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EFFECT OF GAMMA-IRRADIATION ON THE SEEDS OF *CORCHORUS CAPSULARIS* L. AND *C. OLITORIUS* L.

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Abstract

Dry seeds of the variety D-154 of *Corchorus capsularis* and C.G. of *C. olitorius* were treated with different dosages of gamma-rays. Observations on germination, seedling height, survival of plants and pollen sterility of first generation plants indicated that the *C. olitorius* was more sensitive to gamma-rays than *C. capsularis*. The frequency of various types of mutations increased with the increase in dosages of radiation in both the species. Around 80 Kr of gamma-rays for *C. olitorius* and around 90 Kr for *C. capsularis* were found to be the optimum workable dose for mutation study in them.

Introduction

Jacob (1949), Patel and Datta (1960) studied the effects of X-rays on the morphology and cytology of the jute yielding species, *C. olitorius* and *C. capsularis*. In their investigation they have not reported anything about the total effective doses required for inducing gene mutations and about different gamma-ray sensitivity. The importance of repeating this work was felt because (a) of the limited scope of obtaining improved varieties of jute through selection and (b) it was thought that at the evolutionary level this crop (jute) has reached a stage where further recombination was not possible.

Besides producing useful mutants the present study includes an evaluation of the effects of gamma-rays on seeds of *C. olitorius* and *C. capsularis* and the determination of critical doses of gamma-rays for induction of mutation at highest frequency.

Materials and Methods

Dry seeds of *C. capsularis* (var. D-154) and *C. olitorius* (var. C.G.) having about 10% moisture content were exposed to 55, 70, 85 and 100 Kr of gamma-rays from a Co^{60} source to evaluate the effects of gamma-rays on germination, seedling height, viability of plants, flowering habit and morphology, mitotic and meiotic behaviour and pollen grains. Fifty seeds of each dose of both the species were placed on moist blotting paper in Petri dishes for seedling growth. Observations on germination and seedling height were recorded on the fifth and seventh day respectively.

One hundred seeds of each dose from each of the species were grown in earthen pots in the greenhouse. The pots were filled in with sterilized soil, sand and compost. Viability percentage was recorded after one month of sowing and then thinning was done keeping only five seedlings in each pot. Important alterations in the morphological characters and flowering time were recorded. Data on germination, seedling height and plant survival were expressed in terms relative to the control for each irradiation treatment.

For cytological studies, the root-tips were fixed in acetic alcohol (1:3) and transferred to 70, 50 and 30% alcohol. The tips were then hydrolysed in 50% HCl, then put in iron alum (2%) and finally in 1% hematoxylin. A single root-tip was taken out and transferred to a drop of acetocarmine on a slide and heated. The root-tip was then transferred to another drop of acetocarmine and squashed in the usual manner. For meiotic studies, suitable flower buds were fixed in acetic alcohol (1:3) and stored in 70% alcohol. Smears with iron-acetocarmine were made as outlined by McClintock (1940). Pollen sterility was determined in acetocarmine.

Results and Discussion

The effects of five dosage levels of gamma-rays on the germination of seeds of both *C. capsularis* and *C. olitorius* have been shown in Table 1 and in Fig. 1.

TABLE 1

Effects of gamma-rays on seed germination

Radiation dose in Kr	Mean germination% ±S.E. (*C. capsularis*)	Mean germination% ±S.E. (*C. olitorius*)
0 (control)	92.0±0.58	94.6±0.65
55	86.0±1.17	89.3±0.65
70	85.3±0.68	82.0±1.17
85	83.3±0.65	82.6±1.48
100	81.3±0.65	82.0±1.17

Results given in Table 1 clearly showed that in both the species germination was above 80% in all the treatments and there was a negative correlation with the dose. Patel and Datta (1960) also showed that the germination percentage reduced with the increase of dose.

The effects on the hypocotyl and radicle length have been shown in Table 2 and in Figs. 2 and 3 from which it can be seen that both the cases, there is negative correlation with the dose. The data also indicated that *C. olitorius* was more affected than *C. capsularis*. Vijayalakshmi and Rao (1960) found the similar results and they were of the opinion that the seedling height decreased at the initial stage and disturbances were the same in the epicotyl and hypocotyl parts and at the varying doses. Lack of vigour in the early stage may be due to physiological disturbances caused by radiation on the dividing cells as it has profound effects on apical cells.

