GERMINATION, SURVIVAL AND GROWTH IN SPINELESS *SOLANUM KHASIANUM* CL. IN RESPONSE TO GAMMA IRRADIATION

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Abstract

Spineless *Solanum khasianum* is of rare occurrence. Dry seeds having 11 per cent moisture content of spineless *Solanum khasianum* were irradiated with seven different acute doses of gamma rays. The administered doses were 10, 20, 30, 40, 50, 60, 70 k rads.

In general, germination decreased with the increase of dose. Rate of germination was faster at 10 k rad dose and seedlings emerged earlier than unirradiated control, though, no significant difference from control was observed. Seedling growth decreased with the increase of dose rates as compared to control. Reduction was more pronounced in dose above 30 k rad. Survival of seedlings was inversely proportional to dose rate and beyond 40 k rad there was no survival. Retardation in the vegetative growth and delay in flowering was noticed above 10 k rad doses which was directly proportional to increasing exposures. Frequency of leaf abnormalities increased with the increase of dose rates. One dwarf plant was observed in 20 and 30 k rad each treatment which were entirely different from control and other treated plants in their general appearance. These plants bore only few fruits containing abortive seeds.

Introduction

In recent years steroidal hormones have been considered a great importance in oral contraceptive industry. The glycoalkoid "solasodine" obtained from *Solanum* species has been commercially exploiced for this purpose. A number of *Solanum* species are reported to yield solasodine in appreciable quantities, but only few species occur widely in India. Among them, *Solanum khasianum* is most commercially exploited (Chaudhury & Rao, 1964; Chauhan *et al.*, 1975). However, commercial cultivation of this species is not widely done because of low berry production, resulting in reduced alkaloid content, presence of sharp spines on the aerial parts and a synchronous flowering. Therefore, more attention is needed for an intensive breeding programme to improve solasodine content and to remove spines from aerial parts.

Ionizing radiations are increasingly used to induce beneficial mutations. Gamma rays have been used for the genetic improvement in *S. khasianum* particularly for the improvement of solasodine content (Bhatt & Hable, 1978; Chauhan, 1978). Since the radiobiological studies in *S. ehasianum* are still not sufficient to make a comparative study of radiation responses on germination, growth, survival and productivity hence, these aspects have been taken up in response to different doses of gamma rays to provide basic information of this species.

Material and Methods

Dry seeds of *Solanum khasianum* collected from N.B.R.I. were subjected to acute doses of gamma rays in a gamma chamber having 60Co source in the Radiation Biology Laboratory of the N.B.R.I., Lucknow. Three hundred seeds were taken for each treatment and seven different acute doses (10, 20, 30, 40, 50, 60 and 70 k rad) were administered. After irradiation seeds were sown in sterile petri-plates, pots and garden. The petri-plates were kept in the laboratory under uniform environmental condition. Parallel experiment was conducted by growing the seeds on the petri-plates kept in humidity controlled chamber at Indian Toxicological Research Centre, Lucknow. Seed germination and seedling height were recorded from petri-plates of 15-day old seedlings and seedling survival data were recorded from the pots.

Observations

Seed germination data recorded in *Solanum khasianum* in unirradiated and irradiated seeds were presented in the Table 1 and 2. From the data it is clear that there was extremely poor germination at 70 k rad both in laboratory and humidity-controlled chamber. In general, the germination was inversely proportional to the increasing dose, but 10 k rad treatment was found to inhance germination in laboratory condition. Although, it did not differ significantly from the control. In humidity controlled-chamber there was no any such dose which is stimulatory.

Table 1—Germination, survival and inhibition of seedlings of *S. khasianum* in response to gamma irradiation at humidity controlled oven*

S. No.	Treatment	No. of seeds sown	No. of seeds germinated	% of germination	No. of seedlings survived	% of seedling survival
1.	Control	300	285	95	273	94
2.	10 k rad	,,	252	84	186	73
3.	20 k rad	,,	198	66	123	62
4.	30 k rad	,,	147	49	51	34
5.	40 k rad	,,	51	17	18	35
6.	50 k rad	,,	54	18	×	
7.	60 k rad	,,	18	6	×	
8.	70 k rad	,,	6	2	×	

*Temperature 25°C
Light 12 hours
Humidity 40%
Seedlings survival was recorded on 30-day old seedlings.

So far as duration of germination is concenred the untreated seeds germinated in 6-7 days but seeds treated with 10 k rad germinated earlier (4-5 days). Thus at low exposures of gamma rays (10 k rad) germination was faster as compared to unirradiated seeds, since seeds of this treatment achieved 50 per cent germination in lesser time. After 10 k rad treatment onward, duration of germination increases with the increase of dose

Table 2—Germination, survival and inhibition of seedlings of *S. khasianum* in response to gamma irradiation in laboratory*

S. No.	Treatment	No. of seeds germinated	% of germination	% of inhibition	Seedling survival	% of seedlings survival
1	Control	261	87	0	258	98
2	10 k rad	228	76	12.6	221	96
3	20 k rad	210	70	19.5	119	52
4	30 k rad	102	34	60.9	41	40
5	40 k rad	87	29	66.6	14	16
6	50 k rad	44	14	83.1		
7	60 k rad	51	17	80.4		
8	70 k rad	18	6	93.10		

* 300 seeds were sown
Survival was recorded on 30-day old seedlings.

rates (Table 1, 2). Another noticeable point was that seeds of spineless *Solanum khasianum* germinated earlier in comparison to spiny *Solanum khasianum*.

