



Research Article

Sensitivity of rice varieties to gamma irradiation

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Abstract

Six promising rice varieties viz., CO 43, CO 47, CO 48, CO 49, ADT 43 and Improved White Ponni were treated with gamma irradiation with doses of 100Gy, 200Gy, 250Gy, 300Gy and 350Gy of gamma rays in order to study effect of gamma irradiation in seed germination of rice varieties and study the root and shoot length variation. Treated seeds were sown separately in germination paper and nursery with the two replications. The germination percentage was decreased after gamma irradiation. But the decrease was neither proportional to the increase in dosage nor definite pattern was found in all the six rice varieties. At the dose of 350Gy all the six varieties exhibited the low germination percentage especially in the variety ADT 43 is 33%. The gamma ray dose of 300Gy was causing 42-51% seedling height reductions in CO 43, CO 47, CO 48, CO 49 and ADT43. The seedling height was decreased in decreasing manner with the increase of irradiation dose in the varieties such as CO 47 and improved white ponni. The root development in seedlings was inhibited higher in the dose of 300Gy in all the six varieties. At higher dose of 350Gy root length is very much affected in the varieties viz., CO 43 with 76% reduction and 70% reduction in improved white ponni. Plant height and seed fertility percentage were decreased with increase of gamma radiation dose in linear fashion. Seed fertility decreased with increase of radiation dose was observed in CO 47, ADT 43 and improved white ponni. In ADT 43 seed fertility was reduced approximately 69% at gamma ray dose of 350Gy.

Introduction

The use of ionizing radiation, such as X-rays, gamma rays and neutrons and chemical mutagens for inducing variation, is well established. Induced mutations have been used to improve major crops such as wheat, rice, barley, cotton, peanuts, and beans, which are seed propagated (Ahloowalia & Maluszynski, 2001). Ionizing radiations have been successful in inducing genetic variability in rice (Smith, 1972). Many attempts in the field of mutation research have been made by different scientists to get desirable traits in cultivated rice and in the determining the most effective mutagenic treatment (Reddy and Rao 1988; Bansal *et al.*, 1990; Pillai *et al.*, 1993). Rice has a special significance in Asia, where about 90% of the rice is produced and consumed as a staple food. Tropical rice-growing countries need an increased supply of rice because of their increasing population and decreasing land and water resources. In this present study six rice varieties were treated with different doses of gamma radiation.

Materials and Methods

Promising rice varieties viz., CO 43, CO 47, CO 48, CO 49, ADT 43 and Improved White Ponni were treated with gamma irradiation with doses of 100Gy, 200Gy, 250Gy, 300Gy and 350Gy of gamma rays from the ⁶⁰Co source at 13% moisture for mutation study. Treated seeds were sown separately in germination paper by roll towel method and nursery with the two replications. After 14 days of germination the seedlings were evaluated for following attributes viz., germination percentage, shoot length and root length. Five hundred seeds of each irradiated dose along with control were sown in nursery bed. 25 days old seedlings were transplanted to main field by adopting 20x20 spacing in randomized block design with three replications. At the maturity stage data for plant height and total filled spikelets per panicle were recorded from five randomly selected plants of each treatment per replication.

Results and Discussion

In the present gamma irradiation programme, the primary objective was, effect of gamma irradiation in seed germination of rice varieties and study the root and shoot length variation of 14 days old seedlings.

Seed germination: The germination percentage was decreased after gamma irradiation. But the decrease

was neither proportional to the increase in dosage nor definite pattern was found in all the six rice varieties (Fig: 1). At the dose of 350Gy all the six varieties exhibited the low germination percentage especially in the variety ADT 43, it is 33 per cent (Fig: 2). This indicates the effect of gamma radiation on germination. Similar results have been reported in rice by Akbar & Baber (2003) and Pathak & Patel (1988).

Seedling height: Seedling height is the primary index in M_1 generation in any mutation studies (Konzak *et al.*, 1972). The result of present study in rice showed the seedling height variation in different varieties. The gamma ray dose of 300Gy was causing 42-51% seedling height reductions in CO 43, CO 47, CO 48, CO 49 and ADT 43 (Table 1). It indicates that these varieties did not differ in radiosensitivity with respect to seedling height. The seedling height was decreased in decreasing manner with the increase of irradiation dose in the varieties such as CO 47 and improved white ponni, but decrease was proportional to the increase of irradiation dose. Similar results have been reported by Akbar & Baber (2003). Linear dependency between seedling height and radiation dose have been reported by Mikaelson *et al.*, (1968) and Siddiq & Swaminathan (1968).

Root Length: Study of root length variation in present study showed that the reduction of root length with the corresponding increase of radiation dose (Table 1). The inhibition of root development was higher in dose of 300 Gy in all the six varieties. Similar results have been reported by Akbar & Baber (2003). At higher dose of 350Gy root length is very much affected in the varieties of CO 43 (76% reduction) and improved white ponni (70% reduction).

