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Induced Mutability Studies for Yield and Yield Related Characters in Three Wheat (*Triticum aestivum* L.) Varieties

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Abstract: Various doses of gamma irradiation i.e 10, 20, 30 and 35 krad were applied to the seeds of three wheat varieties namely Inqilab-91, Daman-98 and Raj. High reduction in the mean values for all the characters were obtained in response to higher doses of gamma rays (30 and 35 krad,). It was concluded from this study that the higher doses reduced mean values for majority of characters studied while lower dose of 10 krad had beneficial effect on most of the parameters. All the three varieties in this research project responded differently to radiation doses for various plant characteristics.

Key words: Induced mutability, yield, varieties

INTRODUCTION

Wheat (*Triticum aestivum* L.) is most important crop with respect to acreage as well as in production amongst all cereals in Pakistan. In Pakistan it is called gandum (Urdu), kanak (Punjabi) and ghanum (Pashto). The average yield of wheat in Pakistan is very low at farmer's level due to many reasons. Wheat breeders and genetists are trying to evolve varieties which are outstanding in yield. The success of breeding programme rests primarily on the magnitude and nature of genetic variability and its proper manipulation in creating more efficient population by various means.

New genetical approaches are being constantly developed by scientists for improving the efficiency of plant breeding. In recent years, among other approaches, mutation breeding and development of biotechnology including somatic hybridization and anther culture particularly for breeding self pollinated crop such as wheat (*Triticum aestivum* L.) are frequently used. The new approaches, have opened possibilities of creating genetic variability in crop plants which otherwise might be difficult to obtain through conventional methods.

Plant breeders and the scientists of the twentieth century are, therefore, inclined to radiation as a new tool for plant improvement. By the application of radiation, the mutation rate can be increased several thousand times which speaks itself for the effectiveness and use of it in the field of plant breeding. In addition to this, radiation raises the frequency of occurrence of certain extremely rare types of mutation of special nature, to a level where they can usefully be employed by the plant breeders to achieve results that would not be possible to accomplish by other means. Hassan *et al.* (1986) studied 500 wheat mutants of variety LU-26 developed through the use of induced mutation for resistance to stripe and leaf rusts along with other desirable characteristics. It was observed that mutant lines viz wm-6-17,wm-89-1 and wm-56-1-2 were not only resistant but also exhibit high grain yield, more grains spike^{-1}, more spikelets spike^{-1} and higher values of harvest index than the parent variety. Hassan *et al.* (1988a) 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 tillers plant^{-1}, number of spikelets spike^{-1} and length of the spike. Hassan (1988b) reported that higher doses (35 krad) gamma rays effected the number of grain decrease of 17.2%. 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. Khamankar (1989) observed the effects of gamma radiation on two varieties (Arjun and Kalyansons) of wheat in their M_2 generations. The seeds were treated with 32 KR from CO^{60}. In M_2, plants were selected for grain number spike^{-1} and 1000-grain weight. Evaluation of M_3 families (Arjun and Kalyansona) for 7 yield components revealed a wide range in mean grain number spike^{-1}, 1000-grain weight, tiller number plant^{-1} and single plant yield than untreated control. Some families of both cultivars showed an increase in both 1000-grain weight and grain number spike^{-1} with no change in tillering capacity. Zhu *et al.* (1991) reported variation in heading date, plant height fertile spike plant, number and weight of grain plant^{-1} in two different wheat varieties due to radiation. Song *et al.* (1992) irradiated a wheat variety of genotype (Jiangdu I x St) from CO^{60} source. After selection, they obtained a new variety (8165) which was highly resistant to wheat streak mosaic virus. The new variety so obtained was high yielding and gave as much as 48.1% more yield than that of the control in regions of sever infections. More over it had a growth period of 208-210 days and a 1000 grains weight of 38 g. Ibrahim *et al.* (1993) treated Iraqi wheat with gamma rays dose of 13 KR. With this specific dose they found that weight of 1000 grains, protein contents and yield per unit area become higher than its parent. Wang *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, number of tillers, plant height and other characteristics. Results showed that both irradiation sources had similar significant effects on heading date 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 *et al.* (1999) concluded that radiography is a rapid and non-destructive method which offers the possibility of predicting the filed behaviour of irradiated material.

Therefore 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 for the yield and yield related characters in three different wheat varieties.

MATERIALS AND METHODS

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

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

The dry and pure 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 effect of the different doses of gamma radiation on the on the yield and yield related characteristic of wheat (*Triticum aestivum* L.) of the three varieties were studied in M_1 generation.

