VARIETAL SENSITIVITY ANALYSIS IN *Cucumis melo* L. USING GAMMA RAYS AND ETHYL METHANE SULPHONATE

BY

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Thesis

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DECLARATION

I hereby declare that this thesis entitled "Varietal sensitivity analysis in Cucumis melo L. using gamma rays and ethylmethane sulphonate" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any University or Society.

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CERTIFICATE

Certified that this thesis entitled "Varietal sensitivity analysis in Cucumis melo L. using gamma rays and ethylmethane sulphonate", is a record of research work done independently by Sri.NELSON LOPEZ under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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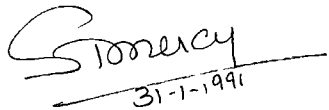

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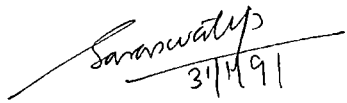

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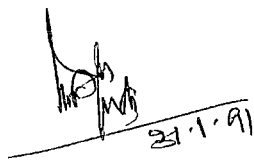

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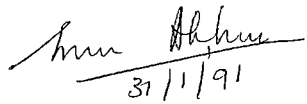

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INTRODUCTION

INTRODUCTION

Genetic variability is essential for any crop improvement programme, hence the creation and management of genetic variability become central to crop breeding. Experimentally induced mutations provide an important source of variability and such artifically induced variability forms the basis for further improvement and evaluation of new varieties.

After the discovery of radiation induced mutagenesis by Muller (1927), plant breeders began to use this technique in a search for novel mutations and additional variability in qualitative as well as quantitative traits. Soon after this, chemical mutagenesis was discovered by Auerbach (Auerbach and Robson, 1947) and this made the investigations on mutagenesis more widely available. A great stimulus was provided by Gustafsson (1947) who was able to induce a substantial number of very useful mutants in barley.

Induced mutations can be generated by physical and chemical agents. Included in the physical agents are the X-rays, gamma rays, beta rays, fast and slow neutrons, alpha particles, deuterons and ultra violet

light, X-rays and gamma rays are by far the most commonly used. The chemical agents include several forms of methane sulphonate, ethyleneimine, diepoxybutane, nitrogen mustards and ethylene oxide. Of these ethyl methane sulphonate (EMS) has been frequently used to induce mutations, specially in soft plant materials.

Chemical mutagens induce more of gene or point mutations and fewer chromosome breaks compared to physical mutagens which produce a random distribution of chromosome breaks. A regional specificity has been attributed to many chemical mutagens. Chemical mutagens produce relatively more intrachromosomal than inter chromosomal changes.

Application of different mutagens as well as different doses of each induce varying degrees of gene mutations and damaging effects. High mutation rates as well as high proportions of mutations in comparison to damage are essential for the economic use of mutagens. The release of commercially important mutants in several crop varieties demonstrates the efficiency of artificial mutagenesis.

Comparatively fewer studies on induce mutagenesis have been carried out in cucurbitaceae. This is one among the more important plant families that are well

known for their value as vegetables, fruits and medicinal products. The cultivated species of this family are not nearly as significant in man's economy as the cereals or the legumes, but in the tropics, sub tropics and warmer portions of the temperate zones, they are crops of more than ordinary importance. Cucumis melo L. which comes under cucurbitaceae includes muskmelon and oriental pickling melon which is commonly known as 'Cucumber' in Kerala. Muskmelons are mostly used as dessert fruits while the oriental pickling melon as ingredients of salad, vegetable and for pickling. They are good sources of carbohydrates, vitamin A, C and minerals.

The present work is intended to investigate the mutagenic effects of gamma rays and EMS on cucumber/ melon (Cucumis melo L.) with a view to assess the amount of genetic variability that can be induced in this crop. It will also evaluate the extent of varietal response exhibited by the crop to different doses of EMS and gamma rays.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Hugo De Vries was the first to suggest the idea of inducing mutations artificially as early as 1901 and using them for breeding. Numerous attempts have been made to induce mutations by high energy radiations and also by other physical and chemical treatments. Since then Mac Dougall, Vail and Shull (1907) treated Oenothera with radium and Morgan (1911), Loeb and Bancroft (1911) used it in Drosophila. Though a few mutants were obtained in these cases they failed to convince other workers that their results were due to treatment effect. In 1927, Muller was able to produce marked increase in the frequency of newly arising sex-linked recessive lethals in Drosophila with X-rays. This was the first clear example of the artificial induction of mutations. Successful experiments of Stadler (1928 a,b) in inducing mutations in barley and maize led to the use of all kinds of physical mutagens by many workers (Gustafsson, 1947; Delaunay, 1931; Sapehin, 1936; Freisleben and Lein, 1944).

The induction of mutations by chemical means was attempted by many workers over a long period (Shiemann, 1912), but not until 1947 when Auerbach and Robson discovered the mutagenicity of mustard gas (Auerbach and Robson, 1947) began the active and productive study of chemical mutagens. Studies of Rapoport (1948) established the high mutagenicity of epoxides and epimines in Drosophila.

Freese (1963) classified chemical mutagens as base analogue substitutes, dyes, acids, metals and alkylating agents. Alkylating agents especially Ethyl Methane Sulphonate (EMS) has proved to be very effective in higher plants. This is due to its relatively low toxic and high genetic effects (Gaul, 1961). Its high mutagenic effectiveness as well as efficiency in higher plants (Konzak et al. 1965) hold promise for its greater use in mutation breeding in crop plants.

For effective utilization of mutation technique an understanding of mutagen specificity and varietal response is indispensable. The efficiency of artificial

mutagenesis has been demonstrated by the release of commercially important mutants in several crop varieties.

Detailed reviews on the various aspects relating to induction of mutations have been presented by many investigators (Gaul, 1961, 1964; Konzak et al. 1965; Gregory, 1966; Gustafsson, 1969; Nilan et al. 1969; Sigurbjornsson and Micke, 1969; Brock 1971 and Davies, 1971).

Here an attempt is made to present a detailed review of mutation research conducted in cucurbits.

I. Effect of mutagens in the M_1 generation

Mutagens disturb the normal biological organization of an organism and these effects manifest in the M_1 generation in a variety of ways like; (1) reduced germination, (2) reduction in survival, (3) growth inhibition, (4) reduced fertility, (5) chlorophyll chimeras, (6) other morphological and developmental abnormalities.

i) Germination of seeds

Irradiation of seeds of Cucurbita maxima with 4 or 50 kR gamma (γ) rays suppressed germination as observed by Goranov (1972a). Sen and Datta (1976) found that when dried seeds of cucumber (Cucumis sativus L.) were irradiated with gamma rays or X-rays at 25-55 kR, seed germination percentage was reduced by the highest dosage but was little affected by other doses. Danno et al. (1980) while investigating the effects of gamma radiation upto 220 kR on wet and dry seeds found that emergence of treated dry seeds was unaffected upto 60 kR, reduced by 20 per cent at 100 kR and inhibited above 220 kR. Germination of wet seeds was reduced by one tenth of the dose required to reduce germination of dry seeds. Narang and Prakash (1983) noticed that as irradiation of seeds with gamma rays increased (5,10,15 and 20 kR) germination decreased in Citrullus lanatus cultivar (cv) Ashai yamato, Lagenaria siceraria cv. Pusa summer and Citrullus lanatus var. fistulosus cv. Ludhiana, but was little affected in Luffa cylindrica cv. Pusa chikni, Cucumis sativus cv Japanese Long Green, Momordica charantia cv. Coimbatore long and Citrullus lanatus cv.

Sugarbaby. Reduction in germination to 40 per cent in M_1 generation and 23 per cent in M_2 generation was reported by Yadava and Singh (1984) when healthy seeds of Cucumis melo var. momordica was irradiated with 5, 10,15 and 20 kR of gamma rays.

Kubicki (1983) observed that in cucumber, seeds treated with concentrations of ethylene imine (EI) from 0.16 per cent to 0.2 per cent failed to germinate. Germination decreased in seeds treated with EI concentrations from 0.02 to 0.2 per cent.

ii) Survival of plants

Mutagen dose and plant survival are closely related. Velich (1969) observed only 3-4 per cent survival at 100 kR of gamma rays when varieties of Cucumis melo var. Cantalupensis Naud., Muskotaly (Muscat), Magyar Kines (Hungarian Treasure) and Bellegarde contalaupe were irradiated with doses between 5-100 kR gamma rays.

Kubicki (1983) found that in cucumber treated with EI concentrations from 0.08 to 0.14 per cent. There occurred a significant reduction of sprouting

and this effect increased with increase in concentration. In the case of treatments with EI at 0.12 per cent and 0.14 per cent, a decline in plant vigour manifested itself most strongly not only in a large reduction of sprouting but also in complete death of plants before flowering.

iii) Growth

Arsagove (1969) observed stimulation of growth on two cucumber varieties, Nezhin 12 and Ossete when treated with chemical mutagens, nitrosomethyl urea(NMU), EI and Dimethyl Sulphate (DMS). Goranov (1972b) reported stimulated stem growth and increased number of leaves when Cucurbita maxima Duchesne cv. Edra Byala 48 4 was irradiated at 4 kR gamma rays whereas 50 kR treatment had an inhibitory effect. Irradiation of seeds with 4 kR gamma rays stimulated the growth of main root and hypocotyl of Cucurbita maxima Duchesne (Goranov, 1972a). Bisaria et al. (1975) observed that irradiation of seeds of Cucumis melo L. with gamma rays increased the length of vines, the number of nodes and lateral branches in doses upto 1 kR and at higher doses these factors decreased. Gamma irradiation of

Luffa cylindrica Roem. at 0.5 to 1.5 kR increased vine length and lateral branching as observed by Kaushik et al. (1976). Singh and Roy (1977) noticed that plants descended from seeds of Cucumis melo L. subjected to 8 kR and 10 kR doses displayed greater vigour. In their trials with two cucumber cvs. irradiated with gamma rays Smetanina and Kodaneva (1982) reported increased plant growth and development. Kartaĭov and Shaban (1988) observed that lesser irradiation of cucumber seeds before sowing stimulated embryonal root growth.

Sen and Datta (1976) noticed that the growth of 30 day old cucumber plants treated with gamma rays was retarded but recovered after 60 days. The combined effect on squash (Cucurbita pepo L.) seeds with 0.5, 2.5 or 5.0 kR gamma irradiation and soaking in solutions containing 0, 20, 100 or 200 mg/l Indole Acetic Acid (IAA) before sowing failed to stimulate seedling growth and inhibited growth as the plants reached flowering stage (Khalil and Moursy, 1976). Kubicki (1983) reported that in cucumber treated with

0.08 and 0.10% concentrations of EI the mean breadth of the first leaf was markedly reduced, where as in the concentration range of 0.04 to 0.06% it changed only slightly. Plants originating from all treatments (0.02 to 0.20%) had smaller breadth and length of the leaf blade as compared to control. Narang and Prakash (1983) observed that fresh weight of 7 days old seedlings of all 7 taxa of cucurbits irradiated, decreased with increasing dose of gamma irradiation (1,5, 10, 15, 20 kR) while the dry weight increased.

iv) Flower production

Gulyaeva and Abashkina (1972) observed forms with a predominance of female flowers following treatment with N-nitroso-N-ethyl urea (NEU) and N-nitroso-N-methyl urea (NMU) in cucumber. After gamma irradiation in muskmelon (Cucumis melo L.) Bisaria et al. (1975) found that the first staminate flower appeared on higher nodes in doses upto 1 kR. Irradiation with higher doses did not affect the position of first hermaphrodite flower but first staminate flowers were produced on higher nodes. Irradiations upto 1.5 kR increased the number of hermaphrodite flowers, 2.0 kR had no significant effect and 2.5 kR reduced their number drastically. Number of staminate

flowers decreased progressively with increase in dose. Irradiation caused a shift towards hermaphrodite flowers. Increase in number of female flowers was noticed by Berzin and Purin (1978) in cucumber after gamma irradiation at 0.25 - 4.0 kR. Nath and Madan (1986) reported that 1.5 and 2.0 kR doses were the most effective in enhancing femaleness in cucumber. The male to female flower ratio decreased in Momordica charantia L. with increasing gamma rays dose from 30 to 60 kR, 0.1 to 0.2% EMS, 0.1 to 0.2% Hydroxyl amine (HA) and 0.01 to 0.02% mitomycin (MC) as observed by Mollaiah and Jafar (1988).

Increase in production of male flowers in cucumber with 0.5 kR gamma irradiation was observed by Zea et al. (1976). Fuji (1977) reported that 3 out of 28 M_1, plants obtained by gamma irradiation of the female strain of cucumber bore male flowers.

Sen and Datta (1976) reported that sex ratio and flowering time were not affected by gamma rays or X-rays at 25 to 55 kR in cucumber. No effect of X-ray irradiation on sex expression was detected by Singh and Roy (1977) in Cucumis melo L.

v) Fertility

The effectiveness of mutagenic treatment could be assessed by reduction in fertility of M_1 plants as reported by Kivi (1962).

Gamma ray irradiation in water melon (Citrullus lanatus Thunb.) resulted in formation of individuals with various degrees of pollen sterility. Approximately one third of individuals which showed less than 50% fertile pollen grains were recognized to be single interchange heterozygotes with a chromosome configuration of nine bivalents and a ring of four chromosomes (Shimotsuma, 1967). Complete sterility was observed by Velich (1969) in melon (Cucumis melo L.) following gamma irradiation at 100 kR. The sterility was associated with meiotic disturbances. Bisaria et al (1975) reported decreased pollen fertility in Cucumis melo L. with increase in dose of gamma irradiation. Similar result was reported in Luffa cylindrica L. (Roem) by Kaushik et al. (1976) when irradiated at 0.5 to 1.5 kR gamma rays. In cucumber treated with 0.06% EI Kubicki et al. (1984) reported slight reduction in pollen fertility and a considerable reduction in seed fertility.

Yield

Increased yield in the M_1 plants of two cucumber varieties was observed by Arsagova (1969) following treatment with NMU, EI and DMS. Presoaking temperature treatment at 80°C for 30 min in Cucurbita maxima Duchesne. before irradiation raised the number of fruits per plant but had no significant effect on fruit weight as reported by Goranov (1972 c). Irradiation at 4 kR increased the number of fruits/plant and fruit weight, whereas 50 kR dose was inhibitory for both characters. High yielding forms of cucumber plants were obtained by Gulyaeva and Abashkina (1972) after treatment with NEU and NMU. Zham and Zhugder (1976) reported that in cucumber the 0.5 to 2 kR gamma ray doses resulted in 15.6 to 18.6% yield increase but had no effect on the fruit ripening date. The treatment increased total fruit sugar and dry matter content. Kardashina (1976) concluded that 0.8 kR gamma irradiation of cucumber seeds was most effective and increased both early and main yields. Fruit size and weight increased in cucumber irradiated with gamma rays at 0.5 to 1.5 kR as reported by Kaushik et al.(1976). In gherkin (Cucumis sativus L.) irradiated with doses of 0.3 and 0.5 kR gamma rays Zea et al (1976) noticed increase in number and weight of fruits/ha of 54 and 46% and 56 and 54% respectively in the M_1 generation.

Singh and Roy (1977) detected plants, descended from seeds of Cucumis melo L. subjected to 8 kR and 10 kR of X-ray irradiation, which produced more and larger fruits than others. Berzin and Purin (1978) obtained increased yield of 14.6 to 31.9% following gamma irradiation of cucumber seeds at 0.25 - 4 kR. Vivipary was reported by Rao and Bhalla (1979) by exposing the seeds of Cucumis melo var. Pubescens Willd. to gamma irradiation at 2.0 kR or a magnetic field of 2000 gauss. Cucumber seeds irradiated with 1 kR gamma rays increased yields by 13% as observed by Kornienko and Sultanbaev (1978). Smetanina and Kodaneva (1982) reported augmented yields and improved fruit quality in cucumber treated at 0.3 to 0.9 kR gamma rays. Nath and Madan (1986) found that 1.5 and 2.0 kR doses of gamma rays were most effective in increasing the number of fruits per plant.

Kartalov and Shaban (1988) observed that seed treatment with a laser from a helium-neon source at 24 megawatts and 632.8 nm increased the yield in cucumber. The treatment applied 4 times increased yields by 10.2% when applied 6 times it increased the total yield by 10.5%.

vi) Other morphological variations

Variations in the morphology of stems, leaves, branches, flowers and fruits may manifest in irradiated plants. Visual differences and variations in chlorophyll content in 5 plants of cucumber following gamma irradiation were obtained by Whelan and Chubey (1973). Kubicki (1983) observed changes in size of first leaves, leaves with reduced surface area, larger deformation of the shape, irregularity of the leaf margin and blade surface as well as various degrees of chlorophyll deficiencies in cucumber after treatment with 0 to 0.2% EI. The only morphological change observed by Yadava and Singh (1984) in Cucumis melo var. momordica Kachri. treated with 20 kR gamma rays was plants which were more vigorous than the controls and had fruits which reached 30 cm in length where as 8 cm was the average in the controls.

vii) Chemical composition

Khalil and Moursy (1976) observed increase in the total nitrogen (N) content of seedlings and phosphorus(P) content of plants at the preflowering stage following combined treatment of squash (Cucurbita pepo L.) seeds with 0.5, 2.5 or 5.0 kR gamma irradiation and soaking in solutions containing 0, 20, 100 or 200 mg/1 IAA.

Potassium (K) content decreased at the seedling stage only and soluble N content was unaffected. Proteins/ soluble N ratio increased at both stages.

Mutations affecting morphology and chemical composition were also obtained by Sanoev and Zorina (1977) in cucumber following irradiation with 10-15 kR gamma rays.

ix) Cytological and physiological changes

In Cucumis melo L. treated with gamma rays Singh and Roy (1977) reported aberrations in metaphase I which included univalents, trivalents and chromosome fragments. Stickiness was at a maximum after 4 kR dose, desynapsis after 10 kR and fragmentation after 8 kR of gamma irradiation.

Kornienko and Sultanbaev (1978) observed increased photosynthesis, respiration and transpiration during flowering in cucumber irradiated with 1 to 15 kR gamma rays.

Mutations in the M_2 generation

i) Chlorophyll mutations

Whitwood and Weigle (1978) observed chlorophyll deficient abnormal leaves in M_2 and M_3 generations of

Cucurbita pepo L. after treatment with 0.035% EMS. Mutations for chlorophyll deficiency including virescent types were obtained in cucumber by Robinson (1978) following treatment with 5-30 kR doses of gamma and X-rays, 9-18 Å of thermal neutrons, 0.5 to 2% EMS and methyl methane sulphonate (MMS), 0.05 to 0.2% EI and 0.025 to 0.2% diepoxybutane. Chlorophyll changes from complete albino to various types of light green, dark green and yellow green spots were observed by Kubicki (1983) in M_2 plants of cucumber treated with EI.

ii) Viable mutations

Bowers (1961) induced non_tendril cucumber with gamma irradiation at 20 kR. Associated with this tendril-less character were brittle leaves, shortened internodes, mis-shapen fruits, recessed stigmas and absence of pollen. Timin (1971) noticed great variability in leaf shape and colour, length of stem, stem branching and fertility in M_2 and M_3 plants of cucumber treated with EI, NEU, NMU and 1-4-bis diazoacetyl butane. Whelan (1973) obtained a gamma ray induced mutation of cucumber which affected plant pubescence after treatment with 32 kR of gamma rays. Mutant plants had glabrous internodes, leaf petioles, laminae especially of first

true leaf, the node areas and perianths. The mutants with yellow cotyledon and revolute cotyledon were induced by Whelan et al. (1975) in cucumber by treatment with 32 kR of gamma irradiation. Treatment with 0 to 0.2% EI in cucumber produced plants with leaves that were either wrinkled, deeply lobed, entirely marginate or deeply serrate as reported by Kubicki (1983). A giant mutant in cucumber treated with 0.06% EI was reported by Kubicki et al. (1984). The mutant was diploid but all the plant parts were enlarged. Cucumber mutant with a compact growth of leaves in a rosette-like arrangement at the shoot apices was isolated by Kubicki et al.(1986 b) following treatment with 0.06% EI. Kubicki et al.(1986 a) also reported a bushy mutant in cucumber induced by 0.06% EI treatment. It had markedly reduced internode length, normal viability and branching ability. Soltysiak et al. (1986) obtained a mutant with determinate type of growth in cucumber treated with 0.06 to 0.1% with EI. A cucumber mutant characterized from emergence onwards by lack of trichomes on its hypocotyl, cotyledons, stem and leaves and fruits, devoid of warts and spines was obtained by Robinson (1986) following thermal neutron irradiation.

Arsagova (1969) reported in the M_2 plants of cucumber treated with NMU, EI and DMS many plants of the female type in spite of the absence of such plants in the control. Monoecious and pistillate plants were obtained by Fuji (1977) following gamma irradiation of the female strain of cucumber. Kubicki (1983) reported M_2 plants with high intensity of maleness, high intensity of femaleness or bisexual flowers and plants that were gynomonoecious and trioecious following treatment of cucumber with 0 to 0.2% with EI. Plants with small flowers and flowers having large, greenish, deeply cut or serrate petals and flowers on tendril were also obtained. A mutant with chloripetalous flowers was obtained by Kubicki and Korzeniewska (1984) in cucumber after treatment with 0.06% EI. The mutant had narrow, separate petals, aberrant leaf form and a tendency to form tendrils on leaves, petals and sepals. Rajasekharan and Shanmugavelu (1984) isolated a mutant in Momordica charantia L. following gamma irradiation. It was early flowering, had a sex ratio of one male flower to approximately twenty female flowers and fruits rich in ascorbic acid, protein, P, K and calcium (ca).

Ahund -zade and Brundnaja(1967) produced an M_2 mutant of the melon variety ulang with two types of fruits, one oval elongate and the other round, following irradiation with 16 kR gamma rays. As a result of seed treatment with moderate and low concentrations of NMU in cucumber, 19 lines were obtained by Gornitskaya (1972) with economically valuable characters, including high yield and relatively high resistance to bacterial infection. Using NEU and NMU Gulyaeva and Abashkina (1972) obtained cucumber varieties, some of them with fruits remaining green for a long time, some with high yield, some with a predominance of female flowers, some resistant to drought and still others with a good spread of runners. Mutant with smooth fruit, through the absence of spines was reported by Robinson (1978) in cucumber treated with 9-18 k of thermal neutrons. Pillai and Anbu (1983) obtained through 75 kR gamma irradiation of ribbed gaurd (Luffa acutangula Roxb.) a new variety with better yields than the parent or the common variety. In the M_2 plants of cucumber following 0 to 0.2% EI treatment, Kubicki (1983) observed plants having fruits that were small, large, round or elongate.

Pivovarov (1972) isolated cucumber plants with relative resistance to Erysiphe cichoracearum following treatment with EI (0.04%), NMU (0.01%) and DMS(0.06%). Dolgikh and Korganova (1974) obtained cucumber mutants resistant to Cladosporium cucumerinum after treatment with 0.02% EI and 0.5 and 1 kR of fast neutrons. In cucumber following treatment with 0.05% EI, mutant resistant to Meloidogyne spp. was obtained by Udalova and Prikhod'ko (1987).

Whelan (1972) detected a light sensitive mutant of cucumber following irradiation with 10 kR of gamma rays. Height of plant, length of internodes and petioles and size of flowers, leaves and fruit were noticeably smaller than normal plants.

iii) Differential sensitivity

Whelan (1970) observed significant differences among 8 cultivars of cucumber following gamma irradiation of seeds. Krizek (1978) reported that among the two cultivars of cucumber, Poinsette proved sensitive to ultraviolet radiation and Ashley slightly so in terms of leaf chlorosis, reduced biomass and inhibition of leaf

and shoot growth. Danno et al. (1980) reported that Cucurbita was generally more resistant to gamma radiation than Cucumis. The two Cucumis cvs.(F_1 Chojitsu-ochiai No.2 and F_1 Kureme-ochiai H) showed no difference in their resistance to radiation. Narang and Prakash (1983) found that among cucurbit cvs., Lagenaria siceraria Standl., Citrullus lanatus var. fistulosus Thunb., were more sensitive to gamma irradiation than cultivars of Cucumis sativus L. and Momordica charantia L. Zagorcheva and Alexandrova (1984) reported that among the two varieties of Cucumis sativus L., Gergana was highly resistant to gamma rays and Bitrenski was highly sensitive and the F_1 and F_2 hybrids between them proved to be more resistant to gamma rays than their parents. Zagorcheva and Alexandrova (1987) found that the short fruited varieties showed greater resistance to gamma irradiation than the long fruited varieties.

iv) Mutagenic effectiveness and efficiency

Ehrenberg (1960) stated that mutagenic effectiveness indicates the relationship of effect to dose. Mutagenic effectiveness was calculated by Konzak et al. (1965) as the ratio of mutation frequency to dose. Gaul et al. (1972) defined efficiency as the ratio of

chlorophyll mutations to biological damage where the criteria for measuring damages are lethality, injury and sterility or chromosome mutations.

Gornitskaya (1972) observed that among the various mutagens moderate and low concentrations of NMU and EI induced the greatest number of useful mutations on cucumber varieties. Gulyaeva and Abashkina (1972) reported that NMU induced 50% of useful mutations and NEU 27% in cucumber. Robinson (1978) treated cucumber with 5-30 kR of gamma rays and x rays, 9-18 of thermal neutrons, 0.5-2.0% ethyl methane sulphonate and methyl methane sulphonate, 0.05-0.2% ethyleneimine and 0.025-0.2% diepoxybutane, of which thermal neutrons resulted in the greatest number of mutations. Among the different mutagens like HA (0.1-0.2%), MC (0.01-0.02%), EMS (0.01-0.02%) and gamma rays (30-60 kR), EMS was the most effective in Momordica charantia L. as reported by Mollaiah and Jafar (1988).

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation to assess the sensitivity of ten Cucumis melo L. varieties to gamma rays and ethyl methane sulphone was carried out in the Department of Agricultural Botany, College of Agriculture, Vellayani during April - June, 1989.

MATERIALS

Pure seeds of ten Cucumis melo L. varieties (Plates 1a and 1b) were used in this experiment. The ten varieties were:

1. Mudikode local
2. Panavalli
3. Attenganam local
4. Lucknow Sweet
5. Verma Surprise
6. Hara Madhu
7. Pulliporan
8. Punthala local
9. Vellanad local and
10. Co-1.

Plates 1a & 1b. Fruits of 10 Cucumis melo L. varieties used in the experiment.

1 - Lucknow Sweet

2 - Verma Surprise

3 - Hara Madhu

4 - Panavalli

5 - Mudikode local

6 - Attenganam local

7 - Pulliporan

8 - Vellanad local

9 - Co-1

10 - Punthala local

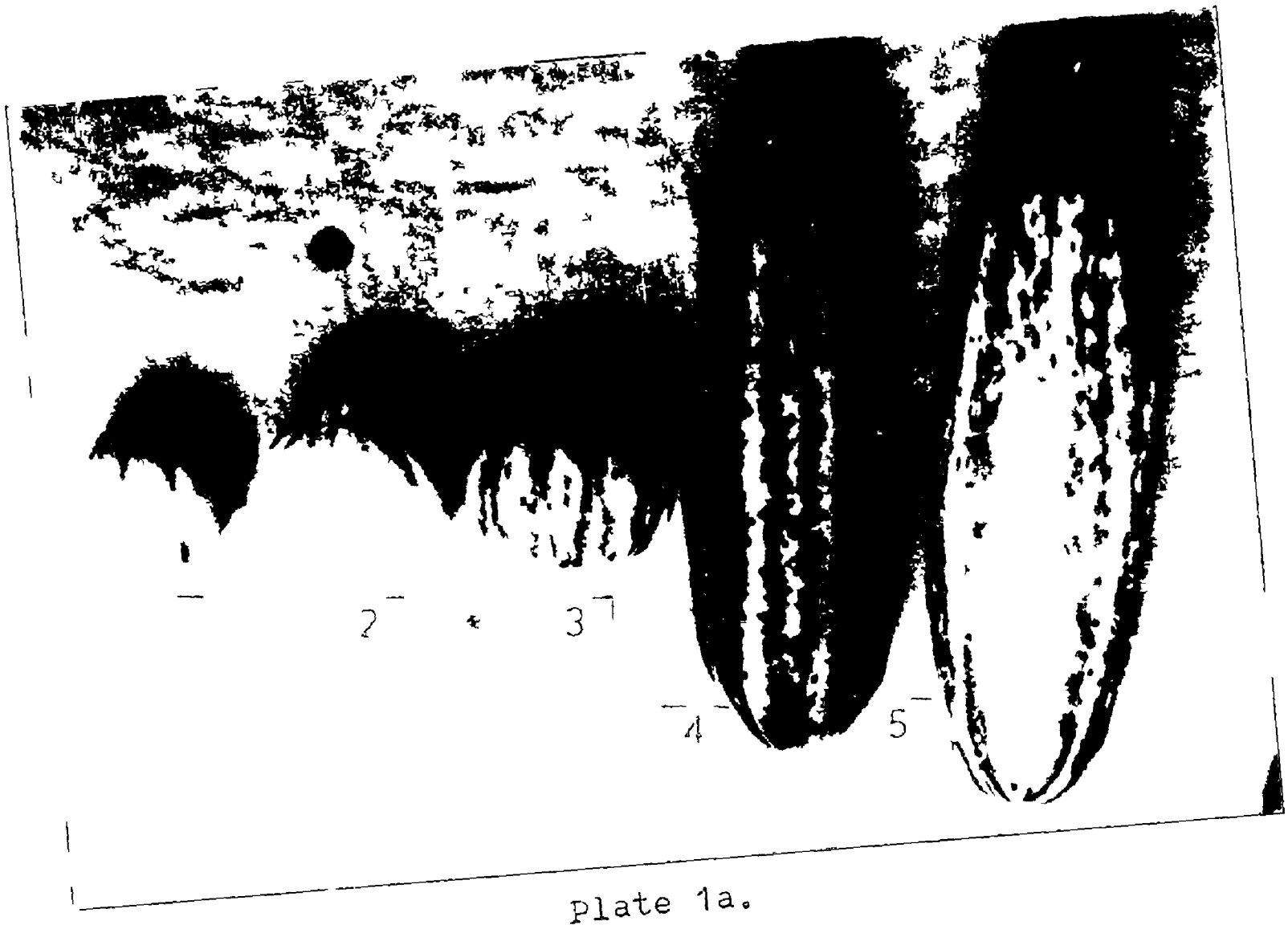

Plate 1a.

