameter of fruits (90.69 per cent).

The expected GA expressed as per cent of mean revaaled large differences among various characters studied. It ranged from 23.21 to 112.37 per cent. The highest GA was

Table 49. Genetic parameters for 9 quantitative characters in the third generation

Sl. No.	Characters	Mean	PCV (per cent)	GCV (per cent)	H^2 (per cent)	GA (expressed as per cent of mean
1.	Plant height (cm)	49.38	40.52	38.98	92.50	77.80
2.	Number of spines per leaf	12.77	21.26	20.36	92.48	40.17
3.	Number of leaves	113.98	34.33	30.52	90.91	64.20
4.	Number of short styled flowers	1.86	65.59	59.68	83.22	112.37
5.	Number of medium and short styled flowers	3.37	46.29	27.60	35.22	33.23
6.	Number of fruits	2.66	26.32	17.29	42.77	23.31
7.	Equatorial diameter of fruits (cm)	6.20	34.68	33.06	90.69	64.84
8.	Spread of the plant (cm)	88.92	24.18	22.30	85.12	42.32
9.	Total leaf area (sq.m)	0.96	33.33	31.25	86.54	59.38

observed for number of short-styled flowers (112.37 per cent) followed by plant height (77.80 per cent), equatorial diameter of fruits (64.84 per cent) and number of leaves (64.20 per cent).

When heritability and GA were together considered number of short styled flowers (83.22 and 112.37 per cent), plant height (92.50 and 77.80 per cent), and equatorial diameter of fruits (90.60 and 64.84 per cent) were found to be superior to other characters.

d. Association of traits.

The results of simple correlations worked out for seven characters in all possible combinations in four families in the third generation are presented in Table 50. The four families selected for the study of the association of traits were the F_3 control and three resistant F_3M_3 families namely F_3M_3 family No. 1, 2 and 9. Among the total 11 families studied in the third generation these four families were completely resistant to bacterial wilt and hence selected for the study of the association of traits.

In F_3 control and F_3M_3 family No. 9 no significant correlations could be seen among the seven characters studied. But in F_3M_3 family No. 1 there were three

Table 50. Simple correlations in F_3 generation

	No. of branches	No. of spines	No. of leaves	No. of M_2 L styled flowers	Diameter of fruits	Spread of plant
	1	2	3	4	5	6
Height - F_3 control	0.0057	-0.0419	0.1512	-0.0802	0.0866	0.0402
" F_3M_3 Family - 1	0.2192	-0.0723	0.6463**	-0.0637	0.0226	-0.5163**
" F_3M_3 Family - 2	-0.8874**	0.2814	-0.5456**	0.3790*	0.2660	-0.6953**
" F_3M_3 Family - 9	0.3340	0.1683	-0.0568	0.0713	-0.2563	0.3395
No. of branches-F_3 control		0.3381	0.0454	0.0143	0.1102	-0.2813
" F_3M_3 Family - 1		-0.0272	0.2065	0.0998	-0.0595	0.4622**
" F_3M_3 Family - 2		-0.1373	0.6449**	-0.4864**	-0.1908	0.7749**
" F_3M_3 Family - 9		-0.0495	0.1427	-0.0586	0.0912	-0.1117
No. of spines-F_3 control			0.2168	0.0463	-0.2882	-0.1461
" F_3M_3 Family - 1			0.1319	-0.2062	-0.1558	0.1258
" F_3M_3 Family - 2			-0.2692	0.0676	-0.0346	0.1884
" F_3M_3 Family - 9			0.1864	0.0618	0.0956	-0.0483
No. of leaves-F_3 control				-0.0929	-0.1628	0.1482
" F_3M_3 Family - 1				0.1801	-0.1445	0.2913
" F_3M_3 Family - 2				-0.2891	0.2599	0.4368*
" F_3M_3 Family - 9				0.1823	0.2156	0.1716

Table 50 (contd...)

	1	2	3	4	5	6
No. of M & L styled flowers						
" F_3 control					0.2275	-0.3665
" F_3M_3 Family - 1					-0.0983	-0.0864
" F_3M_3 Family - 2					-0.0171	-0.2273
" F_3M_3 Family - 9					0.1161	0.3552
Diameter of fruit F_3 control						0.0251
" F_3M_3 Family - 1						-0.3401
" F_3M_3 Family - 2						-0.1926
" F_3M_3 Family - 9						0.1155

* Significant at 0.05 level of probability

** Significant at 0.01 level of probability

significant associations and in F_3M_3 family No. 2 there were eight significant associations of traits.

In F_3M_3 family No. 1, the height was seen significantly and positively correlated with number of leaves and negatively correlated with spread of plant. It was also seen that the number of branches was positively correlated with spread of the plant in this family.

In F_3M_3 family No. 2, height was negatively correlated with number of branches, number of leaves and spread of plant whereas it was positively correlated with number of long and medium styled flowers. The number of branches in this family was seen positively correlated with number of leaves and spread of plant whereas it was negatively correlated with number of long and medium styled flowers. The number of leaves in this family was seen positively correlated with spread of plant.

In general the association was strengthened for most of the characters in the F_3M_3 families compared to the control F_3.

VII. Inheritance of bacterial wilt resistance in the first, second and third generation

The results from various experiments conducted in the first, second and third generation progenies of the cross S. melongena var. insanum x 'Purple Giant' are summarised in Table 51.

Table 51. Inheritance of bacterial wilt resistance in the first, second and third generations

Treatments	Total No. of plants grown	No. of plants wilted	χ^2 value against 3:1 ratio	Remarks
First generation				
Parent: PG	120	11	-	Grown under wilt free conditions
" SI	120	Nil	-	"
Hybrids				
1. F_1 control	120	Nil	-	"
2. F_1M_1 (7 treatments)	840	2	-	"
Second generation				
1. F_2 control	240	26	-	"
2. F_2M_2 (3 treatments)	720	34	-	"
3. F_2M_2 (Families from F_1M_1 fruit colour mutants)	180	14	-	"
4. F_2 control (under artificial wilt infestation)	120	37	2.01	Grown under artificial wilt infestation conditions
Third generation				
F_3 control	60	Nil	-	"
F_3M_3 Family - 1	60	Nil	-	"
" 2	60	Nil	-	"
" 3	60	12	1.20	"
" 4	60	16	0.09	"
" 5	60	16	0.09	"
" 6	60	14	0.09	"
" 7	60	12	1.20	"
" 8	60	12	1.20	"
" 9	60	Nil	-	"
" 10	60	10	2.22	"

Test at P. 0.05 = 3.841, at P. 0.01 = 6.635

The first and second generation progenies were raised under wilt free conditions to conserve the experimental plant population for taking various observations and hence the incidence of wilt was very low. But a small population of 120 F_2 control plants were grown under artificial wilt infestation conditions to study the inheritance pattern of certain important characters in the surviving populations. But the third generation progenies were grown under artificial wilt infestation conditions to evaluate their wilt resistance and hence useful data on the segregation pattern of this important economic character could be obtained.

