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A Male Sterile Pepper (*C. annuum* L.) Mutant

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Summary. 1. After treatment of dry seeds of red pepper *Capsicum annuum* L. with X-rays a male-sterile mutant was discovered in the M_2.

2. The male-sterile mutant segregates in a ratio of 3.28:1 ($\chi^2 = 3.148$, probability 0.07).

3. After an alternative cultivation of male-sterile plants and of a variety with good combining ability relatively good fruit-setting and seed production was obtained.

4. Grafting of male-sterile scions to normal stocks does not affect the male-sterile phenotype.

Many authors (DESHPANDE 1933, PAL 1945, MARTIN 1949, DASKALOFF and MURTAZOV 1955, CHRISTOFF 1956, ANGELI 1957, FUJII, MASABAYASHI and KUWAHARA 1959, DASKALOFF and POPOVA 1960, etc.) have observed high heterosis effects in pepper which manifest earliness, total yield, disease resistance, adaptability to unfavorable conditions and other important qualities. Lots of excellent hybrid varieties are already developed, but their distribution is very limited, due to the high cost of hybrid seed, which is obtained with great difficulty by hand emasculation and pollination. The practical use of heterosis in pepper depends on the development of new techniques which will lead to cheap hybrid seed production without or with very little manual work. The use of male sterility may prove very successful in this respect as it has already done in maize, sorghum, sugar beet, onion etc.

Several types of male sterility are known in the genus *Capsicum*. MARTIN and CRAWFORD (1951) have discovered in *C. frutescens* L. three — one which is totally sterile, another which is male sterile in the field and a third one which proves male sterile under greenhouse condition only; grown in the field the latter is fertile. The authors draw attention to the possibility of using the last two types in hybrid seed production. In *C. annuum* L., PETERSON (1958) has found a male sterile form which is due to interaction between the sterile cytoplasm (*S*) and a nuclear gene (*ms*). The original male sterile plant has been found among a group of seedlings of the Bureau of Plant Introduction pepper accession No. 164835. Using this form OHTA (1961) has made crosses with different Japanese varieties; he recommends it for hybrid seed production. Another type of male sterility was discovered by RUSINOVA-KONDAREVA (1965) in the F_4 generation of interspecific hybrids from the cross *C. peruvianum* var. *bicoloratum* and var. *longisiliquum* and *C. annuum* varieties. The male sterile plants backcrossed with different varieties of *C. annuum* gave only male sterile plants. This is probably a case of cytoplasmic male sterility and, due to the lack of a pollen restorer, the line cannot be used at present for hybrid seed production.

In 1965* the author began experimental work with the purpose of obtaining economically valuable pepper mutants by X-ray irradiation of dry seeds, the main object being to find male sterile plants useful for breeding heterosis varieties and for theoretical studies of male sterility in pepper.

Material and Methods

The old Bulgarian variety Pazardjiska kapia No. 794 was chosen as initial variety. It was developed in 1939 in the Institute for vegetable crops „Maritza" in Plowdiv by single plant selection; the variety is late ripening, has a high yield and very high economic qualities. This variety is used as parent in one of the Bulgarian hybrid varieties D 103 × Pazardjiska kapia No. 794.

Dry seeds were irradiated with X-rays as follows: 180 kV, 22 mA, distance 40 cm, 0,5 mm Cu and 120 r/min. Prior to irradiation the seeds were calibrated for moisture in an exsiccator with saturated $CaCl_2$ solution and blowing of air which has passed through a vial with saturated $CaCl_2$ solution for 4 days.

The M_1 plants were grown in the field on an isolated plot. Seeds were gathered separately from every M_1 plant. In M_2 families were grown containing each 25 plants.

Results and Discussion

In order to determine lethal doses (LD), seeds calibrated for moisture were irradiated with doses from 4 Kr to 22 Kr at intervals of 2 Kr. 300 seeds were irradiated by each dose and were sown 11 days after irradiation. The results of this trial are expressed in

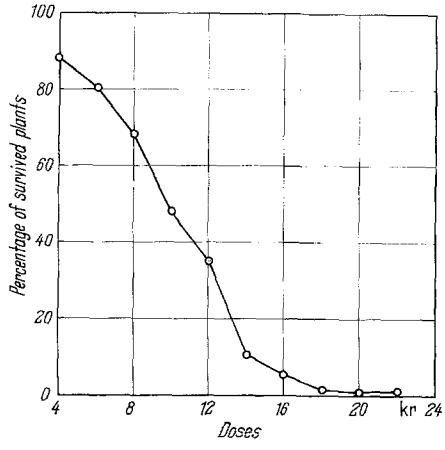

Fig. 1. Percentage of survical plants after treatment with different Kr doses

* The experimental work is carried out in the Institute of Genetics and Plant Breeding, Sofia, under the scientific guidance of Prof. STUBBE and Dr. ZACHARIAS from the Institute for Research of Cultivated Plants in Gatersleben (GDR).

fig. 1. They lead to the conclusion that LD = 50 is about 10 Kr.