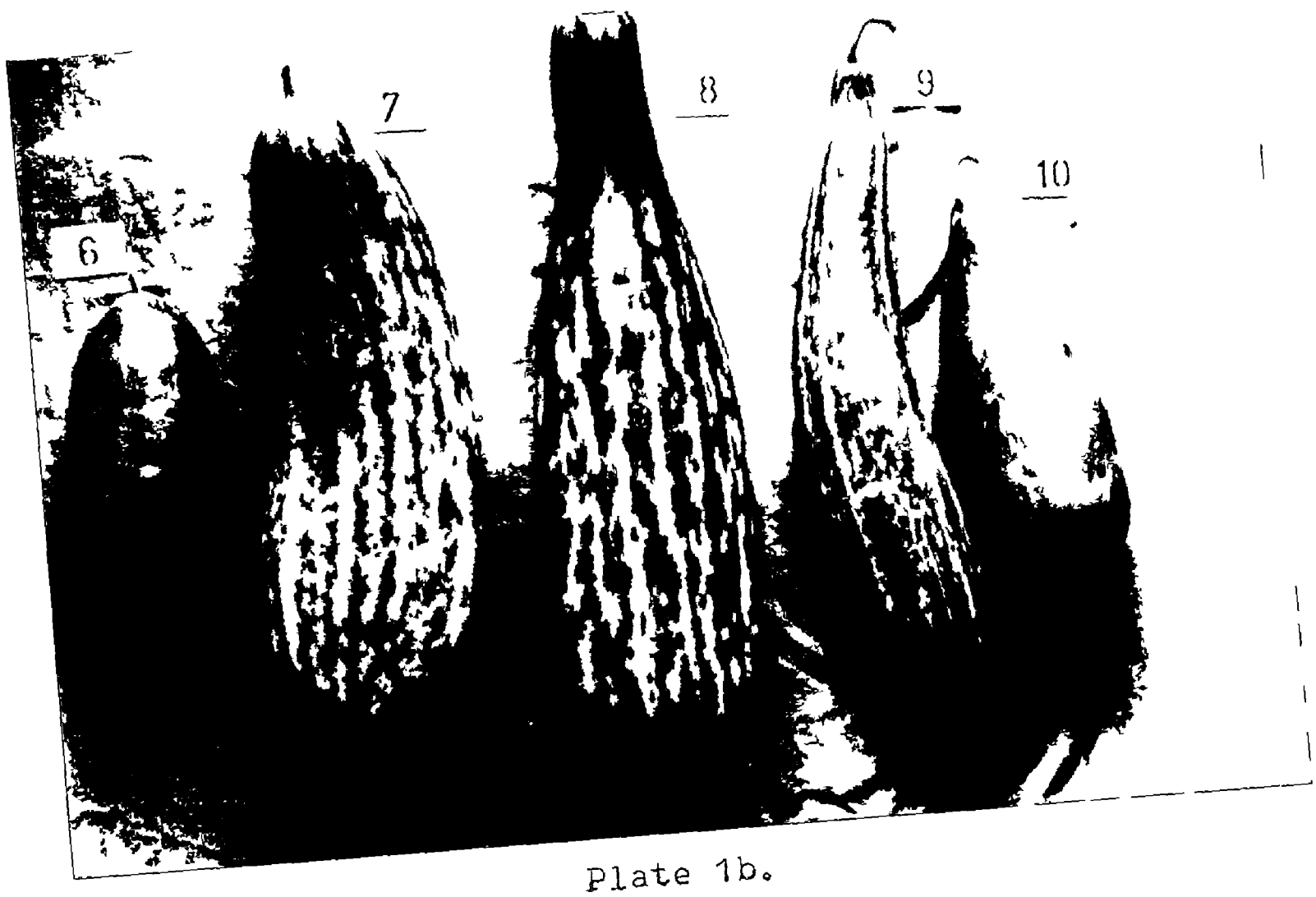

Plate 1b.

Seeds of the variety Lucknow Sweet were received from Pocha Seeds Pvt. Ltd., Pune and seeds of varieties Hara Madhu and Verma Surprise from Verma Seed Company Pvt. Ltd., U.P. Seeds of the varieties Mudikode local and Co-1 were obtained from the College of Horticulture, Vellanikkara and College of Agriculture, Coimbatore respectively while the seeds of the rest of the varieties were collected locally.

Gamma irradiation of seeds was done at the Radio Tracer Laboratory, Kerala Agricultural University, Vellanikkara in a gamma chamber having a cobalt (Co^{60}) source emitting 60 kR/h.

The chemical mutagen used was EMS having a molecular weight of 124.16. The chemical has a specific gravity of 1.18 at $20^{\circ}C$* and was obtained from Sigma Chemical Company, USA.

METHODS

I Mutagen treatments

a) Gamma irradiation

Well filled uniformly dried seeds of uniform size were sorted out. Three samples of 50 seeds each for

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* Personal communication from Brawn, N.M., Sigma Chemical Company, U.S.A.

each variety were irradiated at 3 doses, viz., 10, 20 and 30 kR.

b) Application of ethyl methane sulphonate

Uniform sized, healthy seeds were used for the treatment. Three samples of 50 seeds each for each variety were pre-soaked for 6 h in double distilled water.

Pre-soaked seeds were treated with EMS at 3 different concentrations, viz., 1.0, 1.5 and 2.0 ml per cent for 6 h. The treatment was conducted at room temperature of 27 $\pm$ 1°C. During the period of treatment the solution with the seeds was shaken intermittently to maintain uniform concentration. After the treatment period, seeds were thoroughly washed 2-3 times with distilled water and then rinsed in running water for 2 h to remove all traces of the chemical from the seeds.

II Study of M_1 generation

The experiment was laid out with two controls, viz., the un-irradiated control and the soaked but chemically untreated control in a Randomised Block

Design with 10 x 8 treatments in 2 replications. The gamma irradiated seeds were sown in the field on the second day after treatment and the EMS treated seeds on the first day after treatment. The seeds were sown at the rate of 6 seeds per pit taken at a spacing of 2 x 1.5 m. The plot size was 4 x 1.5 m which had two pits.

The following observations were recorded

A. General observations

1) Germination percentage

Germination counts in the different treatments were taken on the 5th, 10th, 15th and 20th day after sowing and expressed as percentage.

2) Days taken to complete germination

The duration from the date of sowing till the date of last sprout was calculated for each treatment for obtaining the number of days taken to complete germination.

3) Survival of seedlings

Survival of seedlings was determined on the 20th and 30th day after sowing. The survival data was

estimated on the basis of number of seeds sown and expressed as percentage.

4) Chlorophyll chimeras

The M_1 population was examined at regular intervals and plants exhibiting chlorophyll deficient patches on leaves were recorded as chimeras.

5) Morphological abnormalities

The M_1 population was periodically examined to locate plants with morphological variations.

B. Biometric observations

Biometric observations were taken from the four plants selected at random in each plot.

6) Days for opening of first male flower

The mean number of days for opening of first male flower in the observation plants, counted from the date of sowing of the crop was recorded.

7) Node at which first male flower appeared

Node at which the first male flower appeared in the 4 observation plants was recorded starting from the

cotyledon node and the mean value worked out.

8) Days for opening of first female flower

The mean number of days for opening of first female flower (first bisexual flower as in the case of varieties Lucknow Sweet, Verma Surprise and Hara Madhu) in the observation plants, counted from the date of sowing of the crop was recorded.

9) Node at which first female flower appeared

Node at which the first female flower (first bisexual flower as in the case of varieties Lucknow Sweet, Verma Surprise and Hara Madhu) appeared in the 4 observation plants was counted starting from the cotyledon node and the mean value worked out.

10) Sex ratio

The fully developed male and female flowers were counted daily from the date of first flowering to the date of harvest. The sex ratio was expressed as the ratio of number of male flowers to the number of female flowers.

11) Pollen fertility

Pollen fertility was studied in mature flowers produced during the first days of the flowering period. Ten mature flowers were randomly picked from each plot. From each flower two slides were prepared. Anthers were taken and the pollen grains were pressed out and stained in a 1:1 proportion of glycerine-acetacarmine solution. Fertility counts were taken after 2 h of staining. The well stained and properly filled pollen grains were scored as fertile and the others as sterile. In each slide, 5 microscopic fields were scored and the data recorded. Fertility was estimated as percentage of the number of fertile grains to the total number of pollen grains scored. The mean value of recording from the 10 flowers was worked out.

12) Number of fruits per plant

Fruits were harvested when they matured, the maturity for vegetable purpose being judged by visual observation based on colour of fruit and nature of fruit stalk. The total number of fruits obtained from a plot was divided by the total number of plants in that plot to get the number of fruits per plant.

13) Fruit weight

The weight of fruits from a single plot was divided by the total number of fruits from that plot to get the per fruit weight which was expressed in kilogram (kg).

14) Yield per plant

Yield per plant was found out by multiplying mean fruit weight per plant with the number of fruits per plant and expressed in kg.

15) Length of fruit

During harvests five fruits were randomly selected from each plot and the length of fruit from the stalk end to the tip was measured in cm and the average taken.

16) Girth of fruit

During harvest five fruits were randomly selected from each plot and the girth was recorded in centimetre (cm) at the top $1/4^{th}$, bottom $1/4^{th}$ and the middle of the fruit and their average taken.

17) Fruit set

This was worked out by dividing the total number of fruits harvested per plot by the total number of female flowers produced per plot. Fruit set was expressed as percentage.

18) Total number of seeds per fruit

The mean number of seeds from first five mature fruits per plot was recorded.

19) 100 seed weight

The mean weight in gram of 100 seeds extracted from each of frist five fruits harvested from a plot was recorded.

20) Seed sterility

From the seeds extracted from each of the first five fruits harvested from each plot, well filled seeds were counted separately as fertile seeds and half filled and empty seeds counted as sterile seeds. Sterility was worked out by dividing the number of sterile seeds by the total number of seeds and

expressed as percentage. The average value of the five selected fruits was also recorded.

21) Length of main vine

Total length of main vine was measured in metres at the end of the cropping period. Length of 4 observation plants were measured and then average taken.

22) Number of primary branches per plant

The number of primary branches in each of the 4 observation plants was counted at the end of the harvest and their average value recorded.

Statistical Analysis

Data was analysed statistically as per Anova technique given below. The angular transformation was applied to percentage values whereever found necessary (Snedecor, 1956).

Source	Degrees of freedom
Replication	1
Treatments	79
Between varieties	9
Between levels of gamma rays	3
Between levels of EMS	3
Gamma rays vs EMS	1
Variety x gamma rays	27
Vareity x EMS	27
Remaining treatments	9
Error	79
Total	159

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

An experiment was conducted at the College of Agriculture, Vellayani to determine the sensitivity of ten Cucumis melo L. varieties to gamma rays and ethyl methane sulphonate.

The data collected from the field experiment and laboratory studies were subjected to statistical analysis and the results are presented and discussed below.

1. Germination

Germination counts were taken at intervals of 5 days starting from the 5th day after sowing till the 20th day and the number of days taken to complete germination was also recorded for all the 10 varieties.

a. Percentage seed germination under field condition as influenced by gamma rays and EMS on 10 Cucumis melo L. varieties on 5th day after sowing is given in Table Ia.

Statistical analysis of the data showed that there was significant differences in mean values among varieties, between the two mutagens and levels of EMS. No significant difference was noted between levels of gamma rays, variety x gamma ray interaction and variety x EMS interaction.

Table 1a Effect of mutagens on percentage seed germination of 10 Cucumis melo L varieties after 5th day after sowing

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Between treated popln	Control (pared)	1 0%	1 5%	2 0%	Pan treated popln	
[illegible] local	[illegible]	95	85	32	2	85 85	80 08	84 18	42 75	4 07	33 86
	(0 7)	(82 04	(88)	(14)	(26)	86 70	(39 65)	(47 38)	(42 48)	(41 30)	(34 74)
Anava 1	0.00	0 0	00	0 00	0 0	2.13	0 17	2 13	1 67	58	3.77
	(0 00)	(0 00)	(0 00)	(0 00)	(0 00)	(8 38	(17 62)	(8 38)	(2 09)	(14 62)	(7 31)
Cence am local	81	17 7	13	0 70	9 9	80 00	70 92	70 92	6 55	6 60	36 60
	(20.09)	(24 8)	(6 8	(14 99)	(17 09)	44 98	(57 35)	(57 35)	(5 25)	(9 09)	(35 04)
Lu knot swee	0 00	0 0	1	0 00	0 3	35 35	8 35	2 13	3	1 20	01
	(0 00)	(0 0)	(0 38)	(00)	(2 0)	88	(16 77)	(8.38)	(77	(1 00)	(5)
Verma surprise	8.33	4.36	0 00	0 00	3 7	7 45	50 00	17 72	12 19	29 34	16 26
	(16 77)	(12 04)	(0 00	(0 00)	(7. 0)	7 72	(44 98)	(24 89)	(20 43)	(3 01)	(19 60)
Ha a l cnu	0 00	2.1	12 19	0 00	3 3	33.33	34 15	45 82	07	40 00	2 34
	(0 00)	(8 08)	(20 45)	(0 00)	(7 0)	5 88	(35 74)	(42 59)	(3 09)	(44 83)	(26 01)
ullipo an	8.33	15 76	4 36	0 00	7 11	50 00	40 32	4 04	2 08	40 24	23 68
	(16.77)	(23.38)	(12 04)	(0 00)	(13 05)	44.98)	(39.40)	(40.12)	(3..62)	(39.28)	(26.16)
Punthala local	0.00	0.00	0.00	0.00	0.00	41.54	24.52	0.00	0.00	16.52	8.26
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(40.12)	(29.67)	(0.00)	(0 00)	(17.45)	(8.72)
Vellanad local	0.00	0.00	6.70	0.00	1.68	58.46	45.69	45.82	29.08	44.76	23.22
	(0.00)	(0.00)	(14.99)	(0.00)	(3.75)	(49.85)	(42.51)	(42.59)	(32.62)	(41.89)	(22.82)
Co_1	4.36	6.70	6.70	15.76	8.38	50.00	24.52	8.33	22.75	26.40	17.39
	(12.04)	(14.99)	(14 99)	(23.38)	(16.35)	(44.98)	(29.67)	(16.77)	(28.48)	(33.25)	(23.16)
Mean	4.17	7.63	6.06	5.08		46.91	33.67	28.86	23.65		
	(8.24)	(11.66)	(11.01)	(7.05)		(42.45)	(34.63)	(28.84)	(27.08)		
Mean dose effect		7.63	6.06	5.08	6.26		33 67	28.86	23.65	28.73	
		(11.66)	(11.01)	(7.05)	(9.91)		(34.63)	(28.84)	(27.08)	(30.18)	

CD- Between varieties - 9.377 CD- Between levels of EMS - 5.931 CD- Gamma rays Vs EMS - 2.965

Transformed values given in paratheses

Considering varietal response to gamma rays, variety Mudikode local (23.15) was significantly superior to other varieties in germination percentage. Verma Surprise (3.17), Hara Madhu (3.58), Vellanad local (1.68), Lucknow Sweet (0.53), Panavalli and Punthala local (0.00) were on par in germination percentage, but were significantly inferior to the rest of the varieties. No significant variation observed in mean values between Attenganam local (9.59), Co-1(8.38), Pulliporan (7.11), Verma Surprise and Hara Madhu.

In the case of effect of EMS on varieties, Attenganam local (63.60) registered significantly the highest mean value for germination among varieties. Varieties Hara Madhu (49.09), Vellanad local (44.76), Mudikode local (43.97) and Co-1(26.40) were on par in germination percentage but were significantly superior to varieties Lucknow Sweet (11.29), Punthala local(16.52) and Panavalli (7.53) between which mean values did not differ significantly.

Comparing the influence of both mutagens on varieties, Attenganam local recorded significantly higher mean value for germination percentage (36.60) than Panavalli (3.77), Lucknow Sweet (5.91), Verma Surprise

(16.26), Punthala local (8.26), Vellanad local (23.22) and Co-1 (17.39) but mean value was on par with Mudikode local (33.56), Hara Madhu (26.34) and Pulliporan (23.68). Hara Madhu, Pulliporan, Vellanad local, Co-1 and Verma Surprise were on par and superior to Panavalli, Punthala local and Vellanad local. Between the three latter varieties there was no significant difference in mean values for germination percentage.

Significant difference in mean value was found between the three dose levels of EMS and its control. Control had higher germination mean value (46.91) and was significantly superior to 1.5% and 2.0% EMS treatments. The two higher EMS doses showed similar mean germination values.

The difference in mean values between the mutagens gamma rays and EMS was significant irrespective of the varieties, with EMS being superior to gamma rays in inducing very high germination (28.73) than gamma rays (6.26).

b. The effect of mutagens on the percentage seed germination of 10 Cucumis melo L. varieties on 10th day after sowing is shown in table I b.

Table 1b. Effect of mutagens on percentage seed germination of 10 Cucumis melo L varieties at 10th day after sowing.

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	58.86 (50.08)	71.68 (57.83)	58.46 (49.85)	58.33 49.78)	61.83 (51.89)	88.21 (6 .89)	58.33 (49.78)	84.24 (66.59)	58.33 (49.78)	72.28 (59.01)	67.06 (55.44)
Panavalli	66 67 (54.72)	54.18 (47.38)	45.89 (42.51)	66.93 54.88)	58.37 (49.87)	50.00 (44.98)	70.92 (57.35)	58.46 (49.84)	63.87 (53.03)	60.81 (51.30)	59.59 (50.59)
Attenganam local	70.92 (57.35)	50.00 (44.98)	14.64 22.49)	73.65 (59.09)	52.30 (45.98)	71.68 (57.83)	83.33 (65.88)	83 33 (65.88)	84.24 (66.59)	80.65 (64.05)	66.48 (55.01)
Lucknow Sweet	33.07 (35.09)	28.32 (32.14)	45.82 (42.59)	41.67 (40.19)	37.22 (37.50)	58.46 (49.85)	62.94 (52.48)	29.08 (32.62)	45.69 (42.51)	49.04 (44.37)	43.13 (40.93)
Verma Surprise	41.14 (39.88)	22.75 (28.48)	37.45 (37 72)	19.24 26.01)	30.15 (33.02)	58.46 (4 .85)	66.67 (54.72)	58.46 (49.85)	66.93 (54.88)	62.63 (52.33)	46.39 (42.67)
Hara Madhu	33.07 (35.09)	33.07 (35.09	50.00 (44.98)	50.00 (44.98)	41.54 (40.04)	75.48 (60.29)	71.68 (57.83)	79.32 (62.93)	66.93 (54.88)	73.35 (58.98)	57.45 (49.51)
Pulliporan	54.13 (47.38)	50.00 (44.98)	62.55 (52.25)	62.94 (52.48)	57.42 (49.27)	66.93 (54.88)	66.67 (54.72)	67.84 (55.43)	58.46 (49.85)	64.98 (53.72)	61.20 (51.49)
Punthala local	95.66 (77.94)	69.88 (56.69)	73.65 (59.09)	66.93 (54.88)	76.55 (62.15)	87.81 (69.54)	67.84 (55.43)	33.33 (35.25)	44.86 (42.03)	58.46 (50.56)	67.50 (56.36)
Vellanad local	54.31 (47.45)	58.33 (49.78)	77.25 (61.49)	70.92 (57.35)	65.20 (54.14)	80.76 (63.96)	79.32 (62.93)	84.24 (66.59)	66.67 (54.72)	77.75 (62.05)	71.48 (58.03)
Co-1	62.94 (52.48)	77.25 (61.49)	93.32 (74.99)	71.68 (57.83)	76.30 (61.70)	84.24 (66.59)	75.48 (60.30)	58.33 (49.78)	59.68 (50.56)	69.43 (56.81)	72.87 (59.25)
Mean	57.08 (49.74)	51.55 (45.88)	55.88 (48.79)	58.23 (49.74)		72.20 (58.76)	70.32 (57.14)	63.66 (53.47)	61.57 (51.88)		
Mean dose effect		51.55 (45.88)	55.88 (48.79)	58.23 (49.74)	55.22 (48.14)		70.32 (57.14)	63.66 (53.47)	61.57 (51.88)	65.18 (54.16)	

CD - Between varieties - 8.296 CD - Gamma rays Vs EMS - 2.624

Transformed values given in paratheses.

Significant difference in mean values among varieties and between the two mutagens was observed.

With regard to the effect of gamma rays on varieties, Punthala local (76.53), Co-1(76.30) and Vellanad local (65.20) had mean values that were comparable but were significantly superior than the other varieties. Significantly lower mean values of germination percentage were recorded by Hara Madhu (41.54), Lucknow Sweet(37.22) and Verma Surprise (30.15). Vellanad local (65.20), Mudikode local (61.83), Panavalli (58.37), Pulliporan (57.42) and Attenganam local (52.30) did not differ significantly in their mean values.

In the case of effect of EMS on varieties, no significant variation in mean values of germination percentage was observed between varieties Attenganam local (80.65), Vellanad local (77.75), Mudikode local (72.28), Hara Madhu (73.35) and Co-1(69.43) and with the exception of Co-1 all were significantly superior to other varieties. Varieties Verma Surprise (62.63), Panavalli (60.81), Punthala local (58.46) and Lucknow Sweet (49.04) registered significantly lower germination percentage.

Comparing the effect of both mutagens on varieties Co-1 had high mean value for germination percentage of 72.87 and was similar to mean values of Vellanad local (71.48), Punthala local (67.50), Mudikode local (67.06), Attenganam local (66.48), Pulliporan (61.20) and Panavalli (59.59). These varieties were superior to Verma Surprise (46.39) and Lucknow Sweet (43.13). Co-1 was significantly superior in germination percentage to Lucknow Sweet, Verma Surprise and Hara Madhu (57.45).

EMS treatment was significantly superior to gamma ray treatment in inducing higher germination with the best effect shown by the highest dose of 30 kR for gamma rays and lowest dose of 1.0% for EMS treatments.

No significant difference in mean values was noted between levels of gamma rays, levels of EMS, variety x gamma ray interaction and variety x EMS interaction.

c. Germination percentage of seeds of 10 Cucumis melo L. varieties as influenced by the mutagens on 15th day after sowing is depicted in table Ic.

Significant differences in mean value of germination percentage was found among varieties but the differences in mean values between levels of gamma rays, levels of

Table Ic. Effect of mutagens on the percentage seed germination of 10 Cucumis melo L. varieties at 15th day after sowing.

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	58.86 (50.08)	71.68 (57.83)	58.46 (49.85)	66.93 54.88)	65.98 (5 .16)	88.21 (69 39)	66.67 (54.72)	84.44 (66.59)	58.35 (49.75	74 3n (60.25)	69.17 (56.70)
Panavalli	83.33 (65.87)	75.48 (60.30)	66.93 (54.88)	83.33 (65.88)	77.27 (61.73)	50.00 (44 98)	75.48 (60.30)	62.94 (52.48)	71.66 57.83)	65 3 (53 90)	71.15 (57 81)
Attenganam local	79.32 (62.93)	62.55 (52.25)	21 13 (27.36)	73.65 (59.09)	59.16 (50.41)	75 -8 (60.30)	83.33 (65.88)	83.33 (65.80)	87.80 (69.54	82 49 65.40)	70.83 (57.90)
Lucknow Sweet	54.18 (47.38)	41.54 (40.12)	54.18 (47.38)	41.67 (40.19)	47.89 (43.77)	58.46 (49.85)	62.94 (52.48)	37.45 (37.72)	50.00 (44.98)	52.21 (46.26)	5 .05 (45.01)
Verma Surprise	62.55 (52.25)	28.32 (32.14)	45.82 (42 59)	19.24 (26.01)	38.98 (38.25)	62.94 (52.48)	70.92 (57.35)	62.55 (52.25)	66.95 (54.88)	66.84 (54 24)	52.91 (46.24)
Hara Madhu	54.18 (47.38)	41.54 (40.12)	50.00 (44.98)	41.54 (40.12)	46.82 (43.15)	83 33 (65.38)	67.84 (55.43)	79.32 (62.93)	66.93 (54 88)	75.61 (59.78)	61.22 (51.46)
Pullidoran	62.55 (52.25)	50.00 (44.98)	70.92 (57.35)	67.84 (55.43)	62.83 (52.50)	66.93 (54.88)	66.67 (54.72)	62.94 (52.48)	58.46 (49.85)	63.75 (52.98)	63.29 (52.74)
Punthala local	97.88 (81.60)	93.32 (74.99)	88.21 (69.89)	79.32 (62.93)	89.68 (72.35)	87.80 (69.53)	67.84 (55.43)	50.00 (44.98)	50.00 (44.98)	53.91 (53.73)	76.80 (63.04)
Vellanad local	63.87 (53.03)	62.55 (52.25)	84.24 (66.59)	95.66 (77.94)	76.58 (62.45)	80.76 (63.96)	84.24 (66.59)	84.24 (66.59)	66.67 (54.72)	78.98 (62.97)	77.78 (62.71)
Co-1	66.93 (54.88)	77.25 (61.49)	93.32 (74.99)	75.48 (60.30)	78.25 (62.92)	84.24 (66.59)	75.48 (60.30)	58.33 (49.78)	59.68 (50.56)	69.43 (56.81)	73.84 (59.86)
Mean	68.37 (56.76)	60.42 (51.64)	63.32 (53.58)	64.47 (54.27)		73.82 (59.83)	72.14 (58.32)	66.53 (55.17)	63.65 (53.19)		
Mean dose effect		60.42 (51.64)	63.32 (53.58)	64.47 (54.27)	62.74 (53.16)		72.14 (58.32)	66.53 (55.17)	63.65 (53.19)	67.44 (55.56)	

CD - Between varieties - 8.512

Transformed values given in parantheses

EMS, variety x gamma ray interaction, variety x EMS interaction and between gamma rays and EMS were not significant.

Considering the effect of gamma rays on varieties Co-1 (78.25), Vellanad local (76.58), Panavalli (77.27) were on par in germination percentage and were significantly inferior to Punthala local (89.68) but significantly superior to the other varieties in germination percentage. Mean values of germination percentage did not differ significantly between varieties Lucknow Sweet (47.89), Hara Madhu (46.82) and Verma Surprise (38.98) and these were significantly inferior to the rest of the varieties. No significant differences in mean values for germination percentage between varieties Mudikode local (63.98), Pulliporan (62.83) and Attenganam local (59.16) was noted.

In the case of influence of EMS on varieties Attenganam local (82.49), Vellanad local (78.98), Mudikode local (74.36) and Co-1 (69.43) did not differ significantly in mean values for germination percentage but all were significantly superior to the other varieties. Lucknow Sweet (52.21), Hara Madhu (75.61) and Verma Surprise (66.84) were on par in germination

percentage and with the exception of Lucknow Sweet were all significantly inferior to the rest of the varieties. Variation in mean values between Panavalli (65.03), Punthala local (63.91), Pulliporan (63.75) and Lucknow Sweet was not significant.

Comparing the effect of both mutagens Punthala local had the highest mean value for germination percentage (76.80) and was on par with mean germination percentage of Vellanad local (77.78), Co-1 (73.84), Attenganam local (70.83), Panavalli (71.15) and Mudikode local (69.17). These varieties were all significantly superior to Lucknow Sweet (50.05) and Verma Surprise (52.91). Punthala local and Vellanad local were also significantly superior to Hara Madhu (61.22) and Pulliporan (63.29) in germination percentage. No significant difference was found between mean values of Lucknow Sweet, Hara Madhu, Pulliporan and Verma Surprise.

d. The germination percentage of seeds-10 Cucumis melo varieties as influenced by the mutagens on 20th day after sowing is represented in table I d. The graphical representation of the data is shown in Fig.1.

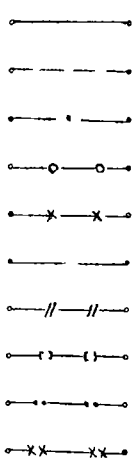
Table 1 d . Effect of mutagens on percentage seed germination of 10 Cucumis melo L. varieties at 20th day after sowing.

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	58.86 (50.08)	71.68 (57.83)	58.46 (49.85)	66.93 (54.88)	65.98 (53.16)	88.21 (69.89)	66 67 (54.72)	84.24 (66.59)	58.33 (49.78)	74.36 (60.25)	69.17 (56.70)
Panavalli	83.33 (65.88)	75.48 (60.30)	70.92 (57.35)	83.33 (65.88)	78.27 (62 35)	50.00 (44.98)	75.48 (60.30)	62.94 (52 48)	71.68 (57.83)	65.03 (53.90)	71.65 (58.12)
Attenganam local	79.32 (62.93)	62.55 (52.25)	21.13 (27.36)	73.65 (59.09)	59.16 (50.41)	75.48 (60.30)	83 33 (65.88)	83 33 (65.88)	87.81 (69.54)	82.49 (65 40)	70.83 (57.90)
Lucknow Sweet	54 18 (47.38)	41.54 (40.12)	54.18 (47.38)	41 67 (40.19)	47 69 (43 77)	58 46 (49.85)	62.94 (52.48)	33.33 (32.25)	50.00 (44 98)	51.19 (44.89)	49.54 (44 70)
Verna Surprise	62.55 (52.25)	28 32 (32.14)	45 82 (42.59)	19.44 (26 01)	38 98 (35 25)	62.94 (52 48)	70 92 (57.35)	62.55 (52.25)	66.93 (54.86)	65 84 (54 24	52.41 (46.24)
Hara Manu	54 18 (47.38)	41 54 (40.12)	50.00 (44 98)	41 54 (40.12)	46 82 (43 15)	83 33 (65 88)	67 84 (55.43)	79.32 (62 93)	66.97 (54 88)	74.36 (59.78)	60.55 (51.46)
Pullipuran	62.55 (52 25)	54 18 (47 38)	70 92 (57 35)	67.84 (55 43)	63 87 (53 10)	66.93 (54 98)	66 67 (54 72)	67.84 (52 48)	58.46 (49.85	63 75 (52.98)	63 81 (53 04)
Punthala local	99 99 (90.00)	93 32 (74 99)	88.21 (69 89)	79.32 (62 93)	90 21 (74 45)	87.81 (69 54	67 84 (55.43)	50.00 (44 98)	50 00 (44.98)	63 91 (53 73)	77.06 (64 09)
Vellanad local	63 87 (53.03)	62.55 (52.25)	84 24 (66.59)	95 66 (77.94)	78.58 (62.45)	80.76 (63 96)	84 24 (66 59)	84 24 (66.59)	66.67 54.72)	78 98 (62 97)	77 78 (62 71)
Co-1	66.93 (54 88)	77.25 (61 49)	93.32 (74.99)	75 48 (60.30)	78 25 (62 92)	84 24 (66.59)	75.48 (60 30)	58.33 (49.78)	59.68 (50.56)	69.43 (56.81)	73.84 (59.86)
Mean	68 58 (57.60)	60 84 (5 .82)	63 72 (53 83)	64 47 (54.27)		73.82 59 83)	72.14 (58.32)	66.12 (54 92)	63.65 (53.20)		
ean dose effect		60 84 (51.38)	63.72 (53.83)	64 47 (54.27)	6 01 (55 33		72 14 (58 32)	66.12 (54.92)	63.65 (53.20)	67.30 55.43)	

CD - Between varieties - 8.45

Transformed values given in parantheses.

