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BIOLOGICAL EFFECTS OF X-RAYS ON CHILLIES (CAPSICUM *ANNUUM* L.)*

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Ever since the pioneering works of Muller (1928) and Stadler (1932) the use of x-rays as a mutagenic agent was well established. The more important contributions in this field were those of Goodspeed and Olson (1928), Johnson (1931), Bless (1938), Gustafson (1941), Jacob (1949), Swaminathan (1963) and Kasyanenko and Ghiller (1967). Further, effects of x-irradiation on the biological characters such as the occurrence of high frequency chromosomal aberrations, inhibition of mitotic activity, depression in DNA synthesis and cell death were reported by Gustafson (1944), Sjodin (1961) Gunckel and Sparrow (1961) and Athwal (1963). A few of these secondary effects were utilised in crop improvement as well as in the study of the fundamental behaviour of the genetic material. The present work was hence undertaken with a view to ascertain the biological effects of x-rays oa the chillies plant on which no information is available at present.

Material and Methods

The K-1 variety of chillies was used in the studies. The pure seed was obtained from the breeders' stock of the Regional Research Station, Kovilpatty, Tamil Nadu. Selected, dry seeds were irradiated at the Division of Genetics, Indian Agricultural Research Institute, New Delhi, with a Philips Model superficial therapy Medical x-ray unit without filter, operated at 50 KV-2MA of tube current. The seeds were irradiated at four dozes viz. 1000 r, 4000 r, 8000 r and 15000 r units. Untreated seeds were used as control. Seeds from each treatment and control were sown for raising seedlings and 20 plants from each treatment and control were selected at random for detailed study. Effects of the x-ray treatments were assessed in terms of the germination percentage, seedling survival, plant height, time for flowering, pollen sterility (as determined by acetocarmine staining), morphological abnormalities, mitosis (of root tips) and meiosis (of flower buds, of the M_1 generation plants), chlorophyll mutations (from M_2 germination raised from M_1 seeds), percentage mutation (estimated on M_1 basis and M_2 basis) and mutation spectrum.

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Results

The results are given in Tables 1 and 2. Table 1 shows that germinatoin was affected to some extent by irradiation, the maximum suppression being given by 8 kr treatment. The survival percentage showed a decrease with increase in dose of irradiations from 75.2 per cent in 1 kr treatment to 65.0 per cent in the 15 kr treatment. It was noted that mortality of the seedlings occurred during the early stages, there being no death of seedlings after 25 days. The height of 25 day old seedlings was significantly affected by irradiation. Thus 1 kr treatment showed the greatest stimulation to the height followed by 8 kr, 15 kr and 4 kr in that order. No significant effect was however, observed in the case of 60 day old plants.

The 15 kr and 1 kr treatments induced earliness in flowering, 15 kr being the most effective. No linear relationship was observed between doses and time for flowering. The chromosomal effects of different doses of x-rays as measured in terms of pollen sterility showed that the highest dose of 15 kr produced the highest sterility of 30.87 per cent, the effects in the other treatments being not significant.

Table 1

Germination, survival and other plant characters in chilli plants under different doses of X-rays

Features	X-ray doses (Kr)				
	0	1	4	8	15
Germination%	88.0	80.0	81.0	76.0	85.0
Survival%	88.0	75.2	73.2	65.2	65.0
Height (cm)					
in 25 days	6.48	9.52	7.39	8.36	8.05
in 60 days	14.20	17.20	14.30	17.20	16.40
Flowering time(days)	77.60	72.65	77.95	76.35	71.90
Pollen sterility%	14.61	20.11	16.58	15.79	30.37

Table 2

Chlorophyll mutation in chilli as affected by x-rays

X-ray dose (Kr)	Mutants in M_1 generation (%)	Mutants in M_2 generation (%)	M_2 Mutation spectrum (%)	
			'Xantha'	Chlorina
1	35	1.1	16.6	83.4
4	35	1.6	55.0	45.0
8	30	2,7	36.6	63.4
15	10	0.3	75.0	25.0

Chromosome fragments were observed in mitosis. Presence of high frequencies of fragments, laggards and anaphase bridges were observed in meiosis; occurrence of breakage-fusion-bridge cycle was observed.

