INVESTIGATIONS ON THE MANIFESTATION OF HYBRID VIGOUR IN BRINJAL (*Solanum melongena Linn.*)

BY

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THESIS

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C E R T I F I C A T E

This is to certify that the thesis herewith submitted contains the results of bonafide research work carried out by Shri T.V.Viswanathan, under my supervision. No part of the work embodied in this thesis has been submitted earlier for the award of any degree.

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C O N T E N T S

INTRODUCTION

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The manifestation of increased size, greater vigour in growth and development, higher productivity and similar effects have long been observed by biologists in various hybrids of plants and animals. Such increase in size and vigour resulting from hybridization has been designated as hybrid vigour for which the term heterosis was first proposed by Shull(1914). Thus hybrid vigour is a phenomenon where cross-bred organisms tend to surpass both their parents in vigour. This has attracted the attention of plant breeders from very early times mainly through the conspicuous effects produced in several economic characters of crop plants. The most spectacular utilisation of hybrid vigour was made in the production of hybrid maize in America. It has also been widely exploited in several asexually propagated plants such as sugarcane and potatoes.

Heterosis is not confined to any group of plants and the phenomenon seems to pervade the plant kingdom as a whole. It has been recorded in diverse plants and in diverse features. Increases have been observed in height, branching, number of leaves and flowers, yield of fruit or seed as the case may be, weight of plant, resistance to pests and diseases etc.

It is generally accepted that the extent of vigour depends upon the degree of genetic diversity between the parents selected. Most of the workers now agree that heterosis is a complex phenomenon of quantitative inheritance and an essential organisational feature of cross fertilising species. At the practical or applied level, experiments of an empirical nature must be designed to utilise in the best possible way the phenomenon of heterosis.

Hybrid vigour shows its maximum affect in the first filial generation. Therefore greatest emphasis has been placed on the use of F1 hybrids as they possess new vigorous superior and desirable characters. The ease with which hybrid seed is produced, is a factor which helps its commercial exploitation. In crops like maize, brinjal and tomato which one artificial pollination gives innumberable number of seeds, hybrid seeds can be produced at a comparatively low cost and to that extent this is a practical proposition.

The present study was undertaken to estimate the extent of expression of vigour in intervarietal hybrids of selected parental types in brinjal(Solanum melongena) and also to examine the feasibility of its practical application on a commercial scale.

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REVIEW OF LITERATURE

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It is a well known fact that the crosses between varieties of diverse types of plants tend to give a greater degree of vigour. In the case of brinjal most of the crosses, which exhibited significant increase in yield were given by combinations of varieties differing widely in their morphological characters. This vital phenomenon has been studied by various investigators both in India and abroad.

Hybrid vigour has been recorded in many vegetable crops with respect to a number of morophological characters including yield. The major contributions of works in relation to the important vegetables viz. brinjal tomato and bhindi are summarised below.

1. HEIGHT OF PLANTS

Balya(1918) after the study of a cross between a native and a foreign variety of brinjal was probably the first to report the superiority of F_1 hybrids in height over their parents. Nagai and Kida(1926) and Tatesi(1927) observed that among seven F_1 hybrids of brinjal studied the increase in height varied considerably.

Some crosses averaged 11 per cent increase over

the mean height of both parents, while with others the average height was just the same as that of the tall parent. Kakizhaki(1930-31) while studying several hybrids of Japanese varieties of brinjal reported an increase in height of more than 6.4 per cent for the F_1 hybrids over the average of both the parents. Pal and Singh(1946) reported that all except two crosses studied showed an increase in height over the taller parent. The F_1 hybrids studied by Venkataramani(1946) almost resembled the female parent and were taller than both the parents. Daskaloff(1955) reported superiority of F_1 hybrids with respect to height of plants when the inbred lines were used for the hybrid seed production. Mishra(1961) found that the hybrids were invariably superior to both the parents except in a few cases showing intermediate plant height. The growth rate of these hybrids was also recorded to be significant. Frydrych(1964) reported the superiority of the intervarietal hybrids to their parents in stature while Rajbhandary(1966) recorded that the height of the hybrid plants was just within the range of the parental limits. Choudhury and Mishra(1966) in their study of 15 F1 hybrids reported that eleven F1 hybrids exhibited increase in the height of 15 days old seedlings. Among the parents the height varied from 2.17 to 3.76 cm., while in hybrids the values ranged between 2.30 and 4.87 cms. Ten hybrids were also reported to be superior to their better parents in seedling length at transplanting

stage. In the ultimate height of main shoot, nine hybrids were significantly superior to their better parents.

Increased growth in tomato hybrids has been recorded by Tatmakor and Alpatjev(1935) Whaley(1939) and Powers(1941). According to Haskell and Brown(1955) and Gottle and Darley(1956) the increased vigour of the hybrids over the parents was manifested in all the vegetative parts.

The intermediate nature in F1 hybrids with regard to height of plants has been reported by Venkataramani(1952) involving six varieties of bhindi. Joshi et al.(1958) reported that the F1 hybrids in general were taller than their superior parents. Out of 29 F1 hybrids studied 11 were taller than the taller parent, the increase being 0.2 to 18.5 per cent. 12 hybrids were found to be intermediate, tending more towards the taller parent. Raman and Ramu(1962) recorded a decrease in final height of hybrids than the respective parents in inter-varietal hybrids of bhindi. Ravindra(1964) observed that in general the plants which recorded the heighest plant height possessed longer internodes.

Isack(1965) observed in bhindi that out of 12 hybrids 11 showed no significant increase in height over the better parent although one hybrid recorded 5.7 per cent

increase over the better parent. One hybrid showed significant increase over the mean of the parents. In the remaining ones the mean height was lesser than the mean of the respective parents. The range of decreased varied from 3.3 to 21.3 per cent.

2. BRANCHES

Hybrid superiority with respect to number of branches in brinjal has been recorded by earlier workers like Nagai and Kida(1926)and Kakizaki(1930-31). Pal and Singh(1946) reported the superiority of five out of eight hybrids. This increase in number ranged from 9 to 54 per cent over the better parent. But three of the hybrids showed lesser number of branches than the respective inferior parent. Mishra(1961) found that the hybrids of brinjal showed their superiority in the average number of branches. The maximum increase recorded was 41.6 per cent over the male parent and 39.6 per cent over the female parent, the average number of branches of male and female parents being 17.56 and 13.54 respectively. Only one hybrid had decreased number of branches when compared to both the parents. Frydrych(1964) also expressed the superiority of the hybrids with respect to number of branches. Choudhury and Mishra(1966) reported that of 15 F1 hybrids 12 exhibited an increase in number of main branches as compared to the better parent, but only nine had statistically shown their superiority. One hybrid recorded 55.25 and 57.10

per cent increase over the better parent and parental mean respectively.

While studying the F1 hybrids of bhindi, Joshi et al.(1958) observed that they produced more number of branches than the better parent out of 14 combinations studied by them. The increase in the number of branches ranged from 1.2 to 25.3 per cent. But only one combination registered significant increase in number of branches. In 8 crosses the hybrids were intermediate, most of them tending towards the superior parent. Five hybrids produced lesser number of branches than the inferior parent. Raman and Ramu(1962) recorded increase in number of branches in two out of nine bhindi hybrids, while seven produced lesser number of branches.

Isaac(1965) in his study on bhindi hybrids recorded that two hybrids out of 12 exceeded the better parents by 4.8 and 8.2 per cent respectively although this superiority observed was not statistically significant. Three hybrids were poorer than the inferior parent and in one case decrease was significant.

3. NUMBER OF LEAVES

The F1 hybrids studied by Bayla(1918) produced more number of leaves than the parents. While Venkataramani(1946) reported intermediate nature of F1 hybrids

as compared to the parents in respect to number of leaves.

Isaac(1965) observed that out of 12 F1 hybrids none of them showed their superiority with respect to this character. This was in agrement with the previous workers also.

4. SPREAD OF PLANTS

The superiority of the F1 hybrids has been recorded by Balya(1918) Nagai and Kida(1926) and Kakizaki(1930-31) in the case of spread of plants also. In their two years of trial Pal and Singh(1946) observed that all crosses showed an increase with respect to spread of plants over the higher parents except one which showed a slight decrease in one year. The percentage of increase varied greatly in the two years. Only in one cross reciprocal differences were observed. Venkataramani(1946) recorded a marked increase in the F1 hybrids as compared to parents with respect to this character. The mean of the F1 hybrid was 82.0 per cent against the parental mean of 69.25 per cent. Choudhury and George(1961) reported that the F1 plants were more spreading than the parents. Mishra(1961) pointed out that the spread of plants followed some what similar trends of increase as in the case of height of main shoot. He concluded that the F1 hybrids had invariably greater spread than the parents. In all the 30 F1 hybrids studied by Rajabhandary(1966) a greater spread than the parental

lines was obtained. Choudhury and Mishra(1966) concluded from the 15 F1 hybrids studied, that the 13 F1 hybrids were significantly superior to their respective better parents in spread along and across the rows. The maximum increase in spread recorded in two crosses were 33.63 per cent and 25.61 per cent over their better parents respectively.

Raman and Ramu(1963) reported that only one hybrid out of 4 crosses exhibited heterosis in respect of spread of the plant.

5. TIME OF FLOWERING AND NUMBER OF FLOWERS

Nagai and Kida(1926) reported from their study of 10 crosses of brinjal that the first flowering time was earlier than the average of both the parents in nine crosses. The average of all the 10 crosses was earlier by 3.16 days. Kakizaki(1931) concluded that the degree of hastening in flower production of brinjal crosses is widely varying according to the different combinations of varieties, and that the cross is earlier than the average of both the parents in a majority of the cases, and that often the cross is earlier than the early parent. Schmidt(1935) reported similar results and observed that earliness was dominant and even transgressive and in one cross it even exceeded the earliest variety. He also observed that the combinations comprising the earliest variety were

extremely early. Aver Janova(1941) also obtained similar results. The F1 hybrids studied by Venkataramani(1946) flowered 18 days earlier than the early parent. The number of flowers produced also was much more. Pal and Singh(1949) reported that the hybrid plants began to flower about 75 to 85 days after sowing and is earlier than the parental varieties. Similar results have been reported by Mishra(1961), some hybrids flowered 15 days earlier than the parental lines.

The F1 plants invariably produced more number of flowers per cluster. Farly flowering of hybrids as compared to their respective parents was also reported by Raman(1964) and Frydych(1964). The significant difference between hybrids and parents in the number of days from sowing to flowering was reported by Rajbhandary(1966). The early flowering was reported to be dominant over late flowering and in one case the hybrid flowered 3 days earlier than the early parents. The maximum difference in duration between hybrids and late flowering parent was only six days. Choudhury and Mishra(1966) obtained F1 hybrids which were intermediate with respect to flowering duration.

In Tomatoes the hybrids are characteristic in early flowering and fruit set. Powers(1945) Finaly(1951) Burdick(1954) Haskell and Brown(1955) and Hojby(1958) have

reported earliness in flowering in hybrid tomatoes. Baldoni(1948) and Wittwer(1953) have suggested that earliness may not be there always in the case of hybrids. Erina(1963) reported that tomatoes having a short period from germination to flowering, when crossed, with forms having a short period from fruit setting to ripening resulted in hybrids that were earlier than either. One hybrid ripened 8 - 9 days earlier than the two parents and another ripened 4 days before the earlier parent. Sawadick(1965) also noted earliness in flowering of tomato hybrids. Petrescu(1966) after studying 35 locally produced F1 hybrids reported that all the F1 plants were outstanding for earliness when compared to either of the parental lines. Hwang(1966) reported the production of an early hybrid in tomato by using a male sterile line.

Venkataramani(1952)observed that four out of seven crosses were either as early as the early parent or earlier than the early parent. Scientific reports of I.A.R.I.(1955) have shown that the round fruited selections from Sabour selection x green velvet types of bhindi resulted in earlier flowering than the former parent. Raman and Ramu(1962) found that four out of nine hybrids of bhindi were earlier than the earlier parent. Raman and Ramu(1963) also recorded in all the nine hybrid studied earlier flowering than the parents.

Isaak(1965) in his study of 12 hybrids of this crop found that none of the hybrids was earlier than the early parent. Only in one cross the hybrid was late flowering than the late variety. With respect to the number of flowers there was an increase in eight hybrids of which 2 registered significant superiority over the better parent. Two hybrids showed decrease in the number of flower. Two hybrids equalled the mid parental value.

6.NUMBER OF FRUITS

Definite increase in the number of fruits has been recorded by Nagai and Kida(1926) and Tatesi(1927). Pal and Singh(1946) reported increase in yield over the better parent in 50 per cent of the crosses. During 1941 - 1942 six out of nine crossesshowed decrease in number compared to the better parent, though as compared to the mean values of the parents, all except one were superior. Venkataramani(1946) reported the intermediate nature of F1 hybrids between the parents, the hybrid plant producing eight fruits while the female and male parents producing ten and seven respectively. Mishra(1961) recorded that the F1 had significantly higher number of fruits than their respective parents. Amongst the parents the average number of fruits per plant ranged from 5.25 to 7.16 and in the hybrids the values ranged from 7.08 to 13.00. Rajkicicer and Palgy(1964) concluded that heterosis in geater yield was mainly due to the incease in

number of fruits. Rajbhandary(1966) attributed the increase in total yield of the hybrids over the parents was due to the increase in the number of fruits produced by the plants, which was in turn brought about by the production of more branches. The partial expression of the clustering habit also contributed to the increase in number of fruits produced per plant. Out of 15 F1 hybrids studied by Choudhury and Mishra(1966) only six hybrids showed superiority over their better parent in number of fruits. However eleven F1 hybrids were significantly superior to their better parents in total number of fruits. The maximum increase in total fruit number recorded was 69.83 per cent in one hybrid followed by 62.11 per cent in another, when compared with the better parent. The long fruited varieties were observed to be more prolific, inducing increased number of fruits in the hybrids than the round fruited varieties. Andronicescu(1966) in his study of 21 brinjal hybrids reported significant difference in total yield over the parental lines which was attributed to the greater number of fruits produced by hybrids.

In tomatoes increase in total yield is attributed to the increase in number of fruits produced by hybrid plants rather than larger sized fruits(Whaley 1939 and Baldoni 1949). This was confirmed by the findings of Finlay(1951) who suggested that in tomatoes the fruit size was intermediate

between the parental types and in certain cases tended more towards the small parental type.

In bhindi,Gurgel and Nitidieri(1956) obtained a variety named "Chifre de Veedo" and subjected it to self-pollination for five successive generations and then crossed with an unselected local variety and with the original strain. In respect of number of fruits no significant difference was observed between the six selfed lines and their F1 crosses with the original variety. The F1 crosses with the other variety were significantly inferior in respect of number of fruits. The findings of Joshi et al.(1958) were that when the mean of the hybrids was compared with the mean of the parents, the difference in favour of the hybrids was just significant. Ten combinations out-yielded the better parent, the range of increase being 9.68 to 62.19 per cent, nine hybrids were found to be intermediate, and ten combinations yielded less than the inferior parent. Isack(1965) while studying 12 F1 hybrids of bhindi observed that one hybrid registered a significant increase in the number of fruit over the better parent. One hybrid was found to be inferior to the lower parent.

