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Effect of gamma radiation on various growth parameters of *Linum usitatissimum* L.

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ABSTRACT

In present study, dry seeds of Linum *usitatissimum* L. (linseed) were irradiated with gamma rays at different doses levels of 10 kR, 20 kR, 40 kR, 60 kR, 80 kR and 100 kR to examine its effects on growth traits and morphological variation. The experiments was carried out in two sets, one with treated seeds and the other untreated which served as control. Effects of this irradiation were evaluated by studying seed germination, seedling growth, leaf size, plant height and length of internode. Gradual reduction in seed germination was observed from lower doses to higher doses. Shoots were measured longer than roots at every dose and control. Shoot and root immerged from irradiated seeds showed gradual decrease in length except 40 kR where, shoots were measured shorter than roots. Biometric measurement of leaf length showed variation among various doses whereas leaf width is constant at all doses, at 100 kR it was moderately increased. Height of the plant showed variable effect in length. Length of internode was noted almost uniform.

Keywords: gamma radiation, doses, growth parameters, Linum *usitatissimum* L.

INTRODUCTION

Linum usitatissimum L. (linseed) is a cool temperate annual herb with erect stems belonging to Linaceae family. Although there are several utilization purposes, it is cultivated commercially for its seed, which is processed into oil and a high protein stock feed after oil extraction. Gamma rays with different irradiation levels have been found to cause a large range of effects on seeds. Gamma rays have proved to be more economical and effective compared to other ionizing radiations because of their easy availability and power of penetration (Moussa 2006). Marcu (2013) examine the effects of radiation on seeds, it was found that radiation not only impacts the germination potential and actual qualities of the germinated seedlings (such as root and shoot lengths), where germination potential is the percentage of seeds that germinated overall and the time of germination compared to when the seed were planted.

The present study was conducted to examine and investigate effect of gamma radiation (γ rays) on growth and morphological changes such as seed germination, seedling growth, leaf size, plant height and length of internodes of plants.

METHODOLOGY

For present study dried seeds of *Linum usitatissimum* L. (linseed) were used. Mature seeds of linseed were collected and the seeds were kept in zip lock pouches at room temperature for further use. Dry seeds were exposed to radiation at 10 kR, 20 kR, 40 kR, 60 kR, 80 kR and 100kR doses (Source: ^{60}Co, P.G Department of Chemistry, RTM Nagpur university). The control linseed seeds were not irradiated. Effect of gamma radiation was studied on various growth and morphological parameters such as seed germination, seedling growth, leaf size, plant height and length of internodes. The experiments were carried out in two sets, one with treated seeds and the other untreated which served as control.

Irradiated seed were grown to examine percentage of germination. For every dose and control 100 seeds were grown, number of seeds germinated and non-germinated was noted. The percentage of germination was calculated and recorded. One week after shoot and root length in cm were recorded for each dose and control. After one and half month of sowing leaf size, height and internode length were examined for all doses with control. Leaf size was ascertain and recorded by measuring length and width of length in cm. Height and internode length was measured and noted.

RESULTS AND DISCUSSION

The seed germination test after gamma irradiation (10kR-100kR) revealed that the maximum germination percentage was observed in control seedlings. As illustrated in Table-1 and Fig. 1, the final germination percentage decreased with increasing gamma ray doses. At 20kR germination percentage showed inconsiderable change. The maximum decrease of the germination percentage was observed at 100kR. Statistical analysis revealed that exposure at doses higher than 10 kR significantly decrease the seeds germination. The biometric measurements of shoot and roots emerged from irradiated seeds show a significant variation of length (Table 2 and Fig.2). The highest shoot length was observed in the control plants. The gamma rays 40kR imposed a significant impact on the shoot length where more radical length was recorded than shoot. Following exposure to gamma rays, inconsistent shoot length decrease was observed among all irradiations. The maximum decrease of shoot length was observed at 40kR followed by 100kR (Table 2).

The maximum radical length was recorded in the control samples, while the radical length of samples exposed to different doses showed decrease in length. The maximum reduction of radical length was observed at 60kR. Results show that gamma radiation treatment with doses higher than 10kR significantly inhibited the length of the radicular system of plants derived from irradiated seeds. Leaf size biometric analysis revealed highest leaf length at 10kR and maximum width at 100kR than control (Table 3 and Fig.3). While in all radiations decreased leaf length was observed. The leaf length was inconsistent among all treatment.

The maximum reduction in length was recorded at 100kR. Leaf width is almost constant and similar to control except at100kR, where minimal increase was observed. Results revealed gamma radiation treatment with doses higher than 10kR significant to bring increase in length of leaf. Radiations such as 40kR, 60kR, 80 kR and 100 kR are responsible for reduction in leaf length. 100kR increases slight increase in width.