Out of the 120 F_2 control plants grown under artificial wilt infestation conditions, 37 plants wilted. The χ^2 value for this figure against 3:1 ratio was not significant. The F_3 control family and three F_3M_3 families were found to be breeding true for the wilt resistance. But the remaining seven F_3M_3 families segregated in an approximately 3:1 ratio for resistance and susceptibility. The value against 3:1 ratio for each of these segregating families was found to be insignificant indicating a close fitting relationship between the observed and expected values.

VIII. Evaluation of selected induced recombinant types in the F_7M_7 generation

The results obtained from the preliminary yield trial of 11 selected induced recombinant types along with the

Table 52. Mean data from the evaluation of selected induced recombinant types in F_7M_7 generation

Sl. No.	Variety	Morphological features	Equatorial diameter of fruit (cm)	Length of fruit (cm)	Wilting (per cent)	Fruit yield per plant (kg)
1.	Mutant SM-4	Semi-erect, nonspiny with round purple fruit	8.00	8.00	0.00	2.75
2.	" 5	Erect, nonspiny with purple streaked oblong fruits	7.50	14.00	0.00	2.00
3.	" 7	Erect, nonspiny with white oblong fruits	7.50	14.00	0.00	2.75
4.	" 12	Semi-erect, nonspiny with purple oblong fruits in cluster	6.50	12.00	0.00	2.20
5.	" 14	Erect, nonspiny with purple oblong fruits	9.00	16.00	0.00	2.75
6.	" 16	Erect, nonspiny with purple oblong fruits	7.00	13.00	0.00	2.30
7.	" 17	Erect, nonspiny with white long fruits	4.50	16.00	0.00	3.00
8.	" 18	Erect, nonspiny with white long fruits	4.00	16.00	0.00	2.50
9.	" 20	Semi-erect, nonspiny, with white oblong fruits	6.50	15.00	0.00	2.20
10.	" 21	Semi-erect, nonspiny with white long fruits	4.00	17.00	0.00	2.30

Table 52 (contd...)

Sl. No.	Variety	Morphological features	Equatorial diameter of fruit (cm)	Length of fruit (cm)	Wilting (per cent)	Fruit yield per plant (kg)
11.	Mutant SM-22	Erect, nonspiny with round purple fruits	7.00	8.00	0.00	2.65
12.	Purple giant (Male parent)	Erect, spiny with round purple fruits	12.00	12.00	60.00	3.60
13.	*insanum* (female parent)	Procumbent, highly spiny with small round green mottled fruits	2.50	2.50	0.00	0.25
14.	Pusa Kranthi (check)	Erect, nonspiny, with purple long fruits	5.00	18.00	90.00	4.50

parents and a check variety 'Pusa Kranthi' in the F_7M_7 generation is presented in Table 52. All the selected mutant types have shown cent per cent resistance against bacterial wilt under artificial screening conditions. While 6 out of 10 plants wilted in the cultivar parent 9 out of 10 wilted in the susceptible check variety 'Pusa Kranthi'. In fruit size SM-14 had the highest equatorial diameter among the mutant types. This was slightly less than that of the 'Purple Giant', but this reduction in equatorial diameter was compensated by the oblong fruit shape in that type. In total fruit yield 'Pusa Kranthi' was the best (4.5 kg per plant) followed by 'Purple Giant' (3.6 kg per plant) and SM-17 (3.00 kg per plant). The average fruit yield of other mutant types ranged from 2.00 (SM-5) to 2.75 (SM-4, SM-7 and SM-14) kg per plant.

Plate No.5

An erect, nonspiny, white fruited resistant induced recombinant type selected in the third generation

Plate No.6

An erect, nonshiny, purple fruited (clustered) resistant induced recombinant type selected in the third generation

Plate no.7

A semi erect, highly branching deep purple fruited prolific bearing resistant induced recombinant type selected in the third generation

Plate No.6

An erect, nonspiny, deep purple fruited (like the 'Purple Giant' parent) resistant induced recombinant type selected in the third generation

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DISCUSSION

DISCUSSION

The essential steps in a resistance breeding programme are the identification of a suitable source for resistance and the incorporation of those genes into the susceptible higher yielders through appropriate breeding techniques. Since the resistance genes are generally found in wild or semi wild relatives of the cultivated one, the process of combining resistance with other desirable agronomic characters is not always easy. Various degrees of incompatibility associated with the production and fertility of the hybrids and the lack of genetic recombination of desirable characters of the two parents, in the succeeding generations may hinder the programme. In the past, breeders were unable to proceed with such breeding programmes involving wide crosses. But of late, the usefulness of subjecting such problomatic hybrid genotypes to mutagenic treatments to enhance recombination potential and to widen the spectrum of variation in segregating generations has been realised. Hybrid seeds have been exposed to mutagens with the above oojective in groundnut (Gregory, 1961), rice

(Jalilmiah and Yamaguchi, 1965), cotton (Peter, 1976), wheat and rice (Virk et al., 1978) and Sesame (Rangaswamy, 1980).

Studies on induced mutagenesis in brinjal have so far been limited to the isolation of non-spiny, high yielding or solasodine yielding mutants of the existing varieties or related species (Sazabady and Tetenyi, 1974, Dhopte and More, 1975, Murthy and Abraham, 1975 and Viswanathan, 1975). The present investigation envisaged a systematic study on the possibilities of combining bacterial wilt resistance and high yield through hybrid seed irradiation of cross involving the wilt resistant wild variety Solanum melongena var. insanum Prain and the susceptible cultivar Purple Giant. The results obtained are discussed in the following sections.

I. Evaluation of germ plasm

The genetic parameters of 27 brinjal varieties were estimated and the cultivar 'Purple Giant' was adjudged as the best commercial variety based on its superior size, weight and yield of fruits (Table 2 and 3).

Days to flower recorded the lowest phenotypic and genotypic coefficient of variation indicating little scope

for improvement of that trait. Peter and Singh (1973) had reported that this character was governed by over dominant gene action.

Higher PCV and GCV values were observed for average weight of fruits and fruit yield, suggesting better scope of selection for these characters in breeding programmes. Among the 13 characters studied,percentage of fruit set had the lowest heritability (38.78 per cent) indicative of a high degree of non-heritable variability. High heritability values were observed for diameter of fruit, length of fruit, weight of fruit, height of plant, number of leaves and number of branches. This shows that one can attempt selection for these characters directly based on phenotypic performance. Panse (1957) had opined that the association between high heritability and genetic advance indicates additive gene effects. The results of the present study indicate such effects for single fruit weight, total fruit yield and equatorial diameter of fruit. Peter and Singh (1973) had also observed additive gene action for the expression of equatorial perimeter of fruit in egg plant.