7. WEIGHT OF FRUITS

All the 10 crosses of brinjal plants studied by Nagai and Kida(1926) exceeded the parental means

by 1 to 71 per cent in yield. Even as compared with the better parent most of them yielded more and the average increase of all the crosses was 15 per cent. Of the two crosses studied by Tatesi(1927) one exceeded the better parent in yield of 8 per cent while the other did not. The cross that showed the highest increase yielded 140.8 per cent more than that of the better parent, while another cross registered an increase of 222.2 per cent over the poorer parent (Kakizaki 1931). In respect of yield per plant by weight the F1 hybrid exceeded both the parents(Venkataramani 1946). The average yield of hybrid plants was 42.2 oz per plant as against the mean yield of 43.0 and 36.0 of male and female parents respectively, the percentage increase over that of male and female parents being 24.1 and 17.2 respectively. Pal and Singh(1946) reported that all the crosses except one showed increase of 129 per cent over the better parent.

While studying different Japanese varieties of brinjal, Odland and Noll(1948) reported that in every case the yield of the hybrids exceeded the mean yield of the parents, the range of increase is from 11 to 153 per cent. The mean of all the F1 hybrids exceeded the mean of all the parents by 62 per cent. The hybrid which gave maximum yield, recorded an increase of 17.25 tones of fruits/acre over that of the best parental variety. This increase in yield was mainly due to an

increase in the number of fruits per plant. Alpatjev(1949) concluded that the intervarietal hybrids recorded an increase in productivity in order of 20 to 40 per cent. Daskaloff also(1955) reported increased yield of F1 hybrids resulted from inbred lines. Mishra(1961) got significant increase in yield in many F1 hybrids although in some cases non-significant differences were also seen. He observed positive correlation between the number of fruits and their weight. Komochi(1963) analysed the components of fruit yield in crosses of six varieties of brinjal and recorded heterotic condition in both fruit weight and fruit number. The ratio of fruit yield/weight of vegetative parts(R/V) was also studied. It was suggested that high fruit yield should result from crossing varieties with a high(R/V) ratio. Lantican, Rajbhandary, Carangal and Deanon(1963) reported hybrid vigour with regard to yield in intervarietal hybrids of brinjal. Raman(1964) reported the superiority of the hybrids in yield. The increase over the parents ranged from 8.7 to 91.0 per cent. According to Frydrych(1964) the F1 hybrids showed greater yield and length of total growing period. An interesting fact revealed was that F1 hybrids recorded good yields when parents produced no fruit at all. The best of the hybrids, yielded 310.17 g. per plant when the parental average remained only 50.18 g. Rajkicicer and Palgy(1964) showed that the increase in yield in the F1 hybrids was due to the increase in the number of fruits produced. Toderi(1965) also recorded

high yields in F1 hybrids. Rajbhandary(1966) reported increased yield of hybrids and in all cases the hybrids exceeded the mean of the parents. This increase ranged from 1.5 to as high as 105 per cent. On the average the percentage of gain was 42.8 out of 33 crosses studied, 22 showed increase in yield over the higher yielding parent, the highest being 66 per cent in one of the crosses. It was also pointed out that diversity in origin of parents had no apparent influence on the yielding ability of the hybrid. Choudhury and Mishra(1966) found that out of 15 hybrids studied for this character 13 exhibited significant increase in total yield over their better parent. The maximum yield recorded was 224.0 and 228.38 per cent in one cross over the higher parent and parental mean respectively. No definite association was observed between the length and the weight of fruits at edible stage but however, a better trend of similarity exists between weight and diameter of fruits.

Balint(1956) recorded heterosis for yield in inter-varietal hybrids of tomatoes. The F1 generation showed an average increase in yield of 25.6 to 93.3 per cent over the higher yielding parent. Vigour was most marked in inter-specific hybrids but significant heterotic effects were also found in intervarietal and occasionally in intravarietal hybrids. After comparing 50 F1 hybrids of tomatoes, Samarov(1965) reported that

in all cases the hybrids excelled the standard in yield and a number of other characters. The greatest yield increase were often found in hybrids between varieties differing in origin and morphological characters.

Joshi et al.(1950) when considered all the hybrids of bhindi as one group and the parents as another, found that the former gave significantly higher yield due to increase in the number and weight of fruits than the latter. Raman and Ramu(1962) reported that three out of nine crosses excelled the better parent in the number and weight of fruits. Isaac(1965) observed that out of the twelve hybrids studied one hybrid registered significant increase in weight of 30.6 per cent over the better parent. Four crosses proved to be superior to the mean of the parents while the increase was not significant in the five other hybrids.

SIZE AND SHAPE OF FRUITS

Nagai and Kida(1926) reported that in every case the cross showed an intermediate fruit shape. Pal and Singh(1946) also recorded the intermediate fruit size in hybrids. Venkataramani(1946) concluded that the fruits of the F1 hybrid were of the same size and shape as those of both the parents. Mishra(1961) reported that in general the fruits of F1 hybrids were invariably longer than either, both or one of the parents.

The vigour was noticed in fruit length in five out of eight F1 hybrids. They have shown fairly high increase in the diameter of fruits also.

In the case of fully matured fruits all the hybrids except one or two, showed appreciably greater size. It was also suggested that the increase in diameter of fruits was brought about not at the expense of the length, but both these aspects of the fruits varied in most of the hybrids, independently showing the hybrid vigour induced by the combinations of different parents. Capinpin, Lunde and Panco(1963) reported that the F1 hybrids were intermediate between the parents in fruit shape. Rajbhandary(1966) suggested that the increase in total yield of the hybrids over the parents was brought about by the improvement in the size and shape of the individual fruits.

Joshi et al(1958) reported significant superiority of the hybrids of bhindi when compared to parents with this character. In F1 hybrids the fruit size was larger than the superior parent. The increase in size ranged from 0.17 to 34.76 per cent. Thirteen combinations were intermediate while in one, the size of fruits was smaller.

Isack(1965) recorded hybrid vigour in fruit

length in eleven out of twelve crosses of Bhindi when the mid parental value was considered. In girth of fruits, only one hybrid showed reduction when the higher parental mean was considered.

NUMBER AND WEIGHT OF SEEDS

Kikizaki(1931) reported the immediate increase in weight of F1 seeds over the selfed seeds of the nother parent. It is quite apparent that the increase in weight of the F1 seeds of brinjal is due to the increase in size of the embryo, and is a manifestation of hybrid vigour. In almost all cases the F1 seeds were heavier(as the immediate effect of cross pollination) than the selfed seeds of the mother parent. The increase in weight varied widely averaging 11.8 per cent and the highest increase was 72 per cent over the selfed seeds of the mother plant. Choudhury and Mishra(1966) found that out of 15 F1 hybrids nine hybrids had significantly lesser number of seeds per fruit than their respective higher parent. Mean weight of 500 seeds in each of the parents and F1 hybrids revealed the significance of only seven hybrids in comparison with the better parent. Rajbhandary(1966) reported that the average number of seeds that set per fruit per cross ranged from 404 to as high as 1067. Seed setting in some cases even exceeded that of the parental varieties. But an intresting thing noted was that in most cases the F1 seeds produced were visually larger and heavier than those produced by

the maternal parent. Whether this particular increase in seed size was a direct result of xenia effect or the consequence of the production of lesser number of seeds cannot be ascertained. Seed number in the hybrid was 50 per cent lower than that of parental lines.

GERMINATION CAPACITY

Venkataramani(1946) reported that the percentage of germination of the crossed seeds was greater than those of the seeds of the selfed parental lines, and that possibly the hybrid vigour was also manifested in the better germination of the hybrid seed. Fifty percentage of the crosses showed early germination as compared to their parents. In the F1 however, in all cases there was higher germination percentage(Pal and Singh 1946). Rajbhandary(1966) reported that the hybrid(78.8 per cent) gave a higher percentage of germination than either parent(73.6 per cent). This result provided a further proof that at least with the parental stocks used in the study, no sterility mechanism was involved and the varieties used were alike in their genomic background. Choudhury and Mishra(1966) observed that out of the 15 F1 hybrids thirteen hybrids exhibited higher percentage of germination than their better parent. The maximum germination of 92 per cent in one of the crosses recorded an increase of 35.29 per cent over the better parent.

CYTOLOGY

Mishra(1962) reported that out of four parents and eight F1 hybrids studied the length and breadth of the pollen grains were found to be maximum in Banaras giant; being 23.01 micron and 19.83 micron respectively. 50 per cent of the F1 hybrids had greater length than either or both of the parents whereas five out of eight hybrids showed increased diameter of grains either over one or both of the parents. All the parents and F1 hybrids invariably showed the shape of pollen grains to be almost round.

Nasrallah and Hopp(1963) studied the inter-specific crosses of five species of Solanum viz; S.melongena(brinjal) S.gilo; S.indicum; S.mammosum and S.ciliatum. S.melongena wa crossed with S.gilo and S.indicum; The F1s of these crosses were highly sterile. But the F1 of S.melongena and S.gilo was highly vigrous.

Pairing was regular in the meiosis of PMCs' of the F1 but irregular chromosome distribution was observed, together with bridge formation probably as a result of inversion, which could be responsible for the sterility. All other inter-specific combinations were incompatible. The chromosome number of S.mammosum 2n = 24 is reported for the first time.

Capinpin, Lunde and Panco(1963) studied the inter-specific hybrids between S.melongina and S.cuningio, chromosome number of each of these species reported to be 2n = 24.

The hybrids were highly fertile, meiosis was regular and 85 to 90 per cent viable pollen was produced as compared to 90 to 95 per cent in the parental varieties. This indicated the complete homology of parental genomes.

Oszvald and Palgy(1964) recorded highly significant differences in percentage of male sterility within but not between F1 hybrids of two common Japanese varieties of brinjal. Babu Rao(1965) in his cytomorphological studies of certain inter-specific hybrids of non-tuberiferous Solanum species reported that all the hybrids showed heterosis with respect to several morphological characters. Meiosis was reported to be normal with high pollen fertility except in one hybrid which showed frequent association of 1 IV + 10 IIs and produced only sterile pollen grains.

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MATERIALS AND METHODS

MATERIALS AND METHODS

The present study was undertaken in the Division of Agricultural Botany, Agricultural College and Research Institute, Vellayani during the year 1966-1967. The experiment was spread over two seasons - August - December, and February - June.

Choice of material and their characteristics

Pure seeds of four varieties of brinjal viz. Pusa purple long, Purple long dutta, Muktakeshi, Banaras Giant were obtained from I.A.R.I., New Delhi and White long from the Agricultural College Farm, Vellayani. Nursery was raised by sowing seeds in pots of 40 x 40 cm. filled with standard pot mixture. Thirty days after sowing seedlings were transplanted in well prepared raised beds of 1M x 5M at a spacing of 80 cm either way. The different varieties commenced flowering 80 days after sowing. The distinguishing features of the varieties selected are summarised in Table I.

TECHNIQUE OF SELFING

In brinjal there are four types of flowers; long styled, medium styled, pseudo-short styled and short styled flowers of which only long styled and medium styled

TABLE.I

Varieties / Characters	Pusa purple long	Muktakeshi	Banaras giant	Purple long dutta	White long
Plant height (in cm)	69.66	70.16	74.85	92.57	84.13
Growth habit	Spreading and bushy	Spreading and bushy	Spreading and bushy	Erect open	Erect and bushy
Spines	Rudimentary spines present	Absent	Absent	Absent	Well developed
Leaf size	Small	Medium	Large	Broad and long	Medium to large
Leaf colour	Light green	Dark green with purple veins	Green	Dark green with purple veins	Light green
Flower colour	Pink	Violet	Light purple	violet	Pure white
Fruit length (in cm)	23.08	18.44	18.56	23.44	18.48
Fruit diameter(in cm)	14.97	24.37	30.48	12.95	18.67
Fruit colour	Purple	Dark purple	White to greenish white	Greenish purple	White
Bearing habit	Solitary rarely in clusters	Solitary	Solitary	Solitary	Both solitary and clusters
Duration of crops	Short	Medium	Medium	Medium	Medium to long

are fertile ones(Krishnamoorthi and Subramonian 1956). The opening of flowers and dehiscence of anthers go together and this has been observed between 7 - 10 A.M. under Vellayani conditions ie. about 2 hours earlier than that has been reported. This may probably be due to high atmospheric humidity and temperature prevalent at Vellayani.

In order to obtain pure seeds of parental variety ten well developed long styled flower buds which would open on the next day were covered with pollen-proof paper bags in the previous evening and labelled. The bag was allowed to remain there for 3 to 4 days until all the flower parts except the ovary had fallen off. The bag was then removed after tying the label on the developing fruit. The fruits were harvested when completely mature the maturity being judged by the standard ripening yellowish tinge of the rind of the variety. Seeds were then extracted, cleaned, dried and stored.

CROSSES MADE AND METHOD ADOPTED

A. CROSSING TECHNIQUE

i. Emasculation

Mature long styled flower buds which would open on the next morning of the female parent were selected the previous evening. The corolla was then split open with a fine pointed needle and scissored off, afterwards anthers, were

carefully removed one after another with the needle. Utmost care was taken not to injure any other floral parts including the removed anthers. The emasculated flower buds were then covered with a pollen-proof bag to prevent contamination from foreign pollen.

ii. Collection of pollen

Mature flower buds of plants which were to be used as pollen parent, were selected on the day of pollination and the coralla was cut off as described above. Then a slit was made at the apex of the anther by a sterilized needle and pollen grains were collected in a clean watch glass containing a wet piece of blotting paper. The whole operation was completed before 6.45 A.M. ie. half an hour before actual dehiscen of anthers.

iii. Pollination

In the same morning the bag covering the emasculated flower bud was removed and the pollen collected from the male parent was dusted gently on the stigma by a camel hair brush. Dusting was done between 10 A.M. and 12 Noon. After pollination, the flower buds were again bagged and labelled. The bag was removed after seven days.

Crossed fruits were harvested when completely mature, maturity being judged by yellowing of the rind. The

TABLE.II

Sl. No.	Female parent	Male parent	No.of flowers crossed	No.of fruits obtained	% of set	Remarks
1	Muktakeshi	Banaras giant	6	6	100	
2	Banaras giant	Muktakeshi	4	3	75	
3	Muktakeshi	White long	6	3	50	
4	White long	Muktakeshi	7	4	57.14	
5	Purple long dutta	Banaras giant	3	2	66.60	
6	Muktakeshi	Purple long dutta	6	6	100	
7	White long	Banaras giant	6	5	83.3	
8	Muktakeshi	Pusa purple long	3	3	100	
9	White long	Purple long dutta	3	-	-	Lost due to borer attack
10	Pusa purple long	Banaras giant	5	-	-	Lost due to bacterial wilt.
11	Pusa purple long	Banaras giant	8	-	-	-do-
12	Pusa purple long	Muktakeshi	6	-	-	-do-
13	Purple long dutta	White long	5	-	-	-do-

seeds were then extracted, cleaned and properly dried and kept for 25 days to over-come the after-ripening period.

The details of crosses effected are given in Table II.

Field plot technique and study of F1 generation

Out of 13 crosses effected fruits of only 8 crosses could be harvested and seeds collected because of the severe infection of bacterial wilt.

Layout

The experiment was laid out in a randomized block design with two replications. In each replication there were 24 plots. The hybrids were planted in the middle and the respective male and female parents flanked on either side. Each plot consisted of two rows of 3 plants each thus a total of six plants in each plot.

Treatments

8 crosses numbered as I to VIII and 5 parental varieties numbered IX to XIII; the total number of treatments being thirteen.

Nursery

Well developed good seeds from 8 crosses and 5 parents were separately sown in pots of 50 cms x 50 cms. The pots were filled up standard pot mixture and seeds were sown at the rate of 200 seeds per pot. The seeds showed

high percentage of germination and good growth.