In 1965 2000 seeds were irradiated with 12 Kr and the M_1 was grown in the field. Next year 620 families from M_2 were grown, from which different types of mutants were selected, namely: male sterile, chlorophyll mutants, mutants with changed fruit shape, with changed fruit colour, with changed leaf shape etc. The results of this work will be reported in a later publication. In the present paper the author briefly reports on a male sterile mutant which is useful in hybrid seed production and in theoretical investigations concerning male sterility in pepper.

Subsequent to a careful study of 15500 M_2 plants, 8 male sterile plants were discovered in family No. 215. The anthers of these plants were reduced in size (one half to two third of the normal size), shrunken and contained almost no pollen (fig. 2). Microscopic examination of the anthers showed only 1–3 normally developed and stained (4 per cent acetocarmine) pollen grains per anther. Unstained pollen grains were not detected. A certain variation in the colour of the anthers from white yellow to purple was observed in one and the same plant. These male sterile plants grow normally and do not differ from the initial variety in general features, but the male sterility is present both under greenhouse and field condition. Grafting of male sterile scions on normal stocks was without influence on the male sterility.

In 1966 under greenhouse conditions in an isolated chamber, heterozygous plants from a cross of male sterile plants with the initial variety were grown. The seeds obtained were sown in 1967 and the segregation ratio was studied. From all 2105 plants 1614 were fertile and 491 male sterile, which gives a segregation ratio of 3,28:1 ($\chi^2 = 3{,}148$, probability = 0,07). This leads to the conclusion that the male sterility is determined by one recessive gene.

In order to find out whether the male sterility is due to one nuclear gene only or to the interaction between a nuclear gene and the changed cytoplasm and also to prove whether the gene causing male sterility in our case is identical with PETERSON's* gene symbolized in the gene list of pepper by LIPPERT et al. (1965) with *ms* the necessary crosses were made. The results of these investigations will be published separately.

In order to transfer male sterility to varieties with good combining ability crosses were made between male sterile plants and such varieties. Another series of crosses were made in order to find out the combining ability of the male sterile line itself and in comparison to the initial variety. A preliminary comparative trial of Pazardjiska kapia No. 794 × D-103, Pazardjiska kapia No. 794 (male sterile) × D-103, Pazardjiska kapia No. 794 and D-103 showed that the combining ability of the male sterile line does not differ from that of the initial variety. Both hybrid combinations are significantly earlier than the parent varieties, but the differences between them are insignificant.

* Seeds from the genotype (*S*)*msms* and (*N*)*msms* were received from Dr. PETERSON and we are very grateful to him for that.

Fig. 2. (left to right). Left: buds of normal and male sterile plants; right: normal and male sterile flowers

In 1967, the possibility of obtaining hybrid seed without manual work for emasculation and pollination was tested under field conditions. On an isolated plot the male sterile plants and the pollen variety D-103 were planted in alternating rows. The male sterile plants were selected after anthesis. Before that it is not possible to distinguish them from heterozygous and normal plants. Up to now no pleiotropic effect of this gene for male sterility is observed. Only a slight tendency of the heterozygous plants to bloom earlier was noticed. The results of this experiment are encouraging. Good fruit set was obtained and a satisfactory number of seeds per fruit. From 10 fruits of Pazardjiska kapia No. 794 (male sterile) × D-103 1496 seeds were obtained while 10 fruits of the initial variety Pazardjiska kapia No. 794 gave 2455 seeds. According to our observations pollination is made by bees, trips, aunts etc.

The optimal ratio between female and pollen plants, planting scheme, time for sowing and planting of the parents is to be determined by future experiments.

The author expresses his gratitude to Prof. STUBBE and Dr. ZACHARIAS for their scientific guidance and to Dr. PEISKER and Mr. VOGT for the precise X-ray treatment of the seeds – all from the Institute for Research of Cultivated Plants in Gatersleben, and to Mrs. RUSINOVA-KONDAREVA for her advice and also to Mrs. PERFANOVA for her technical assistance as well as to all colleagues of the Institute of Genetics and Plant Breeding in Sofia who helped in the work.

Zusammenfassung

1. Nach der Behandlung von trockenen Paprika (*C. annuum* L.)-Samen mit Röntgenstrahlen wurde in der M_2 eine männlich-sterile Mutante entdeckt.

2. Die männlich-sterile Mutante spaltet im Verhältnis 3.28:1 ($\chi^2 = 3{,}148$, Wahrscheinlichkeit 0,07).

3. Bei einer alternativen Auspflanzung von männlich-sterilen Pflanzen und einer Sorte mit guter Kombinationseignung wurde ein verhältnismäßig guter Fruchtansatz und eine ausreichende Menge Samen erzielt.

4. Die Pfropfung männlich-steriler Reiser auf eine normale Unterlage beeinflußt den männlich-sterilen Phänotyp nicht.

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