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Effect of Gamma Irradiation on Some Morphological Characteristics of Three Wheat (*Triticum aestivum* L.) Cultivars

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Abstract: Wheat cultivars Pirsabak-91 (P-91), Khyber-87 (K-87) and Tarnab-78 (T-78) were irradiated with 10kR, 20kR, 30kR and 40kR doses of gamma irradiation. The cultivars showed significant reduction in plant height, survival percentage & 1000-grain weight under the influence of high gamma rays doses (30kR & 40kR) excepting days to germination. Germination of all the cultivars was significantly delayed in response to all the gamma rays doses and low dose (10kR) increased the plant height in case of Pirsabak-91. Higher gamma rays doses (30 & 40kR) also created abnormalities in plant height. All the cultivars responded differently to different gamma rays doses with respect to some of the characters.

Key words: Gamma rays, wheat cultivars, morphological characteristics

Introduction

Due to limited genetic variability among the existing wheat genotypes, Muller (1927) & Stadler (1928) opened a new era for crop improvement and now mutation induction has become an established tool in plant breeding that can supplement the existing germplasm and can improve cultivars in certain specific traits as well. The beneficial mutations so created can either be used as such or the genes so produced may be incorporated into otherwise good commercial cultivars which are lacking in that character. The natural mutation rate is very low and the naturally originating positive mutants are always so scanty that time, labour and experimental area required for their collection would be unreasonably great. Radiation, on the other hand, raises the frequency of occurring certain rare types of mutants of special nature to a level where they can usefully be employed by the plant breeder to achieve the results that would not be possible to be accomplished by other means. Mackey (1954) reported some beneficial radiation induced mutants in wheat with increase straw strength, resistance to stem rust and slightly earlier maturity. Nayeem *et al.*(1999) found nine irradiationally induced mutants in wheat with improved pattern of water soluble protein (glutenin) that could be used successfully as breeding material for the improvement of protein quality in bread wheat. Reddy and Viswanathan (1999) induced rust resistance in hexaploid wheat variety "WH 147" by using gamma rays and EMS. In the light of these encouraging results, the study was made to determine the proper dose of gamma irradiation for the induction of beneficial mutations in wheat.

Materials and Methods

Pure dry seed of Pirsabak-91 (P-91), Khyber-87 (K-87) and Tarnab-78 (T-78) was irradiated with 10, 20, 30, and 40 kR doses of gamma rays from ^{60}Co gamma source at Nuclear Institute For Food and Agriculture NIFA (Peshawar). Unradiated seeds of each cultivar served as control. Field experiment was conducted at Agriculture research Station Sarai Naurang (Bannu). The M_1 material was raised on a plot of size 360 m^2 (net) under split plot design. Each replication was divided into three plots and each plot in turn was subdivided into five subplots for randomization of the cultivars and doses respectively. Each subplot (60 m^2) was consisted of four rows with 50 seeds in each. Plant to plant & row-to-row space was 10 & 20 cm respectively. For data collection of different parameters, ten plants in each subplot were selected at random. The data were recorded for days to germination, survival percentage, plant height and 1000 grains weight and statistically analyzed (Steel and Torrie 1980) for all the levels of significance. For significant F ratios, New Duncan's Multiple Range Test (Leclarg *et al.*, 1963) was applied for comparison among the treatments means.

Results and Discussion

Days to germination: Significant differences in the mean values were observed for days to germination in response to different gamma rays doses for all the cultivars. By comparing the effect of various radiation doses, it was observed that all the doses slightly delayed the germination (Table 1). Pirsabak-91 took 1% more days to germination as compared to Khyber-87 and Tarnab-78. Whereas, the two later cultivars showed no significant difference for the character as evident from the capital alphabets in front of the cultivars means (Table 1). The mean values for interaction between cultivars and doses ranged from 11.2-17 for Khyber-87 & Tarnab-78. The maximum increase in days to germination was 5.5, 6.2 and 6% for P-91, K-87 and T-78 respectively. In general it was noted that germination was delayed with the increase in the radiation intensity. The results coincide with those of Matsumura (1959), Horvat (1961) and Muhammad (1962) who observed delay in germination in wheat species after treatment with gamma rays and x-rays.

Survival percentage: Non significant differences were observed in the mean values for survival percentage of different cultivars under the influence of the same dose as evident from the small alphabets (Table 2). However, highly significant differences were observed in the mean values for survival percentage for all the cultivars in response to different doses as evident from the capital alphabets in front the cultivars means (Table 2). The mean values ranged in descending order between 84.7-54.5, 81.30-53.1 and 82.4-54.2 for Pirsabak-91, Khyber-87 and Tarnab-78 respectively. The most drastic decrease in percentage survival in comparison to control was 54.5, 53.1 and 53.2% for Pirsabak-91, Khyber-87 and Tarnab-78 respectively. In general all the doses adversely affected the survival of all the cultivars. The results recorded are in agreement to those of Matsumura (1959), Masayuki (1970), Khan and Bari (1971) and Chaudary (1983) who advocated that increase in the radiation intensity is associated with the decrease in survival.