Transplanting

Thirty days after sowing healthy and vigrous seedlings were selected for planting in the main field. Before transplanting the main field was thoroughly prepared and levelled. Pits of 25 cms x 25 cms x 25 cms were taken in rows of 80 cms apart at a spacing of 80 cms between pits. Then the pits were burnt with dry leaves as a preventive measure against bacterial wilt. One small basket full of farm yard manure was applied, as a basal dressing in each pits. The pits were watered and two seedlings planted in each pit.

When the seedlings had established well ie. 15 days after transplanting, thinning was done, leaving only one healthy seedling in each pit. Standard vegetable mixture(12 - 24 - 12) was applied twice as top dressing - one,25 days after transplanting and the second after 90 days at the rate of 200 Kg. per hectare. The crop was regularly irrigated twice every day ie. one in the morning and the other in the evening.

Observations on the following characters were recorded for both F1 hybrids and parents.

1. Height of plants
2. Number of branches
3. Number of leaves

4. Spread of plants
5. Time of flowering and number of flowers.
6. Number of fruits
7. Weight of fruits
8. Size and shape of fruits
9. Number and weight of seeds
10. Germination capacity
11. Pollen studies
    a)Pollen size measurement
    b)Pollen sterility counts
12. Studies on Pollen mother cells

The details are given below:

The first observation on height of plants, number of branches and number of leaves, was taken on the 20th days after transplanting and the subsequent ones at 10 days intervals. The last one was taken on the 70th day.

HEIGHT OF PLANTS

Measurements were taken from the ground level to the topmost bud leaf of all the six plants in each treatments by a meter scale. The mean of six plants was taken and analysed.

NUMBER OF BRANCHES

While counting the total number of branches

both primary, secondary and tertiary branches were taken into account and the data were analysed.

NUMBER OF LEAVES

Total number of leaves on all the six plants were counted at each observation. The mean of six plants were taken and analysed.

SPREAD OF PLANTS

Observations were recorded on the 55th day after transplanting ie. when the plants attained full growth. Measurement was taken in the direction where there was maximum spread of plant.

In the present study only three different types of flowers were recorded. ie. Long Styled, Medium styled and short styled. The number of flowers in each category was counted starting from the commencement of flowering till its completion. The counted flowers were marked by tying three different coloured threads on the pedicell of each category.

NUMBER OF FRUITS

The number of fruits set from long styled, and medium styled flowers was separately counted. This observation was taken when the first phase of flower production was over.

WEIGHT OF FRUITS

Mature fruits suitable for vegetable purpose

were harvested periodically and the total weight of fruits obtained from individual plants was recorded separately and the mean of six plants worked out and the final data were analysed.

SIZE AND SHAPE OF FRUITS

Three random fruits from each plant were selected and their length and maximum girth were measured and the mean worked out and analysed.

NUMBER AND WEIGHT OF SEEDS

One well ripened fruit from each plant was selected at random and seeds were extracted carefully and then counted.

Five hundred well developed seeds of both parents and hybrids were counted and the weight recorded.

GERMINATION CAPACITY

Fifty well developed seeds were counted and placed in a petrydish containing moist blotting paper. The number of seeds germinated was counted after 48 hours and the percentage of germination calculated.

POLLEN STUDIES

a) Pollen size:-

Slides of fresh pollen grains were prepared in glycerin acetocarmin medium. The size of the pollen grains was

measured by an occular micrometer. The diameter of one hundred pollen grains taken at random was measured and the mean worked out.

b)Pollen sterility:-

Acetocarmine staining method was used to study pollen sterility. Mature flower buds which would open next day were covered with paper bags. Anthers were collected from such buds and dusted on a slide containing a drop of acetocarmine stain and covered with a cover glass. After half an hour the slides were examined under the microscope. The deeply stained pollen grains were taken as fetile ones while those which took little or no stain were taken as sterile ones. Sterile and fertile pollen grains were counted from 30 microscopic fields and the percentage of sterility was calculated.

STUDIES ON POLLEN MOTHER CELLS

Flower buds of appropriate size was fixed in 3:1 mixture of ethyl alcohol and Acetic acid. Meiosis was studied in temporary actocarmine smears of pollen mother cells.

The data for various characters were analysed by using the analysis of variance method. The mean of the F1 was compared with that of the better parent and also with the parental mean. The data are furnished in tables I to , after testing their significance by critical difference.

EXPERIMENTAL RESULTS

EXPERIMENTAL RESULTS

The results of the investigation are presented hereafter.

1. HEIGHT OF PLANTS

The height of plants at six different stages, commencing from the 20th day after transplanting at equal intervells of 10 days, was recorded. The data pertaining to four typical crosses- two direct and two reciprocals are presented graphically along with their respective parents(Pl.1 & 2).It can be seen from the graphs that the pattern of growth was same in both the hybrids and the parents. But the hybrids were found to exhibit quicker rate of growth as compared to their respective parents. No significant reciprocal difference, either in the rate or in the pattern of growth was noted.

The data relating to final observations were analysed statistically and the mean values are furnished in table III.

From the data presented in Table III, it can be seen that out of eight crosses, six showed significant increase in height over the mean of parents. This increase ranged from 15.27 per cent to 45.73 per cent. This increase was 15.27 per cent, 16.74 per cent, 24.33 per cent, 27.93 per cent and 45.73 per cent in WL x MK; MK x WL; MK x PPL, MK x PLD, WL x BG

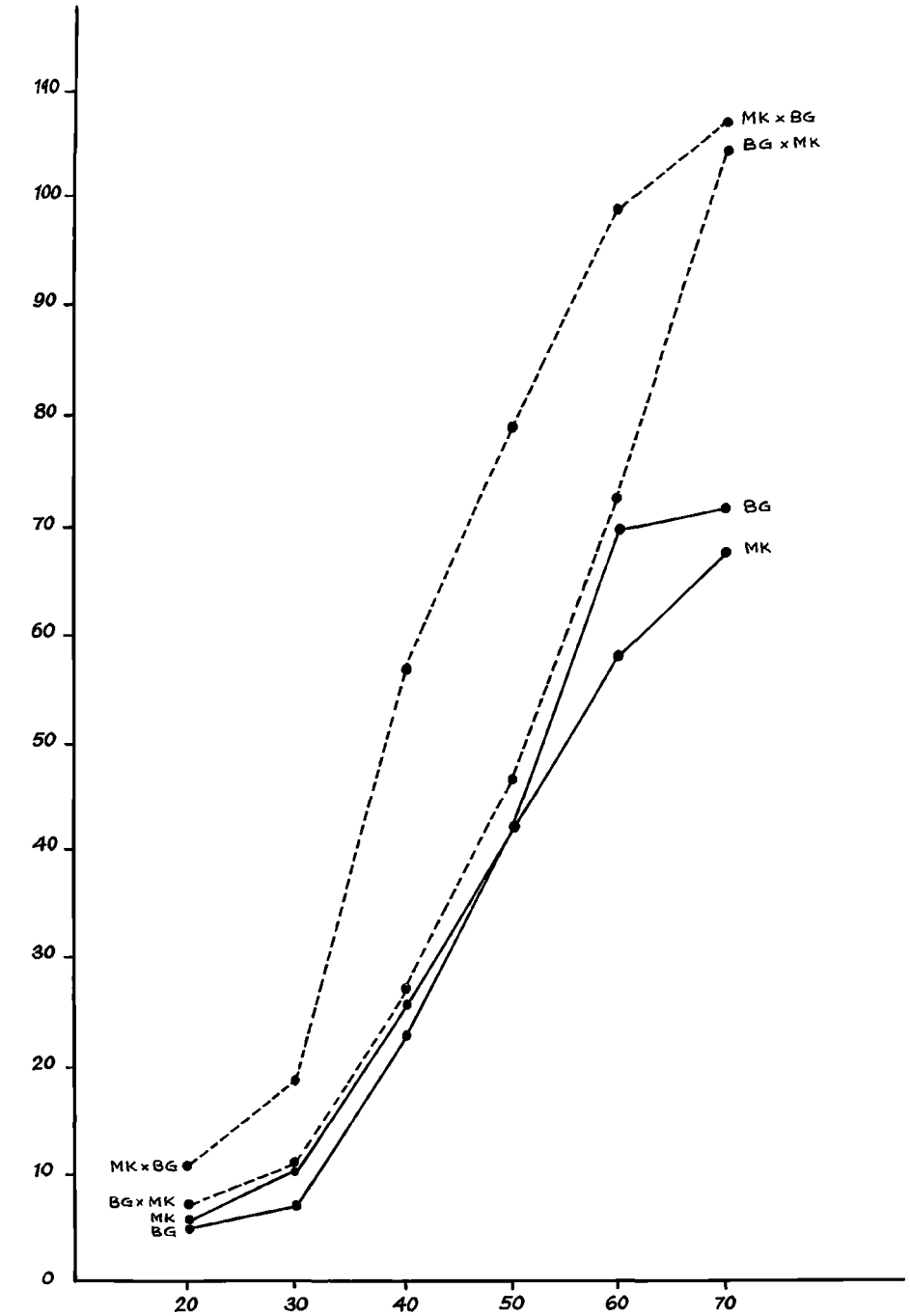
Fig:-1. Graph showing growth pattern in height of plants of parents and hybrids at 10 days' interval

Crosses MK x BG , BG x MK

MK = Muktakeshi

BG = Banaras giant

HEIGHT OF PARENTS & HYBRIDS
AT 10 DAYS INTERVEL



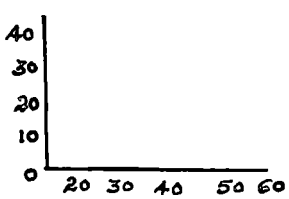


FIG 1

FIG 1

FIG 1

Fig.2. Graph showing growth pattern in height of plants of parents and hybrids at 10' days crosses.

Crosses WL x MK, MK x WL

Parents MK = Muktakeshi

WL = White long

HEIGHT OF PARENTS & HYBRIDS
AT 10 DAYS INTERVEL

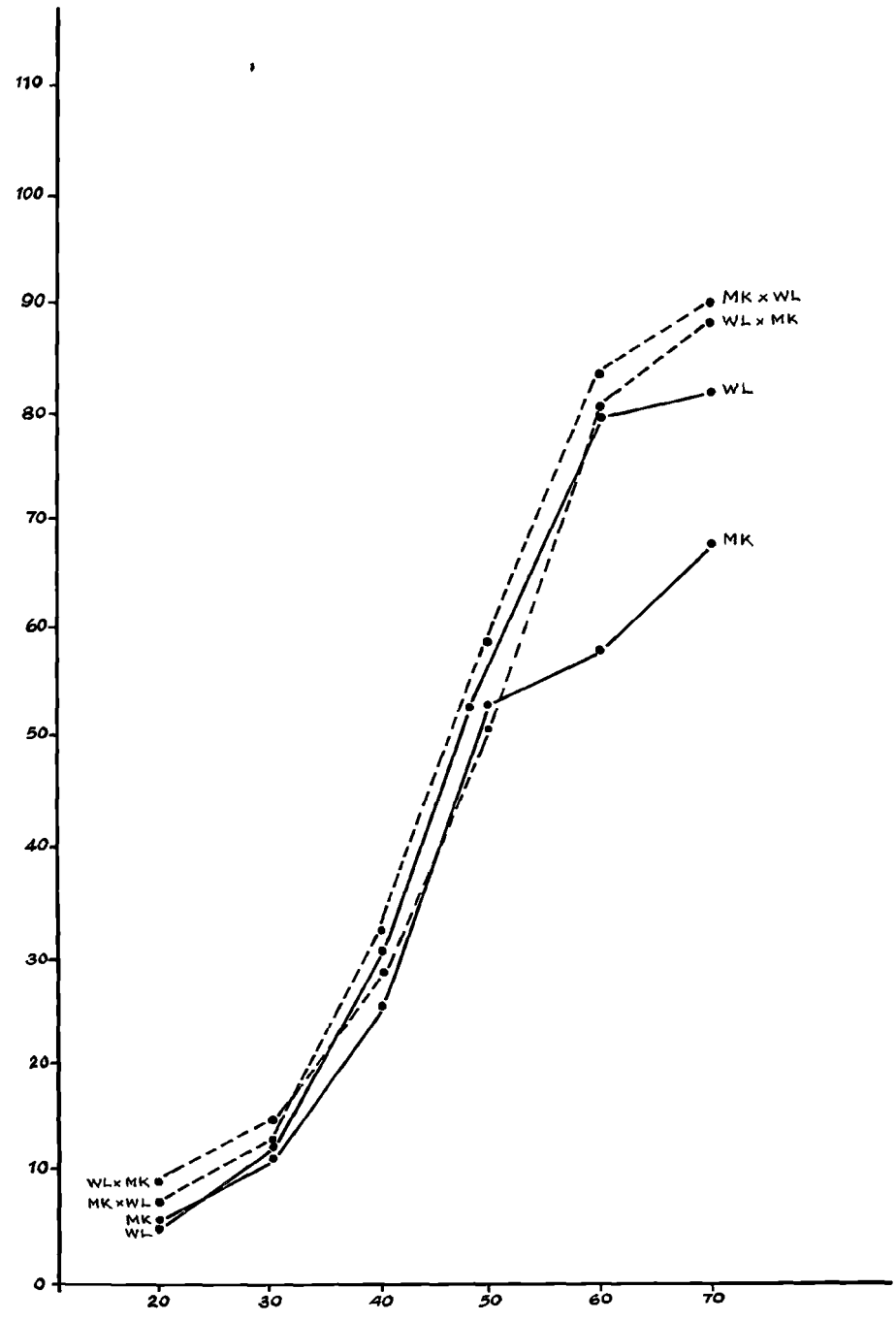


FIG 2

and MK x BG respectively. In the remaining two there was an increase but this increase was not statistically significant.

TABLE.III

Mean height of plants (in cm) parents and hybrids

Sl. No.	Crosses	Mean of F1	Better parent	Parents	inferior parents	Mean increasing or decrease (in%) of F1 over. Better parent	Parental mean
1	WL x MK+	112.99	100.45	96.04	91.63	12.42	17.64*
2	PLD+ x BG	100.66	95.16	94.46	93.77	5.77	6.56
3	MK+ x WL	113.83	100.45	96.04	91.63	13.32	17.47*
4	MK+ x BG	112.83	100.45	97.11	93.77	12.32	16.18*
5	MK+ xPLD	115.00	100.45	97.81	95.16	14.48*	17.57*
6	MK+ xPPL	109.58	100.45	95.05	89.66	9.89	15.28*
7	BG x MK+	103.45	100.45	97.11	93.77	2.98	6.53
8	WL x BG+	118.16	93.77	92.70	91.63	26.01*	27.46*

+ Better parents *Significant at 5% level

L = White long, MK = Muktakeshi, PLD = Purple long Dutta

BG = Banaras giant, PPL = Pusa purple long

When the better parental mean was considered only three hybrids showed their superiority. The hybrids are MK x PPL

Fig.3 Bar diagrams showing mean height of plants of eight hybrids and respective parents.

