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Induced Mutability Studies in Three Wheat (*Triticum aestivum* L.) Varieties for Some Morphological and Agronomic Characteristics

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Abstract: The effect of gamma irradiation was studied on three wheat varieties. Various doses of gamma irradiation i.e. 10, 20, 30 and 35 Krad were applied to seed. High reduction in the mean values for survival percentage, days taken to heading and plant height were obtained in response to higher doses of gamma rays (30 and 35 Krad,) except for days taken to germination and number of ear bearing tillers. Higher doses of 30 and 35 Krad also created some abnormalities in plant types e.g a tiller having two ears attached with each other and sterile ears etc. All the three varieties namely Inqilab-91, Daman-98 and Raj responded differently to radiation doses for germination percentage, survival percentage, days taken to heading, plant height and number of tillers plant^{-1}.

Key words: Varieties, wheat, gamma irradiation

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the cereal of choice in most countries and is the principal food crop of the world. Wheat among the cereals, is the main staple diet in Pakistan. Wheat is self pollinated crop, the natural variation is very low in wheat crop. As such the genetic variation is required for its improvement. The genetic variation may be obtained through selection in the available natural resources, introduction of exotic germ plasm, hybridization and induced mutations.

Ionizing radiation (Gamma rays, X-rays) seem to be especially useful in changing simple inhirited characteristics in highly developed genic systems. Undesirable alterations in other characters are easily handled in mutation breeding programmes because the mutant lines are so similiar to the parent variety that few back crosses will restore the desired background genotype. The commulative effect of the small variations have made mutations an important force in the evolutionary changes that plants have undergone. Groski *et al.* (1987) reported that in M_2, the number of tiller plant^{-1} and the number of spikes plant^{-1} showed significant differences with various doses of gamma irradiation. Hassan *et al.* (1988-a) studied the effect of gamma rays and sodium azide on wheat variety sonalika. Higher dose of gamma rays delayed maturity whereas higher concentration of sodium azide induced earliness. Sodium azide treatment resulted in more reduction in number of tillersr plant^{-1}, number of spikelets spike^{-1} and length of the spike. Ayub *et al.* (1989) concluded that the effect of radiation was depressive and the magnitude of depression varied with the strength of irradiation dose. Most of the effect was restricted to M_1 generation and only little amount was transmitted to the following generation. This reveals that the effect is genotypic in nature, which is transmitted from generation to generation. Zhu *et al.* (1991) noted that considerable variation was induced in heading date, plant height, fertile spike plant, number and weight of grain plant^{-1} in two different wheat varieties due to radiation. Wang-Guixue *et al.* (1995) irradiated the seeds of wheat varieties 77-Zhong-2882 and 79-P-17 with 137Cs gamma rays and CO^{60} gamma rays, respectively, at 20-40 KR to study their effects on the inheritance of heading data, plant height, number of tillers and other characteristics. Results showed that both irradiation sources had similar significant effects on heading data and plant height. Mutants with good characteristics were obtained form variety 77-Zhong-2882 irradiated with 30 KR. Lapochkina (1998) reported that the use of pollen irradiated at dose of 0.75 and 1.5 KR increase yield in hybrid plants in comparison with control. Perez-Talavera *et al.* (1999) concluded that radiography is a rapid and non-destructiv method which offers the possibility of predicting the field behaviour of irradiated material. In view of the above mentioned aspects, the present research project was undertaken to study the effects of gamma irradiation in wheat and to evaluate the possibility of using this physical agent as a source of creating new hereditary changes regarding different morphological and agronomic characters.

MATERIALS AND METHODS

The present research project was carried out from late October 2001 to early May 2002 at the research area of Department of Plant Breeding and Genetics, Faculty of Agriculture, Gomal University, D.I.Khan. The varieties used in this study are given as follows.

1. Inqilab - 91
2. Daman - 98
3. Raj

Pure dry seeds of the above three wheat varieties were obtained from Agriculture Research Institute Ratta Kulachi, Dera Ismail Khan. The seeds were irradiated with 10,20,30 and 35 Krad doses of gamma rays from CO^{60} gamma source at the Nuclear Institute for Food and Agriculture (NIFA), Tarnab, Peshawar. One lot of seeds of each variety was kept as untreated control. Hence there were four irradiated seed lots and one control, totaling five treatments for each variety. The experiment was Lay out in R.C.B.D with Split plot arrangement having four replications. The experimental plot size was kept at an area of 360.0 m^2. Each replication was divided into three blocks and each of the block in turn was sub divided into five sub plots with an area of 6 m^2 each. The distance between the adjacent rows was 30 cm while the plant to plant distance within a row was 10 cm. The three cultivars were allocated at random to main plots (blocks) while four levels of gamma radiation plus control were allocated to sub plots at random in each block. A basic dose of 55-28-0 kgs per hectare N.P.K was applied. A full dose of phosphorous in the form of D.A.P was applied to the field before sowing while half of the nitrogen was supplemented at sowing time and remaining half of the nitrogen with second irrigation. The irradiated seeds along with control were sown on October 29, 2001. Normal agricultural practices for raising the wheat crop were followed uniformally for all the treatments. Hoeing was done two times to control weeds. The experimental plot was irrigated at suitable intervals avoiding the crop with water stress. The harvested bundles of each sub plot for each treatment were labeled. These were kept separate and dried. Each bundle was hand threshed. Maximum 10 plants at random were selected from each sub plot for each treatment for observing the effects of radiation on the following morphological and agronomic characters.