Plant height and spikelet fertility percentage

Plant height and spikelet fertility percentage of M_1 plants showed significant variation due to radiation treatment (Table 1). Reduction of plant height ranged from 22.5-26.03% at the dose of 250Gy in varieties of CO 43 (77.5%) and CO 49 (73.07%). In varieties like CO 48 and improved white ponni plant height was slightly increased when compared to the control. In general plant height was drastically reduced at the dose of 100Gy and 200Gy in all of the six varieties. These results are in agreement with Miah *et al.*, (1970) and Sarawgi & Soni (1993). Interruption in DNA synthesis and other physiological and biochemical changes after mutagenic treatment may lead to reduction of plant height.

Seed spikelet fertility percentage is presented in Table 1. Enhancing effect of seed fertility percentage was observed in varieties of CO 43, CO 48 and CO

49 after radiation treatment. Seed fertility decreased with increase of radiation dose in CO 47, ADT 43 and improved white ponni. These three varieties were highly radiosensitive than CO 43, CO 48 and CO 49. Miyahara (1997) reported that seed fertility in rice was reduced up to 50% when gamma ray dose of 250Gy. In ADT 43 seed fertility was reduced approximately 69% at gamma ray dose of 350Gy. Moreover, mutagenic treatments are generally reducing the reproductive ability of plants (biological material) and increase the number of sterile spikelets in panicle. Similar results were obtained in rice by Avan & Bari, 1979; Sanjeev *et al.*, 1998. The spikelet sterility ranged from 69% (ADT 43 at 350Gy) to 0.25% (CO 43 at 300Gy).

The present study on gamma irradiation of rice varieties revealed that the germination percentages of all six rice varieties were decreased after gamma irradiation treatment. But the decrease was neither proportional to the increase in dosage nor definite pattern was found in all the six rice varieties. At the dose of 350Gy all the six varieties exhibited the low germination percentage especially in the variety ADT 43 is 33%. The gamma ray dose of 300Gy was causing 42-51% seedling height reductions in CO 43, CO 47, CO 48, CO 49 and ADT 43. The seedling height was decreased in decreasing manner with the increase of irradiation dose in the varieties such as CO 47 and improved white ponni. The root development in seedlings was inhibited in higher dose of 300Gy in all the six varieties. At higher dose of 350Gy root length is very much affected in the varieties of CO 43 and improved white ponni with 76% and 70% reduction respectively. Plant height and seed fertility percentage were decreased with increase of gamma radiation dose in linear fashion. In ADT 43 seed fertility was reduced approximately 69% at gamma ray dose of 350Gy. Hence, this indicates the potential of gamma radiation in rice.

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Fig 1: Effect of radiation on seed germination of rice varieties

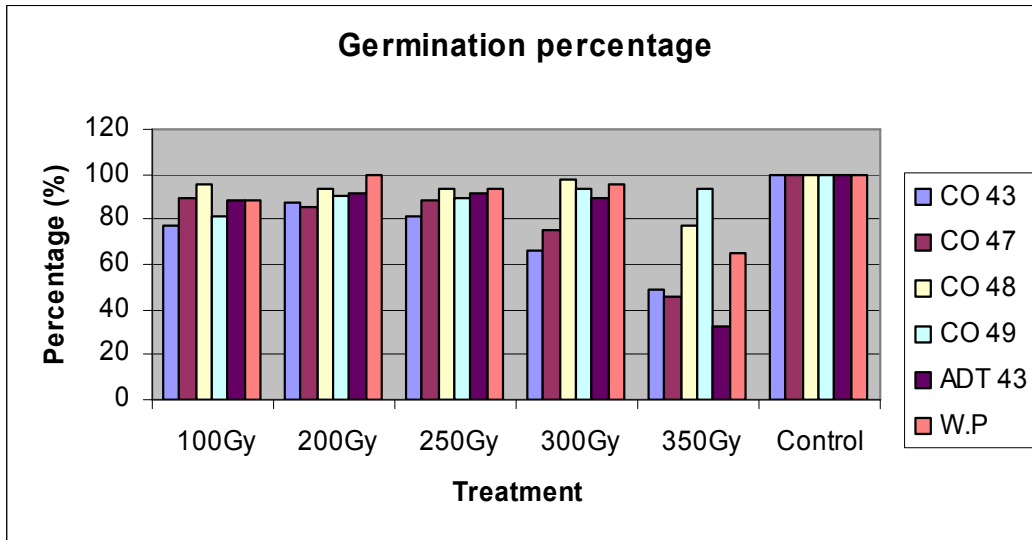
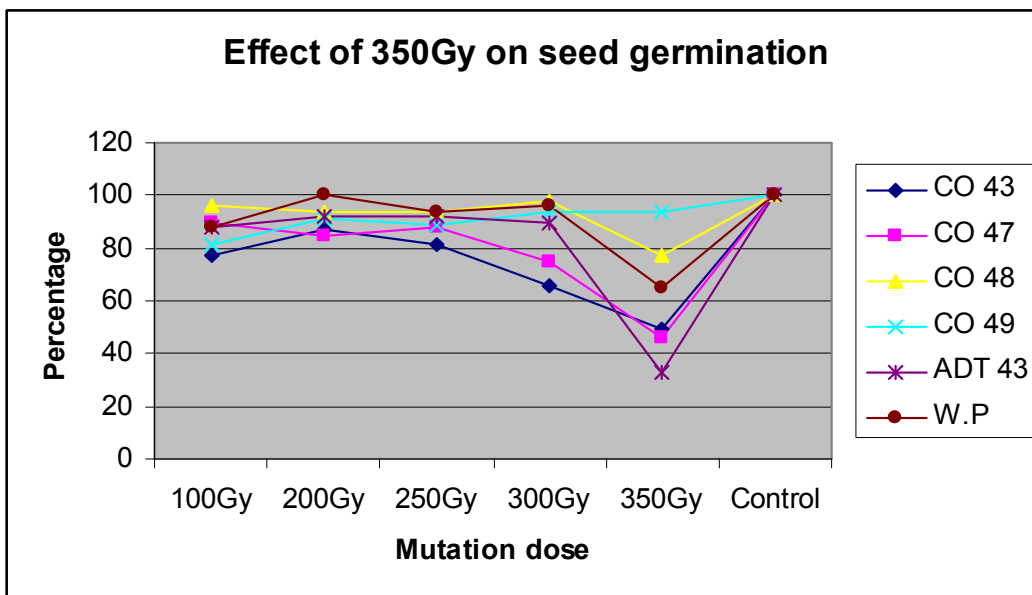