Table 1: Percentage of Seed germination

Treatment	Total no. of. Seed kept for gemrination	Total no. of. Seeds germineted	Percentage of germination
Control	100	89	89 %
10 kR	100	85	85 %
20 kR	100	88	88 %
40 kR	100	79	79 %
60 kR	100	65	65 %
80 kR	100	58	58 %
100 kR	100	56	56 %

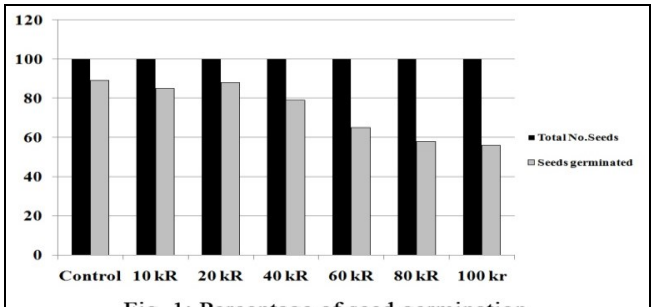

Fig. 1: Percentage of seed germination

Table 2: Biometric measurment of shoot and root emerged from irradiated seeds

Sr. No.	Control		10kR		20kR		40kR		60kR		80kR		100kR	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R
1	14.0	7.9	12.3	8.3	11.5	7.0	6.0	7.0	8.9	4.0	8.0	4.3	7.0	4.8
2	10.7	8.7	12.7	7.6	12.4	6.8	5.0	6.8	8.3	3.6	7.6	4.4	7.2	4.7
3	13.5	8.4	10.7	6.5	10.5	6.5	4.8	6.5	8.5	3.9	7.3	3.9	6.9	4.9
4	12.0	9.4	10.3	7.1	13.2	5.0	5.5	6.3	8.7	3.7	7.4	4.3	7.3	4.4
5	12.3	8.3	11.9	7.2	11.3	6.1	5.9	6.5	8.4	3.8	7.8	4.2	7.1	4.2
Total	62.5	42.7	57.9	36.7	58.9	31.4	27.2	33.1	42.8	19	38.1	21.1	35.5	23
Ave.	12.5	8.54	11.5	7.34	11.7	6.28	5.44	6.62	8.56	3.8	7.62	4.22	7.1	4.6

***S** = Shoot length in cm and **R =** Root length in cm

Table 3: Lenght and width of internode at different kR doses levels of gamma rays

Sr. No.	Control		10kR		20kR		40kR		60kR		80kR		100kR	
	L	W	L	W	L	W	L	W	L	W	L	W	L	W
1	1.3	0.03	1.5	0.03	1.0	0.03	0.9	0.02	1.1	0.04	1.1	0.03	0.8	0.01
2	1.3	0.03	1.4	0.03	1.0	0.02	1.1	0.02	1.0	0.03	1.2	0.03	0.8	0.02
3	1.3	0.03	1.3	0.03	1.1	0.03	1.1	0.02	1.3	0.03	1.0	0.03	1.0	0.03
4	1.3	0.03	1.0	0.03	1.1	0.03	1.2	0.02	1.2	0.04	1.2	0.02	0.7	0.02
5	1.2	0.02	1.2	0.02	1.1	0.02	1.1	0.02	1.1	0.02	1.2	0.03	0.7	0.01
6	1.3	0.02	1.3	0.02	1.0	0.02	1.2	0.02	1.3	0.04	1.1	0.03	0.8	0.01
7	1.2	0.03	1.3	0.02	1.0	0.02	1.2	0.02	1.2	0.04	1.2	0.03	0.7	0.02
8	1.2	0.03	1.2	0.03	1.1	0.03	1.1	0.02	1.3	0.03	1.1	0.02	1.0	0.01
9	1.3	0.02	1.5	0.03	1.1	0.02	1.2	0.02	1.0	0.02	1.0	0.03	0.9	0.01
10	1.3	0.02	1.5	0.03	1.0	0.02	1.2	0.02	1.2	0.03	1.0	0.03	0.9	0.01
Total	11.4	0.26	13.2	0.28	10.5	0.24	11.3	0.20	11.7	0.32	11.1	0.28	8.3	0.15
Ave.	1.27	0.02	1.32	0.02	1.05	0.02	1.13	0.02	1.17	0.03	1.11	0.02	0.83	0.05

***H** = Height in cm and **I =** length of internode in cm

Table 4: Height and length of internode at different kR doses levels of gamma rays