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 hectare^{-1} 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 uniformly 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 morphological characters.

1. Number of spikelets spike^{-1}.
2. Number of grains spike^{-1}.
3. 1000-grain weight. (gm)
4. Grain yield (kg ha^{-1}).

Total number of spikelets spike^{-1} were counted from the primary spikes of the selected plants. The number of grains spike^{-1} was determined by considering the primary spike of each selected plant and their seeds were counted carefully. 1000-grain weight of 10 selected plants in each sub plot was determined in grams by using triple beam balance. Grain yield hectare^{-1} was found by harvesting all the plant of each sub plot, cleaning by hand threshing and then weighed by triple beam balance. Grain yield was determined by the formula given below.

$$\text{Grain yield (kg ha}^{-1}\text{)} = \frac{\text{Plant yield (kg)}}{\text{Plot size (m)}} \times 10000$$

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

Numbers of Spikelets spike^{-1}: The differences in the mean values for number of spikelets spike^{-1} in response to different doses of gamma rays were significant (Table 1), ranging from 19.13 to 20.83. The highest mean for number of spikelets spike^{-1} was recorded due to control (20.83). A gradual decrease in the mean values for number of spikelets spik^{-1}e was observed with the increase in the radiation intensity. The mean values due 20, 30 and 35 krad were non-significant. Similarly, mean values due to 10 and 35 krad were also non-significant from that of control. Radiation doses upto 30 krad depressed the number of spikelets spike^{-1} while 35 krad dose produced a stimulative effect on the number of spikelets spike^{-1}. The difference in the mean values due to varieties were also found highly significant and the mean values recorded were 19.29 for Daman-98, 19.58 for Inqilab-91 and 20.38 for Raj. It is obvious from the results in Table 1, that Daman-98, Inqilab-91 and Raj are different significantly form one another.

The differences in the mean values for interaction between varieties and radiation doses were non-significant. The data ranged between 18.30 to 22.15, 17.13 to 20.65 and 19.35 to 21.80 for Inqilab-91, Daman-98 and Raj respectively. These results are in agreement with those of Khamankar (1989) and Song *et al.* (1992), who also reported variation due to gamma rays.

Number of grain spike^{-1}: According to the differences in the mean values for number of grains spike^{-1} in response to varietal effects and radiation doses effects were highly significant while the interaction between varieties and doses was non-significant and the mean values recorded for Inqlab- 91 as 40.80, for Daman -98 as 47.22 and for Raj as 53.54. Raj showed an increase of 23.79 and 11.80% in grains spike^{-1} as compared to Inqlab- 91 and Daman-98. The effect of various radiation doses were also found highly significant. The mean value recorded (Table 2) for radiation effects were ranged between 41.42 to 52.73. By comparing the mean values due to various radiation doses with one another it was observed that the number of grains spike^{-1} was reduced as the radiation doses increased. The maximum (21.44%) decrease in the grains spike^{-1} was observed due to 35 krad as compared to control.

The difference between the mean values due to interaction between varieties and doses were non-significant. The mean value recorded for grains spike^{-1} were ranged from 35.00 to 46.30, 37.50 to 52.05 and 48.10 to 59.85 for Inqilab-91, Daman-98 and Raj respectively. These findings are in-line with those of Hassan *et al.* (1988b) and Wang Guixue *et al.* (1995).

Table 1: Effects of gamma radiation on number of spike lets spike^{-1} in wheat varieties

Radiation Doses (krad)	Varieties Inqilab-91	Daman-98	Raj	Mean
00	20.05	20.65	21.80	20.83A
10	19.00	20.50	21.50	20.33A
20	18.40	19.20	19.80	19.13B
30	18.30	18.98	19.45	18.91B
35	22.15	17.13	19.35	19.54B
Mean	19.58B	19.29B	20.38A	

Table 2: Effects of gamma rays on number of grains spike^{-1} in wheat varieties

Radiation Doses (krad)	Varieties Inqilab-91	Daman-98	Raj	Mean
00	46.30	52.05	59.85	52.73A
10	44.95	51.75	53.40	50.03A
20	35.00	49.00	56.80	46.93C
30	39.10	45.80	49.55	44.82D
35	38.65	37.50	48.10	41.42E
Mean	40.80C	47.22B	53.54A	