Fig 2: Severe effect of dose 350Gy on seed germination of rice varieties



**Table 1. Mean values of shoot length, root length, plant height and spikelet fertility after radiation treatment**

Variety	Dose	Shoot Length		Root Length		Plant Height		Spikelet Fertility %	
		Actual (cm)	% of control	Actual (cm)	% of control	Actual (cm)	% of control	Actual %	% of control
CO 43	Control	11.04	100	18.06	100.00	79.90	100.00	86.39	100
	100Gy	11.4	103.28	13.90	77.01	77.70	97.13	83.34	96.67
	200Gy	11.56	104.73	10.27	56.90	70.48	88.10	92.81	107.66
	250Gy	8.07	73.11	8.97	49.69	62.00	77.50	88.76	102.96
	300Gy	6.45	58.44	5.31	29.42	68.06	85.08	85.99	99.75
	350Gy	6.50	58.89	4.31	23.88	73.74	92.18	87.12	101.06
CO 47	Control	10.94	100.00	18.22	100.00	97.46	100.00	97.38	100
	100Gy	9.68	88.48	11.15	61.21	90.62	93.33	94.31	97.14
	200Gy	8.50	77.69	9.49	52.10	90.16	92.86	83.51	86.02
	250Gy	8.49	77.60	7.12	39.09	93.10	95.89	83.50	86.00
	300Gy	5.39	49.26	4.55	24.98	95.68	98.55	80.41	82.82
	350Gy	5.04	46.07	6.15	33.76	96.00	98.88	89.12	91.80
CO 48	Control	11.13	100	19.65	100.00	74.50	100.00	88.46	100.00
	100Gy	12.70	114.05	16.00	81.44	62.04	83.13	95.6	108.00
	200Gy	9.75	87.56	13.50	68.72	60.36	80.88	94.47	106.75
	250Gy	9.14	82.08	11.91	60.62	75.82	101.6	93.32	105.45
	300Gy	6.31	56.66	6.58	33.49	71.58	95.91	85.05	96.12
	350Gy	7.89	70.85	9.80	49.88	72.40	97.02	86.53	97.80
CO 49	Control	10.69	100.00	18.73	100.00	69.86	100.00	91.55	100.00
	100Gy	9.90	92.57	16.1	85.97	55.60	79.5	93.31	101.70
	200Gy	8.44	78.91	13.97	74.60	58.34	83.43	91.17	99.40
	250Gy	7.79	72.84	9.87	52.71	51.10	73.07	90.94	99.12
	300Gy	5.75	53.76	9.17	48.97	61.22	87.54	87.96	95.88
	350Gy	8.27	77.32	11.67	62.32	66.72	95.41	87.28	95.14
ADT 43	Control	9.96	100.00	17.57	100	88.56	100.00	93.65	100.00
	100Gy	8.35	83.83	14	79.66	89.34	100.95	91.19	97.57
	200Gy	7.32	73.49	7.32	41.65	88.9	100.46	83.59	89.44
	250Gy	5.41	54.32	6.38	36.30	85.72	96.86	88.07	94.23
	300Gy	5.68	57.03	5.67	32.26	87.56	98.94	89.73	96.01
	350Gy	4.80	48.19	6.31	35.90	86.68	97.95	29.65	31.70
IWP	Control	7.66	100.00	19.25	100.00	88.52	100.00	94.96	100.00
	100Gy	10.7	139.63	12.70	65.97	82.12	92.8	93.19	97.85
	200Gy	9.94	129.72	11.66	60.52	79.38	89.70	91.72	96.31
	250Gy	6.39	83.39	9.60	49.82	105.62	119.35	87.55	91.93
	300Gy	5.67	73.99	7.12	36.95	81.40	91.98	89.28	93.74
	350Gy	5.92	77.26	5.64	29.27	102.20	115.50	92.83	97.47