MEAN HEIGHT OF PLANTS (in cms)

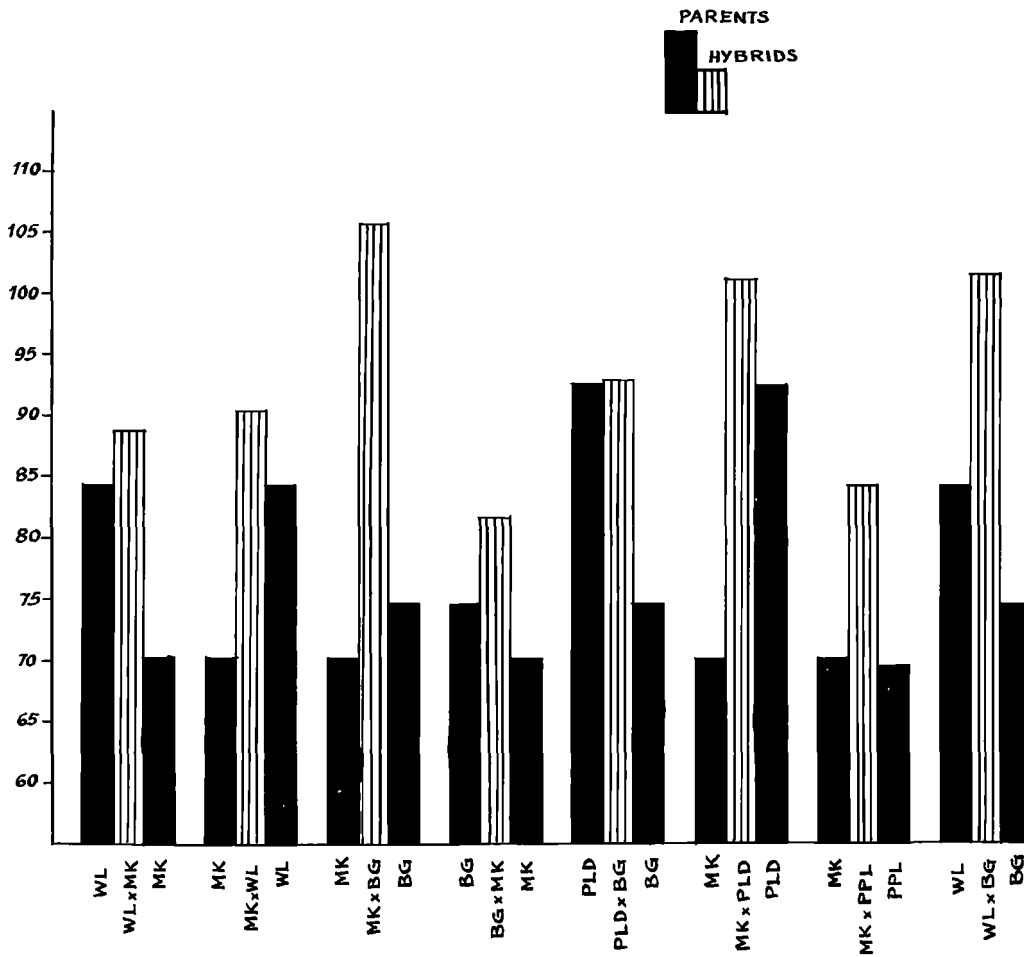


FIG 3

with 20.21 per cent increase; WL x BG with 20.74 per cent increase and MK x BG with 41.16 per cent increase. In the remaining hybrids, though there was a slight increase it did not come to the level of statistical significance. It was specially noted that none of the hybrids showed decrease in plant height when either the parental mean of the better parental mean was considered.

II. NUMBER OF BRANCHES:

Data pertaining to number of branches are presented in Table IV.

TABLE.IV
Mean number of branches of parents and hyorids

Sl. No.	Crosses	Mean of F1	Better parent	Parents	Inferior parent.	Mean increase or decrease(in%) of F1 over Better parent	Parental mean
1	+WL x MK	14.58	14.90	14.47	14.04	-2.14	0.76
2	+PLD x BG	16.91	16.99	14.68	12.37	-0.47	15.10
3	MK x +WL	16.33	14.90	14.47	14.04	9.67	12.85*
4	+MK x BG	16.83	14.04	13.20	12.37	19.87*	25.45*
5	MK x +PLD	18.19	16.99	15.51	14.04	7.12	17.28*
6	MK x +PPL	17.83	23.08	18.56	14.04	-22.74*	-9.93
7	BG x +MK	13.66	14.04	13.20	12.37	- 2.71	3.48
8	+WL x BG	14.99	14.90	13.63	12.37	0.60	11.95

+Better parents *Significant at5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

Only two out of the eight hybrids studied have showed their statistical superiority in the number of branches, when the F1 was compared with parental mean. The increase was 17.26 per cent in MK x PLD and 27.5 per cent in MK x BG. The hybrid MK x PPL showed significant decrease in number of branches. When the better parental mean was considered only one hybrid(MK x BG) showed significant increase, the percentage of increase being 19.87. The mean number of branches produced by the parents ranged from 14.04(MK) to 23.08(PTL).

III. NUMBER OF LEAVES

Results of observations are furnished in Table V.

TABLE.V

Mean number of leaves of parents and hybrids

Sl. No.	Crosses	Mean of				Mean increase or decrease(in%)of F1 over.	
		F1	Better parent	Parents	Inferior parents	Better parent	Parental mean
1	WL+ x MK	92.50	92.67	91.18	90.00	0.14	1.44
2	PLD+ x BG+	119.74	112.99	96.77	80.56	5.97	23.73*
3	MK x WL+	113.08	92.37	91.18	90.00	22.47*	24.01*
4	MK+ x BG	123.58	90.00	85.28	90.56	37.24*	44.91*
5	MK x PLD+	122.66	112.99	101.49	90.00	8.55*	20.85*
6	MK x PPL+	134.25	127.35	108.66	90.00	5.44	23.55*
7	BG x MK+	93.91	90.00	85.28	80.56	4.33	10.20
8	WL+ x BG	109.41	98.37	86.46	80.56	18.44*	26.54*

\+ Better parents *Significant at 5% level.

WL = White long, MK =MUKTAKESHI,PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

There was significant increase in number of leaves produced in six out of the eight crosses when the F1 was compared with mid parental value. This increase ranged from 20.85 in MK x PLD to 44.91 per cent in MK x BG. The two hybrids viz. WL x MK and BG x MK showed increased number of leaves, but this was not statistically significant.

When the comparison was between F1 and the better parental mean only three out of the eight hybrids showed their statistical superiority, they being MK x WL, MK xBG and WL x BG. The maximum increase of 37.24 per cent was recorded by MK x BG and the minimum 18.44 in WL x BG. No hybrids showed decreased number of leaves. The mean of parents ranged from 80.56(BG) to 127.33(PPL) while in hybrids the range was from 92.50(WL x MK) to 134.25 (MK x PPL).

IV. SPREAD OF PLANTS

Data are present in Table VI.

Six hybrids showed their superiority statistically with respect to spread of plants when the F1 was compared with the mid parental value. This increase ranged from 15.28 per cent in MK x PPL to 27.46 per cent in(WL x BG). The remaining two out of the eight crosses also showed increase in spread but not statistically significant.

When the comparison was between F1 and the better parental mean only two hybrids were found to be significant, they being MK x PLD with 14.48 per cent and WL x BG with 26.01 per cent increase.

TABLE.VI

Mean spread of plants (in cm)
Parents and hybrids

Sl. No.	Crosses	Mean of F1	Better parent	Parents	Inferior parent	Mean Increase or decrease in(%) of F1 over. Better parent	Parental mean
1	WL x +MK	112.99	100.45	96.04	91.63	12.42	17.64*
2	+PLDx BG	100.66	95.16	94.46	93.77	5.77	6.56
3.	+MK x WL	113.83	100.45	96.04	91.63	13.33	17.47*
4.	+MK x BG	112.83	100.45	97.11	93.77	12.32	16.18*
5.	+MK xPLD	115.00	100.45	97.81	95.16	14.48*	17.57*
6.	+MK xPPL	109.57	100.45	95.05	89.66	9.89	15.28*
7.	BG x+MK	103.45	100.45	97.11	93.77	2.98	6.53
8.	WL x+BG	118.16	93.77	92.70	91.63	26.01*	27.46*

+ Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta.
BG = Banaras giant, PPL = Fuse purple long.

The mean spread among parents ranged from 89.66 cm in PPL to 100.45 in MK.

V. TIME OF FLOWERING AND NUMBER OF FLOWERS PRODUCED

a) Time of flowering:- Table VII

Seven out of the eight crosses studied were found to have a flowering duration earlier than the mid parental value. This earliness ranged from 1.15(MK xPPL) to 6.98 days in MK x BG.

TABLE.VII

Mean number of days from sowing of flowering of parents and hybrids

Sl. No.	Crosses	Mean of				Mean increase or decrease of(in%)F1 over	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL x MK+	74.00	76.30	78.34	80.39	-3.15	-5.92
2	PLD+ x BG	75.85	76.78	79.00	81.23	-1.18	-3.96
3.	MK+ x WL	73.37	76.30	78.34	80.39	-3.84	-6.34
4.	MK+ x BG	71.78	76.30	78.76	81.23	6.57	-8.86
5.	MK+ xPLD	71.63	76.30	76.54	76.78	-6.06	-6.42
6.	MK x PPL+	68.93	64.53	70.48	76.30	+8.81	-1.63
7.	BG x MK+	81.92	76.30	78.76	81.23	+6.31	+2.89
8.	WL+ x BG	75.67	80.39	80.81	81.23	-5.86	-6.36

+ Better parents.

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

When the flowering duration of the early parent was compared with that of F1 six out of the eight crosses were found earlier and the other two crosses were later.

The flowering duration among parents ranged from 64.53(PPL) to 81.23(BG) days. The range among hybrids was 68.93(MK) x PPL to 81.12(BG x MK) days.

b) Number of flowers produced

1) Table number:- Table VIII.

TABLE.VIII

Mean number(Total) of flowers of parents and hybrids

Sl. No.	Crosses	Mean of				Mean increase or decrease (in%)F1 over	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	+WL x MK	29.65	33.99	28.86	21.73	-17.85*	2.73
2	+PLD x BG	27.24	29.83	22.01	14.19	- 8.65	23.76
3	MK x +WL	31.57	35.99	28.86	21.73	-12.72	9.39
4	+MK x BG	31.38	21.75	17.96	14.19	44.27*	74.71*
5	MK x +PLD	32.25	29.85	25.78	27.73	8.11	25.09*
6	MK x +PPL	58.66	79.41	50.59	21.73	-26.27*	14.91*
7	BG x +MK	15.88	21.73	17.96	14.19	-28.34*	-13.24
8	+WL x BG	42.33	35.09	25.09	14.19	24.00*	68.72*

\+ Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

Though seven out of the eight hybrids studied produced increased number of flowers as compared to the parental mean, this increase was found to be significant only in our. The percentage of increase was found 74.91 in MK x PPL, 25.09 in MK x PLD and 68.72 in WL x BG, the maximum of 74.71 being recorded by the hybrid MK x BG. One of the hybrids showed a slight decrease in the number of flowers produced but not found to be significant.

Only one hybrid, MK x BG showed significant increase when the better parental mean was taken for comparison. Five

Fig:-4 Bar diagram showing mean number of flowers of eight hybrids and respective parents.

MEAN NUMBER OF FLOWERS PRODUCED BY

PARENTS & HYBRIDS

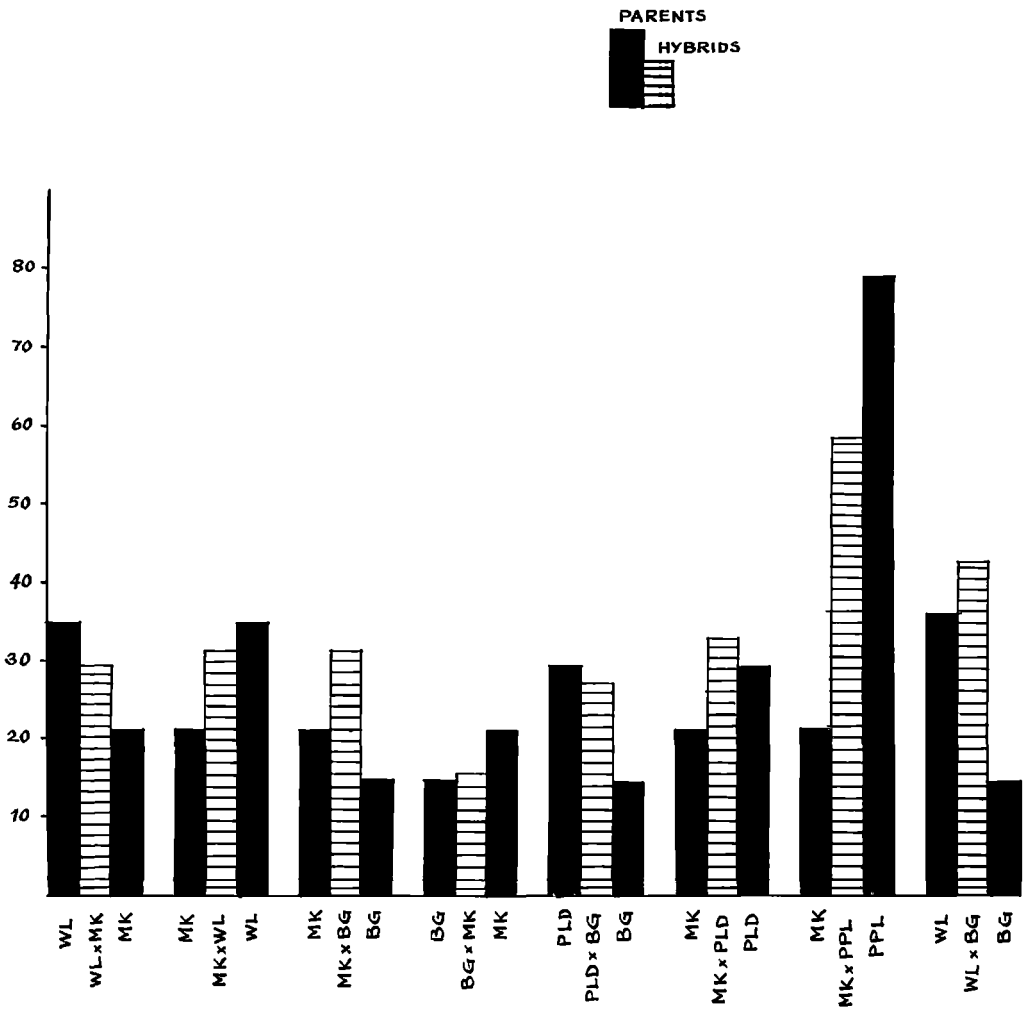


FIG 4

hybrids showed significant decrease in flower number. This decrease ranged from 17.85 per cent in(WL x MK) to 28.35 per cent in(BG x MK).

Among the five parental varieties the number of flowers was found to be least in Banaras giant(14.19) and the maximum of 79.41 in Pusa purple long. In the hybrids this value was found to be least in BG x MK(15.58) and maximum in MK x PPL(58.66). Most of the hybrids were intermediate between the parents with respect to this character.

The three different kinds of flowers produced were noted separately, the medium styled flowers were remarkably small in number and hence they were not subjected to statistical analysis.

2. Long styled flowers:- Results are furnished in Table IX.

TABLE.IX

Mean number of long styled flowers of parents and hybrid

Sl. No.	Crosses	Mean of				Mean increase or decrease of(in%)F1 over	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL+ x MK	15.90	14.89	13.48	12.08	6.77	17.95
2	PLD+ x BG	15.83	17.45	13.64	9.83	-9.28	16.05
3	MK x WL+	18.33	14.85	13.48	12.08	23.43	35.98
4	MK+ x BG	15.88	12.08	10.95	9.85	31.45	45.21*
5	MK xPLD+	18.75	17.45	14.66	12.08	7. 44	27.89
6	MK xPPL+	21.33	22.33	17.20	12.08	-4.52	24.01
7	BG x MK+	10.88	12.08	10.95	9.83	-6.95	-0.65
8	WL+ x BG	24.75	14.89	12.36	9.83	66.21*	100.25*

+Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

Two crosses showed their superiority statistically when F1 was compared to the mid parental value, the percentage increase being 45.2(MK x BG) and 100.25(WL x BG). The other five, though possessed higher values in number of long styled flowers, were not statistically significant. Only one hybrid(BG x MK) showed a decrease in the number of long styled flowers but this decrease was also not found to be significant.