Survival—Seedlings survived up to 40 k rad only. Seedlings survival was lesser in treatments as compared to control which was inversely proportional to dose rate. Percentage of seedlings inhibition increases with the increase of dose rates. There was complte lethality after 40 k rad dose. In unirradiated seedlinges survival was 98 per cent in laboratory and 94 pr cent in controlled condition. The survival in the irradiated seedlings gradually decreased with increase of dose rates. The higher doses caused significant lethality (Table 1, 2). The maximum injury was at 40 k rad dose and there was no survival beyond this dose.

Seedling height—It was noticed that seedling height was greater in control than the treatments (Table 3). The data showed that higher doses caused extreme reduction in seedling height. Length of primary root and hypocotyl was also measured in order to see the responses of different doses of gamma rays in these major organs. It was observed that length of hypocotyl and root was inversely proportional to dose rate, i.e. the length decreased with the increase of dose rates.

Percentage of reduction in seedling, hypocotyl and primary root length was also determined at different treatments by the formula;

$$\% \text{ of reduction} = \frac{\text{Length in control} - \text{length in treatment}}{\text{Length in control}} \times 100$$

In general, the percentage of reduction in length increased with the increase of dose rates (Table 3).

Table 3—Length of seedlings, hypocotyl and roots of 5-day old seedlings

S. No.	Treatment	Length of seedlings in cm	Length of Hypocotyl in cm	Length of root in cm
1	Control	6.5	4.2	2.3
2	10 k rad	6.15	4.05	2.1
3	20 k rad	5.4	3.3	2.1
4	30 k rad	4.2	2.6	1.6
5	40 k rad	3.3	2.1	1.2
6	50 k rad	2.4	1.6	0.8
7	60 k rad	1.5	1.0	0.5
8	70 k rad	×	×	

General growth—In general, the plants of irradiation treatment showed gradual retardation in their vegetative growth and delay in flowering with the increase of dose rates but in this species there was not any adverse effect up to 20k rad treatment in the vegetative growth, reproductive growth and yield. Pigmentation and leaf abnormalities in size shape and form have been noticed in several cases of treatments. These features increased with the increase of dose rates. One dwarf plant was observed in 20 and 30 k rad each treatment which were entirely different from control and other treated plants so far their general appearance and morphological nature is concerned. Plants were less branched. Both vegetative and floral organs were reduced. Fruits were 2-3 in number and reduced in weight which contained 20-30 abortive seeds. Leaves were entirely different in shape and size which were smaller, reduced and some what spoon shaped with entire margin. Leaves showed chimeric pattern and pigmentation. These features of leaves retained for longer time which gradually recovered on maturity. Early flowering was observed in the plangs treated with 10 k rad. Higher doses, on the other hand, caused late flowering.

Discussion

Higher doses of gamma rays have always been found to inhibit germination, whereas certain lower doses are reported to have enhanced germination (Sax, 1963; Nutal *et al.*, 1968; Rajan, 1969; Nath, 1974). Different opinions have been expressed by workers to explain the mechanism of stimulation. Sax (1963) is of the opinion that stimulatory effects are usually of smaller magnitude and are often not reproducible. Stimulation aspect, however, needs more investigations for better explaination.

As regards the cause of inhibition of germination, Ananthaswamy *et al.* (1971) are of the opinion that metablic activity of irradiated seeds is disturbed during germination and this brings about inhibition in germination. Other causes may be inhibition of cell division, uneven damage to meristematic cells, marked decrease in the auxin level, marked effect on auxin synthesis and respiratory enzymes (Gordon, 1954; Gunckel & Sparrow, 1961).

Seedling growth reduction is the common irradiation response observed in the present findings, an observation also reported by many workers in different taxa (Rai & Singh, 1976; Indira & Abraham, 1977; Chopra & Singh, 1978). About suggesting the cause of seedling reduction, Mericle and Mericle (1957) are of the opinion that chromosomal damage and mitotic inhibition may bring about the growth retardation.

Plants obtained from irradiated seeds showed varying motphological changes in the vegetative and reproductive organs. Out of the total population two plants were stunted and their leaves showed characteristic pigmentation and chimeric pattern which recovered with the maturity of the plants. Stunted growth as a response to gamma radiation is also reported in tetraploid *Capsicum annuum* by Indira and Abraham (1977). Several reasons of stunting have been suggested which are: destruction or inhbition of terminal meristems, destruction of auxin or its synthesis, disturbance in nutritional level, failure of assimilation mechanism or inhbition of mitosis or chromsomal damage leading to secondary physiological changes.

Some leaves produced from the plants of irradiation treatments showed various types of variabilities. Hagen and Gunckel (1958) in case of *Nicotiana glauca* and *N. landsdorfii* and their interspecific hybrid have suggested that morphological changes in response to radiation are due to changes in the free aminoacids content. Some irradiated plants showed characteristic pigmentation which increased with the increase of gamma radiation dose. The marked decrease in the chlorophyll content of the leaves is probably due to mutation of genes controlling chlorophyll synthesis and anthocyanin formation is due to destruction of some enzymes through ionizing radiation (Swaminathan, 1964; Mathew & Abraham, 1978).

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