1. Germination percentage
2. Survival percentage
3. Days taken to heading.
4. Plant height (cm)
5. Number of tillers $plant^{-1}$

Germination percentage was calculated by multiplying the number of grains germinated with 100 and was divided by the total number of grains sown. For survival percentage, 25 seedlings were selected in each sub plot 10 days after the germination, the survival percentage was recorded by employing the following formula:

$$\text{Survival percentage} = \frac{\text{Number of plants survived up to harvest}}{\text{Total number of seedlings selected}} \times 100$$

Days taken to heading was determined by counting the days from date of sowing to the time of 50% ear emergence in each sub plot. For the plant height, 10 selected plants from each sub plot measured at maturity in centimeters from the soil surface to the tip of spike. For the number of tillers $plant^{-1}$, ten selected plants in each sub plot were counted by uprooting the plants at the maturity.

Statistical analysis: The data so collected for various morphological characteristics was statistically analysed on Split polit Design for the analysis of variance as suggested by Steel and Torri (1980), while the effects of radiation doses and their varietal response were compared by Duncan's new multiple range test.

RESULTS AND DISCUSSION

Germination percentage: According to data (Table 1) the differences in the mean values due to gamma doses were highly significant. The data revealed that the range of mean values for radiation doses was 21.19 to 91.76 for germination Percentage. The lowest germination percentage (21.19) was recorded for 35 Krad dose and the highest germination percentage was recorded for control. A significant decrease in germination percentage was observed with an increase in the gamma rays doses. All the values with respect to various doses differed significantly from one another. The mean values due to varieties for germination percentage were non-significant and the values were in the range of 57.29 for Raj 58.70 for Inqilab-91 and 60.33 for Daman-98 respectively. The effects of interaction between doses of gamma rays and varieties were non-significant. The values recorded for interaction-ranged form 20.75, to 94.50, 21.25 to 93.00 and 21.75 to 87.79 for Inqilab-91, Daman-98 and Raj respectively. The highest dose of gamma 35 Krad had most adversely affected the germination percentage. The decrease in the mean values due to 35 Krad dose was computed as 78.04, 77.15 and 75.43% for Inqilab-91, Daman-98 and Raj, respectively as compared to their

Table 1: Effect of gamma radiation on germination percentage in wheat varieties

Radiation	Varieties			
Doses (krad)	Inqilab-91	Daman-98	Raj	Mean
00	94.50	93.00	87.79	91.76A
10	80.00	81.15	80.85	80.67B
20	61.23	63.52	55.00	59.92C
30	37.00	42.73	41.25	40.33D
35	20.75	21.25	21.57	21.19E
Mean	58.75B	60.33A	57.29C	

Table 2: Effects of gamma rays on survival percentage of wheat varieties.

Radiation	Varieties			
Doses (krad)	Inqilab-91	Daman-98	Raj	Mean
00	98.72	96.75	94.50	96.66A
10	86.28	79.78	80.00	82.02B
20	70.70	67.53	68.00	68.74C
30	58.78	60.08	55.33	58.06D
35	37.28	34.17	29.15	33.53E
Mean	70.35A	67.66B	65.40C	

Table 3: Effects of gamma radiation on days taken to heading in wheat varieties

Radiation	Varieties			
Doses (krad)	Inqilab-91	Daman-98	Raj	Mean
00	113.0	112.8	115.3	113.7D
10	115.0	112.5	114.2	113.9D
20	115.8	117.0	114.5	115.8C
30	116.8	118.5	123.3	119.5B
35	118.8	119.5	127.5	121.9A
Mean	115.9B	116.1B	119.0A	

Table 4: Effects of gamma radiation on plant height (cm) in wheat varieties

Radiation	Varieties			
Doses (krad)	Inqilab-91	Daman-98	Raj	Mean
00	87.60	91.00	98.30	92.30A
10	87.88	88.30	96.60	90.93B
20	85.80	81.85	93.50	87.05C
30	73.35	80.55	81.40	78.43D
35	72.50	79.00	80.03	77.18E
Mean	81.43C	84.14B	89.97A	

Table 5: Effects of gamma radiation on number of tillers per plant in wheat varieties

Radiation	Varieties			
Doses (krad)	Inqilab-91	Daman-98	Raj	Mean
00	6.660	10.05	8.550	8.400D
10	9.650	9.100	10.60	9.783D
20	7.900	10.40	11.05	9.783C
30	10.85	10.05	12.35	11.08B
35	12.35	13.20	9.500	11.68A
Mean	9.470B	10.56A	10.41A	

Any two means sharing the same letters are not significantly different according to Duncan's New Multiple Rang Test. Capital letters indicate significance at 5% Probability level.

respective controls. These results are in agreement with those of Hassan *et al.* (1988-a) and Zhu *et al.* (1991).

