EXPANSION OF COTYLEDONS AND SEEDLING SURVIVAL IN *SOLANUM NIGRUM* L. COMPLEX IN RESPONSE TO GAMMA IRRADIATION

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Abstract

Dry and water soaked seeds of diploid (2n=24), tetraploid (4n=48) and hexaploid (6n=72) *Solanum nigrum* were irradiated with 10,20,30,40,50,60 and 70 k rads of gamma rays from a 60Co source. 15-day old seedlings showed that gamma rays retard the length and breadth of the cotyledons in all the ploidy groups; the reduction was directly proportional to the doses. As compared to control, the survival rate was poor in all the ploidy groups. In comparison to dry seeds, the survival rate was poor in soaked seeds. Diploids survived up to 40k rad, tetraploids up to 50k rad, and hexaploids up to 30k rad only. The tetraploids were more resistant than other ploidy groups

Introduction

Radiobiological investigations in different ploidy groups of a taxon have been conducted to find out their responses to different doses of ionizing radiations on various parameters, and in general, it has been found that tolerance increases with the increase of ploidy level. The literature, however, is still meagre on expansions of cotyledons. Chauhan (1969), Rudolph and Mikshe (1970), and Chopra and Singh (1978) have worked on this aspects. The present study was undertaken on *Solanum nigrum* complex to see the responses of different doses of gamma rays on expansion of cotyledons and seedling survival.

Material and methods

Dry (moisture content 11%) and soaked (moisture content 100%) seeds were irradiated with different doses of gamma rays (10, 20, 30, 40, 50,60 and 70 k rad) in a gamma chamber having 60Co source in the radiation biology laboratory of the National Botanical Research Institute, Lucknow.

After irradiation, both dry and water soaked seeds were sown in sterile petriplates containing sterile sand, pots and field. The petriplates were kept in the laboratory under uniform environmental condition. Germination studies were made for seeds sown in petriplates and seedling survival was studied only in the pots filled with garden soil.

Observations

Expansion of cotyledons

Length and breadth of cotyledons of 15-day-old seedlings of various treatments were measured, and the data recorded are given in table 1,2 and 3 for diploids tetraploids, and hexaploids respectively. From the data, it is clear that gamma irradiation showed reduction in length and breadth of the cotyledons in all the ploidy groups which is directly proportional to the doses, i.e., length and breadth decreased with the increase of the doses.

Seedling survival

The 60-day-old seedlings in pots, in control and treatments was fully established, and the chances of mortality was negligible. (Table 4, 5).

It has been observed that survival was poor in all the ploidy groups of treatments as compared to the control and survival was inversely proportional to dose rate. At higther doses survival was extremely poor. In comparison to dry seeds, seedling survival was poor in soaked condition. Diploids sur-

Table 1—Average cotyledonary length and breadth of diploid *S. nigrum* in relation to treatments. Data based on 15-day-old seedlings

	Dry				Soaked			
Treatment	Length in mm	Percentage of reduction	Breadth in mm	Percentage of reduction	Length in mm	Percentage of reduction	Breadth in mm	Percentage of reduction
Control	3.2	0.00	1.54	0.00	3.25	0.00	1.5	0.00
10k rad	2.6	18.75	1.47	4.54	2.5	23.07	1.5	0.00
20k rad	2.4	25.00	1.25	18.83	2.5	23.07	1.54	2.66
30k rad	2.0	37.50	1.12	27.27	2.25	30.76	1.25	16.66
40k rad	2.2	31.25	1.08	29.87	2.3	29.23	1.1	26.66
50k rad	2.4	25.00	1.00	35.06	2.0	38.46	1.0	33.33
60k rad	1.75	45.31	1.00	35.06	—	—	—	—

Table 2—Average cotyledonary length and breadth of tetraploid *S. nigrum* in relation to treatments. Data based on 15-days-old seedlings

	Dry				Soaked			
Treatmcnt	Length in mm	Percentage of reduction	Breadth in mm	Pereentage of reduction	Length in mm	Percentage of reduction	Breadth in mm	Percentage of reduction
Control	4.2	0.00	1.8	0.00	4.1	0.00	1.6	0.00
10k rad	3.5	16.66	1.75	2.77	4.0	2.43	1.4	12.50
20k rad	3.3	21.42	1.65	8.33	3.5	14.63	1.2	25.00
30k rad	3.2	23.80	1.50	16.66	3.2	21.95	1.16	27.50
40k rad	2.5	40.47	1.25	30.55	3.0	26.82	1.00	37.50
50k rad	2.3	45.23	1.10	38.88	2.5	39.02	1.00	37.50
60k rad	2.3	45.23	1.00	44.44	2.5	39.02	1.00	37.50

Table 3—Average cotyledonary langth and breadth of hexaploid *S. nigrum* in relation to treatments. Data based on 15-day-old seedlings