Dharmagowda *et al.* (1979) estimated 63.48 per cent heritability for number of fruits per plant. In the

present study this was observed to be 69.43. Gill et al. (1976) have reported that heritability was high for all characters except the number of branches per plant in brinjal whereas Borikar et al. (1981) have concluded that heritability was high for plant height and number of branches per plant. The results of the present study are in agreement with the latter finding.

II. - Screening against bacterial wilt

The screening trials have indicated that among the 36 varieties of brinjal, the wild relative Solanum melongena var. insanum alone was completely resistant to bacterial wilt (Tables 2, 6 and 7). This plant is commonly found as a thorny weed growing wild on the road sides and waste lands throughout South India (Gamble, 1915).

The variety 'Pusa Purple Cluster' which was reported to be resistant at Hasserghatta (Rao et al., 1976) was found to be susceptible under Vellayani conditions. This shows the existence of pathogenic races of Pseudomonas solanacearum with varying virulence in different parts of India. Similar observations were made by Rao et al. (1976) based on the performance at Hasserghatta of five wilt resistant varieties of brinjal obtained from the U.S.A. and the Phillippines.

The weekly observations on wilting showed that maximum number of plants wilted in the first week. Application of 500 g sick soil to each planting spot and dipping the seedlings in fresh bacterial ooze before transplanting were the two treatments given by that time for the induction of wilt. Rao et al. (1976) have observed that wilt symptoms appeared four to five days after inoculation by root injury method (Winstead and Kelman, 1952) and the plants died within 10 to 12 days. The results of the present study have indicated that sick soil treatment combined with dipping seedlings in fresh bacterial ooze before transplanting is equally effective in inducing maximum wilt incidence.

In the present studies once the wilting started, the plant died within a week. From the histopathological studies through electron microscopy in tomato, Wallis and Truter (1978) have described the various stages of infection by the pathogen in the host tissue. Their finding that the rapid multiplication of bacteria within the vessels and consequent clogging have taken place 48 to 72 hours after inoculation is in agreement with the results of the screening trials conducted in the present study.

III Production of F_1 seeds

Results of the crossability studies between Solanum melongena var. insanum (wild relative) and S. melongena (cultivar 'Purple Giant') have shown reciprocal differences. The cross has completely failed to set fruit when 'Purple Giant' was taken as female parent (Table 8). The reason for this may be due to variation in nucleo-cytoplasmic interaction. The cytoplasm of 'Purple Giant' is unaccommodative to particular genes or gene complexes of Solanum melongena var. insanum while the cytoplasm of the latter can tolerate the genotype of 'Purple Giant'. Such reciprocal differences with regards to crossability among the species of Solanum have been reported earlier by Sarvayya (1936), Tatebe (1936), Bhaduri (1951), Nasrallah and Hopp (1963), Krishnappa and Chennaveeriah (1965), Babu Rao (1965), Rajasekharan (1968), Rangaswamy and Kadambavana Sundaram (1973) and Narasimha Rao (1979).

IV. Studies on first generation

a. Effects of mutagen on the hybrids

The effects of mutagen on the hybrid population were estimated based on germination, survival, inhibition of growth and the sterility of pollen and seed (Tables 9 to 17).

1. Germination and survival

In general germination in the nursery showed a uniform pattern in F_1 control and F_1M_1 from 5 to 25 kR. But there was significant reduction of germination in 30, 35 and 40 kR exposures. The trend in survival was also more or less the same in the lower exposures. The post-germination mortality was drastic in 35 and 40 kR exposures. No plants survived in 40 kR exposures (Tables 9 and 10). Such a decrease in germination and survival at higher doses of gamma rays was reported by Viswanathan (1975) in Solanum trilobatum, Goud (1972) in sorghum, Vaidyanathan (1973) in Panicum antidotale, Valeva (1976) in wheat, Ayyaperumal (1977) in ragi and Rangaswamy (1980) in sesame. No mortality was observed in the main field after transplantation. This may be due to the elimination of all the lethal mutants in the nursery stage itself.

2. Inhibition of growth

There was no inhibition of growth as measured by plant height, spread and number of branches in the surviving population of irradiated hybrids in the main field as compared to the control (Tables 11 and 12). The only exception was the height of the plants in the 35 kR exposures which was significantly lower when

compared to that in other treatments. This may be explained as due to physiological effects of radiation at higher doses.

3. Sterility

Both pollen sterility and seed sterility were assessed on the control and exposed hybrids (Tables 14 to 16). A progressive increase in pollen sterility was observed with the increase in the radiation dose. Such occurrence of sterility in irradiated materials has been observed in crop plants such as wheat (Swaminathan, 1965), barley (Sato, 1966, Gaul, 1967), rice (Yamaguchi and Matsubayashi, 1973), green gram (Krishnaswamy, 1977) and Sesame (Rangaswamy, 1980). The greater degree of sterility caused by radiation treatments in barley has been explained to be due to both detectable chromosome aberrations and cryptic deficiencies (Gaul et al., 1966). The M_1 sterility observed in the present study might have been due to any one of the causes given above.

One of the major objective of the present study was to examine the feasibility of using pollen sterility in F_1M_1 generation as a selection index to carry over plants to F_2M_2 generation. The plant

population that could be raised per unit area in egg plant is far less compared to the grain crops like rice, wheat, barley, pulses and sesame. Hence it became necessary to draw effective samples from the F_1M_1 population to raise the F_2M_2 generation. Since many workers have indicated close association between pollen sterility and various chromosomal aberrations (Gaul et al., 1966, Rekhmatulla and Gostimakii, 1976, Katayama, 1963 and Singh, 1970) the degree of pollen sterility in the F_1M_1 was taken as the major criterion for selecting plants in the present study. Accordingly, the F_1M_1 plants were individually scored for pollen sterility and grouped into three classes, low, medium and high, depending on the intensity of pollen sterility. The majority of low sterility plants belonged to the low exposure group. Similar relationship was found between high exposures and high sterility classes and also between medium exposures and medium sterility classes (Table 15). All the seeds obtained from one sterility group were mixed and only random samples from these lots were sown to raise F_2M_2 populations. Results on the frequency of useful mutants obtained in the F_2M_2 generation which will be discussed in detail later.

have shown that the medium sterile F_1M_1 plants yielded more of such useful mutants compared to the low and high sterile groups of plants.

b. Other characters studied

Other characters studied in the first generation were the plant type, number of fruits per plant and equatorial diameter of fruit (Tables 12 and 13). In the case of plant type, the plants in 35 kR exposure showed a significant increase in the angle of divergence of the primary branches from the main stem when compared to the control F_1 and hybrids exposed to lower doses. More plants in the 35 kR exposure treatment were procumbent like the wild parent than the semi-erect type found in the control F_1. From the segregation studies undertaken in the second generation the erect plant type was observed to be partially dominant over the double recessive procumbent type. Hence the appearance of more procumbent types in 35 kR exposure could be explained as due to the occurrence of more number of recessive mutations at higher doses. Viswanathan (1975) has reported the appearance of bushy plant types in the M_1 generation of irradiated Solanum trilobatum. Sazabady and Tetenyi

(1974) have also reported the appearance of such procumbent plant types in M_2 to M_4 generations of Solanum laciniatum which is an erect type.