KEY


Mudikode local
Panavalli
Attenganam local
Lucknow Sweet
Verma Surprise
Hara Madhu
Pulliporan
Punthala local
Vellanad local
Co-1

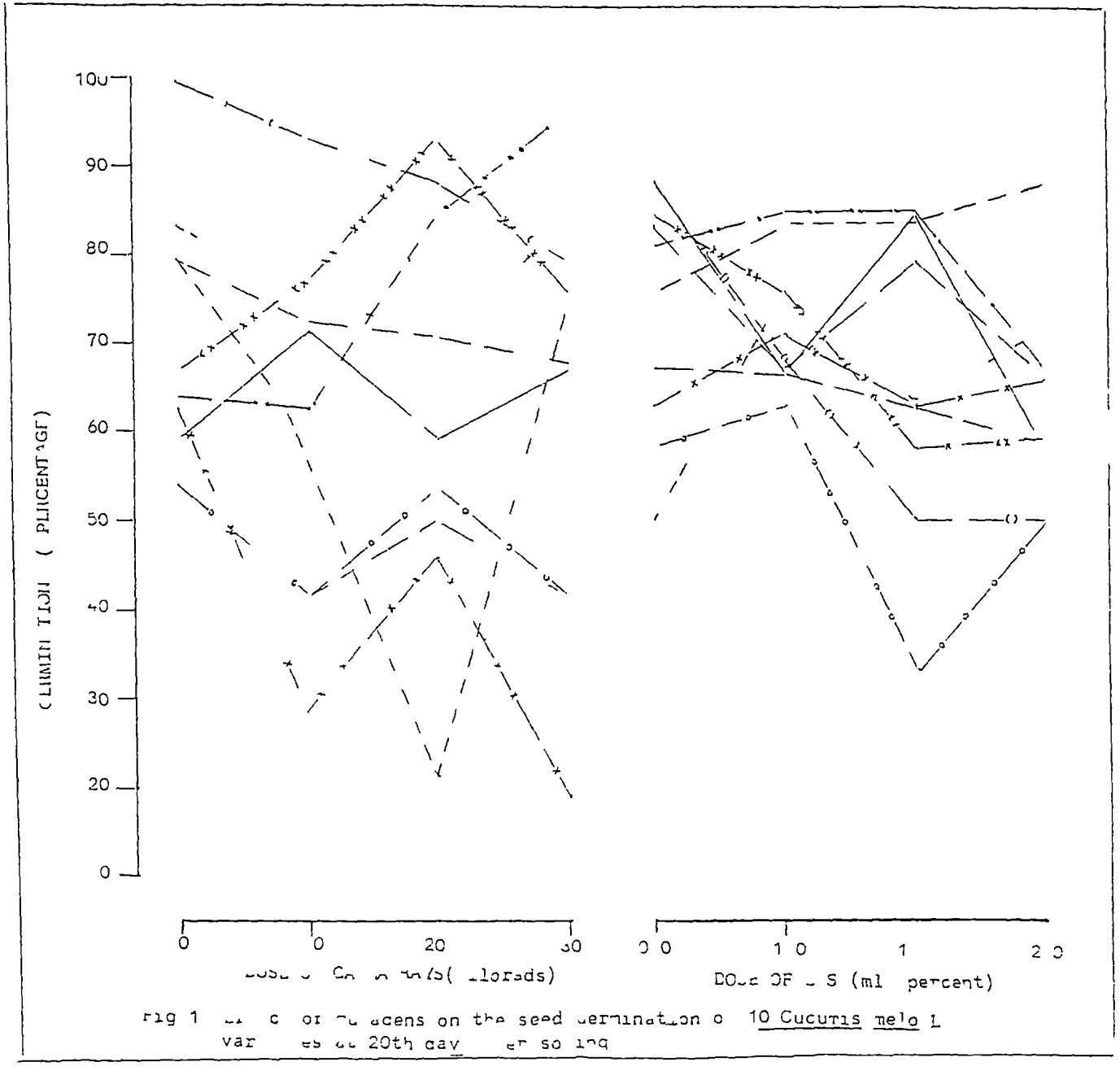


Fig 1 ... of ... gens on the seed germination o ... 10 Cucutis melo L
var ... es at 20th day ... er so ing

Germination of seeds of the different varieties was not observed beyond the 20th day after sowing. Hence this data gives the total germination percentage of seeds of the 10 Cucumis melo L. varieties as influenced by the mutagens. The data is similar to that obtained on the 15th day after sowing with slight increase in germination percentage. The results show similar trends in percentage germination values . as obtained on the 15th day after sowing.

Differences in germination percentage between the different levels of mutagens and their controls were not found to be significant. A similar result where gamma ray had little or no effect on germination was reported by Singh et al. (1978) in bhajra, Danno et al (1980) in Cucumis sativus, Narang and Prakash (1983) in Luffa cylindrica, Cucumis sativus, Momordica charantia and Citullus lanatus cv sugarbaby.

In the present study the germinability of seeds was not significantly affected by the different mutagen doses. However in general, reduction in germination percentage was observed in varieties, Panavalli, Attenganam local, Lucknow Sweet, Verma Surprise and Punthala local with increase in levels of gamma rays except 30 kR in Panavalli and Attenganam local, 20 kR

in Lucknow Sweet and Verma Surprise though the reduction was not statistically significant. In all these varieties the gamma ray treatments registered lower germination percentage than the control. Decreasing germination with increasing dosages of radiations was observed by Fuji and Matsumara (1958) in several crop plants, Goranov (1972a) in Cucurbita maxima, Danno et al. (1980) in Cucumis sativus and Yadava and Singh (1984) in Cucumis melo.

Skoog (1935) and Smith and Kersten (1942) attributed the influence of mutagens on germination to the destruction of auxins while Gordon and Webber (1955) suggested that it would be due to inhibitory action of auxins. According to Brock (1965) reduction in germination in Trifolium subterraneum due to irradiation of X rays and thermal neutrons was because of radiation induced gross chromosomal breakages.

In varieties Mudikode local, Pulliporan, Vellanad local and Co-1 increase in germination percentage which was not significant was observed in gamma ray treatments except 20 kR in Mudikode local and 10 kR in Pulliporan and Vellanad local compared to the control. Germinability of gamma irradiated seeds being better than the control

have been reported by Swarup and Gill (1968) and Rukmanskee (1973) in French bean. Casarett attributed such increase in percentage of germination to increased activity of certain enzymes involved in the synthesis of auxins.

With regard to EMS treatment, reduction in germination percentage compared to control was observed in varieties Mudikode local, Lucknow Sweet (except 1.0% treatment) Hara Madhu, Pulliporan,Punthala local and Co-1. The result is in line with results of Blixt and Gelin (1965) in Pisum; Siddiq and Swaminathan (1968) in rice; Bhojwani and Kaul (1976) in pea and Kubicki (1983) in cucumber. Such an inhibition of germination with EMS treatment has been attributed to the formation of a significant amount of acids on hydrolysis inside the cells during treatment which causes toxicity (Konzak et al. (1965)

2. Days taken to complete germination.

Mean number of days taken to complete germination in 10 Cucumis melo L. varieties as influenced by the mutagens is presented in table 2.

Statistical analysis of the data showed significant variation in mean number of days between varieties, gamma

Table 2. Effect of mutagens on the mean number of days taken to complete germination of 10 Cucumis melo L. varieties.

Varieties	Gamma rays - dose					EMS – dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	7.50	6.50	8.50	12.00	8.13	6.00	10.00	6.50	7.50	7.50	7.81
Panavalli	12.00	14.50	12.00	12.50	13.50	9.50	9.50	9.50	10.00	9.63	11.56
Attenganam local	13.00	9.50	15.00	10.00	11.88	13.00	9.50	7.00	7.50	8.25	10.56
Lucknow Sweet	10.50	14.00	11.50	9.50	11.38	8.00	9.50	10.50	9.00	9.25	10.31
Verma Surprise	15.00	11.00	11.50	8.50	11.50	8.50	8.50	11.00	10.00	9.50	10.50
Hara Madhu	12.50	12.50	8.50	13.00	11.63	5.00	8.50	8.50	7.50	7.63	9.63
Pulliporan	11.00	6.50	11.50	9.50	9.63	10.00	7.00	8.50	8.50	8.50	9.06
Punthala local	11.00	14.00	13.50	11.00	12.38	11.00	9.00	14.00	11.50	11.38	11.88
Vellanad local	8.00	10.50	10.00	12.00	10.38	8.00	10.00	8.50	6.50	8.25	9.31
Co-1	10.00	12.50	9.00	11.50	10.75	8.00	8.00	9.50	8.50	8.50	9.63
Mean	11.15	11.15	11.20	10.95		8.70	8.95	9.45	8.65		
Mean dose effect		11.15	11.20	10.95	11.10		8.95	9.45	8.65	9.02	

CD - Between varieties - 1.480 CD - Gamma rays Vs EMS - 0.468 CD - Variety x gamma rays - 2.961

rays and EMS and variety x gamma rays. Variation in mean values between levels of gamma rays, levels of EMS and variety x EMS was found to be not significant.

Under the influence of gamma rays the variety Mudikode local took significantly lesser number of days (8.13) to complete germination compared to the other varieties. Maximum number of days to completion of germination was recorded by Panavalli (13.50) which was on par with Punthala local (12.38) but significantly inferior in earliness to completion of germination than the other varieties. Variation in mean values between Pulliporan (9.63), Vellanad local (10.38) and Co-1(10.75) was not significant. Pulliporan was significantly earlier in completion of germination than all varieties except Mudikode local. Mean values of Vellanad local (10.38) Co-1 (10.75), Lucknow Sweet (11.38) Verma Surprise (11.50) and Hara Madhu (11.63) did not differ significantly.

Under the influence of EMS, Mudikode local (7.50) Hara Madhu (7.63) Vellanad local (8.25), Pulliporan(8.50) and Co-1 (8.50) did not differ significantly in mean number of days to complete germination. All these varieties, except Vellanad local, Pulliporan and Co-1

were significantly earlier in completion of germination than the rest of the varieties. Vellanad local, Pulliporan, Co-1, Lucknow Sweet (9.25), Attenganam local (9.25), Verma Surprise (9.50) and Panavalli (9.63) were on par. Punthala local (11.38) recorded significantly maximum number of days to complete germination than the rest of the varieties.

Comparing the influence of both gamma rays and EMS together on varieties, Mudikode local (7.81) took significantly lesser number of days to complete germination compared to other varieties. Pulliporan (9.06), Vellanad local (9.31), Hara Madhu (9.63), Co-1 (9.63) and Lucknow Sweet (10.31) were on par in mean values. These varieties except Verma Surprise were significantly earlier than Attenganam local (10.56), Panavalli (11.56) and Punthala local (11.88) in completion of germination.

Irrespective of the varieties EMS treatment induced early completion of germination (9.02) than gamma ray treatment (11.10). Difference in mean values between variety x EMS interaction was not observed but variety x gamma ray interaction was found to be significant.

Significant delay in completion of germination compared to control was observed in 30 kR treatments in Mudikode local and Vellanad local, 20 kR treatment in Attenganam local, 10 kR treatment in Lucknow Sweet and 10 kR and 20 kR treatments in Panavalli. Delay in germination has been reported by Lesley and Lesley (1956) in tomato due to x-ray treatment. Louis and Kadambavanasundaram (1973) reported delayed germination with increase in gamma rays in cowpea. Cherry and Hageman (1961) attributed delay in germination to the impairments of mitotic activity which disrupts germination in seeds. According to Casarett (1968) delayed germination following mutagen treatment may be due to the influence of mutagens on plant hormones and plant growth regulators which causes delay in initiation of germination.

Significantly early germination compared to control occurred in 10 kR treatment in Attenganam local 20 kR treatment in Hara Madhu and Co-1, 10 kR and 30 kR treatments in Pulliporan. In Verma Surprise significant reduction in mean number of days to complete germination occurred with increase in level of gamma rays except between 10 kR and 20 kR where the reduction was not

significant. Earlier germination in gram at low doses of gamma rays has been reported by Mujeeb (1974). Earliness in germination as observed in certain doses of gamma rays on some of the varieties of Cucumis melo L. in the present study may be due to their stimulatory effects in plant hormones and plant growth regulators.

The seeds treated with EMS took more number of days to complete germination than its control in all varieties except Attenganam local but the delay in germination was not significant. Similar result has been reported by Van der Veen and Hildering (1965) in tomato. Delay in germination seems to be caused by physiological damages brought about by chromosomal and extrachromosomal factors.

3. Survival of seedlings

a. The effect of mutagens on the survival percentage of ten Cucumis melo L. varieties at 20th day after sowing is presented in table 3a.

Significant difference was observed in mean values of survival percentage among the tested varieties. However, no significant difference in mean values was observed between levels of gamma rays, levels of EMS,

Table 3 a . Effect of mutagens on the survival percentage of 10 Cucumis melo L. varieties at 20th day after sowing.

Varieties	Gamma rays - dose					EMS – dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0	Mean treated popln	
Mudukode local	50.00 (44.98)	71.68 (57.83)	45.69 (42.54)	52.25	57.48 (49.59)	8 .33 (67.79)	62. 5 (52.25)	80.76 (63 96)	5 . 47.5	70.72 (57.77)	64.10 (53.58)
Panavalli	75.48 (60.30)	75.48 (60.30)	66.67 (5 72)	83.33 (65.88)	75.24 (60.30)	45.82 (42.59)	71.68 (57.83)	56.46 (4 85)	71.6 (57.8)	61.91 (52.03)	68.58 (56.16)
Attenganam local	74.99 59.98)	53.46 (49.85)	58.33 (49.78)	69.88 56.69)	65.41 (54 08)	60.67 (5 72)	85.33 (65 88)	85.35 (65 88)	77.2 61.49	77 65 (61.99)	71.53 (58.03)
Lucknow Sweet	50.00 (44.98)	37.06 (37.48)	50.00 (44 98)	41.67 (40.19)	44.68 (41.91)	54.43 47 52)	62.94 (52.48)	35.33 (35.25)	45.4 (42.35)	40.03 (44 40)	46.86 (43.16)
Verma Surprise	62.55 52.25)	22.75 (28.48)	35.33 (36.25	29.24 (26.01)	34.47 (35.50)	63.87 (52.03)	70.92 (57.35)	62.55 (52.25)	54.3 (47.4)	62.91 (52.25)	48.69 (44.01)
Hara Madhu	50.00 (44.98)	41.54 (40.12)	44.36 (42.03)	41.54 (40.12)	44.49 (44.81)	70.32 (62 93)	54.31 (47.45)	74.99 (59.98)	58.86 (50.06)	66.87 (55.11)	55.68 (48.46)
Pullipuran	58.33 (49.78)	50.00 (44.98)	70.95 (57.35)	45.69 (42.51)	56.24 (48.66)	62.55 (52.25)	45.69 (42.51)	54.59 (47.61)	58.46 49.65)	55.32 (48.06)	55.78 (48.35)
Punthala local	97.88 (81.60)	90.84 (72.36)	77.25 (61.49)	79.32 (62.93)	86 32 (69.60)	84.24 (66.59)	67.84 (55.43)	41.54 (40.12)	50.00 (44.98)	60.91 (51.78)	73.62 (60.69)
Vellanad local	59.68 (50.56)	54.18 (47.38)	80.76 (63.96)	77.25 (61.49)	67.97 (55.85)	75.48 (60.30)	67.84 (55.43)	71.68 (57.83)	54.18 (47.38)	67.30 (55.24)	67.64 (55.54)
Co-1	70.92 (57.35)	73.64 (59.08)	84.24 (66.59)	75.48 (60.30)	76.07 (60.83)	75.48 (60.30)	62.55 (52.25)	29.08 (32.62)	55.14 (47.93)	55.56 (48.28)	65.82 (54.55)
Mean	64.98 (54.68)	57.56 (49.78)	61.21 (51.86)	59.60 (50.84)		69.32 (56.78)	64.97 (53.88)	59.03 (50.54)	57.95 (49.68)		
Mean dose effect		57.56 (49.78)	61.21 (51.86)	59.60 (50.84)	59.46 (50.83)		64.97 (53.88)	59.03 (50.54)	57.95 (49.68)	60.65 (51.37)	

CD Between varieties - 8.256

Transformed values given in parantheses.

gamma rays and EMS, variety x gamma ray interaction and variety x EMS interaction.

Considering the effect of gamma rays on varieties, Punthala local had the highest mean value for survival percentage (86.32) and was significantly superior to all other varieties. Co-1 (76.07), Panavalli (75.24), Vellanad local (67.97) and Attenganam local (65.41) were all on par in survival percentage. These varieties with the exception of Attenganam local were significantly superior to mean survival percentage of varieties, Mudikode local (57.48), Pulliporan (56.24), Lucknow Sweet (44.68), Hara Madhu (44.49) and Verma Surprise (34.47). Difference between mean values of varieties, Mudikode local, Attenganam local and Pulliporan was not significant. Likewise Lucknow Sweet, Hara Madhu and Verma Surprise were also similar in their low response to survival percentage.

Regarding the effect of EMS on varieties, Attenganam local had the highest mean value of survival percentage (77.65) and was significantly superior to the rest of the varieties. No significant difference was noted in mean values between Mudikode local (70.72), Vellanad local (67.30), Hara Madhu (66.87), Verma Surprise (62.91) and Panavalli (61.91). Variation observed in mean survival

percentage between Co-1(55.56), Pulliporan (55.32) and Lucknow Sweet (49.03) were not significant and with the exception of variety Co-1, they were significantly inferior to Mudikode local, Vellanad local, Hara Madhu, Verma Surprise and Panavalli. Mean survival percentages of Co-1, Vellanad local, Hara Madhu, Verma Surprise and Panavalli were on par.

Comparing the effect of EMS and Gamma rays together on varieties indicated no significant difference between mean values for survival percentage among varieties, Punthala local (73.62), Attenganam local (71.53), Panavalli (68.58), Vellanad local (67.64), Co-1 (65.82) and Mudikode local (64.10) all of which were superior to Verma Surprise (48.69) and Lucknow Sweet (46.86). Punthala local and Attenganam local were also significantly superior to Hara Madhu (55.68) and Pulliporan (55.78) which were on par with Panavalli, Vellanad local, Co-1 and Mudikode local. No significant difference between mean values of survival percentage of varieties Hara Madhu, Pulliporan, Verma Surprise and Lucknow Sweet was observed.

b. Mean values for survival percentage of the 10 Cucumis melo L. varieties at 30th day after sowing as influenced by mutagen treatment is shown in table 3 b. The graphical representation of the data is shown in Fig.2.

Variation in mean values of survival percentage among varieties was significant at 30th day after sowing. Difference in mean values recorded between levels of gamma rays, levels of EMS, gamma rays and EMS, variety x gamma ray interaction and variety x EMS interaction was found to be not significant.

In the case of effect of gamma rays on varieties, Punthala local registered highest mean values for survival percentage of 81.53 followed by Co-1 with 72.25. These two varieties were significantly superior to Pulliporan (54.15), Mudikode local (53.30), Lucknow Sweet (41.49), Hara Madhu (40.25) and Verma Surprise (32.38), Punthala local was also significantly superior to Panavalli (71.23), Vellanad local (63.53) and Attenganam local (60.80). There was no significant difference in mean values between Verma Surprise, Hara Madhu and Lucknow Sweet or between mean values of varieties Pulliporan, Mudikode local, Lucknow Sweet and Hara Madhu.

Table 3 b . Effect of mutagens on the survival percentage of 10 Cucuris melo L. varieties at 30th day after sowing.

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	45.82 (42.59)	71.68 (57.83)	45.69 (42.51)	50.00 (44.98)	53.30 (46.98)	73.65 (59.09)	58.46 (49.85)	75.48 (60.30)	5 .46 (49.85)	66.5 (54.77)	5°.91 50.87)
Panavalli	75.48 (60.30)	75 48 (60.30)	58.46 (4°.85)	75.48 (60.30)	71.23 (57.69)	45.82 (42.5°)	66.93 (54.88)	54 18 (47.38)	71 68 (57.83)	59.65 (50.67)	65.44 (54.18)
Attenganam local	66.67 54.72)	54.31 (47.45)	58.33 (49.78)	63.87 (53.03)	60.80 (51.25)	62.55 (52.25)	70.92 (57.35)	70.92 (57.35	71.68 (5 .83)	69.02 (5°.20	64 91 (53.72)
Lucknow Sweet	45.82 (42.59)	37.06 (37.48)	50.00 (44.98)	33.07 (35.09)	41.49 (40.04)	45.69 (42.51)	54.18 (47.38)	33 33 (35.25)	49.99 (44.98)	45.80 (42.53)	43.65 (41.28)
Verma Surprise	54.18 (47.38)	22.75 (28.48)	33.33 (35.25)	19.24 (26.01)	32.38 (34.28)	71.68 (57.83)	62.55 (52.25)	50.00 (44.98)	45.69 (42.51)	57.48 (49.39)	44.93 (41 84)
Hara Madhu	41.54 (40.12)	41.54 (40.12)	44.86 (42.03)	33.07 (35.09)	40.25 (39.34)	54.59 (47.61)	50.00 (44.98	62.55 (52.25)	54.58 (47.61)	55.43 (48.11)	47.84 (43.73)
Pulliporan	58.33 (49.78)	45.82 (42.59)	70.92 (57.35)	41.54 (40.12)	54.15 (47.-6)	58.46 (4 .85)	45.69 (42.51)	54.59 (47.61)	58.46 (49.85)	5 .30 (47.46)	54.23 (47.46)
Punthala local	95.65 (77.94)	82.30 (65.09)	77.25 (61.49)	70.92 (57.35)	81.53 (65.47)	79.32 (62.93)	50.00 (44.98)	19.24 (26.01)	36.13 (36.93)	46.17 (42.71)	63.85 (54.09)
Vellanad local	54.59 (47.61)	54.18 (47.38)	71.68 (57.83)	73.65 (59.09)	63.53 (52.98)	70.93 (57.35)	58.46 (49.85)	66.93 (54.88)	45.82 (42.59)	60.53 (51.17)	62.03 (52.07)
Co-1	70.92 (57.35)	67.84 (55.43)	79.32 (62.93)	70.92 (57.35)	72.25 (58.27)	71.68 (57.83)	50.00 (44.98)	29.08 (32.62)	50.00 (44.98)	50.19 (45.10)	61.22 (51.68)
Mean	60.90 (52.03)	55.30 (48.20)	58.98 (50.40)	53.68 (46.84)		63.44 (52.98)	56.72 (44.90)	51.63 (45.86)	54.25 (47.50)		
Mean dose effect		55.30 (48.20)	58.98 (50.40)	53.68 (46.84)	55.99 (48.48)		56.72 (44.90)	51.63 (45.86)	54.25 (47.50)	54.20 (46.09)	

CD - Between varieties - 7.868

Transformed values given in parantheses

KEY

 Mudikode local

 Panavalli

 Attenganam local

 Lucknow Sweet

 Verma Surprise

 Hara Madhu

 Pulliporan

 Punthala local

 Vellanad local

 Co-1

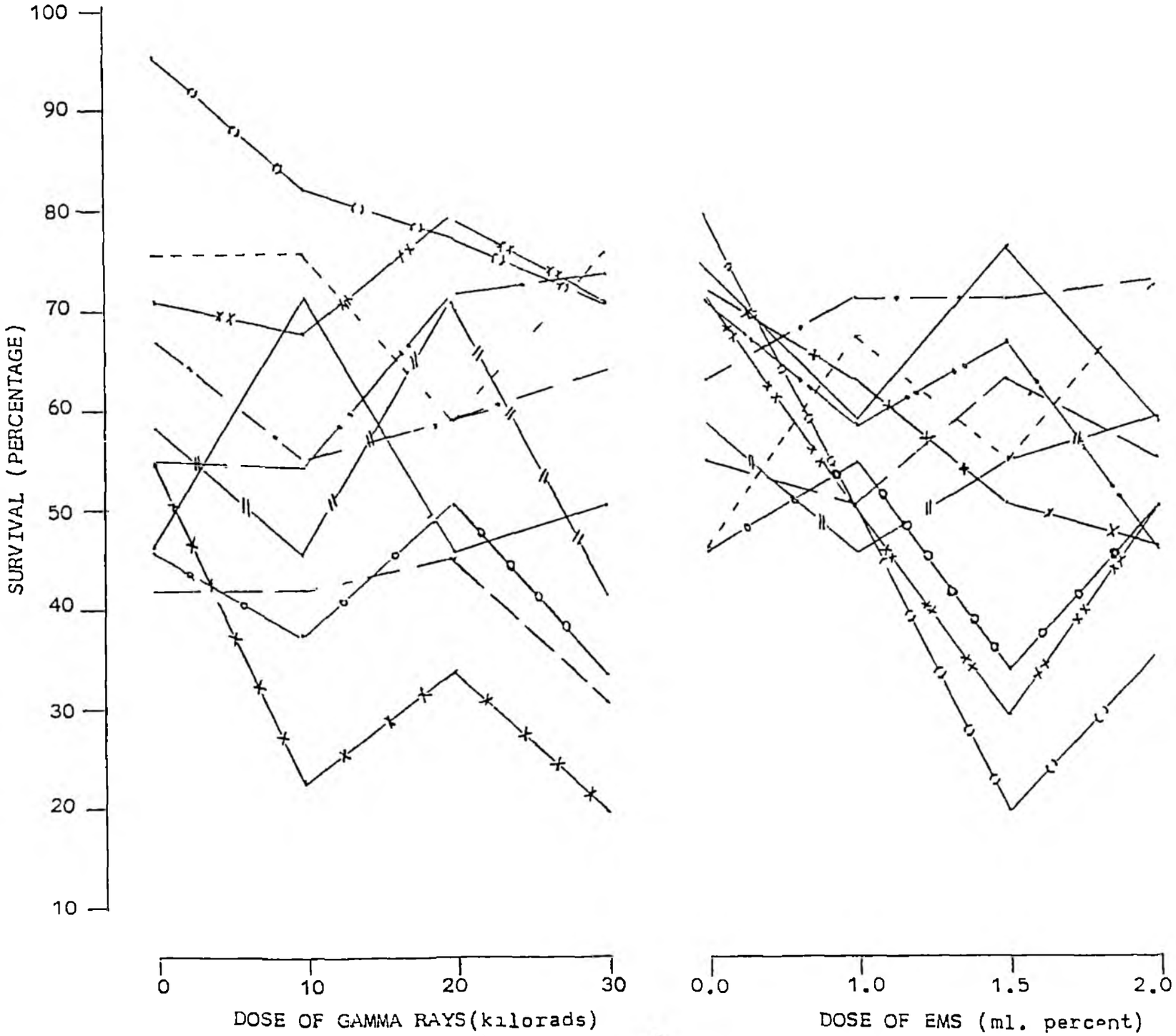


Fig.2 Effect of mutagens on the survival of 10 Cucumis melo L varieties at 30th day after sowing

Considering the effect of EMS on varieties, Attenganam local registered the highest mean value (69.02) for survival percentage followed by Mudikode local (66.51), Vellanad local (60.53), Panavalli (59.65) and Verma Surprise (57.48) which were on par with each other. Attenganam local and Mudikode local were significantly superior to Hara Madhu (55.43), Pulliporan (54.30), Co-1 (50.19), Punthala local (46.17) and Lucknow Sweet (45.80). No significant difference was noted between mean values of Vellanad local, Panavalli Verma Surprise, Hara Madhu, Pulliporan and Co-1. Mean survival percentage of Punthala local and Lucknow Sweet were significantly inferior to mean survival percentage of Vellanad local and Panavalli.

Comparing the effect of gamma rays and EMS together on varieties Panavalli had the highest mean value (65.44) followed by Punthala local (63.85), Attenganam local (64.91), Vellanad local (62.03), Co-1 (61.22), Mudikode local (59.91) and Pulliporan (54.23) between which variation in mean values was not significant. These varieties excepting Co-1, Mudikode local and Pulliporan were significantly superior to Hara Madhu (47.84), Verma Surprise (44.93) and Lucknow Sweet(43.65). Mean values of Pulliporan, Hara Madhu, Verma Surprise

and Lucknow Sweet were comparable. Likewise mean values of Co-1, Mudikode local, Pulliporan and Hara Madhu were also on par.

The different gamma ray treatments of varieties Attenganam local, Lucknow Sweet, Verma Surprise, Hara Madhu and Punthala local recorded reduced survival percentage when compared to control. In varieties Verma Surprise and Punthala local survival percentage decreased with increase in level of gamma rays excepting the 20 kR treatment in Verma Surprise. Similar results due to irradiation were observed by Velich (1969) in varieties of Cucumis melo and Teodoradze (1966) in French bean and soy bean. According to Konzak et al. (1965) reduction in survival percentage with increased doses of radiation may be due to decrease in synthesis of auxins and physiological changes. Structural changes of chromosome complements due to irradiation inhibits normal development of organs which may also result in decreased survival values.