Only one out of the eight crosses showed its significance when the better parental value was used for comparison. This increase of 66.21 per cent was recorded in the cross WL x BG.

The mean number of long styled flowers among parents and hybrids ranged from 9.83 to 22.83 and 10.88 to 24.75 respectively.

3) Short styled flowers:- Data are presented in Table X.

Four out of the eight hybrids produced increased number of short styled flowers and the remaining four decreased number, when the hybrids were compared with the parental mean. But only two in each group showed their superiority statistically. The number of short styled flowers produced by hybrids ranged from 2.39(BG x MK) to 36.41(MK x PPL). The range among parents was observed to be from 7.31 (BG)to 43.50(PPL).

When the better parental mean was taken as a criterion for comparison only one hybrid produced increased number of

TABLE X

Mean number of short styled flowers of parents and Hybrids

Sl. No.	Crosses	Mean of				Mean increase or decrease of(in%)F1 over	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL+ x MK	3.96	14.70	12.78	10.86	-73.06*	-69.01*
2	+PLD x BG	9.83	10.70	9.01	7.31	- 8.13	9.10
3	MK x WL+	13.33	14.70	12.78	10.86	- 9.31	4.30
4	+MK x BG	7.66	10.86	9.05	7.31	-29.46	-15.35
5	+MK xPLD	7.87	10.86	10.78	10.70	-27.53	-27.00
6	+MK xPPL	36.41	43.50	27.18	10.86	-16.30*	34.00*
7	BG x MK+	2.39	10.86	9.05	7.31	-77.53*	-73.59*
8	+WL x BG	17.66	14.77	11.01	7.31	20.13	64.00*

+ Better parents * Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta

BG = Banaras giant, PPL = Pusa purple long.

short styled flowers, but this increase was not found to be statistically significant. Though all the remaining hybrids produced lesser number of short styled flowers, this decrease was found to be significant only in three; they being MK xPPL(16.3 per cent); WL x MK(73.06 per cent) and BG x MK(77.53 per cent).

VI. NUMBER OF FRUITS.

Data relating to the mean number of fruits are given in Table XI.

The hybrids MK x PPL(19.00 per cent) MK x WL(47.77 per cent) MK x BG(77.18 per cent) and WL x BG(128.08 per cent) showed

Fig:-5 Bar diagram showing mean number of fruits of eight hybrids and respective parents.

MEAN NUMBER OF FRUITS PRODUCED BY

PARENTS & HYBRIDS

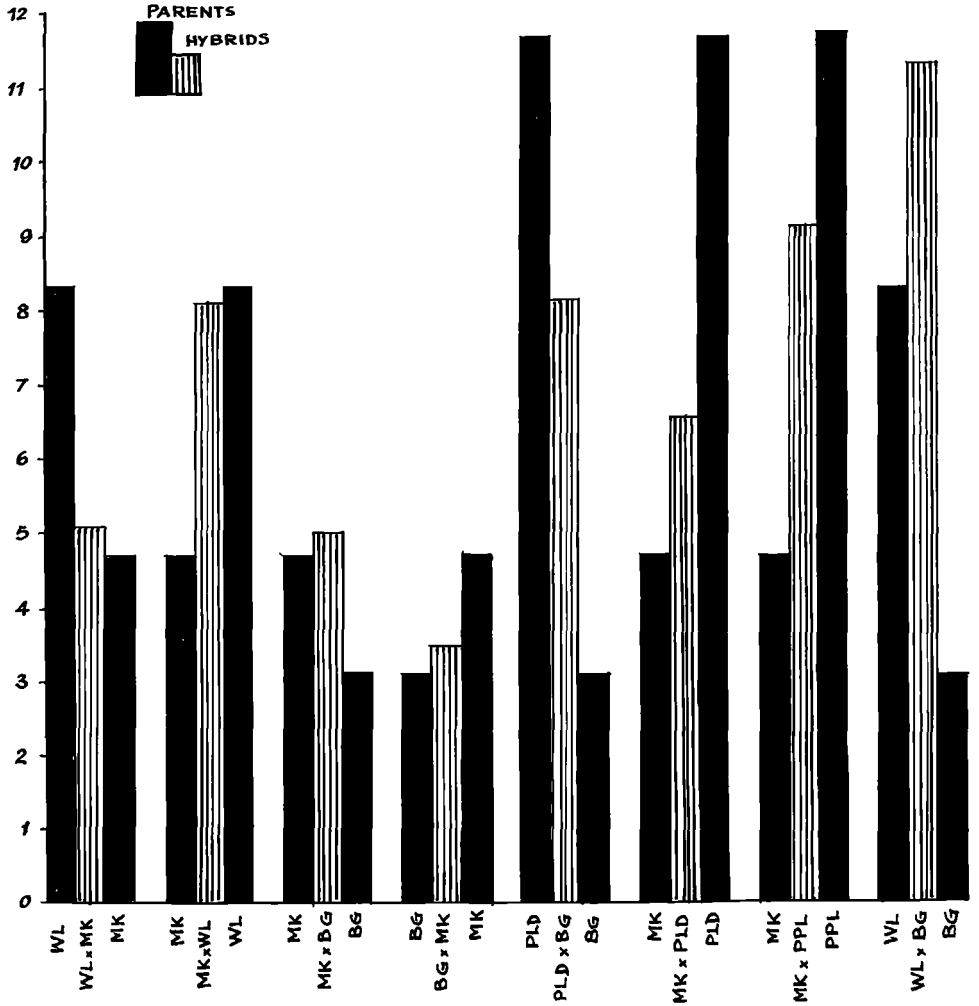


Fig 5

TABLE XI

Mean number of fruits(Total) parents and hybrids

Sl. No.	Crosses	Mean of F1	Mean of Better parent	Mean of Inferior parent	Mean increase or decrease of(in%) F1 over Better parent	Mean increase or decrease of(in%) F1 over Parental mean
1	WL+ x MK	6.07	8.45	6.73	4.30	-28.16*	-4.69
2	PLD+ x BG	9.22	11.70	7.47	3.24	-21.19*	23.43
3	MK x WL+	9.41	8.45	6.37	4.30	11.36	47.77*
4	MK+ x BG	6.66	4.30	3.77	3.24	55.34*	77.18*
5	MK x PLD+	7.33	11.70	8.00	4.30	-37.00	-8.37
6	MK x PL+	14.16	19.50	11.90	4.30	-27.37*	19.00*
7	BG x MK+	3.73	4.30	3.77	3.24	-13.25	-1.06
8	PL+ x BG	13.32	8.45	5.84	3.24	57.66*	128.08*

+ Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta

PG = Banaras giant, PPL = Pusa purple long

significant increase in number of fruits produced when the mid parental value was taken for comparison. The hybrid PLD x BG though showed an increase of 23.44 per cent failed to come at the level of significance.

When the better parental mean was taken for comparison only two hybrids were found to be superior. These hybrids viz. MK x BG and PL x BG showed an increase of 55.34 per cent and 57.66 per cent respectively over the mean of the better parent In four hybrids decrease was found to be significant.

Fig.6:- Bar diagram showing mean weight of fruits produced by eight hybrids and respective parents.

MEAN WEIGHT OF FRUITS (in kgs)

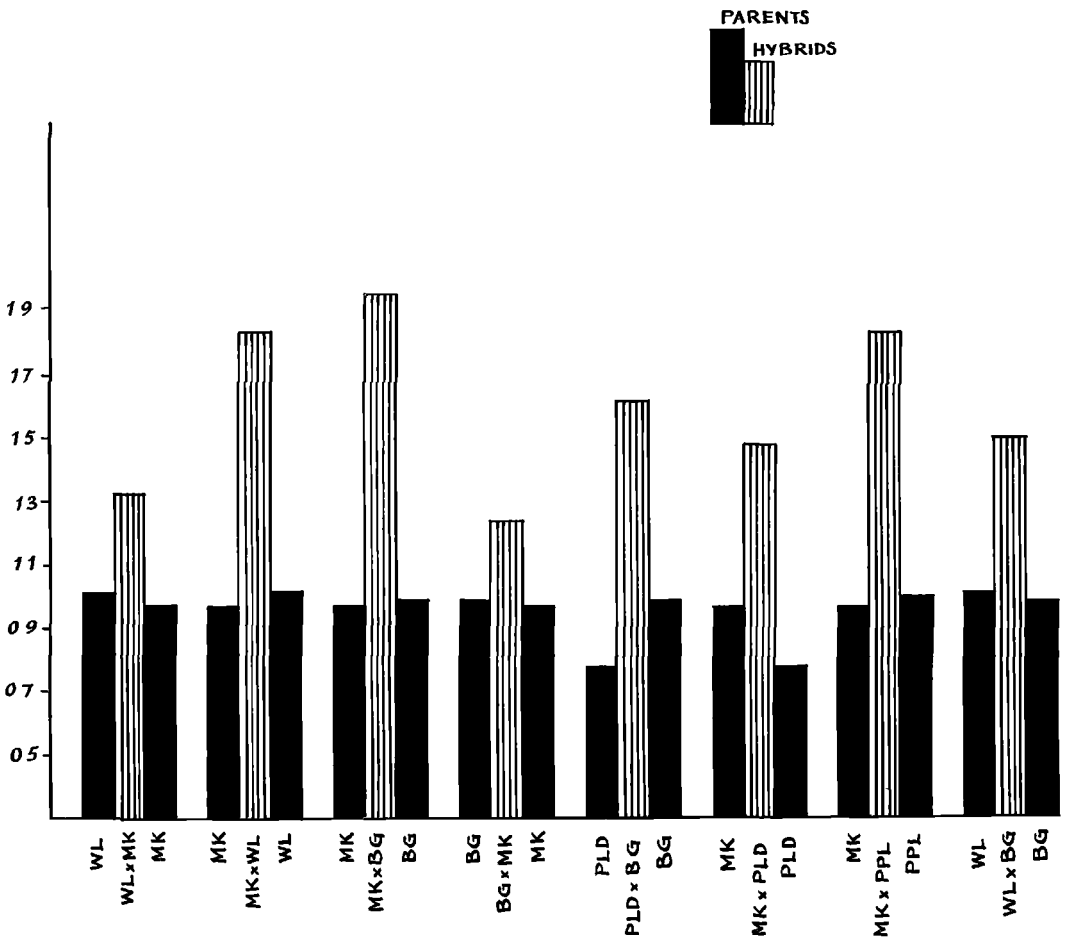


Fig 6

The average number of fruits produced by parents ranged from 3.24 to 19.50 while in hybrids this value ranged from 3.73 to 14.16.

VII. WEIGHT OF FRUITS

Results are furnished in Table XII

TABLE XII

Mean weight of fruits(in kg) of plants and hybrids

Sl. No.	Crosses	Mean of F1	Mean of Better parent	Mean of Parents	Mean of Inferior parent	Mean increase or decrease of(in%) F1 over Better parent	Mean increase or decrease of(in%) F1 over Parental mean
1	WL+ x MK	1.33	1.01	0.99	0.97	31.68	34.33
2	PLD x BC+	1.61	0.99	0.88	0.77	62.62*	88.00*
3.	MK x WL+	1.84	1.01	0.99	0.97	82.17*	85.88*
4	MK x BG+	1.96	0.99	0.98	0.97	98.00*	100.00*
5	MK+ xPLD	1.48	0.97	0.87	0.77	52.57*	70.11*
6	MK xPPL+	1.84	1.00	0.98	0.97	84.00*	86.73*
7	BG+ x MK	1.24	0.99	0.98	0.97	25.25	26.55
8	WL+ x BC	1.50	0.99	1.00	0.99	51.51*	50.00*

+ Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BC = Banaras giant, PPL = Pusa purple long.

With regard to weight of fruits six out of the eight hybrids showed significant increase over the mean of parents.

This increase ranged from 50.00 per cent in WL x BG to 100 per cent in MK x BG. Two hybrids, though showed slight increase ie.26.53 per cent(BG x MK) and 34.33 per cent in WL x MK failed to come at the level of significance.

When the better parental mean was considered all the above crosses which showed significant increase were also found to exhibit their superiority statistically and this increase ranged from 51.51 per cent(WL x BG) to 98 per cent (MK x BG). Here also two hybrids viz.BG x MK and WL x MK though showed slight decrease of 25.25 per cent and 31.68 per cent respectively over the mean of the better parent this did not come to the level of statistical significance.

It was noted here that none of the hybrids studied was observed to have values inferior to not only the mean of the parents but also to the better parental mean,which is a clear case of positive evidence of heterosis.

In hybrids the mean weight ranged from 1.24 kg(BG x MK) to 1.96 kg(MK x BG) per plant while in parents this range was from 0.79 kg(BG) to 1.01 kg in WL.

VIII.LENGTH AND GIRTH OF FRUITS

a)Length of fruits:- Table XIII

Six hybrids showed their superiority with respect to length of fruits, when the parental mean was considered. This increase ranged from 11.32 per cent(MK xPLD)to

42.00 per cent(in PLD x BG). Two hybrids showed a slight decrease in length of fruits but this decrease was not found to be significant.

TABLE.XIII

Mean length of fruits(in cm)of parents and hybrids

Sl.Crosses No.	Mean of				Mean increase or decrease of(in%)F1 over	
	F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1 WL x MK	23.74	18.43	18.42	18.41	28.81*	28.88*
2 PLDx BG	29.80	23.44	21.00	18.56	27.13*	42.00*
3 MK x WL	21.45	18.43	18.42	18.41	16.38*	16.44*
4 MK x BG	16.95	18.56	18.58	18.41	-8.67	-8.42
5 MK xPLD	23.29	23.44	20.02	18.41	-5.09	11.32*
6 MK xPPL	23.88	23.08	20.74	18.41	3.66	15.13*
7 BG x MK	21.49	18.56	18.48	18.41	15.84*	16.28*
8 WL x BG	17.21	18.56	18.49	18.43	7.32	6.92

+ Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta.
BG = Banaras giant, PPL = Pusa purple long.

When the better parental mean was considered six out of the eight hybrids were found to have higher values but only four out of the six crosses showed their superiority statistically. In superior hybrids the increase recorded was 15.84 in BG x MK, 16.38 in MK x WL, 27.13 in PLD x BG and 28.81 in WL x MK. Two hybrids showed a slight decrease in length of

fruits which was not found to be significant.

In hybrids the range was recorded to be from 16.95 cm(MK x BG) to 29.80(PLD x BG), while in parents it was from 18.41 cm(MK) to 23.44 cm(PLD).

b)Girth of fruits:- Table XIV

TABLE.XIV

Mean girth of fruits(in cm) of parents and hybrids

Sl. No.	Crosses	Mean of F1	Better parents	Parents	Inferior parent	Mean increase or decrease of(in%)F1 over. Better parent	Parental mean
1	WL x MK	20.65	24.37	21.52	18.67	-15.26*	-4.04
2	PLDx BG	22.14	30.48	21.71	12.95	-21.36	1.98
3	MKx WL	22.97	24.37	21.53	18.67	- 5.74	6.73
4	MKx BG	29.74	30.58	27.42	24.37	- 2.42	8.46
5	MKxPLD	13.92	24.37	18.66	12.95	-42.92	-25.40*
6	MKxPPL	13.26	24.37	19.67	14.97	-45.59	-32.58*
7	BGxMK	27.78	30.48	24.57	18.67	- 2.23	13.64*
8	WLxBG	27.78	30.48	24.57	18.67	- 8.85	13.06

+Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta.
BG = Banaras giant, PPL = Pusa purple long.