TABLE 2

Effects of gamma-rays on hypocotyl and radicle length

Radiation dose in Kr	Mean hypocotyl length in mm ± S.E. (*C. capsularis*)	Mean hypocotyl length in mm ± S.E. (*C. olitorius*)	Mean radicle length in mm ± S.E. (*C. capsularis*)	Mean radicle length in mm ± S.E. (*C. olitorius*)
0 (control)	70.8 ± 1.61	60.4 ± 1.38	21.8 ± 1.45	17.7 ± 1.09
55	50.7 ± 2.32	51.0 ± 1.25	18.5 ± 1.03	16.1 ± 0.67
70	47.1 ± 2.29	44.3 ± 1.67	15.0 ± 0.93	13.1 ± 0.93
85	38.3 ± 1.70	33.8 ± 1.87	12.6 ± 0.67	10.5 ± 0.48
100	25.2 ± 1.09	24.7 ± 1.67	6.8 ± 0.45	8.8 ± 0.58

From the data on plant survival of both *C. capsularis* and *C. olitorius* presented in Table 3 and in Fig. 4, it is evident that *C. olitorius* is more sensitive to gamma-rays than *C. capsularis* and it was apparent that there was an indirect relationship between dose levels and plant survival. Soriano (1961) is of the opinion that seedling survival markedly reduces at higher doses of gamma-rays. Findings of the Bose Institute (1953-54) have shown that an increase in radiation dose causes a decrease in the survival percentage. The higher sensitivity of *C. olitorius* to radiation may be due to the lower percentage of oil present in the seeds as compared to that of *C. capsularis*.

TABLE 3

Effects of gamma-rays on the survival of plants

Radiation dose in Kr	Mean survival % ± S.E. (*C. capsularis*)	Mean survival % ± S.E. (*C. olitorius*)
0 (control)	92 ± 0.40	93 ± 0.47
55	90 ± 0.28	92 ± 0.40
70	74 ± 1.00	65 ± 1.90
85	60 ± 0.70	51 ± 1.25
100	49 ± 0.85	36 ± 0.40

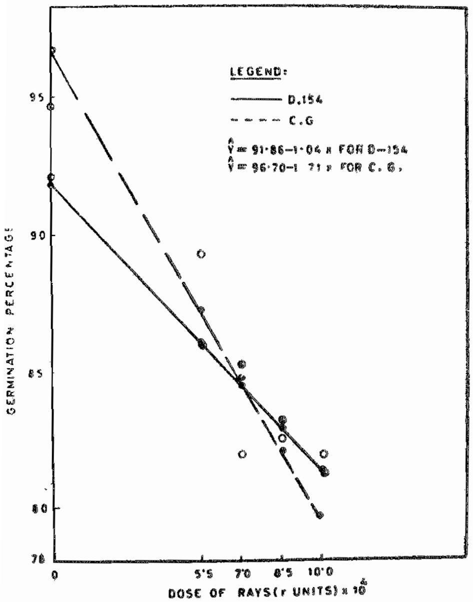

Fig. 1 Relationship between doses and germination percentage of D–154 and C. G.

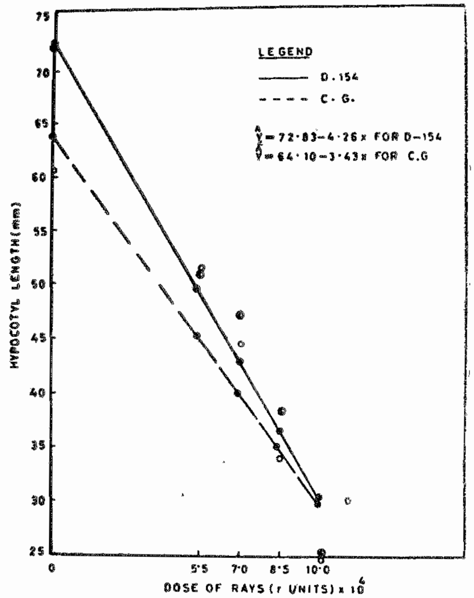

Fig. 2 Relationship between doses and hypocotyl Length of D–154 and C.G.