Different levels of EMS in varieties, Mudikode local, Pulliporan, Punthala local, Vellanad local and Co-1 registered reduced survival percentage compared to control. Similar results wereobtained by Kubicki (1983)

in cucumber and Wellensiek (1965) and Tarasenkov (1969) in peas. Chromosomal alterations due to EMS treatment may have caused such reduced survival percentage.

4. Chlorophyll chimeras

Chlorophyll chimeras were observed in gamma ray and EMS treatments. Chlorophyll deficient narrow streaks were found on the leaves of one plant each in 20 kR and 1.5% EMS treatments of variety Pulliporan, two plants in 20 kR of variety Panavalli (Plate 2b) one plant each in 1.0% and 1.5% EMS treatments of Panavalli, one plant each in 30 kR of Co-1, 20 kR of Lucknow Sweet, 20 kR of Vellanad local, 1.0% EMS treatment of Attenganam local and 1.5% EMS treatment of Mudikode local.

Chlorophyll deficient patches were found on the leaves of two plants each in 20 kR treatments of varieties Verma Surprise and Attenganam local (Plate 2c) and 30 kR treatment of Vellanad local (Plate 3a), one plant each in 1.0% EMS treatments of Panavalli (Plate 3b), Mudikode local and 1.5% EMS treatments of Lucknow Sweet. One plant in 30 kR treatment of Lucknow Sweet had chimeric branch producing light green leaves (Plate 4). Frequency of chlorophyll chimeras was more wth gamma rays than with EMS treatments.

Chlorophyll chimeras

Plate 2a. - Control - Normal leaf

Plate 2b. - Leaf with chlorophyl deficient narrow streaks (20 kR gamma ray treatment of variety Panavalli)

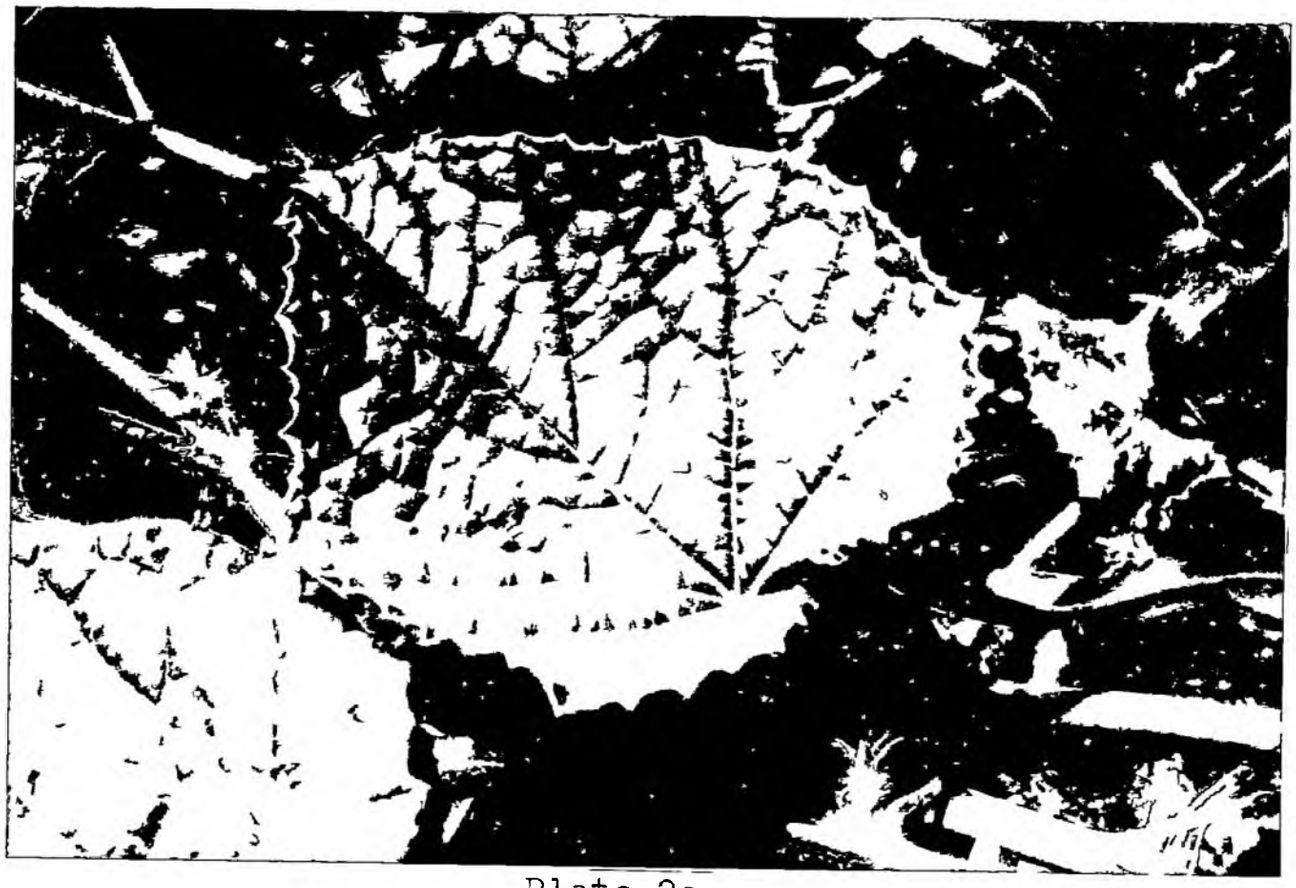


Plate 2a.

Plate 2b.

Plate 2c. - Leaf with chlorophyll deficient patches (20 kR gamma ray treatment of variety Attenganam local)

Plate 2c.

Chlorophyll chimeras

Plate 3a. - Leaf with chlorophyll deficient patches (30 kR gamma ray treatment of variety Vellanad local)

Plate 3b. - Leaf with chlorophyll deficient patches (1.0% EMS treatment of variety Panavalli)

Plate 3a.

Plate 3b.

Plate 4. Light green leaves of chimeric branch (30 kR gamma ray treatment of variety Lucknow Sweet)

1. Normal

2. Light green leaf

Plate 4.

The Chlorophyll chimeras were few in number and appeared only in the two higher doses of gamma rays and two lower doses of EMS treatments of certain varieties. Variations in chlorophyll content were obtained in cucumber by Whelan and Chubey (1973) following gamma irradiation and Kubicki (1983) with EI treatment. Destruction of chlorophyll as a result of mutagen treatment might probably have caused the chlorophyll deficient areas in the leaves as reported earlier by Manju et al. (1983) in horsegram.

A plant in 30 kR treatment of Lucknow Sweet had chimeric branch producing light green leaves. The reason for the chimeric region of this branch may be that only a part of the embryo was affected by gamma rays, the rest remaining normal. Similar chlorophyll chimeras were observed by Swarup and Gill (1968) in French beans and Bezhanidze and Debelyi (1970) in pea.

5. Morphological abnormalities

Morphological variations observed as a result of gamma irradiation and EMS treatment included dwarf bushy plants, plants with crinkled or split leaves and plants producing small deformed fruits.

The highest dose of EMS treatments of varieties Attenganam local and Vellanad local (Plate 5) and the highest dose of gamma rays in Lucknow Sweet produced plants that were initially dwarf and bushy in appearance. However they later recovered and had normal growth. For plant growth respiratory cycle is the main metabolic source of energy so the initial stunted growth of plants may be due to inactivation of respiratory enzymes during early growth phase.

Crinkled or twisted leaves were found in two plants of 2.0% EMS treatment of variety Lucknow Sweet, one plant each in 2.0% EMS treatments of variety Verma Surprise, Attenganam local (Plate 6a) and Pulliporan, one plant in 1.5% EMS treatments of Vellanad local, one plant each in 30 kR gamma ray treatments of Mudikode local (Plate 6 b) and Attenganam local and one plant in 20 kR gamma ray treatment of Punthala local. Split leaves were observed in two plants in 20 kR treatment of Mudikode local (Plate 7) and one plant in 1.5% EMS treatment of Attenganam local. Frequency of abnormalities of leaves was more with EMS than gamma rays. Deformation of leaf shape and irregularities of leaf margins and leaf blade were observed by Kubicki (1983) in cucumber with EI treatment. Leaf

Plate 5. - Dwarf plant (2.0% EMS treatment of variety Vellanad local)

Plate 6a. - Crinkled leaf (2.0% EMS treatment of variety Attenganam local)

Plate 5.

Plate 6a.

Plate 6b. - Crinkled leaf (30 kR gamma ray treatment of variety Mudikode local)

Plate 7. - Split leaf (20 kR gamma ray treatment of variety Mudikode local)

Plate 6b.

Plate 7.

abnormalities were also observed in cowpea by Constantin and Love (1964).

Two plants in 20 kR gamma ray treatment of variety Panavalli producing small round fruits were obtained (Plate 8a). Fruits with pointed beak were observed in one plant in 1.5% EMS treatment and fruits with invaginated beak were observed in one plant in 2.0% EMS treatment of variety Pulliporan (Plate 8 b). Plants with changes in fruit size and shape were reported by Kaushik et al.(1976) in cucumber following gamma irradiation and by Kubicki (1983) with EI treatment. These leaf and fruit abnormalities may be due to disrupted auxin synthesis and auxin transport, disruption of mineral metabolism of the plants and disturbed meiosis leading to chromosome breakages.

B. Biometric observations

6. Days for opening of first male flower

The effect of mutagens on the mean number of days taken for the appearance of first male flower of 10 Cucumis melo L. varieties is shown in table 4.

Statistical analysis of the data showed significant difference in mean values among varieties, between levels of gamma rays, levels of EMS, between the two mutagens and between variety x gamma ray interaction. No significant

Changes in fruit shape

Plate 8a. - Small round fruit (20 kR gamma ray treatment of variety Panavalli)

1. Small round fruit

2. Normal fruit

Plate 8b. - Deformed fruit obtained in variety Pulliporan

1. Normal

2. Fruit with invaginated beak (2.0% EMS treatment)

3. Fruit with pointed beak (1.5% EMS treatment)

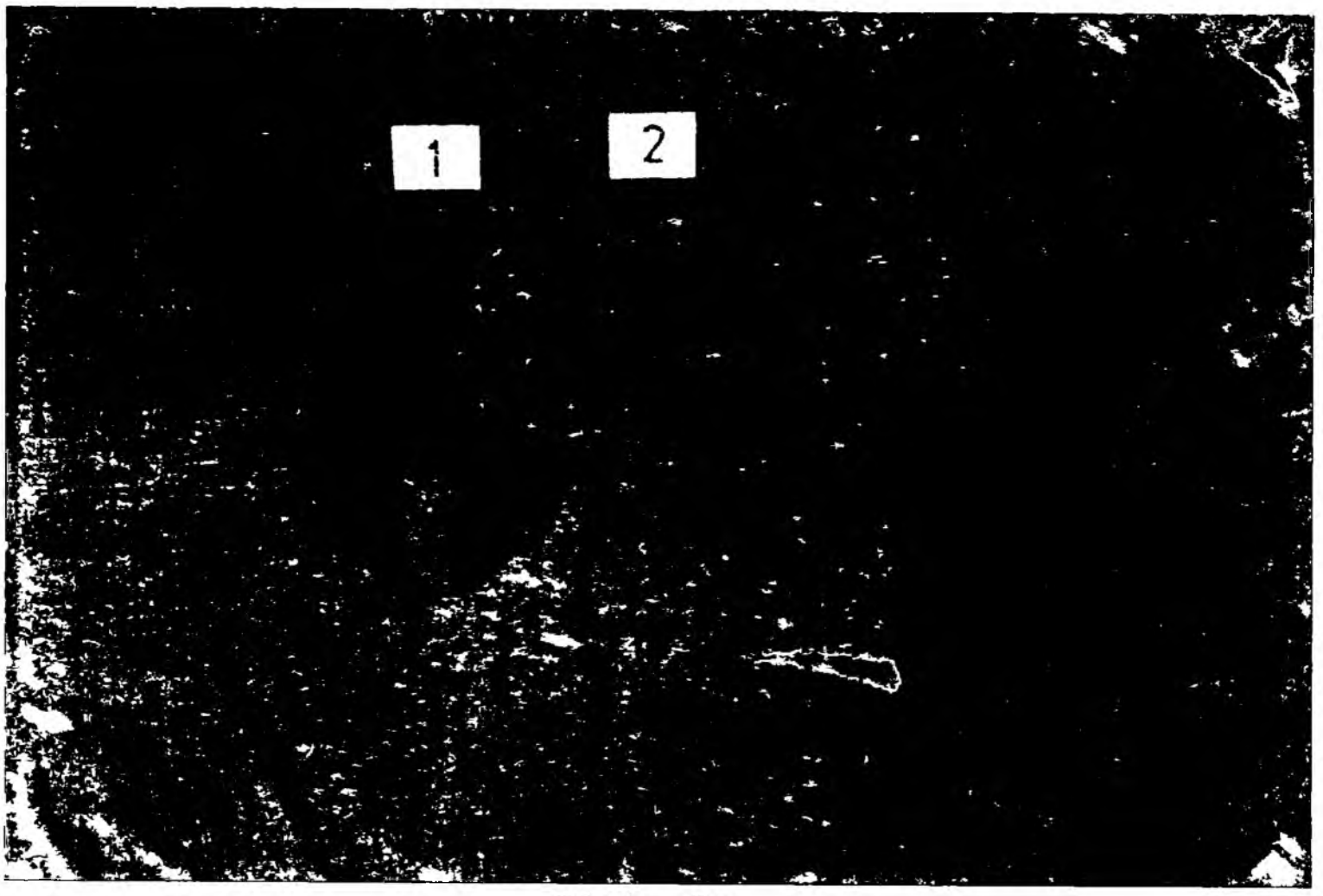


Plate 8a.

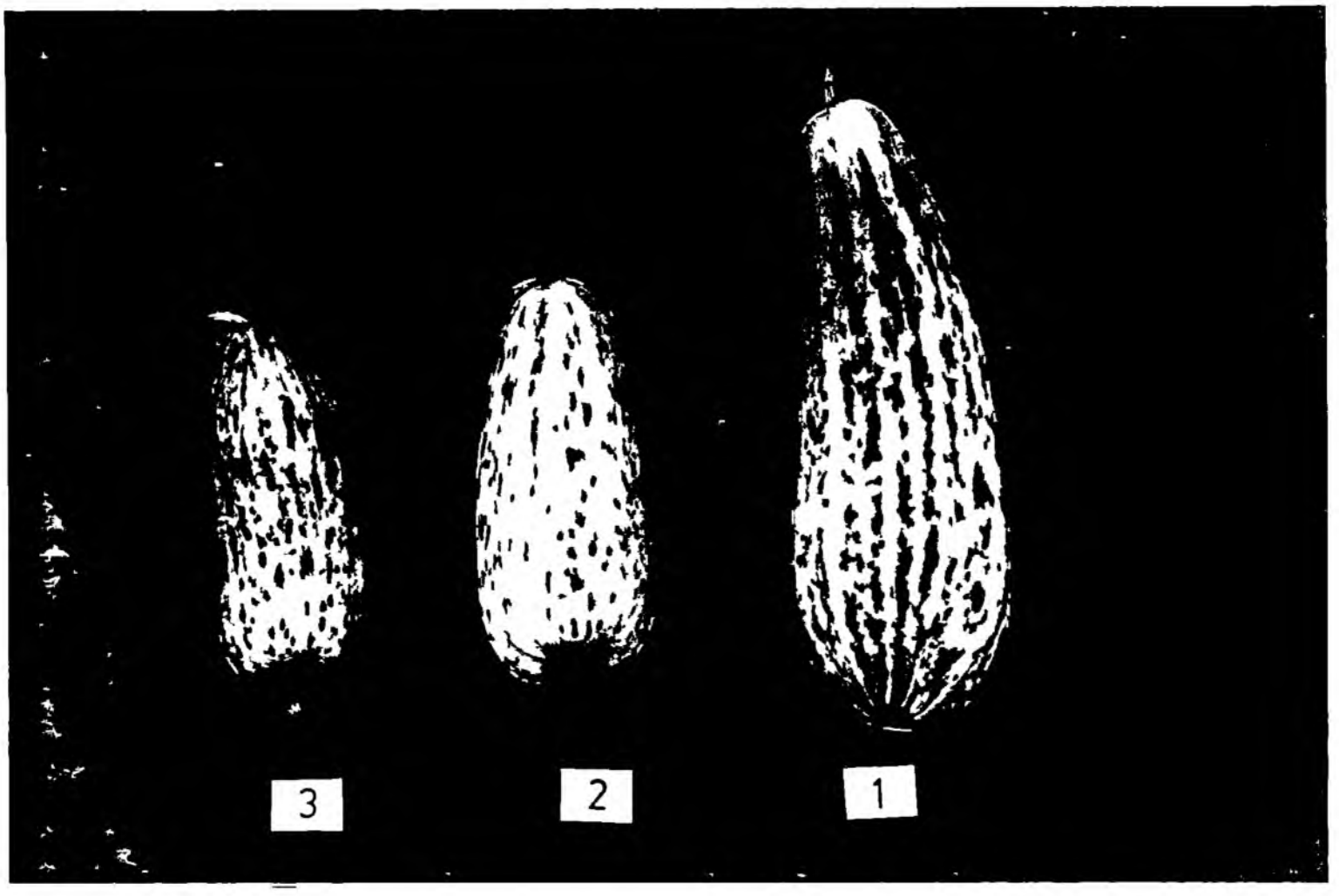


Plate 8b.

Table 4. Effect of mutagens on the number of days taken for the appearance of first male flower of 10 Cucumis melo L varieties.

Varieties	Gamma rays - dose					EMS—dose					General variety mean
	Control (dry	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked	1.0%	1.5%	2.0%	Mean treated popln.	
Puducode local	28.50	28.50	25.50	26.75	27.31	25.25	24.25	27.75	25.50	24.69	25.97
Panavalli	30.00	30.00	29.75	28.50	29.56	25.75	29.50	29.00	29.00	29.56	29.56
Kattenganam local	25.50	25.50	29.00	32.50	28.13	25.75	26.25	25.25	27.50	26.19	27.16
Lucknow Sweet	32.25	30.00	28.25	35.00	31.38	25.50	27.50	28.50	26.50	27.00	29.19
Verma Surprise	30.50	26.00	27.50	32.50	27.63	28.50	27.50	28.50	29.00	28.38	29.00
Hara Madhu	30.25	29.00	28.50	30.50	29.56	26.50	29.00	28.50	28.25	29.06	28.81
Pulliporan	25.00	26.50	25.75	25.50	25.69	24.50	25.50	24.75	25.50	25.06	25.38
Punthala local	29.75	28.50	29.75	29.00	29.25	29.00	32.00	25.00	25.00	27.75	28.50
Vellanad local	26.50	24.75	28.00	29.50	27.19	22.75	22.50	25.50	28.00	24.69	25.94
Co-1	28.25	27.25	27.50	30.50	28.38	27.00	27.00	28.00	27.00	27.25	27.81
Mean	28.66	27.78	27.96	30.02		26.30	27.10	26.88	27.12		
Mean dose effect		27.78	27.96	30.02	28.59		27.10	26.88	27.12	27.03	

CD - Varieties - 0.823 CD - Between levels of gamma rays - 0.520 CD- Between levels or EMS - 0.520

CD - Gamma rays Vs EMS - 0.260 CD- Variety x gamma rays 1.647

difference in mean values was noted between variety x EMS interaction.

Considering the effect of gamma rays on varieties, Pulliporan was the earliest (25.69) in terms of appearance of first male flower and was significantly superior to the rest of the varieties. Vellanad local (27.19) was similar to Mudikode local (27.31) in its response to the appearance of first male flower but was significantly superior to Co-1 (28.38) and Attenganam local (28.13) which were on par with Mudikode local. Verma Surprise (29.63), Panavalli (29.56), Hara Madhu (29.56) and Punthala local (29.25) had no significant variation in the mean values and were significantly inferior to Co-1, Attenganam local, Mudikode local, Vellanad local and Pulliporan. Lucknow Sweet with a mean value of (31.38) took the maximum number of days for appearance of first male flower.

In the case of effect of EMS on varieties, Mudikode local and Vellanad local with same mean value of (24.69) were the earliest in producing first male flower. These varieties were comparable with Pulliporan (25.06). Mudikode local, Vellanad local and Pulliporan were significantly superior to Attenganam local (26.19),

Lucknow Sweet (27.00), Co-1 (27.25), Punthala local (27.75), Hara Madhu (28.06), Verma Surprise (28.38) and Panavalli with mean value of 29.56 took the maximum number of days for production of first male flower.

Considering the influence of both gamma rays and EMS on varieties, Pulliporan (25.38), Vellanad local (25.94) and Mudikode local (25.97) with similar mean values were significantly superior to Attenganam local (27.16), Co-1 (27.81), Punthala local (28.50), Hara Madhu (28.81), Verma Surprise (29.00), Lucknow Sweet (29.19) and Panavalli (29.56). Variety Panavalli required the maximum number of days to produce first male flower. No significant difference between mean values of Panavalli, Lucknow Sweet, Verma Surprise and Hara Madhu was observed.

Between levels of gamma rays the lower doses of gamma rays (10 kR, 20 kR) had similar effect of early flowering (27.78, 27.96) of male flowers than the control (28.66) and the highest gamma ray dose (30 kr) with a mean value of 30.02 took the maximum number of days for the appearance of male flower irrespective of the varieties. In the case of different levels of EMS the control with mean value of (26.36) produced first male flower earlier than

the 1.0% (27.10) and 2.0% (27.12) EMS treatments but was similar in mean values of 1.5% EMS treatment (26.88). No significant difference in mean values between the 1.0% and 1.5% EMS treatment was noted.

Irrespective of the varieties, EMS treatment (27.03) produced first male flowers significantly earlier than gamma ray treatment (28.59).

Variety X EMS treatment interaction was not significant for days to appearance of first male flower. Difference in mean number of days for appearance of first male flower among levels of gamma rays and between its control was not significant in varieties Panavalli, Pulliporan and Punthala local. In Lucknow sweet the 20 kR and 10 kR treatments were significantly early in producing first male flower than 30 kR treatment and control. A similar trend was observed in Hara Madhu and Verma Surprise. In Mudikode local the 20 kR and 30 kR treatments were significantly early in producing first male flower compared to control and 10 kR treatment. In all these varieties, the 20 kR treatment was the earliest in first male flower production.

In Attenganam local and Vellanad local the 20 kR and 30 kR treatments resulted in significant delay in

first male flower production compared to control and 10 kR treatment. In Co-1, the 30 kR treatment resulted in significant delay, compared to the other gamma ray treatments and its control.

7. Node at which first male flower appeared

The effect of mutagens on the node at which the first male flower appeared on 10 Cucumis melo L. varieties is shown in table 5.

Differences in mean number of nodes among varieties, between levels of gamma rays, between levels of EMS, variety x gamma ray interaction and variety x EMS interaction were found to be significant. No significant difference was observed between the two mutagens with regard to this parameter.

In the case of effect of gamma rays on varieties, the first male flower appeared on significantly lower nodes in Mudikode local (2.44), Verma Surprise (2.50), Pulliporan (2.50) and Vellanad local (2.50) than in Lucknow Sweet (3.06), Panavalli (3.13), Punthala local (3.31), Co-1(3.56) and Hara Madhu (4.31). Hara Madhu had the first male flower appearing on the highest node than all the rest of the varieties. No significantdifference in mean number of nodes at which first male flower appeared was indicated between Lucknow Sweet, Panavalli, Attenganam local

Table 5 Effect of mutagens on the node at which first male flower appeared on 10 *Cucumis melo* L. varieties

Varieties	Gamma rays — dose					EMS — dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln	
Adikode local	2.75	2.25	2.00	2.75	2.44	2.75	2.25	2.25	2.50	2.50	2.44
Banavalli	2.75	3.50	3.50	2.75	3.13	3.75	2.00	2.50	3.00	3.06	3.09
Ettenganam local	2.25	2.50	4.25	3.50	3.13	3.50	3.50	2.50	2.50	3.00	3.06
Lucknow Sweet	2.75	2.50	3.00	4.00	3.06	2.50	4.00	3.50	3.50	3.38	3.22
Perma Surprise	2.50	2.00	2.50	3.00	2.50	3.25	2.50	3.75	2.00	2.88	2.69
Para Madhu	4.00	5.00	3.75	4.50	4.31	4.50	3.50	2.00	4.00	3.50	3.91
Pullipuran	2.00	2.75	2.75	2.50	2.50	2.00	2.75	3.25	2.25	2.56	2.53
Punthala local	2.75	3.75	2.75	4.00	3.31	3.75	2.50	3.00	2.00	2.81	3.06
Pallanad local	2.50	2.00	2.00	3.50	2.50	2.00	2.75	2.50	2.50	2.44	2.47
Co-1	3.75	4.50	3.00	3.00	3.56	5.00	4.25	3.50	3.00	3.94	3.75
Mean	2.80	3.08	2.96	3.36		3.30	3.10	2.88	2.72		
Mean dose effect		3.08	2.96	3.36	3.13		3.10	2.88	2.72	2.18	

CD - varieties - 0.434 CD- Between levels of Gamma rays - 0.274 CD - Between levels of EMS - 0.274

CD - Variety x gamma rays - 0.868 CD - Variety x EMS - 0.868

and Punthala local. Co-1 had a mean number of nodes that was comparable with that of Panavalli, Attenganam local and Punthala local.

Considering the effect of EMS on varieties, no significant variation in mean number of nodes was found between varieties Vellanad local (2.44), Mudikode local (2.50), Pulliporan (2.56) and Punthala local (2.81) and with the exception of Punthala local, the mean number of nodes of these varieties was significantly lower than that of Verma Surprise (2.88), Attenganam local (3.00), Panavalli (3.06), Lucknow Sweet (3.38) Hara Madhu (3.50) and Co-1 (3.94). No significant difference in mean number of nodes of Punthala local, Verma Surprise, Attenganam local and Panavalli and between Hara Madhu and Co-1 was observed.

Comparing the effect of both mutagens on the mean number of nodes at which first male flower appeared, there was no significant difference in mean number of nodes between varieties Mudikode local (2.44), Vellanad local (2.47), Pulliporan (2.53) and Verma Surprise (2.69). In these varieties male flower appeared at significantly lower nodes than the rest of the varieties. Hara Madhu with a mean number of nodes of 3.91 had male flower appearing at higher node and was on par with Co-1 (3.75).

No significant difference in mean number of nodes between varieties Attenganam local (3.06), Punthala local (3.06), Panavalli (3.09) and Lucknow Sweet (3.22) was observed.

Between levels of gamma rays, the difference in mean values of number of nodes in control (2.80) and 20 kR (2.96) was not significant. The control produced first male flower on a significantly lower node than the 10 kR (3.08) and 30 kR (3.36) treatments which were on par. The 20 kR treatment resulted in production of first male flower at a significantly lower node than the 30 kR treatment but was on par with the 10 kR treatment.

In the case of different levels of EMS, compared to the control (3.30) there was a gradual decrease in mean number of nodes bearing the first male flower with increase in concentration of EMS. Decrease in mean number of nodes of 1.0% EMS treatment (3.10) from control (3.30) was not significant. The decrease in mean number of nodes between 2.0% EMS treatment (2.72) and 1.0% EMS treatment compared to the control was significant. The 1.5% EMS treatment had first male flower at a significantly lower node (2.88) than the control but was on par with mean number of nodes of 1.0% treatment.

In varieties Mudikode local and Pullıporan, variation in mean number of nodes at which first male flower appeared among the different levels of gamma rays and between their control was not significant. In Vellanad local and Mudikode local difference in mean values between the different levels of EMS and its control was not significant.

In varieties Punthala local, Lucknow Sweet, Vellanad local and Verma Surprise, the 30 kR treatment produced first male flower at significantly higher nodes than their control and the other gamma ray treatments, except for the 10 kR treatment in Punthala local. In Attenganam local, mean value of the 20 kR treatment was significantly higher than its control and the other gamma ray treatments. In Hara Madhu and Co-1, the first male flower appeared at significantly higher nodes in 10 kR treatment than in the control and other gamma ray treatments.

In the case of EMS treatments the 2.0% and 1.5% EMS treatments of varieties Attenganam local and Co-1 and the 2.0% and 1.0% EMS treatment of Verma Surprise produced first male flower at significantly lower nodes than the control and the other EMS treatment. In Punthala local the 2.0% EMS treatment was on par with

1.0% treatment, but had significantly lower mean values than control and 1.5% EMS treatment. In Panavalli and Hara Madhu, the 1.5% EMS treatment bore first male flower at significantly lower nodes than control. First male flower was produced at significantly higher node than control in all EMS treatments of Verma Surprise and also in 1.5% EMS treatment of Pulliporan.

8. Days for opening of first female flower

The effect of mutagens on the number of days taken for the appearance of first female flower on 10 Cucumis melo L. varieties is depicted in table 6.

Variation in mean number of days taken for the appearance of first female flower among varieties, between levels of EMS, between the two mutagens, between variety x gamma ray interaction and variety x EMS interaction was found to be significant. No significant variation found between mean number of days between levels of gamma rays.