With respect to this character only two out of the hybrids showed significant increase over the mean of parents. The hybrids WL x BG and BG x MK recorded 13.06 per cent and 13.64 per cent increase respectively over the mean of parents.

The hybrids PLD x BG, MK x WL and MK x BG though recorded increase over the mean of parents failed to come to the level of significance. Three hybrids showed decrease, but only in to viz. MK x PLD(24.4 per cent) and MK x PPL(32.58 per cent) this decrease was found to be significant.

When the better parental mean was considered none of them showed significant increase, though in one hybrid ie.(BG x MK 2.23 per cent) there was a slight increase over the better parent. Seven hybrids showed decrease in girth of fruits, but only in two this decrease was found to be significant, the hybrids being WL x MK(150.20 per cent) and PLD x BG(27.36 per cent).

IX. NUMBER AND WEIGHT OF SEEDS.

a)Number of seeds:-

i)In crossed fruits:- Table XV.

When artificial crossing was effected, out of the eight crosses 3 showed an increase in number of seeds per fruit as compared to the mean of parents. This increase was maximum in the crossed fruit MK x PLD(87.13 per cent) followed by BG x MK (40.85 per cent) and MK x PPL(25.31 per cent). In five crosses the number of seeds was found to be less than the parental mean. This value ranged from 16.75 per cent in MK x BG to 78.58 in WL x BG.

When the better parental mean was considered the above mentioned three hybrids showed their superiority in this case also.

TABLE.XV

Mean number of seeds in crossed fruits and their selfed ones

Sl. No.	Crosses	Mean of F1	Mean of Better parent	Mean of Parents	Mean of Inferior parent	Mean increase of decrease of(in%) C.F. over. Better parent	Mean increase of decrease of(in%) C.F. over. Parental mean
1	WL x MK+	860	2376	2103	1830	-65.80	-59.10
2	PLD x BG+	1080	2076	1360	703	-46.37	-20.56
3	MK+ x WL	1822	2376	2103	1830	-23.31	-13.36
4	MK+ x BG	1828	2376	2196	2016	-23.04	-16.75
5	MK+ xPLD	2882	2376	1540	703	+21.29	+87.13
6	MK+ xPPL	2861	2376	2283	2190	+20.41	+25.31
7	BG x MK+	3058	2376	2171	2016	+28.70	+40.85
8	WL x BG+	421	2016	1925	1830	-79.11	-78.58

+Better parents

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long

The mean number of seeds in crossed fruits ranged from 421 in WL x BG to 3058 in BG x MK, white in parents this ranged from 703(PLD) to 2376(MK).

ii) In F1 fruits: Table XVI

Five out of the eight hybrids showed increase in number of seeds in F1 fruits when the parental mean was considered. This increase was 10.74 per cent in WL x MK 11.15 in MK x PPL, 30.81 per cent in BG x MK, 42.72 in MK x WL and 56 per cent in WL x BG. Three hybrids showed decreased number of seeds in their

fruits. This decrease was 28.44 per cent in MK x PLD, 29.80 per cent MK x BG and 56.8 per cent in PLD x BG.

TABLE.XVI

Mean number of seeds in F1 fruits and the parents.

Sl. No.	Crosses	Mean of				Mean increase or decrease of (in%) F1 over.	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL x MK+	1835	2316	1657.0	998	-20.76	10.74
2	PLD x BG+	955	3201	2162.0	1123	-70.78	-56.80
3	MK+ x WL	2365	2316	1657.0	998	+ 2.11	42.72
4	PPL x BG+	1936	3201	2758.5	2316	-39.51	-29.30
5	MK+ xPLD	1230	2316	1719.5	1123	-46.89	-28.43
6	MK+ xPPL	2302	2316	2070.5	1825	- 0.60	+11.15
7	BG+ x MK	3600	3201	2758.5	2316	+12.77	+30.87
8	WL x BG+	3201	3201	2099.5	998	-71.10	+56.00

+Better parents

WL = White long, MK = Muktakeshi, PLD =Puple long Dutt
BG = Banaras giant, PPL = Pusa purple long.

When the better parental mean was considered only two hybrids showed increased seed number white the remaining six hybrids showed decreased number of seeds.

In F1 fruits the number of seeds ranged from

925(WL x BG) to 3610 in(BG x MK) while in parents it was only 908 in(WL) and 3201 in(BG),

b)Weight of seeds:-

i)Weight of 500 seeds from crossed fruits:- Table XVII

TABLE.XVII

Mean weight(in gms) of 500 seeds from crossed fruits and selfed fruits

Sl.No.	Crosses	Mean of				Mean increase or decrease of(in%) over.	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	+WL x MK+	2.72	2.40	2.33	2.27	13.33	16.73
2	PLD x +BG+	2.20	2.48	2.25	2.03	-10.49	-2.22
3	MK x +WL+	2.30	2.40	2.33	2.27	- 4.16	-1.28
4	MK x BG	2.77	2.48	2.37	2.27	13.25	16.87
5	+MK+ x PLD	2.33	2.27	2.15	2.03	2.20	8.39
6	+MK+ x PPL	1.90	2.27	2.15	2.06	-16.38	-11.62
7	+BG+ x MK	3.09	2.48	2.37	2.27	24.60	30.39
8	WL x +BG+	3.08	2.48	2.42	2.40	24.59	26.99

+Better parents.

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

When the mean weight of the parents was considered, five hybrids showed increase in seed weight. This increase ranged from 8.39 per cent(MK x PLD) to 30.39 per cent(BG x MK). The decrease was recorded in three hybrids. The decrease ranged from 1.28 per cent(PLD x BG) to 11.62 per cent(MK x PPL).

When the better parental mean was considered all the above hybrids which showed increase and decrease in seed weight behaved alike. In the group where the seed weights is increased the range was between 2.20 per cent (MK x PLD) to 24.6 per cent (BG x MK). In the decreased group the range was from 4.16 per cent (MK x WL) to 16.38 per cent(MK x PPL). The mean weight of crossed seeds was found to be ranging in between 1.90 gms to 3.09 gms while in the parents this range was from 1.22 gms(PLD) to 1.49 gms(BG).

ii) Weight of 500 seeds from F1 fruits: Table XVIII

TABLE.XVIII

Mean weight (in gms) of 500 seeds from the F1 fruit and from the parents

Sl. No.	Crosses	Mean of				Mean increase or decrease of(in%) F1 over.	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL+ x MK	1.90	2.35	2.31	2.28	-19.19	-17.74
2	PLD x BG+	2.30	2.45	2.33	2.22	- 6.12	- 1.28
3	MK x WL+	1.92	2.35	2.31	2.28	-18.30	-16.45
4	MK x BG+	2.11	2.45	2.36	2.28	-13.87	-10.59
5	MK+ x PLD	1.93	2.28	2.24	2.21	-15.35	-13.85
6	MK+ x PPL	1.61	2.28	2.25	2.23	-29.38	-28.44
7	BG x MK+	2.53	2.45	2.36	2.28	+ 2.26	+ 7.27
8	WL x BG+	2.28	2.45	2.40	2.35	- 6.12	- 5.00

+Better parents.

WL = White long, MK = Muktakeshi, PLD = Purple long dutt
BG = Banaras giant, PPL = Pusa purple long.

Out of the eight F1 hybrids only one showed increased seed weight over the mean of parents. This increase was 7.2 per cent(BG x MK), All the remaining hybrids showed a decrease in seed weight. This decrease ranged from 1.28 per cent(PLD x BG) to 28.44 per cent in MK x PPL respectively.

When the better parental mean was considered only the hybrid BG x MK showed a slight increase of 3.26 per cent. In all the others the weight was found to be varying from 6.12 per cent in PLD x BG to 29.38 per cent in MK x PPL. The weight of seeds from F1 fruits was in between 1.61 gms(MK x PPL) to 2.53 gms(BG x MK). In parents this range was from 2.21 gms(PPL) to 2.45 gms(in BG).

X.GERMINATION CAPACITY

a)Seeds from crossed fruits:- Table XIX

TABLE XIX

Germination percentage of crossed seeds and their parents

Sl.No.	Crosses	Mean of				Mean increase or decrease of(in%)F1 over.	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL x MK+	24.00	18.00	15.00	12.00	33.33	60.00
2	PLD xBG	17.00	11.00	9.50	8.00	64.34	78.89
3	MK+ x WL	22.00	18.00	15.00	12.00	11.11	46.66
4	MK+ xBG	44.00	18.00	14.50	11.00	144.44	203.44
5	MK x PLD+	28.00	18.00	13.00	8.00	55.55	115.49
6	MK x PPL+	48.00	21.00	19.50	18.00	128.57	145.89
7	BG x MK+	28.00	18.00	14.50	11.00	55.55	93.10
8	WL+ xBG	25.00	12.00	11.50	11.00	108.33	117.39

+Better parents

WL = White long, MK =Muktakeshi,PLD =Purple long Dutta.

BG = Banaras giant,PPL = Pusa purple long.

The germination capacity of the hybrid seeds was found to be superior to the corresponding parental lines. When the mid parental value was considered all the hybrids showed an increased germination percentage. The range of increase was from 46.66 per cent(MK x WL) to 203.44 per cent(MK x BG).

When the better parental mean was considered the range was from 11.11 per cent(MK x WL) to 144.44 per cent in (MK x BG).

In the hybrid seeds the germination per cent ranged from 34 per cent(PLD x BG) to 96 per cent(MK x PPL) while in parents this range was from 16 per cent(PLD) to 21 per cent(PPL).

b) Seeds from F1 fruits:- Table XX.

When the germination capacity of the F1 seeds were tested, 6 out of 8 hybrids were found to be superior. The increase ranged from 36.84 per cent(PLD x BG) to 163.83 per cent in (MK x BG). Two hybrids showed a decrease in germination percentage, the decrease being 20 per cent in either case.

When the better parental mean was considered all the six hybrids mentioned above showed their superiority here also. The remaining two hybrids showed a decrease in percentage of germination. In the superior ones the range was from 30 per cent(PLD x BG) to 123.06 per cent(MK x BG). The decrease was 23.07 in(WL x MK) and 15.3 per cent(MK x WL).

TABLE.XX

Germination percentage of F1 seeds and their parents

Sl. No.	Crosses	Mean of				Mean increase or decrease of(in%) F1 over	
		F1	Better parent	Parents	Inferior parent	Better parent	Parental mean
1	WL x MK+	10.00	13.00	12.50	12.00	-23.07	-20.00
2	PLD+ x BG	13.00	10.00	9.50	9.00	13.00	36.84
3	MK+ x WL	11.00	13.00	12.50	12.00	-15.38	-20.00
4	MK+ x BG	29.00	13.00	11.00	9.00	123.06	163.63
5	MK+ x PLD	18.00	13.00	11.50	10.00	38.46	56.52
6	MK x PPL+	35.00	22.00	17.50	13.00	59.09	100.00
7	BG x MK+	17.00	13.00	11.00	9.00	30.77	54.54
8	WL x BG+	16.00	12.00	10.50	9.00	33.33	52.37

+Better parents.

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta
BG = Banaras giant, PPL = Pusa purple long.

In the hybrids the percentage of germination ranged from 20 per cent in WL x MK to 70 per cent in MK x PPL. While in parents this range was from 10 per cent(PLD) to 44 per cent(PPL).

CYTOLOGICAL STUDIES:

a)Studies on pollen sterility:

The data relating to sterility of pollen grains were found to be not significant. This showed that there was no significant difference in sterility between parents and hybrids.

b)Pollen measurement:- Table XXI

Out of eight crosses studied, four hybrids showed significant differences in size of pollen when it was compard with

the parental mean. The increase in diameter ranged from 3.29 per cent to 6.75 per cent. The maximum diameter of pollen grains was recorded by the hybrid WL x BG being 31.95 microns. Only one hybrid showed a slight decrease in diameter.

TABLE.XXI

Mean diameter of pollen grains parents and hybrids

Sl. No.	Crosses	Mean of F1	Better parent	Parents	Inferior parent	Mean increase or decrease of (in%) F1 over. Better parent	Parental mean
1	WL x MK+	28.37	29.37	28.96	28.56	-3.40	+2.05
2	PLD x BG+	28.69	30.87	29.63	28.40	-7.06*	-3.10
3	MK x WL+	28.97	29.37	28.96	28.56	-1.36	+0.03
4	MK x BG+	28.73	30.87	29.71	28.56	-6.93*	+2.39*
5	MK+ xPLD	29.88	28.56	28.48	28.40	4.56*	+4.91*
6	MK+ xPPL	29.49	28.56	28.44	28.33	3.27*	3.67*
7	BG+ x MK	29.24	30.87	29.71	28.52	-5.27*	+1.58
8	WL x BG+	31.95	30.87	30.12	29.37	3.46*	6.77*

+Better parents *Significant at 5% level

WL = White long, MK = Muktakeshi, PLD = Purple long Dutta.
BG = Banaras giant, PPL = Pusa purple long.

When the better parental mean was considered increase was found to be significant in three hybrids. The values being 3.27 per cent in MK x PPL, 3.46 per cent in WL x BG and 4.65 per cent in MK x PLD. In the remaining five hybrids three hybrids showed a significant decrease, the range being 5.27 per cent (BG x MK) to 7.06 per cent (PLD x BG). The remaining two showed decreases in pollen diameter but not up to the level of statistical significance.

In hybrids the mean diameter of pollen grains ranged from 28.37 microns(WL x MK) to 31.95 microns (WL x BG). In parents the value ranged from 28.33 microns (PPL) to 30.27 microns(BG).

c) Studies on pollen mother cells:-

The haploid chromosome number as determined from diakinesis and prometaphase was n = 12. Bivalent formation was the rule. Normal 12/12 separation and normal tetrad formation were also observed. The analysis variance Table and critical differences for various character has given in Table I to XIII.

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DISCUSSION

DISCUSSION

The results of observation from the first generation hybrids and their respective parents have been analysed fully and the results presented. Now it remains to discuss briefly, certain matters bearing on the analysis and interpertation of the data as a whole, so as to draw valid conclusions regarding the essential features of manifestation of heterosis.

From the results of the present investigation it is primarily noted that the extent or degree of expression of heterosis in brinjal varies with different parental combinations. This difference between the crosses may, perhaps, be due to the different degrees of genetic diversity between the parents. Similar results of varying degrees of heterosis in respect of several characters were also recorded by Nagai and Kida(1926), Kakizaki(1928, 30,31), Pal and Singh(1956), Venkataramani(1946), Odland and Hall(1948), Choudhury and George(1961) and Mishra(1961). Thus it may be concluded that different varieties respond to the expression of heterosis differently.

Vigour of hybrids can be expressed in various ways. It may be towards an increase in the gross size of the plant or in stepping up the yield or in any other quantitative or qualitative manner.

SIZE OF PLANT

Plant size is constituted mainly by the height, the spread and the number of branches. Increase in number of leaves will also have some effect on the ultimate size of the plant. In the present investigation none of the hybrids showed a reduction in plant height. Six out of the eight hybrids studied, were significantly superior in plant height, when the mid parental value was considered. This number was reduced to three when the F1 hybrids were compared with the better parent.

The facts presented above are in conformity with the results of several workers in egg plant. Nagai and Kida(1926), Tatesi(1927), Kakizaki(1930-31), Pal and Singh(1946), Venkataramani(1946),Mishra(1961), Choudhury and Mishra(1966) and others observed that among the F1 hybrids studied the increase inheight varied considerably. According to Rajbhandary(1960) the height of the F1 hybrids were within the range of parental limits.