From Table *2* it may be seen that chlorophyll mutants were present in all the treatments. Seven M_1 plants each in 1 Kr and 4 Kr treatments and 6 M_1 plants in 8 Kr and *2* M_1 in 15 Kr treatments produced chlorophyll mutants. They were of two types. The clear yellow 'Xantha' seedlings were recognisable soon after germination. They did not develop new leaves and died within a week. The other type showed general yellow colour with yellow spots on the leaves by the fourth leaf stage and were 'Chlorinas'. The mutation percentage in the M, generation showed a decrease with increase in dose. The percentage of mutation did not show any particular pattern in the M_2 generation. The mutation spectrum indicated that the percentage of 'Xantha' mutants increased with increase in dose.

Summary

Studies made on the biological effects of x-rays on K-1 variety of chillies *(Capsicum annuum L.)* showed that x-irradiation had no effect on germination. It caused a reduction in the survival of seedlings, the survival being inversely proportional to the doses of irradiation. X-rays produced an initial stimulative effect on plant growth and induced earliness to flowering. Pollen sterility was caused at higher doses of x-rays. X-irradiation caused morphological abnormalities like dwarfs, narrow leaves, coloured plants and chimeras in the M_1 generation. Structural aberrations of chromosomes were caused by x-rays. 'Xantha' and 'Chlorina' types of chlorophyll mutants were present in the M_2 generation of irradiated chillies.

A wide range of morphological abnormalities were observed among the M_1 plants. A striking effect was the presence of dwarf plants. These dwarfs were superior in yield. The frequency of dwarf plants was different in the different treatments. There were 5 dwarf plants in 1 Kr treatments, 2 in 4 Kr, 4 in 8 Kr and 3 in 15 Kr treatments. In both 1 Kr and 15 Kr, one each of these dwarf plants showed earliness to flowering. Many of these plants had narrow leaves. In the 8 Kr treatment, one plant showed a characteristic branching whereby all branches grew parallel to the ground and was the shortest. Substantial reduction in the width of the leaves also was observed in many plants. In one plant each in the 1 Kr and 8 Kr treatments, the first branches produced were chimeras. Seeds from these branches gave 39.8 percent chlorophyll mutants in the M_2 seedlings; 14 per cent showed variegated leaves. Non-chimeric branches did not produce variegated seedlings.

Normally, the K-1 variety bears pendant fruits. In the treated plants erect types were also present. They did not show any other abnormality. One such plant from 1 Kr treatment showed vigorous growth with wide-spread branches; it flowered profusely and gave the highest yield in the M_1 population.

Purple colouration of various grades of the shoot, flower and fruit was another characteristic of the irradiated plants. Of the total of 617 plants, one plant in the 4 Kr treatment was completely purple. All its 134 progenies (M_2 generation) had purple colour but the intensity differed widely. In others, the colouration developed only in the flowers, persisted in the fruits or faded when the fruits ripened. In the seedling stage, the progeny frequency for purple colour of the M_1 purple parents were as follows:

1	Kr	7 seedlings out of 259
4	Kr	134 seedlings out of 134
8	Kr	0 seedlings out of 130
15	Kr	150 seedlings out of 320

The M_2 progenies of certain M_1 parents gave purple colour expression in the following frequencies :

1	M_1	parent of	1	Kr	treatment gave	1	purple seedling out of	106
5	M_1	,,	4	Kr	,,	6	,,	134
1	M_1	,,	8	Kr	,,	1	,,	126
1	M_1	,,	15	Kr	,,	1	,,	88

Thus the M_1 parents under 4 Kr treatment gave a higher frequency of colour expression in the segregating M_2 generation than the others.

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