Considering the effect of gamma rays on varieties, the variety Attenganam local was significantly the earliest in production of first female flower (32.06), followed by Lucknow Sweet (33.25), than the rest of the

Table 6. Effect of mutagens o the number of days taken for the appearance of first female flower on 10 Cucumis melo - varieties

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated populn.	
Mudikode local	35.50	35.00	33.00	35.00	34.63	33.75	29.75	27.00	28.00	29.63	32.13
Panavalli	34.00	36.00	34.00	35.00	34.75	35.75	36.00	31.50	33.00	34.06	34.41
Attenge am local	31.00	32.50	31.50	33.25	32.06	32.50	31.00	32.50	30.75	31.69	31.88
Lucknow Sweet	36.00	30.00	33.50	33.50	33.25	32.50	33.00	32.00	32.00	32.38	32.81
Verma Surprise	35.00	36.00	35.00	35.50	35.38	34.00	32.00	31.50	34.50	33.00	34.19
Hara sahu	34.75	38.00	36.25	36.00	36.25	32.50	37.00	32.50	31.00	33.25	34.75
Pullipoman	35.00	33.25	34.50	34.50	34.31	34.50	30.75	30.25	31.75	31.81	33.06
Punthala local	36.50	36.00	36.00	36.00	36.13	37.00	34.50	33.00	31.95	34.06	35.09
Vellanad local	35.50	34.50	36.00	36.50	35.63	27.50	32.00	35 50	36.00	32.75	34.19
Co-1	34.50	34.00	36.00	37.00	35.38	32.00	32.50	33.00	34.00	32.88	34.13
Mean	34.78	34.52	34.58	35.22		33.20	32.86	31.86	32.28		
Mean dose effect		34.52	34.58	35.22	34.77		32.86	31.86	32.28	32.34	

CD - Between varieties - 0.792 CD - Between levels of EMS - 0.501

CD - Gamma rays Vs EMS - 0.250 CD - Variety x gamma rays - 1.584 CD - Variety x EMS - 1.584

varieties. Mean number of days taken by Pulliporan (34.31), Mudikode local (34.63) and Panavalli (34.75) for production of first female flower was similar and with the exception of Panavalli, were significantly superior to Verma Surprise (35.38), Co-1 (35.38), Vellanad local (35.63), Punthala local (36.13) and Hara Madhu (36.25). Mean number of days for appearance of first female flower of varieties Vellanad local, Pulliporan and Hara Madhu were on par with that of Verma Surprise and Co-1 but were significantly superior to the rest of the varieties. Difference in mean number of days between varieties Verma Surprise, Co-1 and Vellanad local was not significant.

In the case of effect of EMS on varieties, Mudikode local with a mean value of 29.63 was significantly the earliest in female flower production compared to the rest of the varieties. Varieties Pulliporan (31.81), Attenganam local (31.69) and Lucknow Sweet (32.38) came next in terms of early female flower production and with the exception of Lucknow Sweet, all were significantly earlier than Vellanad local (32.75), Co-1 (32.88), Verma Suprise (33.00), Panavalli (34.06) and Punthala local (34.06).Significant delay in female flower production was observed in Panavalli and Punthala local

compared to the rest of the varieties. No significant difference in mean number of days to first female flower production was observed between varieties Vellanad local, Co-1, Verma Surprise and Hara Madhu.

Comparing the effect of both mutagens together on the varieties, Attenganam local (31.88), Mudikode local (32.13), Lucknow Sweet (32.81) and Pulliporan (33.06) were significantly early in female flower production than the rest of the varieties. Differences in mean number of days between Attenganam local and Mudikode local and between Lucknow Sweet and Pulliporan were not significant. Mean number of days of Mudikode local was on par with that of Lucknow Sweet, Co-1 (34.13), Verma Surprise (34.19), Vellanad local (34.19), Panavalli (34.41) and Hara Madhu (34.75) were superior to Punthala local (35.09) which took the maximum number of days for the appearance of first female flower.

Variation in mean number of days to appearance of first female flower between levels of EMS was significant. The 1.5% (31.88) and 2.0% (32.28) were on par and produced first female flower earlier than the control (33.20)as well as 1.0% (32.86) EMS treatment.

Irrespective of the varieties among the two mutagens EMS treatment (32.34) resulted in early appearance of first female flower than gamma ray treatment (34.77).

No significant variation in days for appearance of first female flower was observed between levels of gamma rays and their control in varieties Punthala local and Verma Surprise. In Panavalli and Hara Madhu the 10 kR treatment recorded a significantly delayed appearance of first female flower compared to control and the other gamma ray treatment except for the 30 kR treatment in Panavalli. In Attenganam local the 30 kR treatment was significantly late than control and 20 kR treatment, but was on par with 10 kR treatment in the appearance of first female flower. In Co-1, 20 kR and 30 kR treatment resulted in significant delay in appearance of first female flower than control and 10 kR treatment.

The 20 kR treatment of Mudikode local and 10 kR treatment of Lucknow Sweet and Pulliporan were significantly earlier than their control and the other gamma ray treatment except in Pulliporan where difference in mean values between gamma ray treatments was not significant.

Difference in mean number of days for appearance of first female flower between levels of EMS and between levels of EMS and their control was not significant in Lucknow Sweet. In Mudikode local and Pulliporan all EMS treatments recorded significantly earlier female flower production than control. The 1.5% and 2.0% EMS treatments of Panavalli and Punthala local were significantly earlier than control and 1.0% EMS treatment in female flower appearance. In Attenganam local 2.0% EMS treatment and 1.0% and 1.5% EMS treatments of Verma Surprise were significantly superior to their control and the other EMS treatment in early appearance of female flower. Significant delay in production of first female flower noticed in 2.0% EMS treatment of Vellanad local and Co-1 compared to 1.0% EMS treatment and their control but the treatment was on par with 1.5% EMS treatment. In Hara Madhu the 1.0% EMS treatment resulted in significantly delayed appearance of first female flower than the control and the two higher EMS doses.

9. Node at which first female flower appeared

Mean number of nodes at which the first female flower appeared on ten Cucumis melo L. varieties as influenced by the mutagens is depicted in table 7.

Table 7. Effect of mutagens on the node at which the first female flower appeared on 10 *Cucumis melo* L. varieties

Varieties	Gamma rays - dose					EMS - dose					General variety mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln	
Kudikode local	7.75	6.75	7.75	6.00	7.06	6.00	4.00	2.75	3.00	3.94	5.50
Panavalli	4.50	5.00	4.50	7.50	5.38	5.50	6.00	5.50	5.00	5.50	5.44
Attenganam local	7.00	8.50	7.50	7.25	7.56	6.50	9.50	8.00	4.50	7.88	7.72
Lucknow Sweet	5.50	4.5	4.00	6.00	5.00	3.00	4.75	5.25	3.50	4.16	4.56
Verma Surprise	5.50	5.00	6.00	6.50	5.75	4.00	7.00	5.50	4.00	5.13	5.44
Hara Madhu	4.25	7.50	9.75	6.25	5.19	7.50	6.00	9.00	6.75	7.19	6.75
Pulliporan	3.00	5.50	7.00	7.00	5.63	4.00	4.75	5.75	5.00	4.88	5.25
Punthala local	6.50	6.25	5.75	8.00	7.38	4.00	5.75	3.50	4.75	4.50	5.94
Vellanad local	6.50	6.50	7.50	7.00	7.63	4.50	7.00	6.50	7.50	6.38	7.00
Co-1	8.50	10.25	7.00	9.50	8.81	7.00	7.50	5.75	5.00	6.31	7.56
Mean	7.00	6.58	6.68	7.10		5.40	6.22	5.86	4.90		
Mean dose effect		6.58	6.68	7.10	6.79		6.42	5.86	4.90	5.66	

CD - Between varieties - 1.032 CD - Between levels of gamma rays - 0.652 CD - Between levels of EMS - 0.652

CD - Gamma rays x EMS - 0.326 CD - Variety x gamma rays - 2.064 CD - Variety x EMS - 2.064

Significant variation was observed between mean number of nodes at which first female flower appeared among varieties, between levels of EMS, between gamma rays and EMS and between variety x gamma ray interaction. Variation in mean number of nodes between levels of gamma rays and between variety x EMS interaction was found to be not significant.

Considering the effect of gamma rays on varieties, Lucknow Sweet (5.00), Panavalli (5.38), Pulliporan (5.63) and Verma Surprise (5.75) produced first female flower at significantly lower nodes than Mudikode local (7.06), Punthala local (7.38), Attenganam local (7.56), Vellanad local (7.63), Hara Madhu (8.19) and Co-1 (8.81). Variation in mean number of nodes among Mudikode local, Punthala local, Attenganam local and Vellanad local was not significant, Co-1 produced first female flower at a significantly higher node than the rest of varieties except Hara Madhu which was on par with Co-1.

Considering the effect of EMS on varieties, Attenganam local (7.88) produced first female flower at a significantly higher node than the rest of the varieties except Hara Madhu (7.19) which was on par with Attenganam local. Varieties Mudikode local (3.94) Lucknow Sweet(4.13),

Punthala local (4.50) and Pulliporan (4.88) did not differ significantly in mean number of node for first female flower production but they produced the first female flower on significantly lower nodes than Co-1 (6.31), Vellanad local (6.38), Hara Madhu (7.19) and Attenganam local. Verma Surprise (5.13), Panavalli (5.50) and Co-1 (6.31) had mean values that were on par.

Comparing the effect of both mutagens together on varieties, Lucknow Sweet (4.56), Pulliporan (5.25), Panavalli (5.44), Verma Surprise (5.44) and Mudikode local (5.50) had mean number of nodes that did not differ significantly amongst themselves ; but produced first female flower at significantly lower nodes than varieties Vellanad local (7.00) Co-1 (7.56), Attenganam local (7.72) and Hara Madhu (7.75), Vellanad local, Co-1, Attenganam local and Hara Madhu did not differ significantly in mean number of nodes. Punthala local (5.94) produced first female flower at a significantly higher node than Lucknow Sweet but was on par with Pulliporan, Panavalli, Verma Surprise and Mudikode local.

Between levels of EMS, 2.0% treatment (4.90) produced first female flower at significantly lower nodes than 1.0% (6.22) and 1.5% (5.86) EMS treatments.

Variation in mean number of node between 2.0% EMS treatment and control was not significant.

Between the two mutagens EMS treatments induced appearance of first female flower at lower nodes (5.66) than gamma ray treatments (6.79).

In Mudikode local, Attenganam local, Lucknow Sweet and Verma Surprise the variation in mean values between the levels of gamma rays and between the levels of gamma rays and their control was not significant. In Panavalli, the 30 kR treatment induced production of first female flower at a significantly higher node than the control and the other gamma ray treatments. In Pulliporan all the gamma ray treatments resulted in production of first female flower at a significantly higher node than the control.

The 20 kR treatment of Punthala local and Co-1, induced first female flower to appear at significantly lower node than the control and other gamma ray treatments except 10 kR treatment in Punthala local. In Vellanad local all the gamma ray treatments resulted in production of first female flower at significantly lower node than the control. In Hara Madhu the 30 kR treatment was on par with 10 kR treatment but produced first female flower at significantly lower node than the control

and 20 kR treatment.

Laibach and Kriben (1950a,b) explained that in cucumber plants transition from vegetative to flowering state was marked by a fall in auxin content of plant. During flowering if gibberellin concentration is more, it will induce maleness whereas a higher concentration of ethylene induced femaleness.

Production of first male flower at higher nodes than the control was observed in 30 kR treatments of varieties Verma Suprise, Vellanad local, 20 kR treatments of Attenganam local and 20 kR and 30 kR treatments of Hara Madhu and 10 kR treatment of Co-1. Position of first female flower was not affected due to irradiation in varieties Mudikode local, Attenganam local, Lucknow Sweet and Verma Surprise. This conforms with the results of Bisaria et al. (1975) where irradiation with higher dose did not affect the position of first hermaphrodite flower but increased the node number for the production of first staminate flower.

EMS treatments did not have any effect on the position of first male flower in varieties Mudikode local and Vellanad local. But in all other varieties, except Verma Surprise, the EMS treatments in general

resulted in appearance of first male flower at lower nodes compared to control. Position of first female flower did not vary significantly due to EMS treatments.

Days to appearance of first male flower was not influenced by EMS treatment in all varieties. In varieties Panavalli, Pulliporan and Punthala local days to appearance of first male flower was not influenced by gamma ray irradiation.

The 20 kR and 10 kR gamma ray treatments of varieties Lucknow Sweet and Hara Madhu and 20 kR and 30 kR treatments of Mudikode local resulted in early flowering of first male flower than their controls. Here irradiation might have resulted in early production of the required amount of gibberellin to initiate male flowering.

The 20 kR and 30 kR treatments of Attenganam local and Vellanad local and 30 kR treatment of Co-1 resulted in delayed flowering of first male flower. First female flower production was delayed with gamma ray irradiation except in 20 kR treatment, in varieties Panavalli, Attenganam local, Mudikode local and Co-1. Delayed appearance of first female flower also occurred at 1.0%

EMS treatment in Hara Madhu, 2.0% EMS treatments in Vellanad local and in all EMS treatments in Co-1. Delay for initiation of flowering as a result of mutagen treatment has been reported by Louis and Kadambavanasundaram (1973) in cowpea and by Khan (1984) in mung bean.

Irradiation induced ehtylene production has been reported to cause femaleness (Iwahori et al. 1970). Delay in appearance of the first male or female flower due to mutagen treatment might be due to the delay in production of required amount of gibberellin to initiate male flower production or ethylene to initiate female flower production. This indicates that in the present study, earliness in appearance of female flower due to irradiation in Lucknow Sweet and Pulliporan and EMS treatments in Panavalli, Mudikode local (except 1.0% treatment) and Verma Surprise (except 2.0% treatment) may probably be due to early production of required amount of ethylene to initiate female flowering.

10. Sex ratio

Table 8 shows the effect of mutagens on the sex ratio of ten Cucumis melo L. varieties. The graphical representation of the data is shown in Fig.3.

Table 8. Effect of mutagens on the sex ratio of 10 Cucumis melo L. varieties

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	28.24	30.37	43.80	35.93	34.59	31.32	38.06	23.19	26.94	29.88	32.23
Panavalli	49.51	36.85	33.74	38.05	39.54	43.66	40.31	24.50	39.54	37.00	38.27
Attengalam local	22.18	43.13	18.21	54.05	34.39	48.13	47.04	32.41	24.94	38.13	36.26
Lucknow Sweet	13.26	23.73	17.85	9.38	16.06	19.27	11.61	17.99	22.48	17.84	16.94
Verma Surprise	20.57	18.62	20.43	30.03	22.41	13.34	20.38	12.42	9.70	13.91	18.16
Hara adhu	24.29	27.47	5.47	7.03	16.07	17.95	6.85	6.50	9.02	10.08	13.07
Pulliporan	30.16	28.60	22.40	25.83	26.75	36.16	21.54	55.57	24.99	34.57	30.65
Punthala local	48.58	62.96	42.90	37.46	47.98	43.73	50.26	34.47	50.43	44.75	46.34
Vellanad local	44.44	57.42	39.60	47.48	47.24	44.70	53.16	59.83	55.70	53.35	50.29
Co-1	55.11	82.92	85.21	81.63	76.22	55.63	61.50	60.16	55.31	58.15	67.18
Mean	33.63	41.20	39.96	36.68		35.39	35.07	32.68	31.90		
Mean dose effect		41.20	39.96	36.68	39.28		35.07	32.68	31.90	33.22	

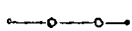
CD - Between varieties - 9.163

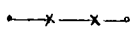
KEY

 Mudikode local

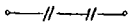
 Panavalli

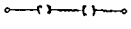
 Attenganam local

 Lucknow Sweet

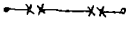
 Verma Surprise

 Hara Madhu

 Pullıporan

 Punthala local

 Vellanad local

 Co-1

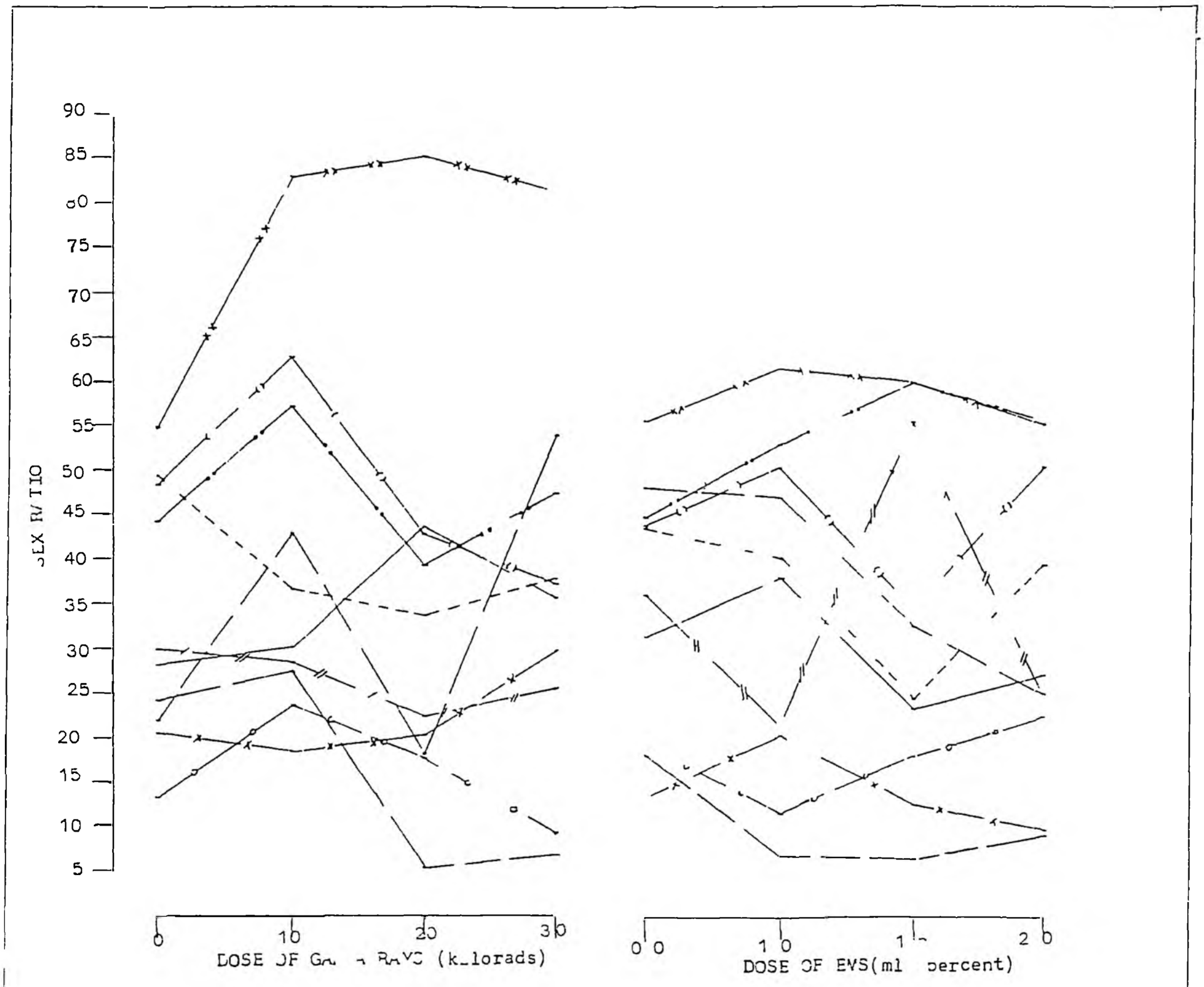


Fig. Effect of mutagens on the sex ratio of 10 Cucumis melo L. varieties

Significant variation in mean values of sex ratio was observed among the varieties. Variation in mean values between levels of gamma rays, levels of EMS, between gamma rays and EMS, variety x gamma ray interaction and variety X EMS interaction was found to be not significant.

Under the effect of gamma rays, variety Co-1 recorded significantly highest sex ratio (76.22) among the varieties followed by Punthala local (47.98), Vellanad local (47.24) and Panavalli (39.54) between which mean values did not differ significantly. Pulliporan (26.75), Verma Surprise (22.41), Hara Madhu (16.07) and Lucknow Sweet (15.06) recorded significantly lower sex ratios than the other varieties. Mean values of Panavalli (39.54), Mudikode local (34.59) and Attenganam local (34.39) were on par.

Under the influence of EMS, Co-1(58.15) and Vellanad local (53.35) obtained significantly higher mean values for sex ratio than all other varieties except Punthala local which was on par with Vellanad local. Mean values of Lucknow Sweet (17.84), Verma Surprise (13.91) and Hara Madhu (10.08) did not differ

significantly and was significantly lower than mean values of the other varieties.

Comparing the effect of gamma rays and EMS on varieties, Co-1 (67.18) registered significantly the maximum mean sex ratio among the varieties followed by Vellanad local (50.29) and Punthala local (46.34). Variations in mean values between Punthala local, Panavalli and Attenganam local and between Mudikode local and Pulliporan were not significant. Mean values of Hara Madhu (13.07), Lucknow Sweet (16.94) and Verma Surprise (18.16) were on par and were significantly lower than mean values of the rest of the varieties.

Increase in sex ratios(male to female) due to EMS treatment was observed for some of the treatments in varieties Vellanad local, Lucknow Sweet, Pulliporan and Co-1. In varieties Mudikode local, Co-1, Attenganam local and Vellanad local, irradiation resulted in increased sex ratio except for the 20 kR treatments in Attenganam local and Vellanad local. Increased production of male flowers due to gamma ray irradiation has been reported in cucumber by Zea et al. (1976) and Fuji (1977).

Increase in sex ratio due to EMS treatments was observed in varieties Mudikode local, Panavalli, Attenganam local, Hara Madhu and Verma Surprise except for the 1.0% EMS treatment. This conforms to the result of Mollaiah and Jafar (1988) in Momordica charantia where EMS, HA and MC were used. Predominance of female flowers flowering treatment with NEU and NMU has been observed by Gulyaeva and Abashkina (1972) in cucumber. Irradiation with the higher doses of gamma rays caused decreased sex ratios in varieties Panavalli, Lucknow Sweet, Hara Madhu, Pulliporan and Punthala local and this is in conformation with the findings of Bisaria et al (1975) in Cucumis melo and Berzin and Purin (1978) in cucumber.

Irradiation was found to induce ethylene production (Kaushik and Bisaria 1974). Ethylene has also been reported to cause femaleness (Iwahori et al. 1970). It is therefore possible that irradiation and EMS treatments exert their effect on sex expression through ethylene production.

11. Pollen fertility

Pollen fertility percentage of 10 Cucumis melo L. varieties as influenced by mutagens is shown in table 9. The graphical representation of the data is shown in Fig.4.

Statistical analysis of the data showed that there was significant difference in mean values between varieties, levels of gamma rays, levels of EMS, gamma rays and EMS, variety x gamma ray interaction and variety x EMS interaction.

Considering the effect of gamma rays on varieties, Attenganam local (78.50), Mudikode local (78.82), Verma Surprise (74.01), Vellanad local (75.45), CO-1 (75.73), Hara Madhu (74.01), Punthala local (73.10) and Lucknow Sweet (72.67) were all on par in pollen fertility. All varieties, except Punthala local, Lucknow Sweet and Pulliporan (71.76) had significantly higher pollen fertility than Panavalli (68.69).

Under the effect of EMS, varieties Lucknow Sweet (85.31), Attenganam local (84.10), Verma Surprise(83.63), Hara Madhu (82.47), Pulliporan (81.89) and Co-1 had pollen fertility that were comparable. Except Co-1,

Table [illegible]. [illegible] pollen [illegible] percentage of 10 [illegible] varieties

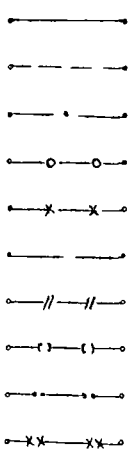
Varieties	Gamma rays - dose: Control (dry)	1 kR	2 kR	3 kR	Mean treated popln.	EMS - dose: Control (soaked)	1.0 %	[illegible] %	2.0 %	Mean treated popln.	General varietal mean
[illegible] local	[illegible] (65.4[illegible])	8[illegible].3 ([illegible])	72.12 ([illegible])	80.08 (63.4	75.62 (62.6[illegible]	(67.[illegible] 64.[illegible]	[illegible].2 [illegible]	[illegible].32 ([illegible])	[illegible] (4[illegible].7[illegible]	[illegible] (6[illegible].70)	[illegible].92 ([illegible])
Paravall[illegible]	7[illegible].70 (60.[illegible])	64.75 (53.56)	[illegible].22 (6[illegible].56	[illegible] (4[illegible]	68.69 (56.22)	64.[illegible] (53.[illegible])	64.67 ([illegible].92)	35.73 (36.69)	61.[illegible] (51.[illegible]2)	[illegible]64 ([illegible]2.19)	[illegible] 54.21)
[illegible] local	67.47 ([illegible].20)	85.54 [illegible]	[illegible].29 ([illegible])	78.68 (62.43)	78.[illegible]0 (62.69)	7[illegible].4[illegible] (61.[illegible])	[illegible]3.94 66.35)	9[illegible].62 (7[illegible].15)	83.3[illegible] (65.[illegible])	[illegible].10 (66.76)	81.30 ([illegible].73)
[illegible]	88.09 (69.78	87.81 [illegible].54)	7[illegible].44 (5[illegible].0[illegible])	44.32 (41.72)	[illegible].67 (59.52)	81.[illegible] (64.70)	[illegible].70 69.44)	81.32 (64.37)	90.4 (71.[illegible])	85.31 (6[illegible].62)	75.99 (6[illegible].[illegible]7)
[illegible]	[illegible]0.94 (72.45)	73.72 (6[illegible].50	[illegible].11 (69.80)	4[illegible].8[illegible] (41.46)	74.01 (61.55)	82.65 (65.[illegible]5)	[illegible].54 (70.18)	7[illegible].53 (63.07)	83.7[illegible] (66.23)	[illegible].63 (66.21)	78.82 (63.88)
[illegible]	90.34 71.86)	86.67 (68.56)	42.[illegible]9 (4[illegible].8[illegible])	7[illegible].13 (60.73)	74.01 (60.[illegible])	81.2[illegible] (64.30)	[illegible]5.71 (6[illegible].76)	84.20 (66.55)	78.74 (62.51)	82.47 (6[illegible].26)	73.24 (62.90)
[illegible]	69.93 (56.72)	80.51 (63.78)	[illegible].44 (55.80)	68.16 (55.63)	71.76 (57.98)	86.[illegible] (68.25)	[illegible].68 (6[illegible].93)	8[illegible].09 (70.68)	67.4[illegible] (55.[illegible]2)	[illegible].89 (65.27)	76.83 (61.63)
Punt[illegible]ala local	92.69 (74.28)	75.07 (60.02)	84.49 (6[illegible].78)	40.13 (39.29)	73.10 (60.09)	75.82 (60.52)	[illegible]2.26 (65.06)	82.37 (65.14)	57.85 (49.49)	74.58 (60.05)	73.84 (60.08)
Vellanad local	89.53 (71.09)	87.30 (69.09)	58.03 (49.60)	66.92 (54.87)	75.45 (61.16)	61.39 (51.57)	90.79 (72.30)	6[illegible].[illegible]7 (56.24)	78.16 (62.12)	74.88 (60.06)	[illegible]5.17 (60.86)
Co-1	85.05 (67.23)	83.63 66.10)	71.32 (57.60)	62.90 (52.45)	75.73 (60.85)	82.79 (65.47)	90.02 (71.56)	7[illegible].4[illegible] (63.04)	73.31 58.[illegible]7)	78.90 64.74)	77.32 (62.79)
Mean	83.25 (66.45)	81.34 (64.70)	71.54 (56.21)	61.53 (51.94)		77.88 (62.23)	84.86 (67.34)	78.08 (62.89)	73.14 (59.28)		
Mean dose effect		81.34 (64.70	71.54 (5[illegible].21)	61.53 (51.94)	71.47 (58.28)		84.86 (67.34)	78.08 (62.89)	73.14 5[illegible].28)	78.69 (63.17)	

CD - Between varieties - 4.211 CD- Between levels of gamma rays - 2.663 CD- Between levels of EMS - 2.663

CD - Gamma rays VS EMS - 1.331 CD - Variety X gamma rays - 8.423 CD - Variety x EMS - 8.423

(Transformed values given in paratheses)

KEY



Mudikode local

Panavalli

Attenganam local

Lucknow Sweet

Verma Surprise

Hara Madhu

Pulliporan

Punthala local

Vellanad local

Co-1

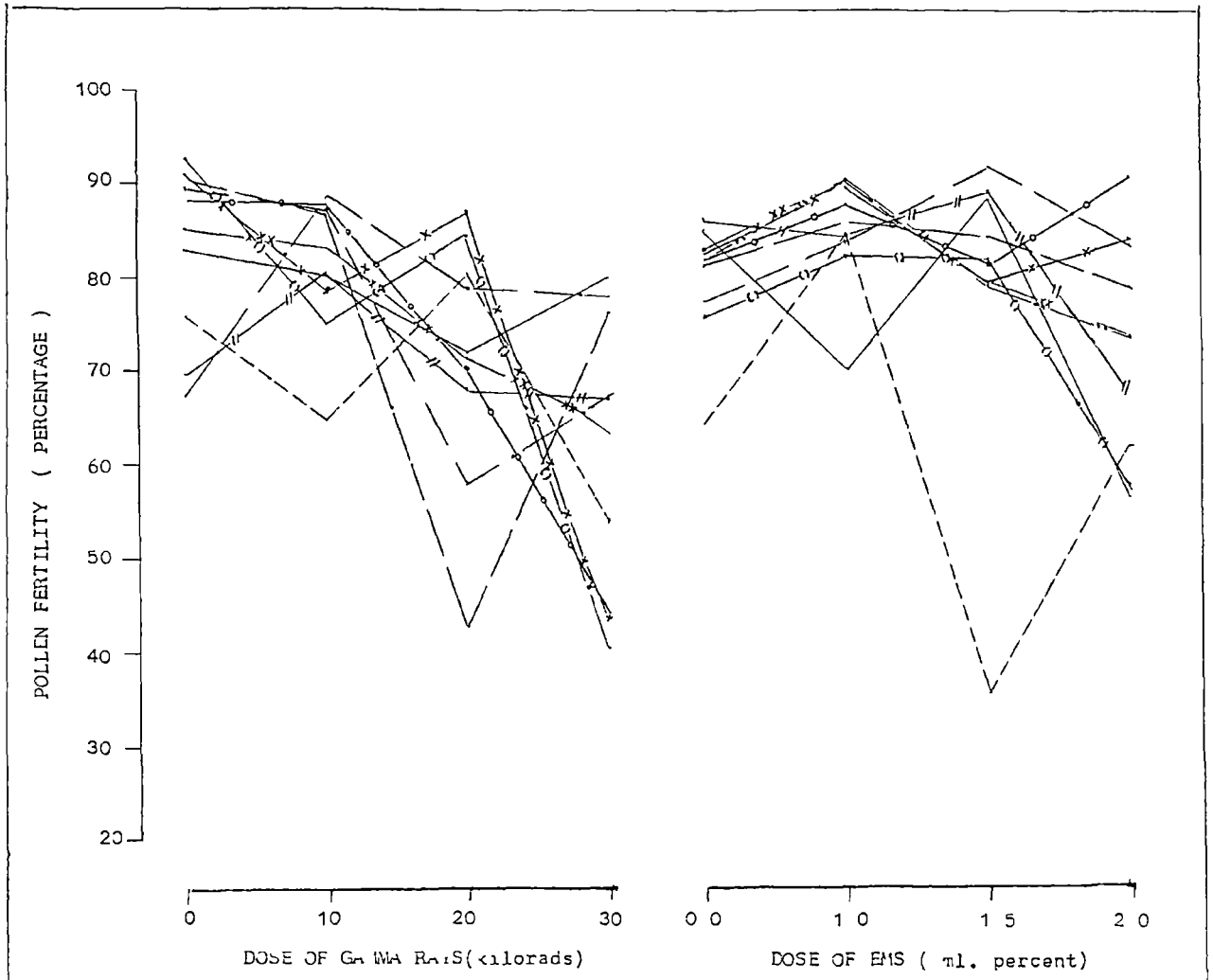


Fig.4 Effect of mutagens on pollen fertility of 10 Cucumis melo L varieties

all these varieties were significantly superior in pollen fertility to Mudikode local (75.01), Vellanad local (74.88), Punthala local (74.58) and Panavalli (61.64). Co-1, Mudikode local, Vellanad local and Punthala local were on par in pollen fertility. Among all varieties Panavalli recorded the lowest pollen fertility.