Number of branches is an important economic character. Production of more number of branches may result in an increased scope for flower production which will ultimately end in increased number of fruits. Thus increased number of branches indirectly helps in increasing the yield. In the present study a general trend for

increase in yield with increase in number of branches was observed. Similar results were obtained by Nagai and Kida(1926), Kakizaki(1930-31), Pal and Singh(1946), Venkataramani(1946), Mishra(1961), Majbhandary(1966) and Choudhury and Mishra(1966).

In the case of number of leaves all the hybrids studied exceeded the mid parental value and this increase was statistically significant only in six out of eight.

This agrees with the findings of Balya(1918) and Venkataramani(1946). Increase in the number of leaves will result in an increased quantity of carbohydrate synthesised in the plant system, through the intensified photosynthetic activity which will have an ultimate effect on increased weight of fruits. Thus increase in number of leaves has an indirect bearing on the total yield. A comparison of the number of leaves produced with the total yield obtained in this study reveals a general trend in this line.

Spread of plant is an important morphological character which follows some what similar trend as in the case of height. Significant increase in spread is observed in six out of eight crosses studied. A close examination of the parental types revealed that some of them were tall and less spreading(PLD) while others were dwarf and more spreading(PPL), but among the F1 hybrids most of them showed increased spread although some were of intermediate nature too.

This is in agreement with the findings of earlier workers like Nagai and Kida(1926), Kakizaki(1930-31),Pal and Singh(1946), Mishra(1961) and Choudhury and Mishra(1966). Though the percentage of increase varied considerably in their studies this may be presumably due to the fact that the above authors made their studies in different selected types material under different environmental conditions.

YIELD CAPACITY

Yield in brinjal depends upon the number of fertile flowers produced per plant, number of fruits set, weight of individual fruit and its size constituted by length and girth. From the point of view of economic cultivation for culinary purpose, earliness and number and weight of fruit are also important factors.

Depending upon the length of style different authors classified flowers of brinjal into various categories. In the present study three different types of flowers were recognized viz; long styled, medium styled and short styled. Of the three only long and medium styled flowers are fertile and capable of bearing fruits. Seven out of eight F1 hybrids in the present investigation were found to produce more number of flowers with a greater proportion of lon and medium styled flower. This observation agrees with that of Mishra(1961) and Choudhury and Mishra(1966). This increased number of flowers produced will facilitate more number of fruit production which is the most desirable attribute from the economic point of view.

The number of fruits produced per plant as

well as their weight have direct relationship with yield. But opinion vary as to the comparative role of the above two factors in increasing the ultimate yield. According to Nagai and Tida(1926), Pal and Singh(1946),Venkataramani(1946) Mishra(1961), Rajkiciear and Palgy(1964) and Choudhury and Mishra(1966) it is the number of fruits produced that is greatly responsible for increasing the total yield. But according to Rajbhandary(1966) the increase in total yield of the hybrids over the parents is brought about not only by a pronounced increase in the number of fruits produced per plant, but also by the improvement of size and weight of fruits.

The present findings are also in agreement in with those of Rajbhandary. Five out of the eight hybrids studied in the present investigation showed an increase in the number of fruits produced per plant as compared to the mid parental value.

In the case of weight of fruits all the hybrids exceeded the mid parental limits. In the case of length of fruits six out of eight hybrids and in the case of girth five out of eight surpased the mean of parents.

In the present study it was found that all the three factors ie: number of fruits per plant, weight of fruits, and also size of individual fruits directly contributed in increasing the total yield of hybrids over their parents.

For economic cultivation early maturing types as profered. In the present study seven out of eight hybrids proved to be early flowering as compared to the mean

of parents. This earliness in flowering duration varied from 1 to 7 days. Thus the degree of hastening of flower production in F1 hybrids was observed to be widely different in different crosses. This is in accordance with the findings of Kakizaki(1931), Schmidit(1935),Venkataramani(1946), Mishra(1961), Rajbhandary(1966) and Choudhury and Mishra(1966). This earliness in flowering may perhaps be due to the dominance of early flowering nature over late flowering.

In the utilization of heterosis on a commercial scale the number of seeds per fruit and their weight have to be considered from two different angles.

In the case of crossed fruits the more the number of seeds per fruit, the higher is the practical utility, since the crossed fruits are utilised for the production of hybrid seeds only. But on the contrary,F1 fruits are utilised for culinary purpose, where seediness is an undesirable character. In the present study out of eight crosses studied 3 crosses showed increased number of seeds in crossed fruits. This increase in number ranged from 25.31 per cent to 87.13 per cent while in F1 fruits three hybrids were found to be having less seeds and the range of decrease was from 28.44 per cent to 56.80 per cent. Similar results have been obtained by Venkataramani(1946) in the case of crossed fruits.

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CYTOLOGICAL STUDIES

Though there was slight variation in percentage of sterility of pollen grains among the hybrids and parents this difference was not statistically significant. This is in conformity with the results of Capinpin,Lunde and Ponco(1963) and Oszvald and Palgy(1964) who had reported that there was no significant difference in sterility between intervarietal hybrids.

With regard to size of pollen four out of eight hybrids studied showed increase over the parental mean. This agrees with the results of Mishra(1962).

Studies of Meiosis revealed no abnormalities. Pairing was observed to be regular and normal 12/12 distribution at anaphase was observed. This has been reported to be so even in cases of inter-specific hybrids in Solanum (Babu Rao,1965).

Exploitation of hybrid vigour on a commercial scale involves extra expenditure for the production of hybrid seeds. This can be a practical proposition only in cases where increase in yield is capable of compensating the extra expenditure on higher cost of hybrid seeds. In the present study increase in yield of hybrids was in the order of 50 to 100 per cent over the mid parental value and 51.51 per cent to 98 per cent over the better parental mean. It

deserves mention that the hybrids in all the eight combinations studied have produced higher yield than even their better parents. This is sufficient to compensate the extra expenditure required for producing hybrid seeds of brinjal. The increase in yield obtained is so high that this phenomenon can be exploited on a commercial scale. It is worth mentioning here that in some of the advanced countries like Japan and U.S.A. a major portion of brinjal crop is produced through hybrid seeds and this can be profitably done in our country also.

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SUMMARY

S U M M A R Y

The present investigation was carried out in the Agricultural Botany division of the Agricultural College and Research Institute, Vellayani during the year 1966-1967.

A detailed study on the first generation hybrids of eight crosses involving 5 parental varieties of brinjal viz. Muktakeshi, White long, Pusa purple long, Purple long Dutta, Banaras giant were made on 11 characters and the following conclusions were drawn.

1. Height of plants

Out of eight hybrids studied six in comparison with mid parental value and three as compared to better parental mean showed significant increase in height.

2. Number of branches.

When the hybrids were compared with the parental mean 2 out of eight showed their superiority statistically. When the comparison was with the better parental mean, only one hybrid was found to be superior.

3. Number of leaves

Six out of eight hybrids showed significant increase when the mid parental value was considered. This was reduced to three when the hybrids were compared with better parental mean.

4. Spread of plants

Out of eight hybrids studied six in comparison with the mid parental value and three as compared to better parental mean showed significant increase in spread.

5. Time of flowering and number of flowers produced

Of the eight hybrids studied seven registered a flowering duration earlier than the mid parental value, and six earlier than the early parent.

Hybrids produced more number of flowers as compared to the mean of the parents and this increase was found to be significant in seven out of eight crosses studied.

6. Number of fruits produced

The different crosses produced are increased in number of fruits per plant. This increase was significant in five out of eight cases when the comparison was made with the parental mean.

7. Weight of fruits.

All the hybrids produced fruits of increased weight though this increase was found to be significant over the better parental value and parental mean only in six out of eight cases studied.

8) Length and girth of fruits

Six hybrids in case of length of fruits and two in case of girth showed their superiority as compared to the parental mean. In comparison with the better parent four out of eight hybrids showed significant increase in length. No hybrids showed significant increase in girth as compared to the better parent.

9) Number and weight of seeds.

Seeds were more in crossed fruits in three out of eight cases studied. In the case of F1 fruits five out of eight hybrids produced increased number of seeds as compared to the parental mean.

10)Germination

Hybrid seeds germinated earlier than their respective parents.

11. Cytological studies

a. Sterility:-

Hybrids did not differ from their respective parents in sterility of pollen grains.

b. Pollen diameter:-

Four hybrids as compared to mid parental value and three to the better parent registered significant increase in diameter of pollen grains.

c. Meiotis studies:-

Meiosis was normal in all the eight intervarietal hybrids studied.

Out of eight intervarietal hybrids studied the crosses WL x BG; MK x BG; MK x PPL showed clear positive evidence of heterosis in 10 out of 11 characters studied.

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A P P E N D I X

APPENDIX

TABLE-I

Analysis of variance Table for height of plants

Source	S.S.	D.F.	Variance	F.Ratio
Total	7549.66	47		
Replication	257.00	1	257.00	5.04*
Treatment	5558.59	12	463.02	9.08*
Error	1734.07	34	51.00	

* Significant at 5% level

C.D.for comparison for height of plants of hybrids and better parents.

1. T_1 & T_{10} = 11.98
2. T_2 & T_{12} = 12.57
3. T_3 & T_{10} = 11.98
4. T_4 & T_{11} = 11.59
5. T_5 & T_{12} = 12.57
6. T_6 & T_9 = 11.07
7. T_7 & T_{11} = 11.59
8. T_8 & T_{10} = 11.98

C.D.for comparison for height of plant of hybrids and mean ox parent.

1. T_1 = 10.37
2. T_2 = 11.18
3. T_3 = 10.90
4. T_4 = 10.78
5. T_5 = 11.08
6. T_6 = 11.92
7. T_7 = 10.78
8. T_8 = 11.18

TABLE.II

Analysis of variance table for number of branches

Source	S.S.	D.F.	Variance	F.Ratio
Total	425.08	47		
Replication	54.04	1	54.04	26.01**
Treatment	279.39	12	23.28	8.62**
Error	91.65	34	2.70	

** Significant at 5% level.

C.D.for number of branches produced parent(Better parent) and hybrids.

1. T_1 & T_{10} = C.D.2.72
2. T_2 & T_{12} = 2.86
3. T_3 & T_{10} = 2.72
4. T_4 & T_9 = 2.58
5. T_5 & T_{12} = 2.86
6. T_6 & T_{13} = 3.25
7. T_7 & T_9 = 2.58
8. T_8 & T_{10} = 2.72

C.D.for number of branches produced between mean of and hybrids.

T_1 = C.D.2.64
T_2 = 2.58
T_3 = 2.50
T_4 = 2.46
T_5 = 2.58
T_6 = 2.68
T_7 = 2.46
T_8 = 2.52

TABLE.III

Analysis of variance table or number of leaves produced

Source	S.S.	D.F.	Varince	F.ratio
Total	17533.62	47		
Replication	11404.02	1	1114.02	13.61*
Treatment	13636.38	12	1136.37	13.88*
Error	2783.22	34	81.86	

*Significant at 5% level

C.D.for comparison between better parental mean and hybrids.

1. T_1 & T_{10} = 15.81
2. T_2 & T_{12} = 15.83
3. T_3 & T_{10} = 14.81
4. T_4 & T_9 = 14.21
5. T_5 & T_{12} = 15.83
6. T_6 & T_{13} = 18.27
7. T_7 & T_9 = 14.21
8. T_8 & T_{10} = 14.81

C.D.for comparison between parental mean and hybrids.

T_1 = 14.41
T_2 = 14.21
T_3 = 10.55
T_4 = 13.50
T_5 = 14.01
T_6 = 14.32
T_7 = 13.50
T_8 = 13.43

TABLE.IV

Analysis of variance table for spread of plants

Source	S.S.	D.F.	Variance	F.ratio
Total	7388.51	47		
Replication	996.45	1	996.45	11.35*
Treatment	3400.68	12	283.39	3.22*
Error	2991.38	34	87.98	

*Significant at 5% level

1. T_1	& T_9	= 14.53	T_1	= 15.13
2. T_2	& T_{12}	= 16.48	T_2	= 14.81
3. T_3	& T_9	= 14.53	T_3	= 14.28
4. T_4	& T_9	= 14.53	T_4	= 14.15
5. T_5	& T_9	= 14.53	T_5	= 14.50
6. T_6	& T_9	= 14.53	T_6	= 15.37
7. T_7	& T9	= 14.53	T_7	= 14.15
8. T_8	& T11	= 15.13	T_8	= 14.40

TABLE.V

Analysis of variance table for numbers of flowers produced.

Source	S.S.	D.F.	Variance	F.ratio
Total	11275.30	47		
Replication	512.34	1	512.34	37.05*
Treatment	10292.63	12	857.71	62.01*
Error	470.33	34	13.83	

* Significant at 5% level.

C.D.for testing the number of flowers produced by better parents and hybrids.

1. T_1 & T_{10} = 6.18
2. T_2 & T_{12} = 6.55
3. T_3 & T_{10} = 6.18
4. T_4 & T_9 = 5.75
5. T_5 & T_{13} = 6.55
6. T_6 & T_{13} = 7.69
7. T_7 & T_9 = 5.75
8. T_8 & T_{10} = 6.18

C.D.between mean of parents and hybrids.

1. T_1 = 6.00
2. T_2 = 5.86
3. T_3 = 5.65
4. T_4 = 5.59
5. T_5 = 5.86
6. T_6 = 5.86
7. T_7 = 5.59
8. T_8 = 5.71

TABLE.VI

Analysis of variance Table for number of long styled flowers.

Source	S.S.	D.F.	Variance	F.ratio
Total	1214.48	47		
Replication	23.45	1	23.45	2.15
Treatment	821.56	12	68.46	6.30
Error	369.67	34	10.86	

C.D.for comparison between long styled flowers produced by mean by hybrids mean.

1. T1 & T10 = 5.42
2. T2 & T12 = 5.84
3. T3 & T10 = 5.42
4. T4 & T9 = 5.09
5. T5 & T12 = 5.84
6. T6 & T13 = 6.69
7. T7 & T9 = 5.09
8. T8 & T10 = 5.42

C.D.for comparison between parental mean and hybrid mean.

1. T1 = 5.27
2. T2 = 5.13
3. T3 = 6.11
4. T4 = 4.92
5. T5 = 5.13
6. T6 = 5.35
7. T7 = 4.95
8. T8 = 5.07

TABLE.VII

Analysis of variance table for number of short styled flowers produced

Source	S.S.	D.F.	Variance	F.ratio
Total	4490.54	47		
Replication	6.27	1	6.27	1.14
Treatment	4298.54	12	358.21	65.6*
Error	185.73	34	5.46	

* Significant at 5% level

C.D.for comparison between stors styled flowers produced by better parental mean and hybrids.

1. T1 & T10 = 3.87
2. T2 & T12 = 6.06
3. T3 & T10 = 3.87
4. T4 & T12 = 6.06
5. T5 & T12 = 6.06
6. T6 & T13 = 4.72
7. T7 & T12 = 6.06
8. T8 & T10 = 3.87

C.D.for comparison between parental mean and hybrid mean.

1.T1 = 5.22
2.T2 = 3.65
3. T3 = 3.55
4.T4 = 3.65
5. T5 = 3.61
6.T6 = 3.65
7.T7 = 3.65
8.T8 = 3.75

TABLE.VIII

Analysis of variance table for total number of fruits produced

Source	Sum of square	D.F.	Variance	F.ratio
Total	911.03	47		
Replication	3.68	1	3.68	2.28
Treatment	840.46	12	70.03	35.72*
Error	66.89	34	1.96	

* Significant at 5% level

C.D.for comparison between hybrids and mean of better parents.