Data on the number of fruits per plant and diameter of fruits showed a general reduction in the values for the populations exposed to higher doses, compared to the control F_1 (Table 13). Such decrease in the mean values following irradiation has been reported by Swaminathan (1965) in wheat, Peter (1976) in cotton, Kaushik and Kallon (1979) in tomato and Rangaswamy (1980) in sesame. In diameter of fruits, the control hybrids and the hybrids exposed to radiation upto 25 kR have shown values slightly less than the mean of the two parents. The intermediate nature of F_1 fruits in brinjal was reported by many workers (Tatebe, 1943; Capinpin et al., 1963; Gopimony and Sreenivasan, 1970). The fruit size was seen significantly reduced at 30 and 35 kR exposures as compared to that in the other treatments. This may be explained as due to the physiological effects of radiation at higher doses.

V. Studies on second and third generations

a. Inheritance of four qualitative characters

1. Plant type

The F_2 segregation ratio in the control F_2 and F_2M_2 from low sterility group has indicated that the plant

type is monogenically controlled with partial dominance of erectness over procumbent nature (Table 18). This was further confirmed in the third generation studies (Table 45) where the procumbent types were breeding true while the semi-erect types were segregating to erect, semi-erect and procumbent types in 1:2:1 ratio. Earlier reports are also in agreement with these results (Anon., 1967 and Baha-Eldin et al., 1968). The significant variation found in the segregation ratio for F_2M_2 (M.S.) and F_2M_2 (H.S.) populations may be due to the higher mutation frequency existed in the medium and high sterility groups of F_1M_1 plants from which the F_2M_2 population were derived. Such alterations in the monohybrid segregation ratios in F_2 populations derived from mutagen treated F_1 seeds were reported by Burilkov and Vishnevskaya (1979) in tomato.

2. Fruit colour

The data presented in Tables 17, 19 and 46 indicated that the fruit colour of the two parental varieties used in the present study is governed by two independently inherited genes. Three fruit colour mutants, purple, mottled green and white were induced in the F_1M_1 generation by irradiation. The appearance of these mutants is explained as due to independent mutations at either or both of the two loci. The colour

pattern in the F_2M_2 progenies derived from F_1M_1 mutants further substantiated the two gene mechanism for the inheritance of fruit colour. The normal segregation ratio appeared in the F_2 control population confirmed these results. The genotypes for the different colour types are suggested as follows:

Parents.

S. melongena var. insanum (mottled green) : pp GG

S. melongena (Purple Giant)(Purple) : PP gg

Hybrids

F_1 (mottled purple) : P p Gg

F_2 (mottled purple) : PP GG or
P p GG or
PP Gg or
P p Gg

F_2 (purple) : ppgg or P p gg

F_2 (mottled green) : p pGG or p p Gg

F_2 (white) : p p gg

F_1M_1 (mottled purple) : P p Gg

F_1M_1 (purple mutant) : P p gg

F_1M_1 (mottled green mutant) : p p Gg

F_1M_1 (white mutant) : p p gg

3. Number of spines on leaf

Since both the parents of the hybrid material studied were of spiny nature, normal inheritance studies on that character could not be undertaken in the second generation. But the appearance of non-spiny and very sparsely spiny types among the plants of segregating F_3M_3 families indicated the complex nature of this character (Table 48). The complexity seen further confounded by the fact that among the non-spiny mutants appeared, some were having fruits with sparsely spiny calyx. Many earlier workers have reported that spiny nature was monogenically dominant over non-spiny nature (Hagiwara and Ida, 1938; Khan and Ramzan, 1953 and Capinpin et al., 1963).

4. Bacterial wilt resistance

The results presented in table 51 indicate the simple monogenic inheritance of this important character in brinjal. Of the 120 F_2 control plants grown under artificial wilt infestation conditions, 37 wilted giving the classical 3:1 ratio for the segregation of resistant and susceptible genotypes. This was further confirmed in the third generation where seven out of ten F_3M_3 families grown again segregated into resistant and susceptible types

in the 3:1 ratio suggesting heterozygous condition for the particular locus in their parents. The earlier reports (Gopimony and Sreenivasan, 1970; Swaminathan and Sreenivasan, 1972; Vijayagopal and Sethumadhavan, 1973) on this character was also in agreement with the present findings.

b. Segregation patterns for quantitative traits

There was significant difference in the segregation pattern for various quantitative traits among the three different F_2M_2 populations studied (Table 18 to 33).

1. Equatorial diameter of fruits

The major objective of the present study was to break the close association which existed between the wilt resistance and the small fruited character of the wild parent (Solanum melongena var. insanum) used for the hybridization work.

The practical difficulties experienced in carrying over all the F_1M_1 plants into F_2M_2 families prompted the author to select the first formed selfed fruits from the F_1M_1 plants belonging to low, medium and high sterility groups and to raise the F_2M_2 populations from mixtures of seeds obtained from the first formed selfed fruits.

Of the total 10 large fruited (equatorial diameter of over 6.0 cm) induced recombinants obtained from the F_2M_2 generation eight were from F_2M_2 (M.S.) group, one from F_2M_2 (H.S.) group and one from the bulk F_2M_2 raised from the fruit colour mutants obtained from the F_1M_1 generation (Tables 27 and 28). So maximum recovery of large fruited segregants were from the F_2M_2 progenies of medium sterile F_1M_1 plants, There was no such mutant in the F_2M_2 (L.S.) group which was the progeny from F_1M_1 plants of low pollen sterility. From F_2M_2 (H.S.) only one large fruited mutant was recovered.