Comparing the effect of the two mutagens together on the varieties, Attenganam local (81.30), Verma Surprise (78.82), Lucknow Sweet (78.99), Hara Madhu (78.24), Co-1 (77.32), Mudikode local (75.92), Pulliporan (76.83) and Vellanad local (75.17) recorded pollen fertility that were on par. Among all varieties Panavalli (65.17) recorded significantly the lowest mean value for pollen fertility. Punthala local registered pollen fertility (73.84) that was significantly lower than that of Attenganam local but higher than that of Panavalli and on par with the rest of the varieties.

In general there was a significant reduction in pollen fertility with increase in levels of gamma rays except between control and 10 kR treatment where the reduction was not significant. Between the levels of EMS the 2.0% EMS treatment resulted in significant reduction of fertility compared to control and the lower

levels of EMS. Control and 1.5% EMS treatment recorded pollen fertility that were on par.

Irrespective of the varieties among the two mutagens the EMS treatment resulted in significantly higher pollen fertility (78.69) than gamma ray treatment (71.47).

Among the interactions, in varieties Mudikode local and Pulliporan, gamma ray irradiation did not have significant effect on pollen fertility. In Verma Surprise and Lucknow Sweet (Plates 9a, 9b) all the gamma ray treatments resulted in significant reduction in percentage pollen fertility compared to control, except 10 kR treatment in Lucknow Sweet which was on par with its control. The 30 kR treatments of Panavalli, Punthala local, Co-1 and 20 kR and 30 kR treatments of Vellanad local recorded reduced percentage pollen fertility than their control and other gamma ray treatments except 20 kR in Co-1 and 10 kR in Panavalli. In Hara Madhu the 20 kR treatment resulted in significantly lower pollen fertility than the control and 30 kR treatment but the value was on par with 10 kR treatment. In Attenganam local the 10 kR treatment resulted in significant increase in pollen fertility than the control but was on par with the other

Pollen fertility

Plate 9a. - Control

Plate 9b. - Sterile pollen grains
(30 kR gamma ray treatment of
variety Lucknow Sweet)

Fertile - stained pollen grains
Sterile - unstained pollen grains.

Plate 9a.

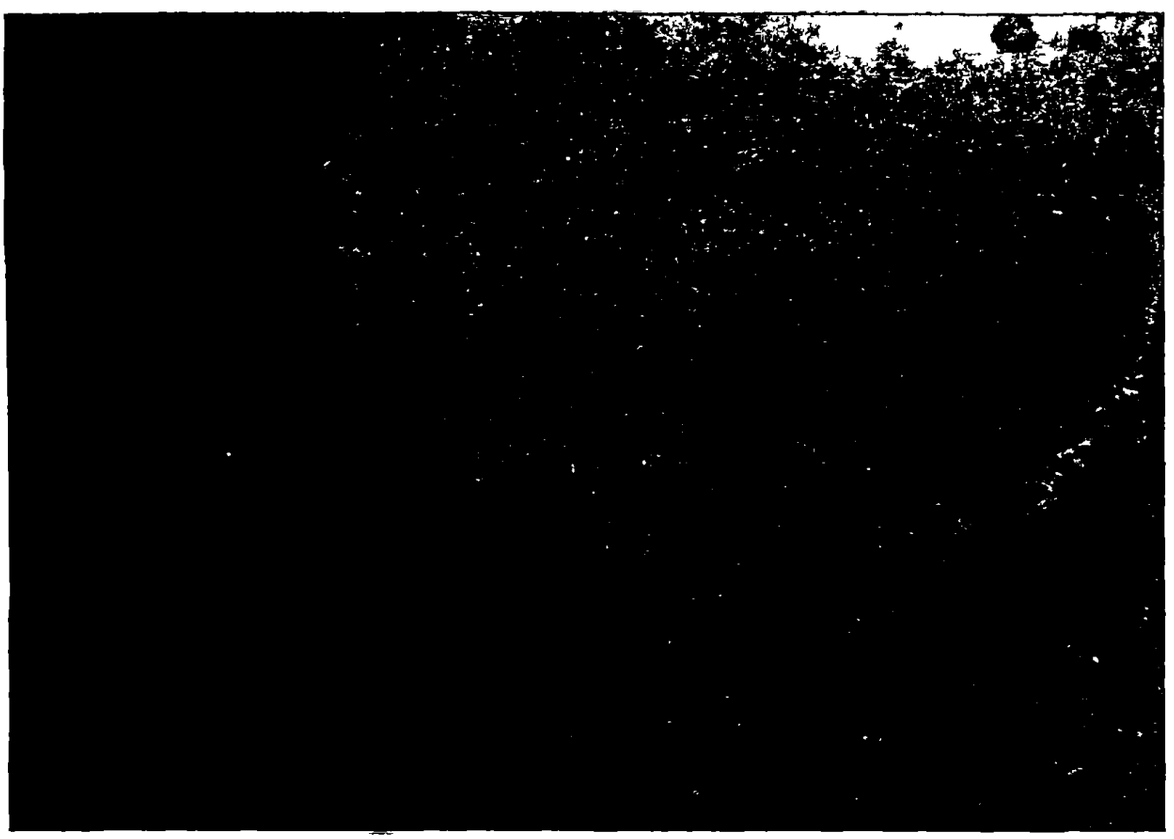


Plate 9b.

gamma ray treatment.

In general, there was reduction in percentage pollen fertility with increase in dose of gamma rays in all varieties except Attenganam local. These results are in agreement with Bisaria et al. (1975) who reported decreased pollen fertility in Cucumis melo L. with increase in dose of gamma irradiation. A similar result was also reported in Luffa cylindrica L. (Roem) by Kaushik et al (1976).

In varieties Lucknow Sweet, Verma Surprise and Hara Madhu EMS treatment did not have significant effect on pollen fertility. The 1.0% and 2.0% EMS treatments of Mudikode local, 1.5% EMS treatment of Panavalli and the 2.0% EMS treatments of Pulliporan and Punthala local induced significant reduction in pollen fertility compared to control and the other EMS treatments. A similar result was obtained by Kubicki and Korzeniewska (1984) in cucumber with EI treatment. Decreased fertility with increasing dose of mutagens was also reported by Louis and Kadambavana-sundaram (1973) in cowpea and Bhojwani and Kaul (1976) in pea.

Greater reduction in pollen fertility was noted with gamma rays than with EMS treatments.

Gaul et al (1966) attributed M_1 sterility caused by radiation to be due to cryptic structural differences in chromosomes and chromosomal aberrations. It was also reported by Sato and Gaul (1967) that chemically induced sterility cannot be attributed to chromosomal aberrations but to other reasons including genic alterations or micromutations. The reason for lower sterility values with EMS than gamma ray treatment might be due to the elimination of chromosomal aberrations induced by the chemical to a large extent during later development. Increased sterility due to irradiation may be due to inactivation of respiratory enzymes and a high decree of chromosomal breaks and other toxic disturbances.

Increased fertility observed in 1.0% EMS treatment of Panavalli, 1.5% EMS treatment and the gamma ray treatments of Attenganam local may be due to the fact that the plants which survived were either escapes or those that had resisted the lethal effects of the mutagens.

12. Number of fruits per plant

Mean number of fruits per plant of 10 Cucumis melo L. varieties influenced by the mutagens is shown in table 10.

Significant variation in mean number of fruits per plant was noted among varieties, between levels of gamma rays and between variety x gamma ray interaction. No significant difference was obtained between mean values of different levels of EMS, between EMS and gamma rays and between variety x EMS interaction.

Under gamma ray treatments, variety Attenganam local (1.74), Lucknow Sweet (1.69) and Mudikode local (1.59) were significantly superior in mean number of fruits/plant to the rest of the varieties except Punthala local (1.43) which was on par with that of Mudikode local and Lucknow Sweet. No significant difference in mean values of Pulliporan (1.07), Panavalli (1.16), Hara Madhu (1.20), Co-1 (1.22), Vellanad local (1.23) and Verma Surprise (1.23) was noted.

Under EMS treatment Punthala local with a mean value of 1.67 for number of fruits/plant was significantly superior to the mean values registered by the

Table 0. Effect of mutagens on the number of fruits/plant of i Cucumis melo L. varieties

Varieties	Gamma rays dose					EMS dose					General variety mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	2.32	0.93	1.70	1.40	1.59	1 07	1.44	.05	1.35	1.23	1.41
Panavalli	1 45	1.09	1.02	1.07	1.16	1.00	0.74	1.22	1.11	1.17	1 16
Attengaden local	1.38	1.7	2.07	1.80	1.74	1.14	1.53	1.83	1.25	1.44	1.59
Lucknow Sweet	1.44	2.70	1.13	1.50	1.69	1 59	1.67	0.03	1.65	1.39	1.54
Verma surprise	1.40	0.75	1.38	1.38	1 23	1 10	0.70	1.15	1.32	1.07	1.15
Para Madhu	1.90	1.09	1.00	0.80	1.20	1.25	0.68	0.66	1.06	0.91	1.05
Pulliporan	1.60	1.05	0.54	1.09	1.07	1.15	1.50	1.54	1.67	1.47	1.27
Punthala local	1.29	1.25	1 42	1 74	1.43	1.10	1.62	2 04	1.90	1.67	1.54
Vellanad local	1.75	1.50	1.00	0.67	1.23	1.25	1.13	0.95	1.25	1.15	1.19
Co-1	1.80	1.66	0.75	0.66	1.22	1.76	1.47	0.77	0.95	1.24	1.22
Mean	1.63	1.37	1.20	1.21		1.30	1.25	1.18	1.35		
Mean dose effect		1.37	1.20	1.21	1.26		1.25	1.18	1.35	1.26	

CD - Between varieties - 0.293 CD - Between levels of gamma rays - 0.185 CD Variety x gamma rays - 0.586

rest of the varieties except Lucknow Sweet (1.39), Attenganam local (1.44) and Pulliporan (1.47) where the difference in mean values with that of Punthala local was not significant. Mean number of fruits/plant of Hara Madhu (0.91), Verma Surprise (1.07) and Vellanad local (1.15) and Panavalli (1.17) were similar. Hara Madhu was significantly inferior to the means registered by varieties Mudikode local (1.23), Co-1 (1.24), Lucknow Sweet (1.39), Attenganam local (1.44), Pulliporan (1.47) and Punthala local (1.67).

Comparing the effect of both mutagens together on varieties, the result shows that there was no significant variation in mean number of fruits/plant among varieties, Attenganam local (1.59), Punthala local (1.54), Lucknow Sweet (1.54), Mudikode local (1.41) and Pulliporan (1.27) and these varieties with the exception of Mudikode local and Pulliporan were significantly superior to mean values recorded by varieties Vellanad local (1.19), Panavalli (1.16), Verma Surprise (1.15) and Hara Madhu (1.05). Mean number of fruits/plant of varieties, Verma Surprise, Panavalli, Vellanad local, Co-1 (1.22) and Pulliporan (1.27) were on par.

Irrespective of the varieties, variation in mean number of fruits/plant between the different levels of gamma rays was not significant but all treatments were significantly inferior to the mean number of fruits/plant recorded by the control.

In Panavalli and Punthala local irradiation with gamma rays did not effect the number of fruits/vine significantly.

In Attenganam local the 20 kR treatment resulted in significant increase in number of fruits/vine compared to the control.The treatment was on par with the rest of the treatments. In Lucknow Sweet the 10 kR treatment resulted in significant increase in number of fruits/vine than the control and the two higher doses of gamma rays. Increase in number of fruits following irradiation with gamma rays has been reported by Zea et al. (1976) in Cucumis sativus L.; Singh and Roy (1977) in Cucumis melo L.; Nath and Madan (1986) in Cucumis sativus L.

The 10 kR and 20 kR treatments of Vellanad local and 10 kR treatment of Verma Surprise recorded reduction in fruit number compared to control and the other gamma ray treatments. The 10 kR and 30 kR treatments of Mudikode local, 20 kR treatment of Pulliporan and all gamma ray

treatments of Hara Madhu and Co-1 recorded significantly decreased number of fruits compared to their control. Decreased fruit number following gamma irradiation was reported by Goranov (1972c) in Cucurbita maxima Duchesne.

In general EMS treatments resulted in slight decrease in mean values for number of fruits/vine compared to control in varieties Panavalli, Hara Madhu, Vellanad local and Co-1. In all other varieties in general there was an increase in mean value for number of fruits/vine compared to control. In all these cases the variation in mean values between the treatments and control was not statistically significant. It appears from the present study that increase or decrease in fruit number following mutagen treatment does not show any stable or general trend as different varieties shows differential response to the different levels of gamma rays and EMS.

13. Fruit weight

Mean weight of fruits in kg of 10 Cucumis melo L. varieties as influenced by the mutagens is presented in table 11. On statistical analysis significant variation in mean weight was noted among varieties and variety x gamma ray interaction. No significant variation in mean

Table 1 Effect of mutagens on the weight of fruit (kg) of 10 Cucumis melo L. varieties

Varieties	Gamma rays - dose					EMS - dose					General Varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln	
Mudikode local	3 16	2.40	3.85	2.92	3 08	2.65	2.60	2.32	2.61	2.54	2 81
Panavalli	2 85	2.56	2 10	1.75	2.32	2.44	1.61	2 61	1.66	2.08	2.20
Attenganam local	1.22	1.40	1.33	1.56	1.38	1.34	1 79	1.09	1 05	1 32	1.35
Lucknow Sweet	0.54	0.43	0.30	0.36	0.41	0.38	0.54	0 63	0.38	0.48	0.44
Verna Surprise	0.56	0.51	0.54	0 73	0.59	0.70	0.51	0.89	1.03	0.78	0 68
Nara Madhu	0 65	0.97	0.74	1.05	0.85	0.84	1.03	0 66	0.74	0.82	0.83
Pulliporan	2.68	3.12	2.71	3.33	2.71	3.74	2 54	2.89	2 72	2 97	2 84
Punthala local	2.42	2.34	1.86	1.72	2.09	2.43	2 41	2 35	2 38	2 39	2 24
Vellanad local	3.02	3.06	2 84	2.53	2.86	3.12	2 64	2 30	3 06	2.78	2.82
Co-1	2 35	2.71	3.69	2.55	2.83	2 10	2 99	2.44	2.54	2.52	2 67
Mean	1.94	1.95	1 89	1.85		1.97	1 86	1 81	1 82		
Mean dose effect		1.95	1.89	1.85	1.90		1.86	1 81	1.82	1.83	

CD- Between varieties - 0.314 CD - Variety x gamma rays - 0.629

values was observed between levels of gamma rays, between levels of EMS, between mutagens and between variety x EMS interaction.

Considering the effect of gamma rays on varieties, Mudikode local (3.08 kg), Vellanad local (2.86 kg), Co-1 (2.83 kg) and Pulliporan (2.71 kg) were significantly superior in terms of mean weight of fruit to rest of the varieties. Mean values of Punthala local (2.09 kg) and Panavalli (2.32 kg) were comparable and were superior to varieties Attenganam local (1.38 kg), Hara Madhu (0.85 kg), Verma Surprise (0.59 kg) and Lucknow Sweet (0.41 kg). Lowest weight was recorded by Lucknow Sweet which was comparable with that of Verma Surprise.

Effect of EMS on varieties shows that Pulliporan recorded the maximum mean weight of fruit 2.97 kg and was on par with mean values of varieties Vellanad local (2.78 kg), Mudikode local (2.54 kg) and Co-1 (2.52 kg) but superior to the rest of the varieties except Punthala local (2.39 kg) had a mean value that was on par with the values of Co-1 and Mudikode local. Attenganam local

(1.32 kg) was significantly inferior, in mean weight of fruit to varieties Panavalli (2.08 kg), Punthala local, Co-1, Mudikode local, Vellanad local and Pulliporan, but was significantly superior to Lucknow Sweet (0.48 kg), Verma Surprise (0.78 kg) and Hara Madhu (0.82 kg).

Comparing the effect of both mutagens together on varieties, Co-1 (2.67 kg), Mudikode local (2.81 kg) Vellanad local (2.82 kg) and Pulliporan (2.84 kg) had values that were comparable as well as superior to mean values registered by Punthala local (2.24 kg). Panavalli (2.20 kg), Attenganam local (1.35 kg), Hara Madhu (0.83 kg), Verma Surprise (0.68 kg) and Lucknow Sweet (0.44 kg). Variation in mean fruit weight between Lucknow Sweet, Verma Surprise and Hara Madhu was found to be not significant. Attenganam local was superior to varieties Lucknow Sweet, Verma Surprise, and Hara Madhu but inferior to the other varieties.

In varieties Attenganam local, Lucknow Sweet, Verma Surprise, Hara Madhu and Vellanad local difference in mean values for fruit weight between levels of gamma rays and between levels of gamma rays and their control was not significant. The 20 kR treatments of Mudikode local and Co-1 and the 30 kR treatment of Pulliporan

recorded a greater mean fruit weight than that of their controls and the other gamma ray treatments except 10 kR which was on par in fruit weight with 30 kR in Pulliporan. Increase in fruit weight following gamma irradiation was observed earlier by Goranov (1972 c) in Cucurbita maxima and by Zea et al. (1976) in Cucumis sativus. Significantly lower mean weight of fruit compared to control and other gamma ray treatments was observed in the 30 kR treatment in Panavalli and Punthala local. A similar result has been reported by Goranov (1972 c) in Cucurbita maxima with 50 kR gamma ray treatment. The EMS treatments of all varieties except Panavalli, Vellanad local, Punthala local and Pulliporan in general resulted in slight increase in mean weight of fruit compared to control but this increase in weight was not statistically significant.

14. Yield/vine

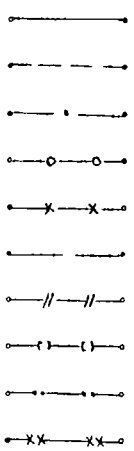
Mean yield per vine on the 10 Cucumis melo L. varieties as influenced by the mutagens is shown in table 12. The graphical representation of the data is shown in Fig.5.

Table 12. Effect of mutagens on the yield/vine (kg) of 10 Cucumis melo L varieties

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Kudikode local	7.28	2.21	6.23	4.01	4.93	2.75	3.61	2.34	3.48	3.05	3.99
Kanavalli	4.09	2.80	2.15	1.85	2.72	3.96	1.17	3.17	1.84	2.54	2.63
Pattenganam local	1.70	2.76	2.74	2.73	2.48	1.52	2.07	2.00	1.31	1.88	2.18
Lucknow Sweet	0.77	1.17	0.38	0.49	0.70	0.62	0.92	0.39	0.63	0.64	0.67
Arka Surprise	0.80	0.38	0.75	1.09	0.76	0.78	0.37	1.06	1.38	0.90	0.82
Pera adhu	1.23	1.04	0.74	0.87	0.97	1.05	1.28	0.44	0.78	0.89	0.92
Kallipooran	4.18	3.24	0.91	3.47	2.95	4.19	4.34	4.50	4.59	4.41	3.68
Kunthala local	3.09	2.93	2.60	2.98	2.90	2.73	3.93	4.74	4.65	2.85	3.45
Pallanad local	3.43	4.51	2.84	1.64	3.61	3.91	3.02	2.11	3.78	3.21	3.40
CO-1	4.23	4.49	2.77	1.63	3.28	3.66	4.36	1.91	2.40	3.08	3.18
Mean	3.28	2.55	2.21	2.07		2.52	2.56	2.26	2.48		
Mean dose effect		2.55	2.21	2.07	2.28		2.56	2.26	2.48	2.43	

CD - Between varieties - 0.785 CD- Between levels or gamma rays - 0.497 CD Variety x gamma rays - 1.571

KEY


Mudikode local
Panavalli
Attenganam local
Lucknow Sweet
Verma Surprise
Hara Madhu
Pulliporan
Punthala local
Vellanad local
Co-1

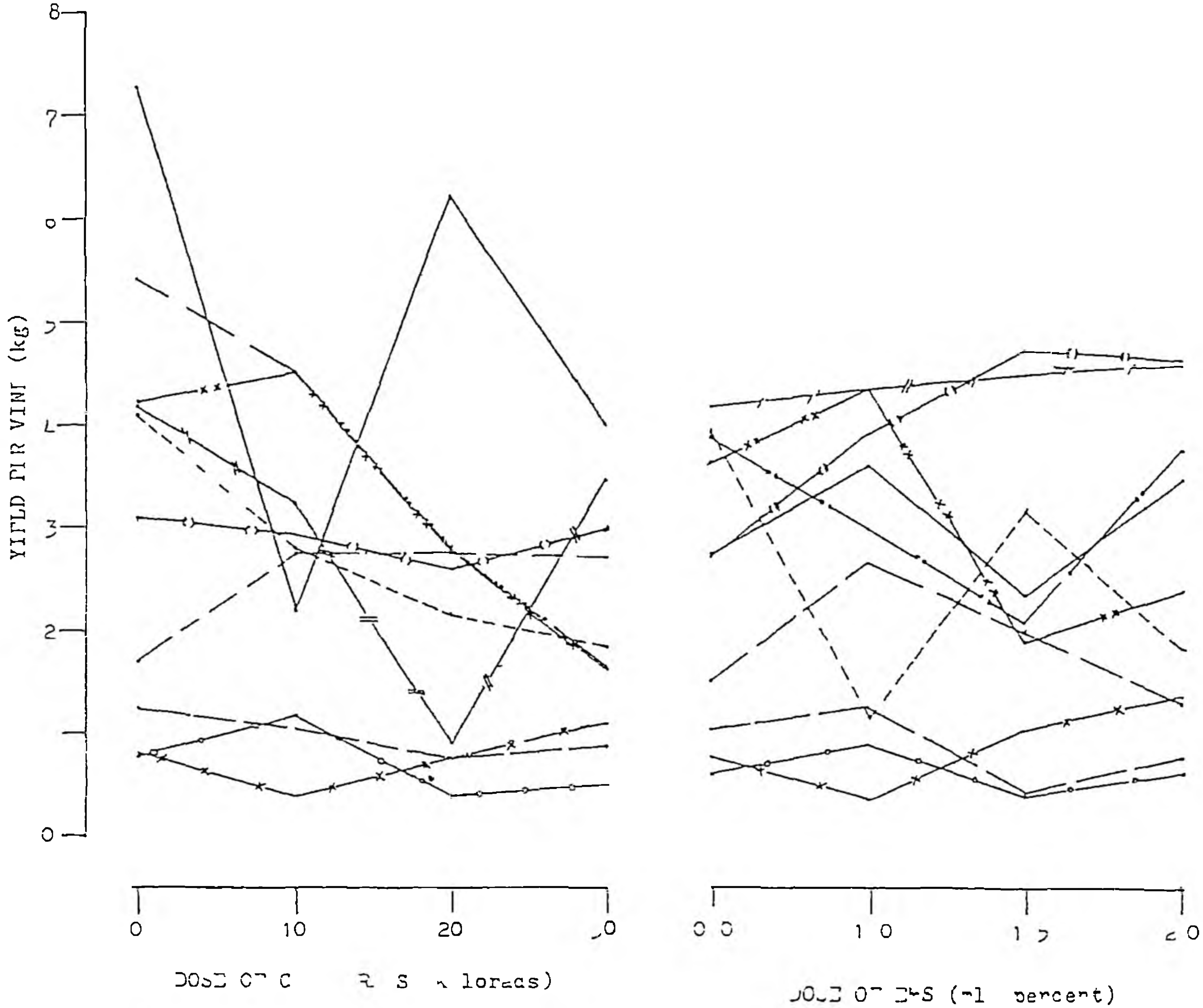


Fig. 5 Effect of mutagens on the yield per vine of 10 *Cucumis melo* L. varieties

Statistical analysis of the data showed significant variation in mean values among varieties, between levels of gamma rays and variety x gamma ray interaction. Difference in mean values between levels of EMS, between the two mutagens and between variety x EMS interaction was not significant.

Varietal response to gamma rays shows that the variety Mudikode local with a mean yield/vine of 4.93 kg was significantly superior in mean yield/vine to the rest of the varieties. Difference in mean values between Panavalli (2.72 kg), Punthala local (2.95 kg), Co-1 (3.28 kg) and Vellanad local (3.28 kg) was not significant and all were significantly superior to mean yields of Lucknow Sweet (0.70 kg). Verma Surprise (0.76 kg) and Hara Madhu (0.97 kg). Lucknow Sweet, Verma Surprise and Hara Madhu had mean values that did not differ significantly from each other.

Considering the varietal response to EMS treatments, variety Pulliporan recorded maximum mean yield/vine (4.41 kg) and was significantly superior to the rest of the varieties. Mean values of Panavalli (2.54 kg), Punthala local (2.85 kg), Mudikode local (3.05 kg), Co-1(3.08 kg) and Vellanad local (3.21 kg) were

comparable and on par. These varieties were significantly superior to mean values of Lucknow Sweet (0.64 kg) Hara Madhu (0.89 kg) and Verma Surprise (0.90 kg).

Comparing the varietal response to both mutagens together Vellanad local (3.40 kg), Punthala local(3.45 kg) Pulliporan (3.68 kg) and Mudikode local (3.97 kg) recorded mean yields/vine that were similar and all were significantly superior to Attenganam local (2.18 kg), Hara Madhu (0.92 kg), Verma Surprise (0.82 kg) and Lucknow Sweet (0.67 kg). Difference in mean values between varieties Lucknow Sweet, Verma Surprise and Hara Madhu was not significant.

Difference in mean yield/vine between levels of gamma rays 10 kR (2.55 kg) 20 kR (2.21 kg) and 30 kR (2.07 kg) showed no significance and all resulted in significantly lower yield compared to control. The mean yield also decreased with increasing gamma dosage.

In Lucknow Sweet, Verma Surprise, Hara Madhu and Punthala local, variety x gamma ray interaction was not significant for yield. All the gamma ray treatments of Mudikode local and Panavalli as well as 20 kR and 30 kR gamma ray treatments of Vellanad local and

Co-1 produced significantly lower yields than their control and the other gamma ray treatments.

In Attenganam local all the gamma ray treatments consistantly resulted in significantly increased yield compared to the control. In Lucknow Sweet 10 kR treatment and in Verma Surprise 30 kR treatment resulted in higher mean yields than control (Table 14). Increased yield following gamma irradiation in cucumber was reported by Zham and Zhugder (1976), Kardashina (1976), Berzin and Purin (1978), Kornienko and Sultanbaev (1978) and Smetanina and Kodaneva (1982).

All the EMS treatments of Panavalli, Vellanad local, Co-1 and Hara Madhu (except 1.0% EMS treatment of Co-1 and Hara Madhu) resulted in slight reduction in yield compared to control.

In general all EMS treatments of Mudikode local, Attenganam local, Lucknow Sweet, Verma Surprise, Pulliporan and Punthala local resulted in increased yield compared to control. Such increase in yield due to chemical mutagen treatment has also been reported in cucumber by Arsagova (1969), Gulyaeva and Abashkina (1972).

15. Length of fruit

Table 13 presents the data on the effect of mutagens on the length of fruit on ten Cucumis melo L. varieties.

Statistical analysis of the data shows significant difference in mean length of fruit among varieties and between variety x EMS interaction. Difference in mean values between levels of gamma rays, levels of EMS and variety x gamma ray interaction was not significant.

Considering the effect of both mutagens separately and when compared together the results obtained were in general, the same. The variety Co-1 produced fruits with greatest mean length followed by Vellanad local, Pulliporan, Mudikode local, Panavalli, Punthala local, Attenganam local, Hara Madhu, Verma Surprise and Lucknow Sweet which recorded the lowest mean length of fruit. Mean values of these varieties in general differed significantly among themselves.

Variety x EMS interaction was not significant for mean length of fruit in Mudikode local, Lucknow Sweet, Verma Surprise, Hara Madhu and Punthala local. In Pulliporan the 1.5% and 2.0% EMS treatments produced fruits with significantly lower mean value for length of fruit than the control.