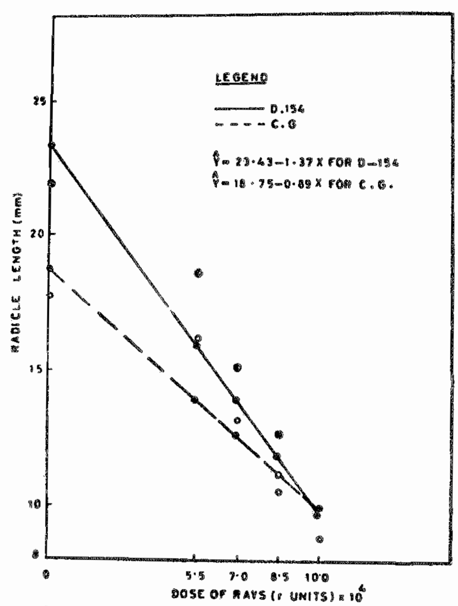

Fig. 3 Relationship between doses and radicle Length of D–154 and C.G.

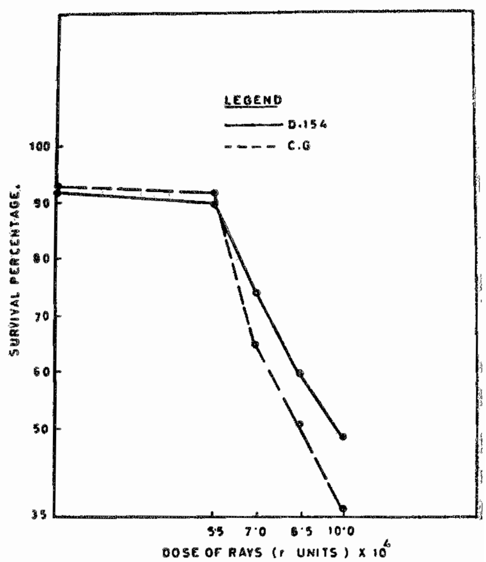

Fig. 4 Relationship between dose and seedling survival of D–154 and C.G.

Invariable abnormality in the third leaf of the treated populations was the characteristic of radiation effect. Various other morphological changes were observed particularly in the leaves and stems of the treated plants of both the species. These included fasciated stems, bifurcation of the stem tips, bushy appearance of the plant, narrower and irregularly serrated leaves etc and these followed a positive correlation with the dose. The region on the stem where the anomalies developed was restricted to first 4-5 leaves excluding the cotyledonary leaves. The latter in all cases remained unaffected. However, exception was with the production of crinkled and wavy leaves, mostly in the form of chimeras, continued till the maturity of the plant. Findings reported by Mia and Ali (1965) are in conformity with this. Radiation gives rise to different genetic composition to some or all of the dividing cells of the embryos. The plant parts that are expected to be developed from this kind of mosaic sector and probably due to intrasomatic selection pressure clearly explains the exposition of the above stated morphological abnormalities.

The chromosomal aberrations resulting from the actions of gamma-rays on the root-tip cells included bridges and breakages of chromosomes. The percentage of abnormal cells increased with the increase in dosages in both the species, *C. olitorius* being more affected. These confirm the results presented by Caldecott *et al.* (1954).

Pollen mother cells were also studied and different degrees of aberrations were noticed and these included lagging chromosomes, bridges with or without fragments, univalents etc in the chimeric branches as against seven bivalents in the control and there was a positive correlation with the dose in both the species. The formation of univalents may have been caused by the failure of normal pairing or early separation of the homologous pair. These findings are in agreement with the findings of Basu (1962).

Analyses of pollen grains confirmed the high degree of chromosomal aberration. The analyses showed that 55.16 per cent pollen grains were nonstained in the highest dose against 0.76 per cent in the control. The authors are of the opinion that chromosomal aberrations cause unequal distribution of chromosomes and thereby producing nonfunctional pollens.

From this study it can be concluded that ionizing radiation had a profound effect on the dividing cells of the embryo causing irregular mitosis and resulting morphologically deviating plants. Later studies on the screening and selection of the true mutant types in the M_2 generation indicated that 80 Kr for *C. olitorius* and 90 Kr of gamma-rays for *C. capsularis* are the optimum workable dose for mutation study in jute.

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