The above results are contrary to the earlier reports that mutation frequency was independent of the degree of M_1 sterility (Gaul, 1958 in barley, Bekendam, 1961 in rice and Hildering and Vanderveen 1966 in tomato). Gaul *et al.* (1969) have further stated that response to positive yield selection in barley was higher in progenies derived from fertile M_1 spikes than in those derived from partially sterile M_1 spikes. The results from the present study showed that the frequency of the appearance of large fruited segregants is higher in progenies derived from medium sterile M_1 plants. This may be due to the fact that the material subjected to mutagen treatment in the present study was heterozyous

as against the pure breeding varieties used in earlier studies. Moreover, the earlier findings were based on point mutations either of macro or chlorophyll origin whereas in the present study, the induced recombinants were scored based on a polygenic character like fruit size. The large fruited plants obtained in the present study may be the result of rare recombinations. Perhaps such recombinations take place at a higher rate in medium sterile M_1 plants. The fact that even a small population of 240 F_2M_2 (M.S.) plants had yielded as many as eight large fruited mutant recombinants indicates that the restricted sampling of F_1M_1 plants based on pollen sterility was effective in recovering desirable genotypes in the second generation.

2. Other quantitative traits

The segregation patterns for other quantitative traits studied were also found to be varying significantly among the different F_2M_2 and F_2 control populations grown. The only exception was for the number of branches in which case a drastic shift towards the lower grade was observed uniformly in all the treatments (Table 22). Complementary to this trend, the height of the plant also showed a drastic shift towards

the higher grades. There was only less than 10 per cent dwarf types in the other treatments. The tall and sparsely branching characters were associated with the cultivar parent 'Purple Giant'. A strong reversal to the cultivar parent in height and branching pattern was shown by the majority of F_2 progenies. This type of character reversal towards one of the parent has been predicted in wide crosses by Allard (1960) who explained this phenomenon as due to selective fertility of those male gametes which contain more of one parental genotype than the other. In the present study, perhaps majority of the fertile F_1 pollen might have contained the 'Purple Giant' chromosomes carrying the genes for tall and sparsely branching characters.

Another interesting feature of the second generation populations was the appearance of positive transgressors in height, number of spines, number of leaves, number of short, long and medium styled flowers, number of fruits, spread of the plant and total leaf area. The proportion of positive transgressors among the F_2M_2s compared to F_2 control showed a decreasing trend in height and number of long and medium styled flowers, whereas it showed a definite increasing trend

in the number of spines on leaves, number of leaves, number of short styled flowers, number of fruits per plant, spread of the plant and pollen sterility. The appearance of negative transgressors was found in spread of the plant and total leaf area; but it did not show any definite trend. The increase or decrease of the proportion of positive transgressors among the F_2M_2 populations could be explained as the result of micromutations induced in the positive or negative directions respectively. Their presence in the F_2 control population may be due to the persistance of the hybrid vigour expressed in the F_1 generation.

c. Segregation pattern under artificial wilt infestation conditions

The role of natural selection in eliminating the weak plants from populations and the survival of the fittest have been emphasized since Darwin's time. Breeders have become interested in studying the population dynamics under various environments. A separate experiment was conducted in which 120 control F_2 plants were grown under severe bacterial wilt infestation conditions to study the segregation pattern of plant type, fruit colour and fruit size in the surviving population.

With reference to plant type, the normal 1:2:1 ratio of erect, semi-erect and procumbent types was found to have changed to 1:3.23:2.15. In fruit colour, the normal 9:3:3:1 ratio of mottled purple, green mottled, purple and white was changed to 9.5:17:10:1 in the surviving population. But in fruit size, both diseased and disease free populations were showing the same low equatorial diameter. The alterations of segregation ratio for plant type and fruit colour may be explained as due to associations of erect stand and mottled purple and white fruit colour wit susceptibility to wilt.

d. Variations for quantitative traits

The extent of altered mean values and genetic variability present in the segregating generation decide the scope for selection in the breeding population. The utilization of mutagens in inducing mutations for enlarging the variability in quantitatively inherited characters has been demonstrated in crops such as groundnut (Gregory, 1961; Krull and Frey, 1961), rice (Jalilmiah and Yamaguchi, 1969), cotton (Siddiqi, 1971; Peter, 1976; Milkoveski et al., 1976) and wheat (Virk et al., 1978). Such a micromutational a pproach is likely to be more rewarding for crop improvement (Gaul, 1964).

1. Mean values

The mean values for the second generation (Tables 34 to 43) showed a decreasing trend for plant height, number of branches, number of leaves, number of long and medium styled flowers, number of fruits, spread of the plant and total leaf area in the F_2M_2 population as compared to untreated control hybrids. However the mean values for number of spines per leaf and equatorial diameter of fruits showed a positive shift.

In the third generation, a definite positive shift in the means could be seen only in plant height, number of long and medium styled flowers and equatorial diameter of fruits in the different F_3M_3 families, when compared to control F_3. In the other characters, different families expressed different trends. These results, in general, indicated that mutational or induced recombinational events might have shifted the mean away from the selection history of the population (Brock, 1965). From the studies on wheat and rice, Virk et al. (1975) have indicated that the deviations of a treated population from its control might arise from a symmetrical and directional effects of the treatment. They have further reasoned that the contributions might have been made by

the differences in the frequency of opposite mutations and also due to opposite directions of dominance at the mutated loci.

On comparing the third generation means with those of the second generation, it was seen that the mean values of most of the F_3M_3 families further increased for plant height, number of fruits and equatorial diameter of fruits. This type of increase in the mean values over the generations was found in wheat (Scossiroli 1965, Brojovic, 1966), Arabidopsis thaliana (Brock, 1967) and sesame (Rangaswamy, 1980). The increase in means from generation to generation was ascribed to the elimination of the deleterious mutants (dwarfs and other undesirable drastic mutants like sterile plants and off types). Selection of only normal looking plants in the F_1 also might have resulted in the upward shift in the mean values as observed in the present study. The decreased mean values seen in the case of number of branches, number of leaves and spread of the plant may be due to the general shift of the characters towards the genotype of the cultivar parent as a result of selective fertility of male gametes containing the genotype of the cultivar parent, as explained earlier (Allard, 1960).

2. Variability

The coefficient of variation worked out for the

treated populations has given a statistical measure for the variability produced in the population (Tables 34 to 43). In general the variability was higher in the treated populations compared to control in both the second and third generations. Such increased variability in the hybrid irradiated populations was reported in many crops like groundnut (Grgory, 1961) rice (Jalilmiah and Yamaguchi, 1965), cotton (Siddiqi, 1971 and Peter, 1976) and wheat (Virk et al., 1978). In the present study very high increase in variability to the tune of two to three times that of the control in the second generation, was noted in number of short styled flowers and equatorial diameter of fruits. An increased mean with decreased coefficient of variation in the third generation was observed in height, number of leaves, number of short styled flowers, number of fruits and equatorial diameter of fruits. Such increased mean with decreased variability in advanced generation was reported in barley (Gaul, 1961) and wheat (Swaminathan, 1963). This has been attributed to the recovery effects operating in the directions opposite to the mutagenic effects.