Table 13. Effect of mutagens on the length of fruit (cm) o 10 Cucumis melo L. varieties

Varieties	Gamma rays - dose					EMS — dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0 %	1.5%	2.0%	Mean treated popln.	
Mudikode local	43.63	44.00	50.65	54.48	49.19	46.57	46.28	44.79	42.00	44.91	46.55
Panavalli	40.17	45.90	38.17	38.29	40.63	37.82	40.88	47.07	33.50	39.82	40.22
Attenganam local	27.59	27.25	27.08	28.29	27.55	27.67	32.32	23.17	22.32	26.37	26.96
Lucknow Sweet	15.00	13.63	15.50	12.50	14.16	13.25	15.25	17 25	15.17	15.23	14.69
Verma Surprise	19.83	18.25	17.25	20.50	18.96	21.50	15.75	20.00	18.75	19.00	18.98
Hara adnu	18.67	21.13	19.25	24.75	20.95	22.44	23.50	19.63	17.75	20.83	20.89
Pulliporan	47.34	52.62	42.42	51 75	48.53	53 69	51.21	45 34	46.82	49.27	48.90
Punthala local	38.38	39.00	33.48	32.63	35.87	41.44	37.00	38.69	38.75	38.97	37.42
Vellanad local	53.83	54.75	57.96	54.75	55.20	63.50	56.42	58.42	67.07	61.35	58.27
Co-1	58.50	56.75	63.13	57.00	58.85	53.92	70.25	58.34	70.75	63.32	61.08
Mean	36.29	37.33	36.49	37.44		38.18	38.88	37.27	37.29		
Mean dose effect		37.33	36.49	37.44	37.09		38.88	37.27	37.29	37.81	

CD - Between varieties - 3.376 CD - Variety x EMS - 6.752

The 1.0% and 1.5% EMS treatments of Panavalli and the 1.0% and 2.0% EMS treatments of Co-1, produced fruits with significantly higher mean value for length of fruit than the control and the other EMS treatment.

All the gamma ray treatments of Mudikode local, Hara Madhu, Vellanad local and Pulliporan (except 20 kR) recorded increased fruit length compared to their control. In Panavalli and Punthala local the 20 kR and 30 kR gamma ray treatments resulted in decreased fruit length than their control. In all these cases the difference in mean length of fruit was not significant.

16. Girth of fruit

Table 14 depicts the data on the effect of mutagens on the girth of fruit on ten Cucumis melo L. varieties.

Statistical analysis of the data shows significant difference in mean values among varieties and between variety x EMS interaction. Variation in mean values between levels of gamma rays, levels of EMS and variety x gamma ray interaction was not significant.

Under the influence of gamma rays the varieties Hara Madhu (40.20 cm) and Mudikode local (38.74 cm) recorded mean girths of fruit that were on par with

Table 14. Effect of mutagens on the girth of fruit(cm) in 10 Cucumis melo L.varieties

Varieties	Gamma rays - dose					EMS—dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Kudikode local	38.09	36.34	43.96	37.55	38.74	34.13	30.50	35.59	37.08	34.33	36.53
Panavalli	33.42	36.42	32.25	31.63	33.43	40.46	35.13	40.67	31.21	36.87	35.15
Attenganam local	33.71	33.05	33.88	33.86	33.63	32.54	35.75	32.86	29.21	32.59	33.12
Lucknow Sweet	30.25	29.75	30.04	29.89	29.98	26.88	37.75	36.25	31.38	33.07	31.52
Verma Surprise	35.38	33.75	32.75	41.75	35.91	30.75	34 00	36.75	43.00	36.13	36.02
Para Vadhu	34.88	43.13	37.50	45.28	40.20	36.88	41.00	36.25	29.50	35.91	38.05
Pulliporan	32.46	37.40	32.71	35.69	34.57	40.38	35.94	35.67	36.32	37.08	35.82
Punthala local	36.29	34.92	35.55	32.88	34.91	32.67	35.25	35.33	35.21	34.62	34.76
Vellanad local	34.46	32.29	33.75	29.41	32.48	32.21	31.46	31.63	35.88	32.80	32.63
Co-1	36.50	31.46	32.61	31.42	33.00	28.96	30.34	33.25	29.04	30.40	31.70
Mean	34.54	34.75	34.50	34.93		33.58	34.71	35.42	33.78		
Mean dose effect		34.75	34.50	34.93	34.73		34.71	35.42	33.78	34.64	

CD - Between varieties - 2.411 CD - Variety x EMS - 4.822

each other but significantly superior to the mean values of other varieties. Lucknow Sweet (29.98 cm) had significantly the lowest mean girth of fruit than all the other varieties except Vellanad local (32.48 cm). Mean values of Pullıporan (34.57 cm), Attenganam local (33.63 cm), Panavalli (33.43 cm), Co-1 (33.00 cm) and Vellanad local were on par.

Under the influence of EMS treatments, varieties Pullıporan (37.08 cm), Panavalli (36.87 cm), Verma Surprise (36.13 cm) and Hara Madhu (35.91 cm) did not differ significantly in mean values among themselves. Pullıporan and Panavallı were significantly superior in mean girth of fruit to the rest of the varieties. Mean values of Verma Surprise (36.13 cm), Hara Madhu (35.91 cm), Punthala local (34.62 cm), Mudikode local (34.33 cm) and Lucknow Sweet (33.07 cm) were on par. Co-1 (30.40 cm) recorded the minimum girth and was on par with Attenganam local (32.59 cm) and Vellanad local (32.80 cm).

Comparing the effect of gamma rays and EMS together on varieties, Mudikode local (36.53 cm), Verma Surprise (36.02 cm), Pullıporan (35.82 cm), Panavallı (35.15 cm) and Punthala local (34.76 cm) were on par in mean girth of fruit. All these

varieties except Punthala local and Panavalli were significantly superior to Lucknow Sweet (31.52 cm), Co-1 (31.70 cm), Vellanad local (32.63 cm) and Attenganam local (33.12 cm) mean girth of which did not differ significantly.

In Pulliporan, Punthala local, Vellanad local and Co-1 the difference in mean girth of fruit between levels of EMS and between levels of EMS and its control was not significant. The 2.0% EMS treatment of Hara Madhu and the 1.0% and 2.0% EMS treatments of Panavalli resulted in significant decrease in mean girth of fruit than the control and the other treatments. The 1.5% and 2.0% EMS treatments of Mudikode local and Verma Surprise resulted in increased mean girth of fruit compared to control and 1.0% EMS treatment. In Lucknow Sweet, the 1.0% and 1.5% EMS treatments induced significantly increased mean girth of fruit than the control and 2.0% EMS treatment.

Gamma ray treatments in Hara Madhu and Pulliporan produced fruits with greater mean girth of fruit than the control while in Punthala local, Vellanad local and Co-1 the gamma ray treatments resulted in slight reduction in mean girth of fruit compared to control. In all these

cases the difference in mean girth of fruit between gamma ray treatments and its control was not significant.

Increase in size of fruit due to increase in length and girth of fruit as a result of certain levels of gamma ray irradiation in some of the varieties is in conformity with the results obtained by Kaushik et al. (1976) in cucumber and Singh and Roy (1977) in Cucumis melo.

17. Fruit set percentage

Table 15 presents the fruit set percentage on 10 Cucumis melo L. varieties as influenced by the mutagens.

Statistical analysis shows significant variation in mean values among varieties between levels of gamma rays, variety x gamma ray interaction and between variety x EMS interaction. No significant difference was noted in mean values between levels of EMS and between gamma rays and EMS.

Under the effect of gamma rays, variety Co-1(9.44) recorded significantly the highest mean value

Table 15. Effect of mutagens on the fruit set percentage of 10 Cucumis melo L. varieties

Varieties	Gamma rays - dose: Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	EMS - dose: Control	1.0%	1.5%	2.0%	Mean treated popln.	General varietal mean
Udikode local	[illegible] (12 [illegible])	[illegible] (9.08)	.37 (.57	3.46 10 71	[illegible].52 ([illegible].74	[illegible] (1 87)	[illegible] 11	.9 .0[illegible]	4. (11 [illegible]	.4 10.60	3 [illegible] (10.[illegible]7)
Panavalli	2 (1 [illegible]	4 76 12.60	[illegible]0 1 94)	[illegible].5 12 26	.47 ([illegible] 32	[illegible].3 [illegible])	4 (12 1	[illegible] 7[illegible] 11 1[illegible]	7.2 (15 6[illegible]	.55 1[illegible].56	.01 15.9[illegible]
Attergana 10	[illegible] ([illegible] 68)	[illegible].9 1[illegible].[illegible]7)	2.7[illegible] (61)	[illegible] 6[illegible] (14.90	.05 ([illegible].6[illegible])	84 (.29	[illegible].2 1 [illegible])	[illegible].69 [illegible].13	[illegible] (12.0	6.28 (.[illegible])	5.6[illegible] (13.46)
[illegible] kno [illegible]	[illegible])	. [illegible] ([illegible]	1 .36 [illegible])	2 [illegible]	6.04 .[illegible]9	62 ([illegible])	[illegible] (1[illegible]	[illegible] 25 8 [illegible]	[illegible] 7 5.0	.84 [illegible].03	[illegible] (1[illegible] 3)
Verma Surprise	[illegible] [illegible]0 [illegible])	[illegible].55 7.15	12 (10 [illegible]7)	5 5 [illegible]3 [illegible])	[illegible] 45 (10 45)	70 [illegible].45	[illegible] (. 2	[illegible] 7 97)	[illegible] 0 (8.2	2.06 ([illegible].21)	2.76 ([illegible].33)
Hara Madhu	[illegible] ([illegible])	2.3[illegible] [illegible].76	[illegible].09 [illegible] 1)	.9 (5.54	[illegible].74 [illegible] 20	[illegible] (. 1)	[illegible] ([illegible] 7)	1.9[illegible] 3.12)	1.[illegible] (7 [illegible]	[illegible].09 (8. 7	2 42 (8.69)
Pullipuram	[illegible]0 (1 [illegible])	2.85 [illegible].71)	26 (6.44)	[illegible].2[illegible] (6 70)	2 55 ([illegible].03)	62 [illegible]1)	2 [illegible]	7.[illegible]7 [illegible].40	[illegible] ([illegible]	[illegible] 71 2.18)	3.6[illegible] (10.60)
Purthala local	7.[illegible]8 (15 [illegible])	7.96 (16.3[illegible])	.59 (1[illegible] 92)	[illegible].3 (1[illegible].54	[illegible].31 ([illegible].40)	[illegible]. 6 (14.60)	11 [illegible] (1[illegible]. 5)	[illegible].46 (14.7[illegible]	12 [illegible] (20.[illegible]0	9.16 (7.42	7 74 15.91)
Vellanad local	3 [illegible] (11 29)	7.85 (16.27)	5.62 (13.71)	1.97 (8.07)	4.82 (12.34)	[illegible].09 ([illegible].66)	4 [illegible]7 (12 3)	5.40 (1[illegible] 43)	6 24 (14.46)	5.08 ([illegible].97)	4 95 (12 65)
Co-1	1[illegible] [illegible]9 (20 [illegible]0)	13.83 (21.83)	5.67 (13.76)	5.86 (14.01)	9.44 (17.55)	[illegible] 02 (2[illegible].27)	[illegible]2 (12 [illegible]7)	7.07 (5.41)	2.74 (9.52)	6.66 (14.47)	8.05 (16.01)
Mean	5.46 (13.08)	5.90 (13.40)	4.35 (11.59)	4.05 (11.22)		5.49 (13.04)	4 5[illegible] (11.[illegible]5)	4.85 (12.[illegible]0)	5.[illegible]2 (12.56)		
Mean dose effect		5.90 (13.40)	4.35 (11 59)	4.05 (11.22)	4.77 (12.07)		4.5[illegible] (11.[illegible]5)	4.85 [illegible]2.20)	5.12 (12.56)	4.84 (12.17)	

CD - Between varieties - 1.929 CD - Between levels of gamma rays - 1 220 CD - Variety x gamma rays - 3.859

CD - Variety x EMS - 3.859 (Transformed values given in parantheses)

among all other varieties, Lucknow Sweet (6.04), Panavalli (5.47), Attenganam local (5.05) and Vellanad local (4.82) were on par in fruit set percentage and all were significantly superior in fruit set percentage than Mudikode local (3.52), Verma Surprise (3.45), Hara Madhu (2.74) and Pulliporan (2.55) between which mean values did not differ significantly.

Considering varietal response to EMS, Punthala local (9.16) recorded significantly highest fruit set percentage among all varieties followed by Panavalli (6.55), Co-1 (6.66), Attenganam local (6.28) and Vellanad local (5.08), the mean values of which were on par. These varieties were significantly superior in mean values to the rest of the varieties. Hara Madhu (2.09) recorded the lowest mean values for fruit set percentage and was on par with that of Verma Surprise (2.06).

Comparing the varietal response to both mutagens together, varieties Co-1 (8.05) and Punthala local (7.74) recorded significantly higher fruit set percentage than the rest of the varieties. Hara Madhu (2.42) recorded the lowest fruit set percentage and was on par

with Verma Surprise (2.76) and Pulliporan (3.63). Mean values for fruit set percentage of Panavalli (6.01), Attenganam local (5.67), Vellanad local (4.95) and Lucknow Sweet (4.94) did not differ significantly.

All the gamma ray treatments in Panavalli, 30 kR treatment in Hara Madhu, 20 kR treatment in Pulliporan, Punthala local and Co-1 resulted in significantly lower fruit set percentage than their controls. The 20 kR treatment in Pulliporan was on par with the other gamma ray treatments in fruit set percentage. In Punthala local and Co-1 the 20 kR treatment was on par with the 30 kR treatment in fruit set percentage. The 10 kR and 30 kR gamma ray treatments in Attenganam local and the 10 kR treatment in Lucknow Sweet and Vellanad local resulted in a significant increase in fruit set percentage than their controls.

Variety x EMS interaction was not significant in fruit set percentage for Mudikode local, Verma Surprise and Vellanad local. All the EMS treatments in Co-1, 1.0% EMS treatment in Hara Madhu and Pulliporan and the 1.0% and 1.5% EMS treatments in

Panavalli induced significantly lower fruit set percentage compared to their controls.

Increased fruit set percentage compared to control was observed in 1.5% EMS treatment in Attenganam local and 2.0% EMS treatment in Lucknow Sweet and Punthala local. There are no available reports on the effect of mutagen treatments on the character, fruit set percentage in Cucurbits.

18. Total number of seeds/ fruit

The mean values of total number of seeds/ fruit on ten Cucumis melo L. varieties as influenced by mutagens is given in table 16.

Variation in mean value for total number of seeds/fruit between varieties, levels of gamma rays and between variety x gamma ray interaction was significant. Difference in mean values between levels of EMS, gamma rays and EMS and between variety x EMS interaction was not significant.

Under the effect of gamma rays, among the varieties, Co-1 recorded significantly the highest mean value for total number of seeds/fruit (954.89)

Table 16. Effect of mutagens on the total number of seeds/fruit of 10 Cucumis melo L. varieties

Varieties	Gamma rays - dose					EMS - dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln	
Mudikode local	905.75	697.50	602.13	793.25	749.66	781.25	823.04	711.38	820.38	784.01	766.83
Panavalli	655.3	789.38	356.25	557.13	589.47	613.75	544.13	541.38	616.63	605.47	597.47
Attenganam local	518.00	576.54	510.88	574.25	544.92	631.50	562.38	559.33	631.96	591.79	570.60
Lucknow Sweet	374.50	307.63	470.75	430.00	395.72	315.13	306.75	349.00	304.65	318.88	357.30
Verma Surprise	447.00	319.67	255.50	440.00	365.54	424.25	274.09	429.34	415.50	385.80	375.67
Hara Madhu	467.50	339.00	374.75	387.50	392.19	399.75	527.10	412.50	377.00	429.09	410.64
Pulliporan	590.50	885.25	726.50	702.25	726.13	920.00	817.75	793.50	718.25	812.38	769.25
Punthala local	874.13	608.75	752.38	700.50	734.07	627.00	743.50	736.00	851.00	739.38	736.66
Vellanad local	740.00	643.75	730.17	908.00	755.48	748.75	688.25	659.25	653.00	687.31	721.40
Co-1	658.75	982.67	1016.63	961.50	954.89	900.75	980.00	871.00	1025.00	944.19	949.54
Mean	643.13	615.01	579.59	645.44		636.81	626.70	616.27	641 34		
Mean dose effect		615.01	579.59	645.44	613.35		626.70	616.27	641.34	628.10	

CD - Between varieties - 54.860 CD- Between levels of gamma rays - 34.696 CD - Variety x Gamma rays - 109.720

followed by Vellanad local (755.48), Mudikode local (749.66), Punthala local (734.07) and Pulliporan (726.13) between which mean values did not differ significantly. All these varieties were significantly superior in mean values to the rest of the varieties. Verma Surprise (365.54) recorded lowest mean value and was on par with Lucknow Sweet (395.72) and Hara Madhu (392.19). Mean values of Panavalli (589.47) and Attenganam local (544.92) did not differ significantly.

Under the influence of EMS among the varieties, Co-1 registered significantly the highest mean value (944.19) for total number of seeds/fruit and Lucknow Sweet significantly the lowest mean value (318.88). Mean value of Pulliporan (812.38) was on par with that of Mudikode local (784.01) along with Co-1, these varieties were significantly superior in mean values to all the other varieties. Mean value of Panavalli (605.47) was on par with that of Attenganam local (591.79) and both were significantly superior to Hara Madhu (429.09) and Verma Surprise (385.80) mean values of which were on par.

Comparing the effect of gamma rays and EMS on varieties taken together in general, the same trend as in the case of the effect of gamma rays on varieties was observed. Here the lowest mean values for total number of seeds/fruit was observed in Lucknow Sweet (357.30).

All the gamma ray treatments of Mudikode local, Punthala local and the 10 kR treatments of Verma Surprise and Hara Madhu resulted in significantly lower mean values for total number of seeds per fruit compared to control. All the gamma ray treatments of Pulliporan 10 kR treatment of Panavalli, 10 kR and 20 kR treatments of Co-1 and 30 kR treatment of Vellanad local induced significantly higher number of seeds/fruit than their control.

The EMS treatments of varieties, Vellanad local, Pulliporan, Verma Surprise, Lucknow Sweet and Panavalli (except 1.5% EMS treatment of Verma Surprise, Lucknow Sweet and Panavalli) resulted in lesser number of seeds/fruit than the control. All the EMS treatments of Punthala local, Co-1 and Hara Madhu (except 1.5% EMS in Co-1 and 2.0% in Hara Madhu), 2.0% EMS treatment of Attenganam local and 1.0% and 2.0% EMS treatments of

Mudikode local, produced fruits with greater number of seeds/fruit than control. However, in these cases the difference in mean values between treatments and control was not statistically significant.

19. 100 Seed weight

Table 17 presents the mean values for 100 seed weight in grams of 10 Cucumis melo L. varieties as influenced by the mutagens.

Statistical analysis of the data shows significant variation in mean values for 100 seed weight among varieties, between levels of EMS and between variety x EMS interaction. Difference in mean values between levels of gamma rays, gamma rays and EMS and between variety x gamma ray interaction was not significant.

Under the influence of gamma rays on varieties Hara Madhu (2.67g) recorded significantly the highest mean value for 100 seed weight followed by Attenganam local (2.46g) and Verma Surprise (2.45g). These varieties were superior in mean values to that of the other varieties. Co-1 recorded lowest 100 seed weight (1.63g) and was on par with Lucknow Sweet (1.80g).

Table 17. Effect of mutagens on 100 seed weight in grams of 10 Cultivars/Selections varieties

Varieties	Gamma rays - dose					EMS — dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln	
Kudikode local	2.01	2.06	2.07	1.96	2.03	2.12	1.92	1.83	2.04	1.98	2.00
Panavalli	1.97	1.97	1.81	2.00	1.94	2.07	2.24	1.90	1.92	2.03	1.98
Attenganam local	2.73	2.29	2.68	2.12	2.46	2.64	2.13	2.45	1.96	2.30	2.37
Lucknow Sweet	1.98	2.54	1.22	1.57	1.80	1.81	2.52	2.71	1.89	2.23	2.01
Verma Surprise	2.38	2.53	2.46	2.82	2.45	2.49	1.94	2.59	3.03	2.51	2.48
Hara Madnu	2.64	2.50	2.46	3.07	2.67	3.19	3.22	3.06	3.04	3.15	2.90
Pullipuran	1.85	2.03	1.85	1.91	1.94	1.94	1.73	2.03	1.83	1.88	1.91
Punthala local	1.86	2.05	2.03	1.56	1.88	1.71	1.72	1.79	1.87	1.77	1.82
Vellanad local	2.42	2.00	2.08	2.26	2.19	1.79	1.73	1.93	2.10	1.89	2.04
Co-1	1.61	1.65	1.82	1.44	1.63	1.88	1.53	1.49	1.40	1.58	1.60
Mean	2.14	2.14	2.05	2.07		2.16	2.07	2.18	2.10		
Mean dose effect		2.14	2.05	2.07	2.09		2.07	2.18	2.10	2.12	

CD - Between varieties - 0.200 CD - Between levels of EMS - 0.126 CD - Variety x EMS - 0.400

Mean values for 100 seed weight of Mudikode local (2.03g), Panavalli (1.94g), Pulliporan (1.94g) and Punthala local (1.88g) did not differ significantly.

Under the effect of EMS treatment, among the varieties Hara Madhu (3.13g) recorded significantly highest mean 100 seed weight followed by Verma Surprise (2.51g), Attenganam local (2.30g) and Lucknow Sweet (2.23g), Co-1(1.58g) recorded the lowest 100 seed weight and was on par with Punthala local (1.77g). Mean 100 seed weights of Panavalli (2.03g), Mudikode local (1.98g), Vellanad local (1.89g) and Pulliporan (1.88g) were on par.

Comparing the varietal response to both mutagens together Hara Madhu (2.90g) recorded highest mean value for 100 seed weight among all varieties followed by Verma Surprise (2.48g) and Attenganam local (2.37g) the mean values of which were on par. Co-1 (1.60g) recorded significantly lowest mean 100 seed weight. Mean values of Lucknow Sweet (2.01g), Mudikode local (2.00g), Panavalli (1.98g), Pulliporan (1.91g) and Punthala local (1.82g) did not differ significantly.

Variety x EMS interaction was not significant for 100 seed weight in varieties Mudikode local, Panavalli, Hara Madhu, Pulliporan, Punthala local and Vellanad local. In varieties Co-1 and Attenganam local, the 2.0% EMS treatment resulted in significantly lower mean 100 seed weight than the control and was on par with the 1.0% EMS treatment. In Co-1 the 2.0% EMS treatment was also on par with 1.5% EMS treatment.

In Lucknow Sweet the 1.0% and 1.5% EMS treatment and the 2.0% EMS treatment of Verma Surprise were significantly superior in 100 seed weight than the control and the other EMS treatments.

The 10 kR and 20 kR gamma ray treatments of Co-1 and Punthala local, 10 kR and 30 kR treatments of Pulliporan, 20 kR and 30 kR treatments of Verma Surprise and the 30 kR treatments of Panavalli and Hara Madhu induced a slight increase in 100 seed weight compared to their control.

In Attenganam local and Vellanad local the gamma ray treatments resulted in slight decrease in 100 seed weight compared to control. However, in all the varieties studied, variety x gamma ray interaction was not significant.

20. Seed sterility

Table 18 presents the percentage seed sterility on ten Cucumis melo L. varieties as influenced by the mutagens. The graphical representation of the data is shown in Fig.6.

Difference in mean values of percentage seed sterility among varieties, between levels of gamma rays and between levels of EMS was found to be statistically significant. Variation in mean values between the mutagens, between variety x gamma ray interaction and between variety x EMS interaction was not significant.

Under the influence of gamma rays Panavalli (13.77), Lucknow Sweet (12.53), Hara Madhu and Verma Surprise (11.29) were on par in mean values for percentage seed sterility. Panavalli and Lucknow Sweet recorded significantly higher values than that of other varieties, Pulliporan (7.58) registered the lowest mean value and was on par with Vellanad local (7.78), Punthala local (9.14) and Co-1 (9.59).

Table 18. Effect of mutagens on percentage seed sterility on 10 Cucumis melo L. varieties

Varieties	Gamma rays — dose				Mean treated poplⁿ.	EMS — dose				Mean treated popln.	General varietal mean
	Control (dry)	10 kR	20 kR	30 kR		Control (soaked	1.0%	1.5%	2.0%		
Kalkode local	5.56	5.49	9.06	19.30	10.90	5.33	5.48	12.83	16.42	12.52	11.41
	13.63	(16.93	(16.28)	26.05	(16.22	(5.34)	(7 16	20.98	23.90	(20.35	18.28)
Kanivalli	7.00	11.6	14.69	16.79	3.77	6.70	9.31	12.07	7.15	9.06	1.42
	15.34)	(19.92)	(22.33)	(24. 8	21.44	(1 .00)	(.72)	20.32	(15.50)	(1 .39)	19.41)
Kattenga nam local	7.16	12.01	9.24	11.55	0.9	5.47	.47	12.06	15.20	10. 5	0.00
	(1 .52	20.27	(1 .69)	(19.71	(16.30	(1 52	(5.86)	20.32	22.93)	(18.16	5.23
Muc now Sweet	7.50	15.08	1 .86	15 65	12.53	5.85	9.21	9.61	14.51	10.55	11.54
	.89	(22.84)	(21 85	21.68	20.57	(15.99)	(7 .45	(15.05	(22.39)	(15.72)	18.64)
Ver a Surprise	.60	12.45	.67	16.54	11.29	6.70	5.16	11.93	12.89	11.07	1.48
	4.89	(20.48)	(15. 2)	24.07)	(19.39)	14.99)	22.90)	20.20	(21.03)	(19.78)	19.58)
Nara Sahu	6.27	17.02	12.54	10.85	1.07	6.08	15.17	14.02	13.62	12.22	1.95
	14.49)	(24.35)	(20.73)	(19.22)	19.70	(14.27)	(22.91)	21.98)	(21.75)	(20 20)	(.95)
Pulliporan	6.49	8.63	7.93	7.25	7.58	6.86	.12	6.89	14.48	10.34	8.96
	(14.74)	(17.08)	(16.35)	(5.62)	(15.95)	(15.17)	(21.23)	(15.22)	(22.36)	(18.50)	(17.22)
Puntnala local	7.42	6.74	10.57	11.05	9.14	6.34	1 .15	8.33	7.22	8.26	8.70
	(15.80)	(15.04)	(16.96)	(20.10)	17.48)	(14.58)	(9.50)	(16.77)	(15.58)	(16.61)	(17.04)
Vellanad local	6.89	8.61	6.38	9.25	7.78	5.23	10.03	5.96	7.87	7.27	7.53
	(15.21)	(17.05)	(14.63)	(17.68)	(16.14)	(13.21)	(18.46)	(14.13)	(16.29)	(15.52)	(15.83)
Co-1	6.89	11.58	8.20	11.68	9.59	5.88	7.42	6.80	12.46	8.14	8.87
	(15.22)	(19.89)	(16.63)	(19.97)	(17.93)	(14.02)	(15.80)	(15.11)	(20.56)	(16.40)	(17.16)
Mean	6.78	11.20	10.59	12.86		6.04	11.75	10.05	12.18		
	(15.07)	(19.38)	(18.76,	(20.83)		(14.21)	(19.90)	(18.31)	(20.23)		
Mean dose effect		11.20	10.59	12.86	11.55		11.75	10.05	12.18	11.33	
		(19.38)	(18.76	(20.83)	(19.66)		(19.90)	(18.31)	(20.23)	(19.48)	

C - between varieties - 2.127 CD- Between levels of gamma rays - 1.345 CD- Be ween levels of EMS - 1.345

Transformed values given in parentheses.

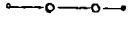
KEY

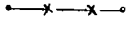
 Mudikode local

 Panavalli

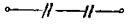
 Attenganam local

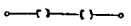
 Lucknow Sweet

 Verma Surprise

 Hara Madhu

 Pulliporan

 Punthala local

 Vellanad local

 Co-1

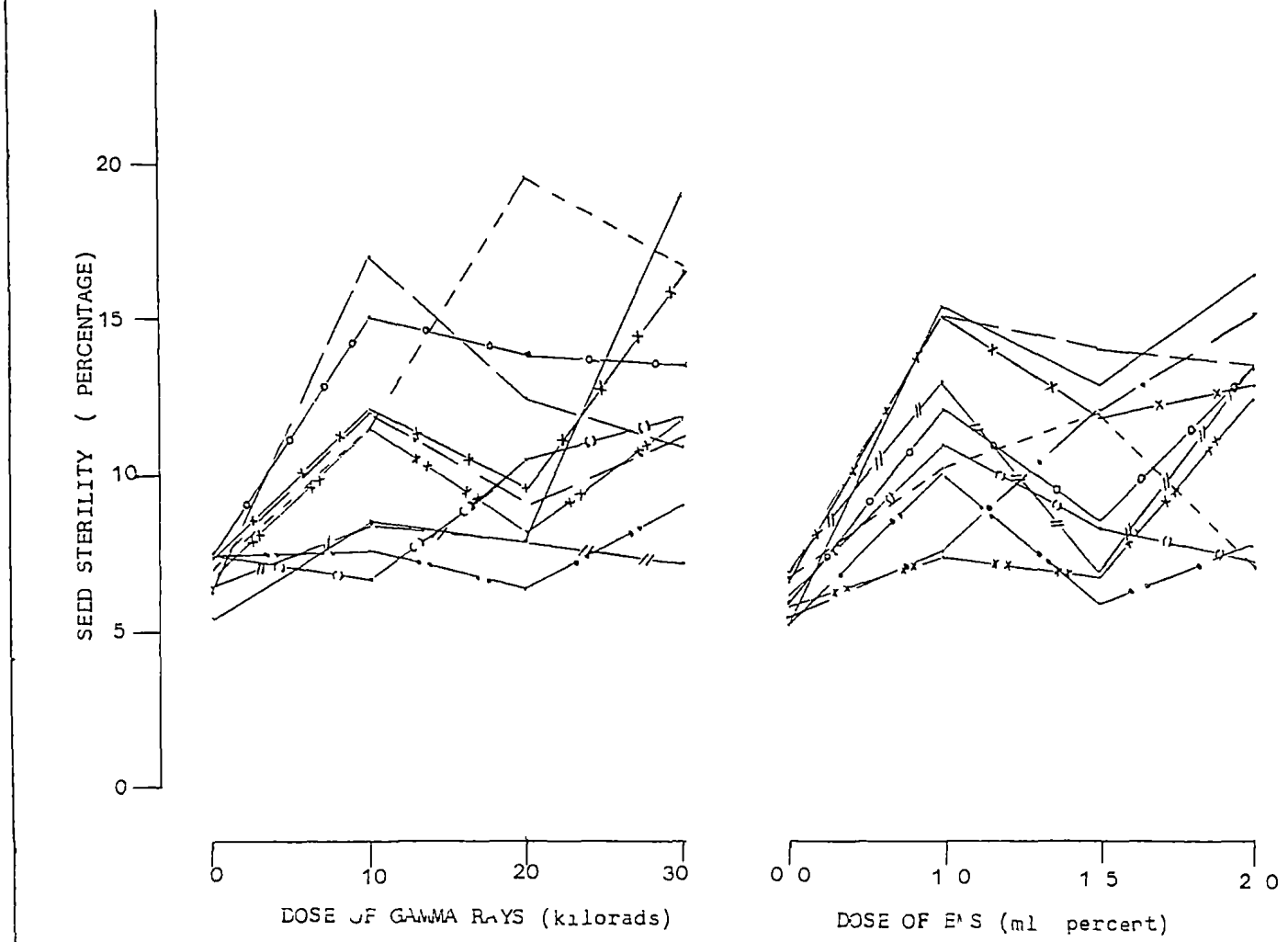


Fig.6 Effect of mutagens on seed sterility o 10 Cucumis melo L varieties

Under the effect of EMS, Mudikode local (12.52), Hara Madhu (12.22), Verma Surprise (11.67), Lucknow Sweet (10.55) and Pulliporan (10.34) did not differ significantly in mean values for percentage seed sterility and all these varieties except for Lucknow Sweet and Pulliporan recorded significantly lower percentage of seed sterility than Panavalli (9.06) Punthala local (8.26), Co-1 (8.14) and Vellanad local (7.27).