1. T1 & T10 = 1.98
2. T2 & T12 = 2.45
3. T3 & T10 = 1.98
4. T4 & T9 = 2.15
5. T5 & T12 = 2.45
6. T6 & T13 = 2.84
7. T7 & T9 = 2.15
8. T8 & T10 = 1.98

C.D.for comparison between mean of hybrids and mean of parents.

T1 = 2.33
T2 = 2.17
T3 = 2.11
T4 = 2.09
T5 = 2.15
T6 = 2.13
T7 = 2.09
T8 = 2.12

TABLE.IX

Analysis of variance table for weight of fruits

Source	S.S.	D.F.	Variance	F.ratio
Total	7.9723	47		
Replication	0.7017	1	0.7017	13.37*
Treatment	5.4847	12	0.4571	8.71*
Error	1.7859	34	0.0525	

* Significant at 5% level

C.D.for comparison between hybrid and better parents.

1. T1 & T10 = 0.39
2. T2 & T11 = 0.36
3. T3 & T10 = 0.39
4. T4 & T11 = 0.36
5. T5 & T9 = 0.35
6. T6 & T13 = 0.48
7. T7 & T11 = 0.36
8. T8 & T11 = 0.36

C.D.for comparison between hybrid and mean of parents

T1 = 0.37
T2 = 0.36
T3 = 0.35
T4 = 0.35
T5 = 0.35
T6 = 0.38
T7 = 0.35
T8 = 0.35

TABLE.X

Analysis of variance table for length of fruits

Source	S.S.	D.F.	Variance	F.ratio
Total	501.60	47		
Replication	0.02	1	0.02	
Treatment	429.54	12	35.79	16.88*
Error	72.04	34	2.12	

*Significant at 5% level

C.D.for comparison of length of fruits between better parental mean and hybrids.

T1 & T10 = 2.39
T2 & T12 = 2.55
T3 & T10 = 2.39
T4 & T11 = 2.33
T5 & T12 = 2.55
T6 & T13 = 1.45
T7 & T11 = 2.33
T8 & T11 = 2.33

C.D.for comparison of length of fruits between mean of parents and hybrids.

T1 = 2.33
T2 = 2.53
T3 = 2.41
T4 = 2.19
T5 = 2.37
T6 = 2.37
T7 = 2.19
T8 = 2.25

TABLE.XI

Analysis of variance table for girth of fruits

Source	S.S.	D.F.	Variance	F.ratio
Total	1622.68	47		
Replication	10.18	1	10.18	2.52
Treatment	1476.34	12	122.94	30.50*
Error	137.16	34	4.03	

* Significant at 5% level

C.D.comparison for girth of fruits of hybrids and better parents.

T1	&	T9	= 3.10
T2	&	T11	= 3.20
T3	&	T9	= 3.10
T4	&	T 11	= 3.20
T5	&	T9	= 3.10
T6	&	T9	= 3.10
T7	&	T11	= 3.20
T8	&	T11	= 3.20

C.D.for comparison for girth of fruits of hybrids and mean of parents.

T1	= 3.24
T2	= 3.12
T3	= 3.04
T4	= 3.04
T5	= 3.10
T6	= 3.24
T7	= 3.04
T8	= 3.04

TABLE.XXII

Analysis of variance Table for pollen sterility

Source	S.S.	D.F.	Variance	F.ratio
Total	205.84	47		
Replication	0.15	1	0.15	
Treatment	84.63	12	7.05	1.9 N.S.
Error	121.06	34	3.56	

N.S. = Not significant

TABLE.XIII

Analysis of variance Table for size of pollen

Source	S.S.	D.F.	Variance	F.ratio
Total	62.91	47		
Replication	0.08	1	0.08	0.20
Treatment	49.51	12	4.12	10.56*
Error	13.32	34	0.39	

* Significant at 5% level

C.D.for comparison betweenmean of hybrids and better parents

1) T1 & T10 = 1.01
2) T2 & T11 = 1.03
3) T3 & T10 = 1.01
4) T4 & T11 = 1.03
5) T5 & T9 = 0.91
6) T6 & T9 = 0.91
7) T7 & T11 = 1.03
8(T8 & T11 = 1.03

C.D.for comparison between mean of parents and hybrids.

T1 = 1.03
T2 = 0.95
T3 = 0.93
T4 = 0.96
T5 = 0.95
T6 = 1.01
T7 = 0.93
T8 = 0.94

ILLUSTRATIONS

PLATE.I

Fig. 1 Photograph of the hybrid MK x WL and the respective parents.

MK = Muktakeshi - Female parent
WL = White long - Male parent

Fig. 2 Photograph of the hybrid WL x MK and the respective parents.

WL = White long - Female parent
MK = Muktakeshi - Male parent

Fig. 3 Photograph of the hybrid WL x BG and the respective parents.

WL = White long - Female parent
BG = Banaras giant Male parent

PLATE.II

Fig.1 Photograph of the hybrid MK x PLD and the respective parents.

MK = Muktakeshi - Female parent

PLD = Purple long Dutta - Male parent

Fig.2 Photograph of the hybrid MK x BG and the respective parents.

MK = Muktakeshi - Female parent

BG = Banaras giant - Male parent.

Fig.3 Photograph of the hybrid MK x PPL and the respective parents.

MK = Muktakeshi - Female parent

PPL = Pusa purple long - Male parent

PLATE.III

Fig.1 Photograph of the hybrid BG x MK and the respective parents.

BG = Banaras giant - Female parent

MK = Muktakeshi - Male parent

Fig.2 Photograph of the hybrids PLD x BG and the respective parents.

PLD = Purple long Dutta - Female parent

BG = Banaras giant - Male parent.

PLATE.IV

Fig:- 1 Photograph of the crossed fruits of Banaras giant.

Fig:- 2. Photograph of the fruits of the hybrid PLD ? BG and their respective parents.

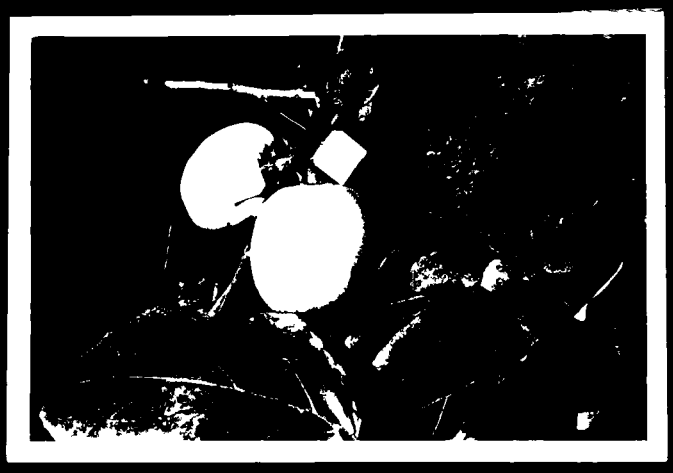
PLD = Purple long Dutta

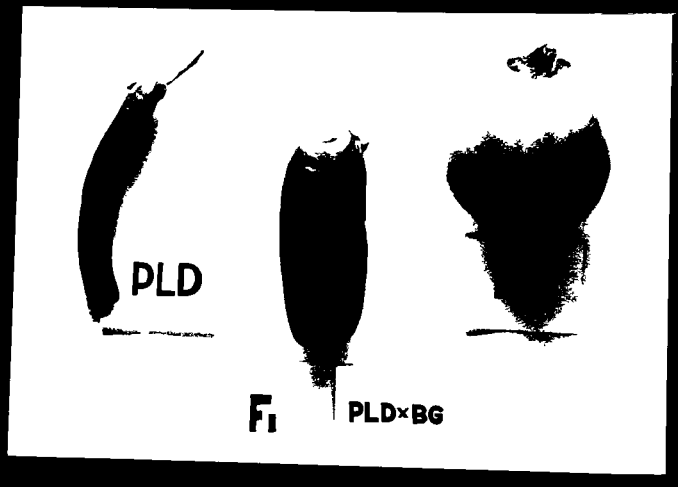
BG = Banaras giant

Fig :-3 Photograph of F1 fruits of the hybrid MK x WL and their respective parents.

MK = Muktakeshi

WL = White long.




PLD
F1
PLD×BG

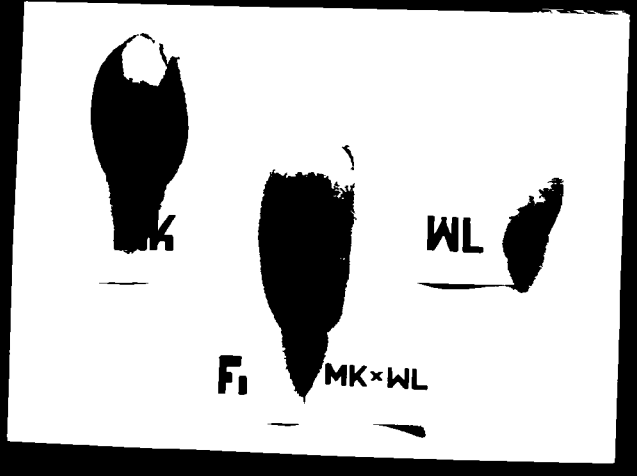

K
WL
F1
MK×WL

PLATE.V

Fig:- 1 Photogrpah of the F1 fruit of the hybrid MK x PPL and the respective parents.

MK = Muktakeshi

PPL = Pusa purple long.

Fig:-2 Photograph of the fruit of F1 hybrid WL x MK and the respective parents.

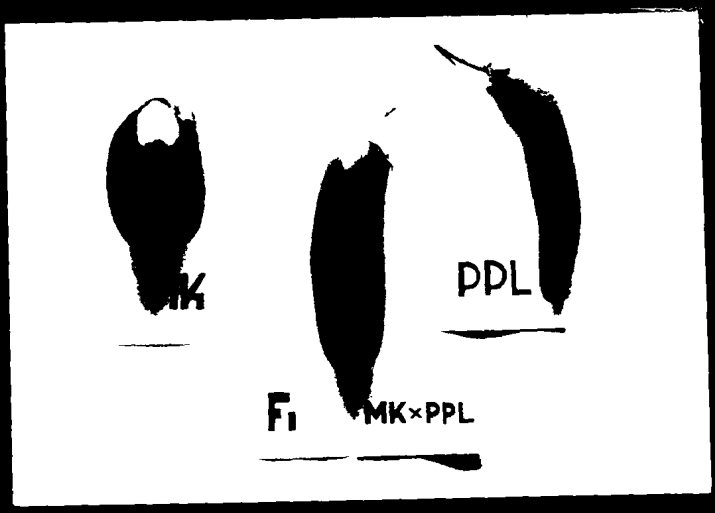
WL = White long

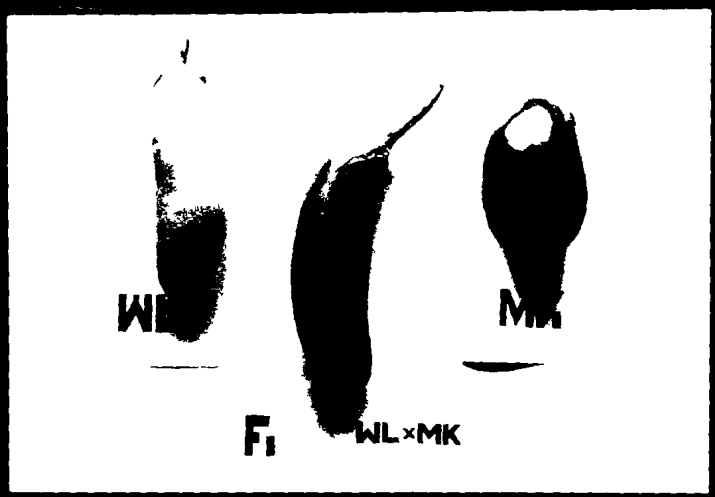
MK = Muktakeshi

Fig:-3 Photogrpah of F1 fruit of the hybrid BG x MK and the repsective parents.

BG = Banaras giant

MK = Muktakeshi.


PPL
F1 MK×PPL


F1 WL×MK

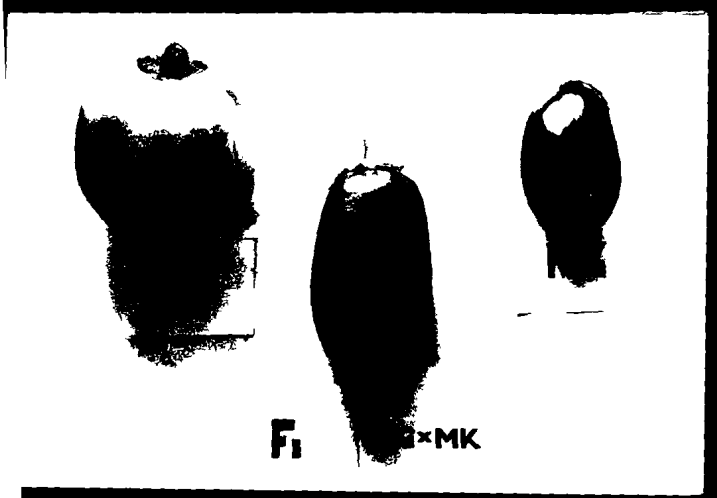

F1

PLATE.VI

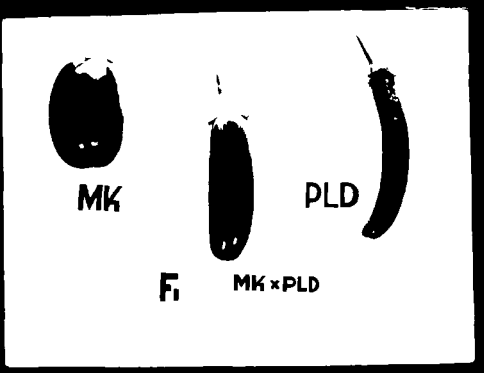
Fig:- 1 Photograph of F1 fruit of the hybrid MK x PLD and the respective parents.

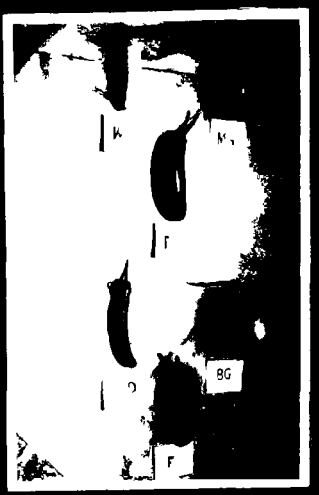
MK = Muktakeshi

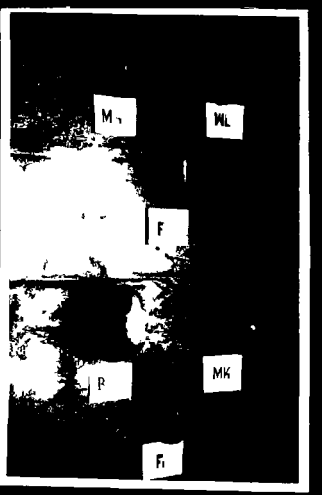
PLD = Purple long dutta

Fig:-2 Colour photographs of the F1 fruit of the cross(1)WL x MK and their respective parents(2)PLD xBG and their respective parents.

Fig:-3 Colour photographs of the F1 fruit of the cross(1)MK x WL and their respective parents(2)BG x MK and their respective parents.


MK
PLD
F1
MK×PLD


BG
F


WL
F
MK
F1