3. Genetic parameters

Mutagenic treatments induce genic and chromosomal mutations along with non-heritable changes due to

physiological disturbances which together contribute to the total induced variance. A comparison of the different genetic parameters estimated in the second and third generations may reveal the heritable portion of the total induced variation (Tables 44 and 49).

(i) Genotypic variances

In general, the genotypic coefficient of variation increased in the third generation for most of the characters, except in the case of equatorial diameter of fruits where opposite trend was noted. This can be explained as due to the selection applied in the second generation. The only character for which selection was rigorously practiced in the second generation was the fruit size. The F_3M_3 families were grown from seeds obtained from the large fruited plants only. As a result, the genotypic coefficient of variation was drastically reduced from 93.43 per cent in the second generation to 33.06 per cent in the third generation.

(ii) Heritability

The heritability estimates have also shown similar trend as in the case of genotypic coefficient of variation. In all characters studied except diameter of fruit, the h^2 increased in the third generation

compared to the second. The selection applied on fruit size resulted in a decreased h^2 for that character in the third generation.

(iii) Genetic advance

This parameter has also followed the same trend as genotypic variance and h^2. The high values of genotypic coefficient of variation, heritability and genetic advance might be indicative of mutations at additive gene loci. Similar high heritability estimates were observed by Rangaswamy (1980) in sesame for different quantitative traits.

High heritability would indicate that additive gene action is operative for the trait and that the phenotype of a trait would strongly reflect the genotype. Characters showing high genotypic coefficient of variation and heritability would decide the extent of achievement of the objectives in the selection programme. The genetic gain that can be expected by selection for a character is given by the estimates of genetic advance for that character.

In the present study, the selection exercised in the treated population of the hybrid based on fruit size and bacterial wilt resistance has resulted in the

isolation of genetically potential lines with desirable traits. The larger measure of genotypic coefficient of variation, heritability and genetic advance estimates for the various characters in the F_3M_3 generation indicate the effectiveness of the mutagenic treatment of the hyorid as a tool in enhancing the chances for obtaining better combination of characters in brinjal.

(v) Association of traits in the third generation

The major objective of the present study was to enhance the recombination potential of the F_1 hybrids and to increase the variability in the F_2 population to enable the selection of a bacterial wilt resistant, large fruited brinjal plant. Recombination is the key factor in the creation of genetic variation. In certain cases the linked genes may be inherited in blocks in which free recombination might not be possible by hybridization. It is desirable to increase recombination particularly by breaking the blocks of genes in which there is negligible crossing over. Further release of genetic variability and independent assortment of linked loci can be expected if recombination in the F_1 is enhanced (Hagberg et al., 1977). Irradiation of F_1

seeds of tomato has resulted in a two-fold increase in the variation, and the ffequency of crossing over, and significantly changed the F_2 segregation ratios for marker loci (Krol et al., 1979).

In order to obtain information on such altered associations of traits as a result of radiation treatment of F_1 seeds, simple correlation coefficients were fitted among the seven characters at phenotypic level, for four families in the third generation. The results are given in Table 50.

No significant correlation could be obtained in the F_3 control family. In general, the associations were strengthened for most of the character pairs in the F_3M_3 families, compared to the control F_3. This type of induced associations have been reported in wheat (Scossirole et al., 1966) Pisum (Gottschalk, 1968), rice (Madhusudana Rao and Siddiq., 1976) and sesame (Rangaswamy, 1980).

The control F_3 as well as the three F_3M_3 families chosen for this study were completely resistant to the bacterial wilt. Maximum new associations were obtained in F_3M_3 family No. 2, followed by F_3M_3 family No. 1. Since the bacterial wilt resistance, which was found to be a

qualitative character, monogenically inherited, could not be included in the present study, the newly developed strong association of that character with the large fruit size was not revealed in this analysis. However, the fact that significant new associations of characters were formed only in the F_3M_3 families indicate the many new recombinations that have taken place in the F_1M_1 generation as a result of irradiation.

VI. Evaluation of the selected types in F_7M_7 generation

From among the 10 F_3M_3 families grown in the third generation, a number of induced recombinant types which exhibited the bacterial wilt resistance in combination with commercial fruit characters and economic yield were selected and carried through F_4M_4, F_5M_5 and F_6M_6 generations. The final evaluation, of the eleven selected mutant segregant types along with the parents and a susceptible check variety 'Pusa Kranthi', was conducted under severe artificial epiphytotic conditions for bacterial wilt. The results are presented in Table 52. All the selected induced recombinant types were completely resistant to bacterial wilt, while 90 per cent of 'Pusa Kranthi' plants and 60 per cent of the 'Purple Giant' plants succumbed to

the disease. In fruit size, all the round fruited types showed an equatorial diameter much higher than the mean of the two parents. The oblong fruited types compared favourably with the fruit size of 'Pusa Kranthi'. In total fruit yield, majority of the mutant types were lower yielding compared to the cultivar parent and the check variety.

The informations obtained in this study relate to bacterial wilt resistance and yielding ability of the brinjal germ plasm assembled, the sensitivity of the hybrid genotypes to gamma irradiation, various estimates of the extent of variability induced in F_1M_1, F_2M_2 and F_3M_3 generations of the cross between the wilt resistant wild variety insanum and the best cultivar Purple Giant. The close association between bacterial wilt resistance and small fruit size found in insanum which persisted in the F_2 and back cross generations in conventional breeding programmes was brocken by gamma irradiation of the hybrid seeds. The nature of new associations formed and the strengthening of the existing ones in the selected F_3M_3 families were also studied in relation to the control F_3 family. Another important information obtained in the present study was that the response to selection for positive

fruit size in the F_2M_2 generation was higher in progenies derived from medium sterile F_1M_1 plants.

The evaluation of the ten F_3M_3 families derived from the large fruited F_2M_2 plants under artificial wilt infection condition has confirmed the monogenic dominant nature of wilt resistance character in brinjal. But the evaluation of 11 large fruited resistant lines in F_7M_7 generation has indicated their inferiority in fruit yield per plant to the cultivar parent Purple Giant and the check variety Pusa Kranthi. Hence, further improvement of these selected wilt resistant lines in productivity is essential for their acceptance as commercial varieties. Since these selected induced recombinant types express the dominant wilt resistance character, their use as male parents to cross with high yielding susceptible cultivars for the production of wilt resistant high yielding hybrid brinjal varieties is suggested as future line of work.