Sr. No.	Control		10kR		20kR		40kR		60kR		80kR		100kR	
	H	I	H	I	H	I	H	I	H	I	H	I	H	I
1	37.5	1.7	28.5	1.3	33.0	1.0	18.0	1.0	31.0	1.1	29.0	1.6	27.0	0.8
2	36.0	1.3	29.0	0.6	31.0	1.0	25.0	1.4	29.0	0.5	28.0	1.6	27.5	1.5
3	36.0	0.9	32.0	1.0	29.5	0.6	27.5	0.6	31.0	0.7	37.0	1.5	29.0	0.9
4	37.0	1.3	31.0	0.7	33.0	1.0	33.0	0.9	33.0	1.0	28.0	1.6	29.0	1.4
5	34.0	0.6	33.0	0.9	26.0	1.4	31.0	0.8	32.0	0.7	31.0	1.4	31.0	1.3
Total	180.5	5.8	153.5	4.5	152.5	5.0	134.5	4.7	156	4.0	153	7.7	143.5	5.9
Ave.	36.1	1.16	30.7	0.9	30.5	1.0	26.9	0.94	31.2	1.3	30.6	1.54	28.7	1.1

***H** = Height in cm and **I =** length of internode in cm

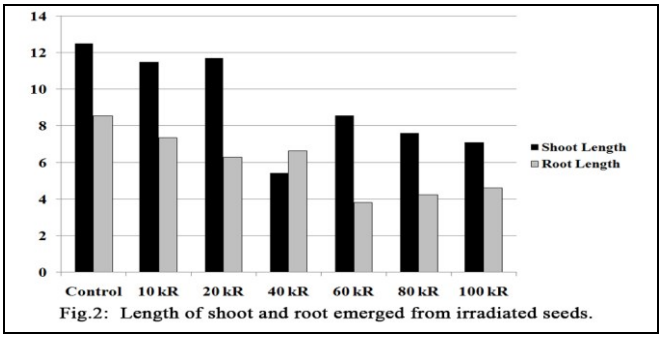

Fig.2: Length of shoot and root emerged from irradiated seeds.

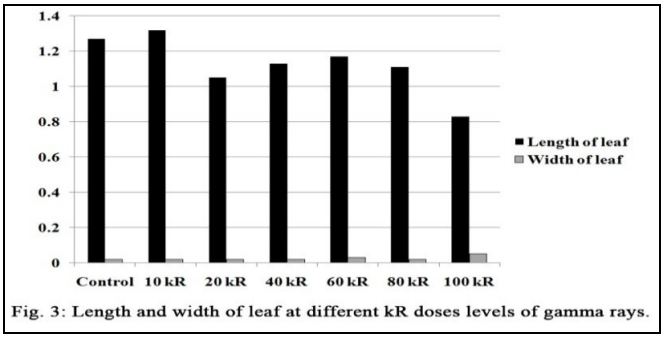

Fig. 3: Length and width of leaf at different kR doses levels of gamma rays.

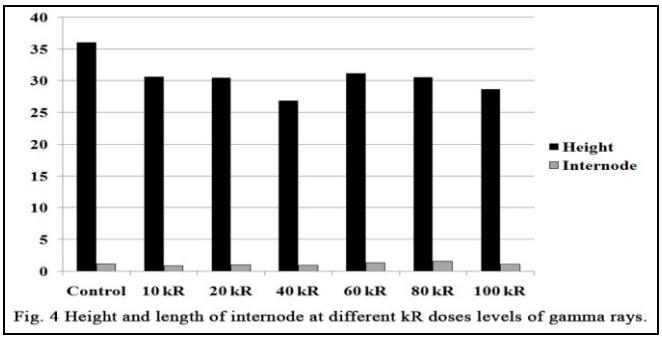

Fig. 4 Height and length of internode at different kR doses levels of gamma rays.

Height of plant and length of internode showed significant variations (Table 4 and Fig.4). Maximum height was observed in control while in irradiated plants the height was variable. Maximum reduction in plant height was observed in plant irradiated at 40kR. Internode length of plant treated at 80 kR was noted maximum. However internode length has minimal variation in length. Biometric analysis revealed that exposure at dose 10kR and higher are significant to bring decrease in plant height. 60kR and 80kR are noticed to increase in internode length.

These results are in accordance with the findings of previous researchers who reported that the seed germination potential of different crops decreased by increasing the irradiation dose. Akgun and Tosum (2004) reported the reduced germination due to inhibitory effect of gamma radiation. Gradual reduction in shoot and root length immerging from irradiated seeds are reported by Delia Marcu et al. (2013) in maize. Yadav (2016) observed different doses of gamma rays produced variable effect in the leaf morphology which did not show dose dependent effect. Irfaq & Nawab (2001) observed gamma treatment (0.1, 0.2, 0.3, 0.4 kGy) of three wheat cultivars caused a delay of the germination process and decrease of the survival percentage and plant height.

CONCLUSION

The present results show that seed treatment with 60Co gamma radiation (10kR-100kR) decreased seed germination, affects the shoot and root growth, moderate change in leaf morphology, decreased plant height and internode. These findings confirm the results obtained by earlier studies that showed the inhibitory effects of plant growth and development exposed to high doses of gamma radiation.

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