Table 3: Effects of gamma rays on 1000- grain weight (gms) in wheat varieties

Radiation Doses (krad)	Varieties Inqilab-91	Daman-98	Raj	Mean
00	43.75	43.25	38.25	41.75A
10	43.50	39.75	37.25	40.17B
20	38.0	40.25	37.00	38.42C
30	35.25	38.25	37.25	35.42D
35	33.60	36.35	31.00	35.65E
Mean	38.82B	39.57A	35.25C	

Table 4: Effects of gamma rays on grain yield (Kg ha^{-1}) in wheat varieties

Radiation Doses (krad)	Varieties Inqilab-91	Daman-98	Raj	Mean
00	3968	3875	3815	3886B
10	4033	4133	3890	4019A
20	3950	3590	3527	3689C
30	3795	3083	3000	3293D
35	2910	2830	2830	2857E
Mean	3731A	3502B	3412C	

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

1000-grain weight (gm): According to the Table 3 differences in the mean values for 1000-grain due to varietal effect radiation doses effect as well as due to interaction between varieties and doses were highly significant. It is clear from (Table 3) that the range of mean values for 1000-grain weight due to radiation doses was 35.65 to 41.75 gms. A simultaneous decrease in the grain weight was noted as the radiation intensity increased. The maximum decrease in the 1000-grain weight was calculated, as 15.16% due to 35 krad dose as compared to the mean value (41.75) of control.

The differences in the mean values due to varieties were also highly significant. The values computed for 1000-grain weight were 38.82, 39.57 and 35.25 gms for Inqlab-91, Daman-98 and Raj respectively. The increase in 1000-grain weight was of 23.2 and 15.95% for Inqilab-91, Daman-98 respectively as compared to the mean values of Raj.

The effects of interaction between varieties and doses was also found to be highly significant. The mean values presented in Table 3, showed the range of 33.60 to 43.75 for Inqilab-91, 36.35 to 43.25 for Daman-98 and 31.00 to 38.25 for Raj, respectively. Reduction for 1000-grain weight due to 35 krad dose were 23.2, 15.95 and 18.95% for Inqlab-91, Daman-98 and Raj respectively, as compared to their mean values of their respective controls. In general, gradual decrease appeared in the 1000-grain weight of each variety with increase in radiation intensity.These findings are inline with those of Galal *et al.* (1975), Hassan *et al.* (1986) and Zhu *et al.* (1991).

Grain yield (kg ha^{-1}): According to the data regarding to grain yield (Kg ha^{-1}) indicates that the results obtained due to varietal effects as well as due to gamma radiation doses effects were highly significant. The difference in the mean values due to interaction between varieties and doses was also significant. Table 4 indicates that the differences in the mean values due to varietals effects were highly significant. The values obtained were 3731, 3502 and 3412 Kg for Inqlab-91, Daman-98 and Raj respectively. The increases in grain yield (Kg ha^{-1}) for Inqilab-91 were 6.13 and 8.54% as compared to the mean values of Daman-98 and Raj, respectively.

It is clear from the (Table 4) that the differences in the mean values in response to various radiation doses were highly significant. The mean values recorded for doses effect ranged from 2857 to 4019 Kg ha^{-1}. By comparing the mean values in response to various radiation doses with one another, it was observed that grain yield was decreased by all the doses except 10 krad dose which exceeds than control. A maximum increase in grain yield (Kg ha^{-1}) of 3.30% was recorded in case of 10 krad as compared to the mean value of control. The decrease in grain yield (Kg ha^{-1}) due to 35 krad was recorded as 24.47% as compared to the mean value of control.

The effects of interaction between varieties and doses of gamma rays were found significant. Table 4 indicated that the mean values ranged between 2910 to 4033, 2830 to 4133 and 2830 to 3890 for Inqlab-91, Daman-98 and Raj, respectively. The maximum decrease in the mean values for yield (Kg ha^{-1}) due to 35 krad dose in comparison to their respective controls was 27.84, 31.52 and 27.24% for Inqlab-91, Daman-98 and Raj, respectively. While the increase in the mean values for grain yield (kg ha^{-1}) due to 10 krad dose in comparison to their respective control was recorded as 1.16, 6.24 and 1.92% for Inqlab-91, Daman-98 and Raj, respectively. In general all the doses decreased the grain yield except 10 krad dose which produced stimulative effect and increased grain yield (Kg ha^{-1}) in all the three varieties. These find are quite in conformity with those of Muhammad *et al.* (1986), Song *et al.* (1992) and Perez *et al.* (1999) who also reported variation due to gamma radiation.

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