SUMMARY

SUMMARY

A resistance breeding programme, involving hybridization between one bacterial wilt resistant wild brinjal variety (Solanum melongena var. insanum Prain) and a susceptible cultivar brinjal (Purple Giant) selected from among 36 brinjal varieties evaluated, was undertaken in the Department of Agricultural Botany, College of Agriculture, Vellayani during the period 1975 to 1981. The F_1 seeds of the above cross were exposed to eight different doses of gamma rays (5 to 40 kR) to enhance the recombination of bacterial wilt resistance found in the wild variety with better fruit and yield characters of the cultivar parent. Various genetic studies were undertaken on the first, second and third generations. The selected induced recombinant types were carried through segregating generations and final evaluation was done in the F_7M_7 generation. The various findings from these studies are summarised below:

I. Studies in the first generation

1. Significant reduction in germination was noted in 30, 35 and 40 kR exposures. The post germination mortality was found to be drastic in 35 and 40 kR exposures. No plants have survived in 40 kR exposure.

2. A progressive increase in pollen sterility and seed sterility was noted with the increase in radiation dose. The cause of this is explained as due to either detectable chromosome aberrations or cryptic deficiencies.

3. There was no inhibition in the surviving population of the treated hybrids in the main field in any of the growth parameters studied except height which was significantly lower in the 35 kR exposure compared to control F_1.

4. A significantly higher proportion of the plants in the 35 KR exposure was procumbent like the wild parent compared to semi erect plant types found in the control F_1 and other exposures. This was explained as due to more number of resessive mutations that took place at higher doses.

5. The number of fruits per plant and equatorial diameter of fruit showed a general reduction in the treated hybrids at higher doses when compared to control F_1. This has been explained as due to physiological effects of radiation at higher doses.

II. <u>Studies in second and third generations</u>

1. The inheritance of plant type, fruit colour, number of spines on leaf and bacterial wilt resistance

was studied and explained. A monogenic inheritance for plant type and bacterial wilt resistance and a digenic inheritance for fruit colour were observed. The genotypes of different fruit colour types were suggested. The inheritance of number of spines on leaf was found to be a complex one.

2. The bacterial wilt resistance in brinjal was found to be purely qualitative in nature and its dominant monogenic inheritance was confirmed from results obtained in F_3M_3 families.

3. Maximum recovery of mutants for large fruit size was obtained from F_2M_2 population grown from the medium sterile F_1M_1 plants. The recovery of such mutants was either nil or very low in other treatments.

4. Majority of the F_2 progenies, irrespective of their origin and previous treatments given, have shown a strong reversal to the cultivar parent in height and number of branches. This has been explained as due to selective fertility of those male gametes which contained more of the genotype of cultivar parent than the wild parent in F_1 generation.

5. The appearance of positive transgressors in the F_2 showed a decreasing trend for height and number of long

and medium styled flowers and a definite increasing trend in number of leaves and total leaf area among the treated F_2 populations compared to control F_2. Such increase or decrease of the positive transgressors was explained as the result of micromutations induced in the positive or negative directions respectively.

6. The segregation pattern for plant type and fruit colour was found to be significantly changed in the population grown under artificial wilt infestation conditions compared to the one grown under disease free conditions. This change was explained as due to strong associations of some of these characters with the wilt disease susceptibility.

7. The mean values for plant height, number of branches, leaves, long and medium styled flowers, fruits spread of the plant and total leaf area have shown a decreasing trend in F_2M_2s compared to control F_2. But the same for number of spines per leaf and equatorial diameter of fruits showed a positive shift in F_2M_2s compared to control F_2. This has been explained as due to differences in the frequency of opposite mutations and also due to opposite directions of dominance at the mutated loci.

8. An increase in the mean values over generations was noted in plant height, number of fruits and equatorial diameter of fruits. This has been explained as due to result of elimination of undesifable types and lethals in the segregating generations.

9. A decfease in mean values was noted over generations in number of branches, leaves and spread of the plant. This may be due to the general shift in the mean of the characters towards the cultivar parent as a result of selective fertility of male gametes containing the genotype of the cultivar parent.

10. In general the coefficient of variability was higher in the treated population compared to control in both second and third generation.

11. An increased mean with decreased coefficient of variation in the third generation was observed in height, number of leaves, number of short styled flowers, number of fruits and equatorial diameter of fruit. This was attributed to the recovery effect operating in the opposite directions to the mutagenic effects.

12. In general the GCV, h^2 and GA have increased in the third generation compared to the second for most of the characters studied. The only exception for this was

equatorial diameter of fruits and it was explained as the result of rigorous selection applied in the F_2 generation for larger fruit size. The high values of GCV, h^2 and GA might be indicative of mutations at additive gene loci.

III. Association of traits in the third generation

1. No significant correlation could be obtained in the F_3 control family.

2. In general, the associations were strengthened for most of the character pairs in the F_3M_3 families compared to control F_3.

3. Maximum new associations were obtained in F_3M_3 family No. 2 followed by F_3M_3 family No. 1. The fact that significant new associations of characters were formed only in the F_3M_3 families indicates the many new recombinations that would have taken place in the F_1M_1 as a result of irradiation.

IV. Evaluation of selected types in F_7M_7 generation

1. The 11 induced recombinant types evaluated were found to be completely resistant to bacterial wilt while 90 per cent of 'Pusa Kranthi' and 60 per cent of Purple Giant wilted.

2. The fruit size of the selected mutant recombinant types were much higher when compared to the average of the two parents which was normally seen in F_1 and succeeding generations under conventional breeding programmes.

3. In total fruit yield of the selected types were inferior to the cultivar parent as well as the check variety 'Pusa Kranthi'.

4. The use of the selected types as male parents in single crosses with high yielding susceptible varieties for the production of high yielding bacterial wilt resistant hybrids of brinjal is suggested as future line of work.

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* Original not seen

APPENDIX

Appendix - I

Analysis of variance for 13 characters in brinjal germ plasm

Characters	Mean squares due to		
	Replication	Varieties	Error
df	2	26	52
1. Height (cm)	102.383	2155.066**	63.639
2. Number of branches	37.642	277.296**	3.296
3. Number of leaves	414.481	17001.085**	151.725
4. Days to flower	3.420	73.750**	8.574
5. Number of short styled flowers	1.037	101.855**	12.063
6. Number of medium and long styled flowers	88.938	282.189**	44,464
7. Number of fruits/plant	68.481	333.701**	42.699
8. Percentage of fruit set	11.706	1164.695**	401.658
9. Diameter of the fruit (cm)	0.049	13.936**	0.184
10. Length of fruit (cm)	0.198	39.463**	0.480
11. Weight of single fruit (g)	62.439	42770.945**	126.660
12. Total fruit yield (g)	233945.037	6122645.850**	298135.383
13. Number of plants wilted per plot	1.640	5.550**	1.140

** Significant at 0.01 level of probability

Appendix - II

Analysis of variance for germination and survival in the nursery of F_1M_1 generation

Characters	Mean squares due to		
	Replication	Treatments	Error
df	3	10	30
1. Germination on 21st day of sowing (per cent)	52.157	598.260**	73.263
2. Survival on 31st day of sowing (per cent on germination)	2.203	3339.978**	34.527