Plant height (cm): Non significant differences in average plant height (cm) were observed due to interaction between varieties and doses between Pirsabak-91 and Khyber-87. However, Tarnab-78 revealed slight deviation for the character under the influence of 10 kR dose. Significant differences were observed in the mean values under the influence of irradiation doses for wheat cultivars (Table 3). The average plant height ranged from 86.2-71.2, 89.5-77.5, 96.8-77.5 (cm) for Pirsabak-91, Khyber-87 and Tarnab-78 respectively.

Table 1: Effect of gamma irradiation on days to germination of wheat cultivars

Radiation doses (kR)	Cultivars			Mean
	Pirsabak-91	Khyber-97	Tarnab-78	
00	11.5efg	102.g	11fg	10.9E
20	12.5def	11.2fg	12def	11.9D
30	13.7cd	13.5cd	13cde	13.3C
30	14.7ab	14.5bc	15ab	15.2B
40	15a	16.5a	17a	16.8A
Mean	14.6A	13.2B	13.7B	-----

Mean values sharing same letters are not significantly different according to DMRT. Capital letters indicate significance at 5% level of probability

Table 2: Effect of gamma irradiation on survival percentage of wheat cultivars

Radiation doses (kR)	Cultivars			Mean
	Pirsabak-91	Khyber-97	Tarnab-78	
00	97.7a	95.5a	92.2a	96.4A
20	84.7b	81.3b	82.4b	82.8B
30	70.2c	70.1c	71.1c	70.4C
30	62.0d	61.3d	61.0d	61.5D
40	54.5e	53.1e	54.2e	53.9D
Mean	78.3C	72.2C	72.9C	------

Mean values sharing same letters are not significantly different according to DMRT. Capital letters indicate significance at 5% level of probability

Table 3: Effect of gamma irradiation on plant height (cm) of wheat cultivars.

Radiation doses (kR)	Cultivars			Mean
	Pirsabak-91	Khyber-97	Tarnab-78	
00	85.5bcd	89.5abc	86.8a	90.4A
20	86.2bcde	86.8bcde	95.1a	89.3B
30	84.2cdef	80.3def	92.0ab	58.5C
30	48.3cdef	79.2efg	79.2def	86.9D
40	71.2h	77.5fgh	78.5fg	75.6E
Mean	79.9C	82.6B	88.4A	------

Mean values sharing same letters are not significantly different according to DMRT. Capital letters indicate significance at 5% level of probability

Table 4: Effect of gamma irradiation on 1000-grain weight of cultivars.

Radiation doses (kR)	Cultivars			Mean
	Pirsabak-91	Khyber-97	Tarnab-78	
00	42.2a	41.7a	36.7bcd	40.2A
20	42.0a	38.3bc	35.7de	38.6AB
30	36.5bcd	37.1c	35.5de	36.3C
30	33.7ef	36.7cd	31.2gh	33.8CD
40	32.0fg	34.7e	29.5i	32.0DF
Mean	37.2AB	37.7AB	33.7CD	------

Mean values sharing same letters are not significantly different according to DMRT. Capital letters indicate significance at 5% level of probability

The maximum reduction in plant height occurred at 40 kR dose for all the cultivars. By comparing the mean values of different irradiation doses with control, it was observed that the average plant height (cm) was decreased with the increase in the radiation intensity except for 10 kR in Pirsabak-91, which slightly increased (86.2 cm) over the control (85.5 cm). So all the doses adversely affected the average plant height. Plant height was inversely proportional to the increase in the radiation intensity. The results correspond to those of Froier (1954), Abrams (1957), Sen and Joshi (1958) and Zhu *et al.* (1991).

1000-grain weight (gm): The differences in the mean values were highly significant due to cultivar effect, radiation doses and due to interaction between cultivars and doses (Table 4). Under the influence of different irradiation doses, the range of the mean values for 1000-grain weight (gm) was 42-32, 38.2-34.7 & 36.7-29.5 for Pirsabak-91, Khyber-87 and Tarnab-78 respectively. A simultaneous decrease in the mean values for the character was observed due to increase in the radiation intensity. The maximum decrease in 1000-grain weight (gm) was 24.2% in response to 40kR dose as compared to control. The differences in the mean values due to cultivars effect were highly significant and were in the range of 40.2-32.9 (Table 4). In general, all the irradiation doses produced negative effect on 1000-grain weight (gm). The present results coincide with those of Dumanovic and Denic (1967), Masayuki (1970), Galal *et al.* (1975) and Khalil *et al.* (1986). However, the results achieved by Fowler and Macqueen (1972), Khamankar (1989), and Zhu *et al.* (1991) don't agree with present results. Such type of controversy might be due to the agro-climatic conditions under which the experiment was conducted or due to the genetic background of the cultivars used. Minimum germination and survival was observed in response to 30 & 40kR doses of gamma irradiation. Germination of all the varieties was delayed in response to all the doses of gamma irradiation. It was observed in general that doses of higher level might cause deleterious effects on different characteristics.

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