	Dry				Soaked			
Treatment	Length in mm	Percentage of reduction	Breadth in mm	Percentage of reduction	Length in mm	Percentage of reduction	Breadth in mm	Percentage of reduction
Control	6.5	0.00	3.5	0.00	6.5	0.00	3.57	0.00
10k rad	4.5	30.76	2.0	42.85	4.37	32.76	1.90	43.62
20k rad	3.4	47.69	1.50	57.14	3.25	50.00	1.50	55.48
30k rad	3.2	50.76	1.50	57.14	3.10	52.30	1.25	62.90
40k rad	2.5	61.53	1.25	64.28	3.00	53.84	1.25	62.90
50k rad	2.4	63.07	1.25	64.28	2.50	61.53	1.00	70.32
60k rad	2.5	61.53	1.00	71.42	—	—	—	—
70k rad	2.4	63.07	1.00	71.42	—	—	—	—

Table 4—Number of seeds germinated on 30th day of sowing in pots and number and percentage of seedlings survived on 60th day of sowing. Data based on 300 seeds having moiture content 11 percent

Treatment	2×						4×						6×					
	No. of seeds germinated		No. of seedlings survivad		Percentage of survival		No. of seeds germinated		No. of seedlings survived		Percentage of survival		No. of seeds germinated		No. of seedlings survival		% of survival	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Control	187	172	181	166	95.79	96.02	105	99	101	91	96.19	91.91	142	154	131	142	92.25	92.
10k rad	184	173	47	46	25.51	26.58	94	91	71	63	75.53	69.23	90	75	36	29	40.00	38.
20k rad	64	71	18	16	28.12	22.53	71	72	36	32	50.70	44.40	61	59	16	17	26.22	28.
30k rad	54	48	13	12	24.07	25.00	48	51	16	16	33.33	31.37	28	29	7	8	26.92	27
40k rad	31	34	8	6	25.80	17.64	24	27	11	10	45.83	37.03	7	—	—		—	—
50k rad	16	11	—	—	—	—	17	18	4	5	28.52	27.77	—	—	—	—	—	—
60k rad	12	—	—	—	—	—	11	15	—		—	—	—	—	—	—	—	—
70k rad	13	—	—	—	—	—	9	—	—		—	—	—	—	—	—	—	—

Table 5—Number of seeds germinated on 30th day of sowing in pots and number and percentage of seedlings survived on 60th day of sowing. Data based on 300 seeds having moisture content 100 percent

Treatment	2×						4×						6×					
	No. of seeds germinated		No. of seedlings survived		Percentage of survival		No. of seeds germinated		No. of seedlings survived		Percentage survival		No. of seeds germinated		No. of seedlings survived		Percentage of survival	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Control	186	181	177	170	95.16	93.92	102	112	94	102	92.15	90.07	136	139	131	132	96.32	94.96
10k rad	188	181	61	56	32.44	30.93	98	103	70	75	71.42	72p81	71	79	41	39	57.74	49.36
20k rad	75	70	16	16	21.33	22.85	78	81	41	39	52.56	48.14	66	62	20	18	30.30	29.07
30k rad	46	39	13	11	28.26	28.20	49	41	22	19	44.89	46.34	29	13	8	3	27.58	23.07
40k rad	26	22	3	2	11.53	9.09	40	52	14	17	35.00	32.69	—	—	—	—	—	—
50k rad	18	—	—	—	—	—	25	29	8	—	32.00	—	—	—	—	—	—	—
60k rad	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
70k rad	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

vived up to 40 k rad, tetraploids up to 50 k rad and hexaploids up to 30 k rad only. It may be inferred that in *Solanum nigrum* hexaploids are more sensitive than tetraploids and diploids, but tetraploids are comparatively more resistant.

Discussion

It has been found during present investigation that expansion of cotyledons decreased with the increase of dosages and marked difference in expansion is recorded at higher doses in all the ploidy groups. Rudolph and Miksche (1970) have also found various degrees of radiosensitivity in the cotyledonary expansion of several species of *Pinus*. So for it has been very difficult to give any specific reason for the inhibition of expansion of cotyledons.

Survival of seedlings of different ploidy groups showed some interesting observation. Diploids survived up to 40 k rad, tetraploids up to 50 k rad and hexaploids only up to 30 k rad. Among the three ploidy groups, the tetraploids showed maximum tolerance. It is difficult to say why the hexaploids are so sensitive beyond 30 k rad.

It has been advocated by many researchers that tolerance to irradiation increases with the increase in ploidy level. This may be due to small interphase chromsomal volume or increase in genetic redudency of polyploids (Sparrow *et al*; Fujii and Matsumura, 1959; Sparrow *et al.*, 1961 and Yamagata *et al.*, 1969). Acording to Sparrow and Woodwell (1962) plants which have low chromosome numbers and large nuclear volume are most sensitive, while polyploids with high chromosome numbers and smaller nuclear volume are highly resistant. Sparrow and Schairer (1958) have found that tolerance increases with the increase of ploidy in *Sedum* and *Chrysanthemum*. Contrary to this, it has been observed in several cases that there is no co-relation between radiosensitivity and ploidy (Swaminathan & Natarajan, 1957; Fujii & Matusumura, 1959; Bhaskaran & Swaminathan, 1960). In such cases some other factors might be responsible.

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