** Significant at 0.01 level of probability

Appendix - III

Analysis of variance for seven characters in the F_1M_1 generation

Characters		Mean squares due to		
		Replication	Treatments	Error
	df	3	9	27
1.	Height (cm)	43.752	825.206**	41.370
2.	Spread	115.079	713.556**	185.205
3.	Number of branches	7.440	3.661**	0.472
4.	Plant type	62.577	834.642**	54.152
5.	Number of fruits	6.352	4.777**	0.893
6.	Diameter of fruits (cm)	0.102	16.338**	1.368
7.	Pollen sterility (per cent)	1.681	538.399**	1.433

** Significant at 0.01 level of probability

Appendix - IV

Analysis of variance for 10 characters in F_2M_2 generation

Characters		Mean squares due to		
		Replication	Treatments	Error
	df	5	5	25
1.	Height (cm)	10.758	508.378**	14.812
2.	No. of branches	1.508	20.639**	1.002
3.	No. of spines/leaf	7.967	10.601*	3.140
4.	No. of leaves	124.392	3186.951**	145.567
5.	No. of short styled flowers.	2.682	2.565	1.982
6.	No. of long and medium styled flowers.	1.541	6.397	3.286
7.	No. of fruits	1.476	7.927**	1.627
8.	Diameter of fruits (cm)	0.148	58.928**	0.103
9.	Spread (cm)	34.299	854.470**	44.758
10.	Total leaf area (sq.m.)	0.011	0.393**	0.016

** Significant at 0.01 level of probability

* " 0.05 " "

Appendix - V

Analysis of variance for 10 characters in the F_3M_3 families

Characters	Mean squares due to		
	Replication	Families	Error
df	2	12	24
1. Height (cm)	20.948	1141.254**	29.924
2. No. of branches	1.296	12.677	8.913
3. No. of spines/leaf	21.531	27.584**	7.306
4. No. of leaves	394.982	3952.189**	321.051
5. No. of short styled flowers	0.834	3.940**	0.248
6. No. of medium and long styled flowers	6.516	4.168*	1.552
7. No. of fruits	0.086	0.924**	0.281
8. Diameter of the fruit(cm)	2.478	12.979**	0.420
9. Spread of the plant (cm)	35.496	1249.485**	68.746
10. Total leaf area (sq.m)	0.006	0.283**	0.014

* Significant at 0.05 level of probability

** Significant at 0.01 level of probability

APPENDIX - VI

Triphenyl Tetrazolium chloride (TTC) agar medium

(Kelman, 1954)

Peptone	10.00 g
Casaminoacid	1.00 g
Glucose	5.00 g
Agar	20.00 g
Distilled water	1000.00 ml
pH	6.5

Two hundred ml portions of the medium was sterilized in flasks by autoclaving at 15 lb pressure for 20 minutes. Before plating, one ml of sterile one per cent solution of 2, 3, 5 Triphenyl tetrazolium chloride stored in the dark after autoclaving at 15 lb pressure for eight minutes, was added to each flask to give a final concentration of 0.005 per cent tetrazolium chloride.

Appendix - VII

Analysis of variance for number of plants wilted per plot in the artificial screening trial of 12 brinjal varieties

Character	Mean squares due to		
	Replication	Varieties	Error
df	2	11	22
No. of plants wilted per plot	1.965	21.020**	2.330

GENETIC STUDIES IN BRINJAL WITH RELATION TO BACTERIAL WILT RESISTANCE

BY

R. GOPIMONY

ABSTRACT OF A THESIS

submitted in partial fulfilment of the requirements

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ABSTRACT

The F_1 seeds of the cross *Solanum melongena* var. *insanum* (wild variety of brinjal) x Purple Giant (cultivar) were exposed to gamma irradiation to enhance recombination of bacterial wilt resistance found in the former and the better fruit and yield characters found in the latter variety. Significant reduction in germination and survival in nursery pots was observed in the higher doses tried. No plants survived in 40 kR treatment.

A progressive increase in pollen sterility and seed sterility was noted in the main field with the increase in radiation dose. But no inhibition in growth was observed except in height which was significantly lower in the plants of 35 kR exposure when compared to that of control F_1. The proportion of plants with procumbent plant type was significantly higher in this exposure as compared to the semi-erect types found in the control F_1 and other treated hybrids. The number of fruits per plant and diameter of fruit have shown a general reduction in the treated hybrids at higher doses when compared to control F_1.

From inheritance studies undertaken in the second generation the plant type and bacterial wilt resistance were found to be monogenically inherited. Erect plant type was found to be partially dominant over procumbent and resistance was completely dominant over susceptibility. The fruit colour was controlled by two independently inherited genes expressing four different phenotypes.

The recovery of induced recombinant types with large fruit was maximum from the F_2M_2 population derived from medium sterile F_1M_1 plants when compared to F_2M_2 populations derived from low sterility and high sterility groups of F_1M_1 plants.

Majority of F_2 progenies of all treatments showed a strong reversal to the cultivar parent in height and number of branches.

The segregation pattern for plant type and fruit colour was significantly changed in the F_2 control population grown under artificial wilt infestation conditions when compared to those grown under wilt free conditions.

The mean values for plant height, number of branches, leaves, long and medium styled flowers, fruit, spread of plant and total leaf area showed decreasing trend in F_2M_2s compared to control F_2.

An increase in mean values over generations was observed in plant height, number of fruits and equatorial diameter of fruit. The opposite trend was found in number of branches, leaves and spread of plant. In general the coefficient of variation was higher in the treated populations compared to control.

Ten induced recombinant types with large fruit were carried over to the third generation to compare them with the control F_3. An increased mean with decreased coefficient of variation was observed in height, number of leaves, short styled flowers, fruit and equatorial diameter of fruit in the F_3M_3 families.

The general trend was that the GCV, h^2 and GA have increased in the third generation compared to second for most of the characters studied. The only exception was diameter of fruit for which rigorous selection was applied in the second generation.

From the study of associations of traits in the third generation it was found that the various associations have strengthened for most of the character pairs in F_3M_3 families compared to the control F_3 family. Maximum new associations were observed in F_3M_3 family No. 2 followed by F_3M_3 family No. 1.

Selected recombinant types were carried through successive generations under field conditions. Finally eleven superior types selected from F_6M_6 generation were evaluated under artificial wilt infestation conditions along with the parents and a check variety Pusa Kranthi and found that the selected types were completely resistant to wilt disease. But their yielding ability was inferior to the cultivar parent and the check variety. The use of these resistant lines as parents to cross with susceptible high yielders for the production of wilt resistant high yielding hybrid varieties of brinjal is suggested as future line of work.