Comparing the effect of both the mutagens together Hara Madhu (11.95), Lucknow Sweet (11.54), Verma Surprise (11.48), Panavalli (11.42), Mudikode local (11.41) and Attenganam local (10.00) were on par in mean values for percentage seed sterility and all with the exceptions of Mudikode local and Attenganam local recorded significantly lower percentage of seeed sterility than Pulliporan (8.96) Co-1 (8.87), Punthala local (8.70) and Vellanad local (7.53).

Between the levels of gamma rays the 30 kR (12.86) in general resulted in significantly higher mean value for seed sterility than 20 kR (10.59) and 10 kR (11.20) treatments the mean values of which were

on par. All the gamma ray treatments induce significantly higher seed sterility than control (6.78).

Among the levels of EMS the 2.0% EMS treatment (12.18) in general induced significantly higher seed sterility than the 1.5% EMS treatment (10.05) and 1.0% EMS treatment (11.75). All the EMS treatments resulted in significantly higher seed sterility than control (6.04).

Variety x mutagen interaction was not significant. In general in all varieties, compared to control, seed sterility increased with increase in dose of gamma rays and EMS except 10 kR gamma ray treatment and 1.5% EMS treatment where a slight reduction in seed sterility was noticed. Decreased fertility with increasing dose of gamma rays and EMS was reported by Zannone (1965) in Vicia sativa, Ojoma and Chheda (1971) in cowpea and Kubicki et al.(1984) in cucumber.

Radiation induced sterility may be the result of chromosome aberrations while sterility induced by chemicals may be due to cryptic deletions and specific gene mutations (Nerkar, 1977).

21. Length of main vine at harvest

Table 19 presents the data on mean length of main branch at harvest of 10 Cucumis melo L. varieties as influenced by the mutagens. The graphical representation of the data is shown in Fig.7.

Statistical analysis of the data shows significant variation in mean length of main vine at harvest among varieties and between levels of EMS. No significant variation observed in mean values between levels of gamma rays, gamma rays and EMS and between variety x gamma ray interaction and between variety x EMS interaction.

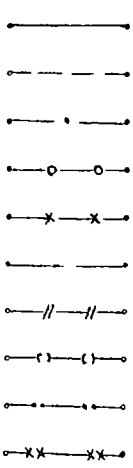
Under the influence of gamma rays Mudikode local (4.08 m) Co-1 (3.97 m) and Punthala local (3.87 m) were on par in mean length of main vine at harvest and all except Punthala local were significantly superior in mean values to that of the other varieties. Verma Surprise (2.11 m) recorded the least mean value for main vine length and was on par with that of Lucknow Sweet (2.49 m). Mean values of Pulliporan (3.07 m), Attenganam local (3.06 m) Hara Madhu (2.97 m) and Panavalli (2.74 m) did not differ significantly in mean values.

Table 19. Effect of mutagens on length of main branch (m) at harvest of 10 *Cucumis melo* L. varieties

Varieties	Gamma rays - dose					EMS — dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mundkode local	3.27	3.58	5.30	4.16	4.08	2.07	3.81	3.32	3.23	2.95	3.57
Panavalli	2.86	2.72	2.66	2.70	2.74	2.86	2.66	2.96	3.14	2.91	2.82
Attenganam local	3.08	2.95	3.14	3.08	3.06	2.73	3.80	3.77	2.65	3.24	3 15
Lucknow Sweet	2.06	2.78	2.65	2.45	2.49	2.46	2.07	1.98	2.50	2.25	2.37
Verma Surprise	2.22	1.95	2.07	2.18	2.11	2.85	2.36	2.42	2.14	2.44	2.27
Hara Madhu	3.19	2.94	2.76	2.98	2.97	2.43	3.99	2.91	3.58	3.23	3.10
Pulliporan	3.29	2.75	3.44	2.80	3.07	3.24	3.60	2.66	2.09	2.90	2.98
Punthala local	4.17	3.25	3.89	4.15	3.87	4.46	4.36	3.31	2.86	3.75	3.80
Vellanad local	3.77	3.41	2.89	3.67	3.44	3.39	2.76	3.77	3.43	3.34	3.38
Co-1	3.71	4.16	4.03	4.52	3.97	4.32	5.17	4.19	3.82	4.38	4.24
Mean	3.16	3.05	3.28	3.27		3.08	3.44	3.13	2.94		
Mean dose effect		3.05	3.28	3.27	3.20		3.44	3.13	2.94	3.17	

CD - Between varieties - 0.472 CD Between levels of EMS - 0.298

KEY


Mudikode local
Panavalli
Attenganam local
Lucknow Sweet
Verma Surprise
Hara Madhu
Pulliporan
Punthala local
Vellanad local
Co-1

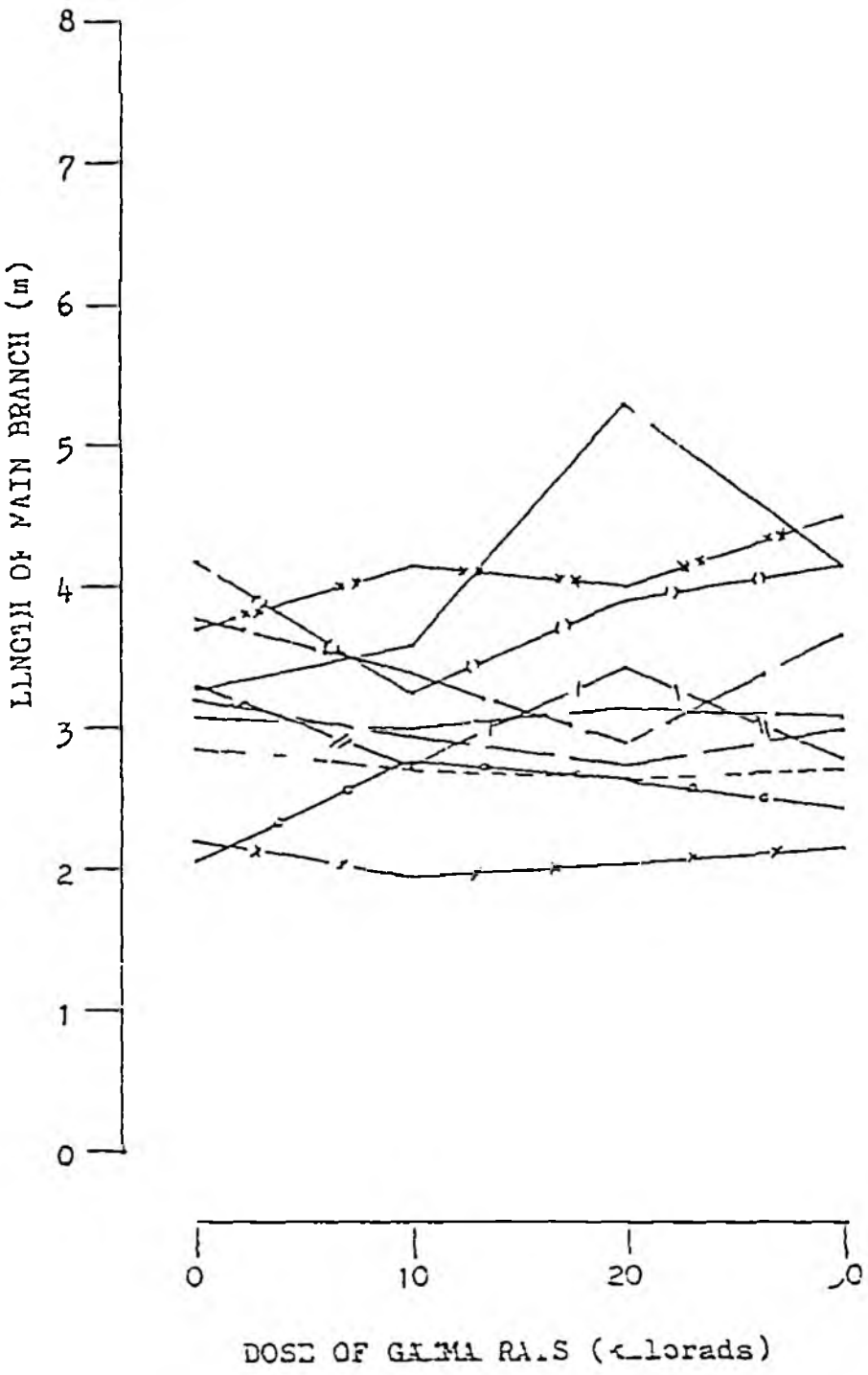


Fig. 7 Effect of mutagens on length of *Cucumis melo* L. varieties

Under the influence of EMS among varieties Co-1 (4.38 m) recorded significantly the maximum value for mean length of main vine. Lucknow Sweet (2.25 m) recorded the minimum value among varieties and was on par with that of Verma Surprise (2.44 m). No significant difference was observed in mean values between varieties Vellanad local (3.34m), Attenganam local (2.34 m), Hara Madhu (2.32m), Mudikode local (2.95 m) and Panavalli (2.91 m).

Comparing the influence of both mutagens together on varieties Co-1 (4.24 m) recorded maximum mean value for length of main vine and was on par with mean value of Punthala local (3.80 m). Verma Surprise recorded the least mean value (2.27 m) among varieties and was on par with that of Lucknow Sweet (2.37 m). Mean values of Attenganam local (3.15 m), Hara Madhu (3.10 m), Pulliporan (2.98 m) and Panavalli (2.82 m) were on par.

Between levels of EMS, the 1.0% EMS (3.44 m) treatment resulted in significant increase in mean length of main vine compared to control (3.08) and 2.0% EMS treatment (2.94 m) and was on par with the 1.0% (3.13 m) EMS treatment.

In general the 10 kR treatment of all varieties resulted in slight decrease in mean length of main vine compared to control where as the higher levels of 20 kR and 30 kR gamma rays resulted in slight increase in mean length of main vine compared to control. Increase in length of main vine have been reported by Goranov (1972 b) in Cucurbita maxima, Bisaria et al. (1975) in Cucumis melo L. Kaushik et al. (1976) in Luffa cylindrica.

In general the 2.0% EMS treatment of all varieties induced slight reduction in mean length of main vine compared to control. The lower levels of EMS resulted in slight increase in mean length of main vine compared to control. Increase in mean length of vine due to chemical mutagens has been reported in cucumber by Arsagova (1969).

The inhibition in vine elongation by lower level of 10 kR gamma ray treatment and the highest dose of 2.0% EMS treatment might be due to cytological and physiological changes in the cells. Gunckel and Sparrow (1961) have reported changes in auxin levels and in the biological and physiological activities and the inactivation of vital enzymes.

The increase in plant growth in the present study may be due to destruction of inhibitory substances and an increase in auxins, gibberellins etc. which stimulates elongation of vine.

22. Number of primary branches/plant

Mean number of primary branches at harvest of ten Cucumis melo L. varieties as influenced by the mutagens is presented in table 20. Statistical analysis of the data shows significant variation in mean number of primary branches/plant at harvest only among the varieties. Variation in mean values between levels of gamma rays, levels of EMS, gamma rays and EMS, between variety x gamma ray interaction and between variety x EMS interaction was not significant.

Varietal response to gamma rays shows varieties Panavalli (8.49), Mudikode local (8.44), Pulliporan (8.12), Vellanad local (7.75), Co-1 (7.75), Hara Madhu (7.42) and Attenganam local (7.23) had comparable mean values for number of primary branches. Panavalli and Mudikode local were significantly superior to Verma Surprise (6.79) and Lucknow Sweet (6.14) in mean values. Hara Madhu, Attenganam local, Punthala local (7.07), Verma Surprise and Lucknow Sweet had mean values that were on par.

Table 20. Effect of mutagens on the number of primary branches at harvest of 10 Cucumis melo L. varieties

Varieties	Gamma rays - dose					EMS — dose					General varietal mean
	Control (dry)	10 kR	20 kR	30 kR	Mean treated popln.	Control (soaked)	1.0%	1.5%	2.0%	Mean treated popln.	
Mudikode local	6.25	8.75	10.83	7.92	8.44	8.00	9.21	9.13	7.25	8.40	8.42
Panavalli	8.25	7.67	8.88	9.17	8.49	8.25	6.09	10.63	7.34	8.08	8.28
Attenganam local	7.84	6.84	7.00	7.25	7.23	9.17	6.75	8.25	6.75	7.73	7.48
Lucknow Sweet	5.75	6.75	5.38	6.67	6.14	6.25	4.88	6.17	6.63	5.98	6.06
Verma Surprise	6.50	5.67	7.75	7.25	6.79	6.88	7.25	7.38	6.54	6 96	6.88
Hara adhu	7.00	7.00	7.00	8.67	7.42	6.25	6.25	4.50	6.88	5.97	6 69
Pulliporan	8.50	8.34	8.50	7.13	8.12	8.50	9.83	7.79	5.63	7.94	8.03
Punthala local	6.21	6.63	6.13	9.29	7.07	8 38	6.75	6.50	6 50	7.03	7.05
Vellanad local	6.50	7.88	6.00	7.63	7.75	10.63	10.75	11.25	8.79	10.36	9.05
Co-1	8.54	6.67	7.63	8.17	7.75	8.09	9.50	7.59	7.38	8.26	8.01
Mean	7.43	7.22	7.51	7.91		8.04	7.73	7.92	7.00		
Mean dose effect		7.22	7.51	7.91	7.55		7.73	7.92	7.00	7.55	

CD - Between varieties - 1.409

Varietal response to EMS shows that Vellanad local (10.36)recorded significantly the maximum mean value for number of primary branches at harvest among all varieties. Mean values of Mudikode local (8.40), Co-1 (8.26), Panavalli (8.08), Pulliporan (7.94), Attenganam local (7.73) and Punthala local (7.03) did not differ significantly and all were significantly superior in mean values to that of Lucknow Sweet (5.98) and Hara Madhu (5.97). Hara Madhu, Lucknow Sweet, Verma Surprise (6.96) and Punthala local (7.03) were on par in mean values.

Comparing the varietal response to both mutagens together Vellanad local (9.05), Mudikode local (8.42), Panavalli (8.28), Pulliporan (8.03) and Co-1 (8.01) did not differ significantly in mean number of primary branches and all were significantly superior in mean values to that of Lucknow Sweet (6.06), Hara Madhu (6.69), Verma Surprise (6.88) and Punthala local (7.05).

In all the varieties except Attenganam local, Pulliporan, Vellanad local and Co-1 all the gamma ray treatments in general resulted in increased number of primary branches than the control. However this increase was not significant. Increased number of branches has been reported by Bisaria et al (1975) in Cucumis melo L. and

Kaushik et al (1976) in Luffa cylindrica.

In the case of variety x EMS interaction in all varieties except Mudikode local, Verma Surprise, Hara Madhu and Vellanad local, the EMS treatments in general resulted in decreased number of primary branches than the control. Decrease in number of primary branches was however not significant.

To sum up, gamma ray and EMS treatments on ten Cucumis melo L. varieties studied here, yielded a wide spectrum of variable response in each of the 22 characters analysed.

Considering the efficiency of both mutagens on the basis of reduction of survival percentage (lethality) and sterility (pollen sterility), in general among the various doses of gamma rays employed 30 kR was the most efficient on the basis of lethality and sterility. With EMS treatment 1.5% and 2.0% EMS treatments were in general the most efficient when estimated on the basis of lethality and sterility respectively.

In general among the two mutagens EMS was more efficient with respect to lethality while on the basis of sterility gamma rays was more efficient than EMS in the present study.

SUMMARY

SUMMARY

The present investigation was undertaken to elucidate the effect of gamma rays and EMS on ten Cucumis melo L. varieties in the M_1 generation. The experiment was laid out in RBD with two replications.

The germinability of seeds was not significantly affected by the different mutagen doses. However, in general reduction in germination percentage was observed in varieties, Panavalli, Attenganam local, Lucknow Sweet Verma Surprise and Punthala local with gamma ray treatments while the germinability was better in some others such as Mudikode local, Pulliporan, Vellanad local and Co-1. Reduction in germination percentage compared to control was observed in EMS treatments of Mudikode local, Hara Madhu, Pulliporan, Punthala local and Co-1.

Significant delay in completion of germination compared to control was observed in different doses of gamma ray treatment in some of the varieties while early germination was noted in some others. Significantly early germination compared to control occurred in all gamma ray treatments of Verma Surprise.

Survival percentage in general was reduced with mutagen treatments in most of the varieties. Among the two mutagens the EMS treatment resulted in greater reduction in survival percentage than gamma ray treatment. This reduction in survival percentage was however not statistically significant.

Cholorophyll chimeras were observed in both gamma ray and EMS treatments. One plant in 30 kR treatment of Lucknow Sweet had an entire chimeric branch producing light green leaves while others had leaves with chlorophyll deficient narrow streaks and patches. Frequency of chlorophyll chimeras was more with gamma rays than with EMS treatments.

Morphological variations were observed as a result of mutagens treatments which included dwarf bushy plants, leaf abnormalities such as crinkled or split leaves and two plants in 20 kR gamma ray treatment of variety Panavalli produced small rounded fruits compared to elongated fruits in its control.

In general the lower doses of gamma rays resulted in early flowering of first male flower while the higher 30 kR treatment resulted in delayed appearance of first male flower. The 20 kR treatment was in general the

earliest in first male flower production. Among EMS treatments the 1.0% and 2.0% EMS treatments in general resulted in a delayed production of first male flower.

Regarding the appearance of first female flower a significant delay was observed in the higher doses of gamma ray treatments in Co-1 and Attenganam local while a significantly early appearance of first female flower was noted with the lower levels of gamma ray treatments in Mudikode local, Lucknow Sweet and Pulliporan. The 1.5% and 2.0% EMS treatments in general produced first female flower earlier than control and 1.0% EMS treatment. Irrespective of the varieties, among the two mutagens, EMS treatment resulted in significantly early appearance of first male and first female flower than gamma ray treatment.

In most of the varieties the EMS treatments in general resulted in the appearance of first male flower at lower nodes compared to control. Between the two mutagens EMS treatment induced appearance of first female flower at lower nodes than gamma ray treatment.

Increase in sex ratio (male to female) due to some of the EMS treatments was observed in a few varieties while a decrease was observed in others. Irradiation with higher doses of gamma rays caused decreased sex

ratio in Panavalli, Lucknow Sweet, Hara Madhu, Pulliporan and Punthala local.

In general there was reduction in pollen fertility with increase in dose of gamma rays in all varieties except Attenganam local. The 1.0% and 2.0% EMS treatments of Mudikode local, 1.5% EMS treatment of Panavalli and the 2.0% EMS treatment of Pulliporan and Punthala local induced significant reduction in pollen fertility compared to control. Greater reduction in pollen fertility was noted with gamma ray treatment than with EMS treatment.

The different varieties showed differential response to different levels of gamma rays and EMS for number of fruits produced per plant. The 20 kR treatment of Mudikode local and Co-1 and the 30 kR treatment of Pulliporan recorded greater fruit weight compared to their control while 30 kR treatment in Panavalli and Punthala local produced fruits with significantly lower fruit weight than their control. In Mudikode local, Panavalli, Vellanad local and Co-1 irradiation of gamma rays in general resulted in significantly lower yields than their control while in Attenganam local gamma ray irradiation resulted in significantly increased yield compared to

control. Different levels of EMS did not have any significant effect on varieties for fruit weight and for yield/plant.

Increase in length and girth of fruit as a result of certain levels of mutagen treatment occurred in some of the varieties while in others a decrease in length and girth of fruit occurred.

Significantly lower fruit set compared to control occurred in 20 kR treatment in Panavalli, Punthala local, Pulliporan and Co-1 whereas 10 kR treatment in Lucknow Sweet and Vellanad local resulted in a significant increase in fruit set. Lower levels of EMS treatments in Hara Madhu, Co-1, Pulliporan and Panavalli induced significantly lower fruit set compared to control. Increased fruit set was observed in 2.0% EMS treatment in Lucknow Sweet and Punthala local.

Irradiation with gamma rays resulted in significantly lower number of seeds compared to control in Mudikode local and Punthala local while in Pulliporan greater number of seeds than control was produced due to gamma ray treatment.

In Co-1 and Attenganam local 2.0% EMS treatment resulted in a significant reduction in 100 seed weight while lower levels of EMS treatments in Lucknow Sweet

resulted in a significant increase in 100 seed weight compared to their control. Different levels of gamma rays did not produce significant significant effect on varieties for 100 seed weight.

In general in all varieties compared to control, seed sterility increased with increase in dose of gamma rays and EMS except 10 kR gamma ray treatment and 1.5% EMS treatment where a slight reduction in seed sterility was noticed.

The 10 kR treatment of all varieties in general resulted in slight decrease in mean length of main vine compared to control whereas the higher levels of gamma rays resulted in slight increase in mean length of main vine. In general the 2.0% EMS treatment of most of the varieties induced slight reduction in mean length of main vine while the lower levels of EMS resulted in slight increase in mean length of main vine compared to control.

To conclude the present study of ten Cucumis melo L. varieties revealed a differential response to the different doses of the two mutagens tested. The variability in mean values compared to control for the different characters studied in the M_1 generation indicates a positive response

to selection and scope for improvement in this crop. Detailed analysis on the segregating later generations is suggested to identify desirable lines for further testing.

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* Original not seen.

APPENDICES

APPENDIX I

ABSTRACT OF ANOVA

Source	DF	Mean squares					
		Germination (%)				Days to complete germination	Survival(%
		5 DAS	10 DAS	15 DAS	20 DAS		20 DAS
Treatments	79	652.757**	238.947**	231.208**	245.473**	10.771**	205.193**
Between varieties	9	1603.418	616.382	639.586	681.761	23.169	565.181
Between levels of gamma rays	3	96.878	66.859	89.489	112.932	0.246	88.385
Between levels of EMS	3	960.309**	250.698**	192.682	194.927	8.701**	212.859
Gamma rays Vs EMS	1	22578.980**	1834.750**	262.531	188.188	189.225**	34.062
Variety x gamma rays	27	93.631	148.223	162.957	171.266	9.459	93.826
Variety x EMS	27	187.129	102.752	82.434	85.663	4.649	114.339
Remaining treatments	9	422.811	418.408	530.505	578.636	5.044	507.259
Error	79	175.859	137.071	144.910	142.678	4.430	136.336

(contd.)

Anova (contd)

Source	DF	Survival (%) (30 DAS)	Days to appearance of first male flower	Node at which first male flower appears	Days to appearance of first female flower	Node at which first female flower appears	Sex ratio	Pollen fertility	Fruits/ plant
Treatments	79	179.856 **	11.047 **	1.168 **	10.396 **	6.569 **	665.229 **	146.824 **	0.345 **
Between varieties	9	419.691	37 436	4.195	19.895	22.238	4493.410	142.330	0.589
Between levels of gamma rays	3	105.994	20.908 **	1.087 *	2.034	1.271	282.318	876.042 **	0.820 **
Between levels of EMS	3	196.208	2.587 **	1.275 *	7.021	6.904 *	60.065	221.917 **	0.102
Gamma rays Vs EMS	1	12.531	120.766 **	0.077	198.031 **	61.876 **	222.875	272.625 **	0.282
Variety X gamma rays	27	77.726	5.598 **	0.693 *	2.999 **	3.697 *	184.430	140.247 **	0.377 *
Variety X EMS	27	106.108	5.201	0.869 *	9.998 **	2.989	138.831	88.365 **	0.237
Remaining treatments	9	505.413	5.884	0.577	7.347	5.765	237.148	65.340	0.256
Error	79	123.830	1.357	0.377	1.256	2.132	167.954	35.482	0.172

(contd.)

Anova (contd.)

Source	DF	Fruit weight	Yield/ vine	Length of fruit	Girth of fruit	Fruit set (%)	Seeds/ fruit	100 seed weight	Seed sterility (%)	Length of main vine	Primary branches/ vine
Treatments	79	1.947	4.761	523.418	27.817	28.244	83866.530	0.383	23.421	1.106	3.954
Between varieties	9	14.934**	25.840**	4367.637**	77.120**	103.665**	624895.100**	2.224**	32.915*	5.971**	13.572**
Between levels of gamma rays	3	0.044	5.816**	6.779	0.805	23.139*	18914.000*	0.038	120.073**	0.237	1.687
Between levels of EMS	3	0.111	0.355	12.167	15.219	13.615	2494.667	0.052**	152.806**	1.399*	10.593
Gamma rays Vs EMS	1	0.071	0.204	41.391	3.703	0.160	3600.000	0.042	4.883	0.072	0.918
Variety X gamma rays	27	0.379*	2.328*	21.032	16.932	20.534**	22787.480**	0.152	11.998	0.314	2.403
Variety X EMS	27	0.224	1.186	40.325*	26.084**	16.686**	8370.370	0.137**	10.088	0.532	1.849
Remaining treatments	9	0.286	3.332	31.823	32.255	20.324	10256.890	0.238	14.910	0.642	4.185
Error	79	0.198	1.236	22.799	11.629	7.450	6019.291	0.080	9.056	0.446	3.971

** Significant at 1% level

* Significant at 5% level

VARIETAL SENSITIVITY ANALYSIS IN *Cucumis melo* L. USING GAMMA RAYS AND ETHYL METHANE SULPHONATE

BY

NELSON LOPEZ

Abstract of the Thesis

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ABSTRACT

The effect of gamma rays and EMS on ten *Cucumis melo* L. varieties was studied in the M_1 generation.

Germinability of seeds was not significantly affected by the different mutagen doses. However in general germination percentage decreased in varieties Panavalli, Attenganam local, Lucknow Sweet, Verma Surprise and Punthala local with gamma ray treatment while in Mudikode local, Pulliporan, Vellanad local and Co-1 germinability was better. EMS treatments in Mudikode local, Hara Madhu, Pulliporan, Punthala local and Co-1 resulted in decreased germination percentage.

Significant delay in completion of germination compared to control was observed in different levels of gamma ray treatments in some of the varieties while early germination was noted in some others.

Survival percentage, in general, was reduced with mutagen treatment in most of the varieties.

Chlorophyll chimeras were noticed in both mutagen treatments. Morphological variations observed included leaf and fruit abnormalities.

In general the lower doses of gamma rays resulted in early flowering of male flowers while 30 kR treatment resulted in delayed male flowering. Among EMS treatments, 1.0% and 2.0% treatments in general resulted in a delayed production of first male flower.

In the case of appearance of first female flower a significant delay was observed in the higher doses of gamma ray treatments in Co-1 and Attenganam local while a significantly early appearance of first female flower was noted with lower doses of gamma ray treatments in Mudikode local, Lucknow Sweet and Pulliporan. The 1.5% and 2.0% EMS treatments in general produced first female flower earlier than control and 1.0% treatment.

In most of the varieties the EMS treatments in general resulted in the appearance of first male flower at lower nodes compared to control. EMS treatment induced appearance of first female flower at lower nodes than gamma ray treatment.

Increase in sex ratio (male to female) due to some of the EMS treatments was observed in some varieties while a decrease was observed in others. Irradiation with higher doses of gamma rays caused decreased sex ratio in Panavalli, Lucknow Sweet, Hara Madhu, Pulliporan and Punthala local.

In general in all varieties there was reduction in pollen and seed fertility with increase in dose of gamma rays and EMS except 10 kR gamma ray treatment and 1.5% EMS treatment where a slight increase in seed fertility was noticed.

Different varieties showed differential response to different levels of gamma rays and EMS for number of fruits produced per plant and also for length and girth of fruit. Higher doses of gamma rays in Mudikode local, Co-1 and Pulliporan recorded greater fruit weight compared to control while 30 kR treatment in Panavalli and Punthala local recorded lower fruit weight compared to control. In Mudikode local, Panavalli, Vellanad local and Co-1 irradiation of gamma ray in general resulted in significantly lower yields than their control while in Attenganam local gamma ray irradiation resulted in significantly increased yield compared to control.

Significantly lower fruit set compared to control occurred in 20 kR treatment in Panavalli, Punthala local, Pulliporan and Co-1 whereas 10 kR treatment in Lucknow Sweet and Vellanad local resulted in a significant increase in fruit set. Lower levels of EMS treatments in Hara Madhu, Co-1, Pulliporan and Panavalli induced significantly lower fruit set compared to control.

Irradiation with gamma rays resulted in significantly lower number of seeds compared to control in Mudikode local and Punthala local while in Pulliporan greater number of seeds than control was produced due to gamma ray treatment.

In Co-1 and Attenganam local, 2.0% EMS treatment resulted in a significant reduction in 100 seed weight while lower levels of EMS treatments in Lucknow Sweet resulted in a significant increase in 100 seed weight compared to their control.

The 10 kR treatment of all varieties in general resulted in slight decrease in mean length of main vine compared to control whereas the higher levels of gamma rays resulted in slight increase in mean length of main vine. In general the 2.0% EMS treatment of most of the varieties induced slight reduction in mean length of main vine while the lower levels of EMS resulted in slight increase in mean length of main vine compared to control.