Survival percentage: According to data (Table 2) the differences in the mean values for survival percentage due to gamma rays doses were highly significant. The range of mean values for radiation doses in ascending order were 29.15 to 98.72 for survival percentage. The mean values of radiation doses showed the lowest percentage (29.15) of survival due to 35 Krad dose in Raj and decrease was computed as 69.15% as compared to 94.50% survival of control. Generally a significant decrease in survival percentage was observed with an increase in the radiation intensity and the decrease was inversely related to the intensity of gamma rays doses. The maximum survival percentage was observed in the control of all the varieties.

Days taken to heading: According to data (Table 3), the difference in the mean values due to varietals effects for days taken to heading were 115.9, 116.10 and 119.0 for Inqlab-91, Daman-98 and Raj, respectively. It was noticed that Raj took more days to heading as compared to Inqilab-91 and Daman-98 respectively. Raj took 2.4 and 2.6% more days to heading as compared to Inqilab-91 and Daman-98. The mean values for days taken to heading due to doses, were also found to be highly significant except for 10 Krad as compared to the control. By comparing the mean values of various doses with one another, it was observed that time taken to heading was increased with the increase of radiation intensity except for 10 krad. The values noticed for various doses were ranging form 113.7 to 121.9, representing an increase of 6.7% in days taken to heading due to 35 Krad dose as compared to control. The interaction between varieties and doses was also found non significant and the values ranged form 113.00 to 118.80, 112.802 to 119.05 and 115.30 to 127.50 for Inqlab-91, Daman-98 and Raj respectively. An increase of 5.8, 6.7 and 12.2% was observed in days taken to heading for Inqlab-91, Daman-98 and Raj respectively as compared to their mean values due to 35 Krad to their respective controls. These results are quite inline with those of Hassan *et al* (1988-a), Zhu (1991) and Din *et al.* (2003) who also recorded variation in different parameters of the wheat crop.

Plant height (cm): Due to varietal effect the differences found in the mean values were highly significant. Differences recorded for plant height were in the range of 81.43 cm, 84.14 cm and 89.71 cm for Inqilab-91, Daman-98 and Raj respectively. It is evident from Table 4, that increase in the mean values of Daman-98 and Raj for plant height (cm) was 2.74 and 8.56% respectively as compared to the mean value of Inqilab-91 (81.43 cm) for plant height. Highly significant effect of various radiation doses were recorded. By comparing the mean values due to various radiation doses with one another it was found that the

average plant height was decreased with increase in radiation doses except for 10 krad in Daman-91 (88.30 cm) which did not show any decrease in height but slight increase was observed in this special case as compared to its respective control. The mean values for plant height due to different radiation doses ranged between 77.18 to 92.30 (cm) and differed significantly. The maximum decrease in plant height due to 35 Krad dose was 15.12 cm by comparing the mean value due to 35 Krad (77.18 cm) to control (92.30 cm). The interaction between varieties and doses was non significant and the data obtained for effects of radiation doses on varieties indicated that various radiation doses in increasing arrangement produced gradual reduction in plant height in Inqilab-91, Daman-98 and Raj. The values obtained were ranging between 72.50 to 87.60 cm, 79.00 to 91.00 cm and 80.03 to 98.30 cm for Inqilab-91, Daman-98 and Raj respectively. The maximum reduction in plant height due to 35 krad dose in case of Inqilab-91, Daman-98 and Raj was 15.10 12.00 and 18.27%, respectively as compared to their respective controls. These results are quite inconfermity with those of Hassan *et al.* (1988-a) and Zhu *et al.* (1991).

Number of tillers plant $^{-1}$: The mean values differences of tillers per plant in response to different doses of gamma rays were highly significant and the mean values shown in Table 5 ranged form 8.40 to 11.68. The highest value of 11.68 tillers was obtained due to 35 Krad while the minimum value for number of tillers (8.40) was obtained in control. The maximum increase in number of tillers plant^{-1} was observed due to 35 Krad dose, which was computed as 16.80% in comparison to the mean value of control. In general, the number of tillers per plant exhibited gradual increase with the increase in radiation intensity except for 35 Krad which showed slight decrease in tillers number plant^{-1}. The difference in the mean values due to interaction between doses varieties were highly significant. The values ranged between 6.66 to 12.35, 10.05 to 13.20, 8.55 to 9.50 for Inqilab-91, Daman-98 and Raj respectively. The number of tillers plant^{-1} was increased in all the three varieties. The maximum increase of 46.07, 23.86 and 30.76% were noted for Inqilab-91, Daman98 and Raj, respectively. These results are in agreement with those reported by Ghafoor and Sidiqui (1976) and Wang *et al.* (1995).

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