Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

European Journal of Experimental Biology, 2015, 5(7):6-11

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Assessment of the effects of gamma radiations on various morphological and agronomic traits of common wheat (*Triticum aestivum* L.) var. WH-147

Mushtaq Ahmad Khah[1] and Rakesh Chandra Verma[2]

Cytogenetics Laboratory, School of Studies in Botany, Vikram University, Ujjain, India

ABSTRACT

The aim of the present study was to assess the effects of different doses of gamma radiations on various morphological and agronomic traits of common wheat in order to identify the most effective radiation dose which can be applied for successful mutagenic research studies. For this purpose, dry and healthy seeds of 'WH-147' bread wheat cultivar were exposed to different doses of gamma radiations (5, 10, 15, 20, 25 and 30 kR) at the Bhabha Atomic Research Center (BARC), Mumbai. All the traits studied showed a gradual decrease in their mean values with the increasing intensity of gamma radiations except in 15 kR at which spike number per plant and seed weight showed some increment over the control sets. It has been concluded from the study that higher radiation doses (25 kR and 30 kR) have reduced mean values and increased quantitative variability for most of the traits studied which could be successfully employed in mutation breeding for the improvement of this important cereal crop.

Key words: *Triticum aestivum,* common wheat, gamma radiation, mutations

INTRODUCTION

Ionizing radiations have been most successfully used for crop improvement through induced mutagenesis. Determination of optimum dose, radiosensitivity and treatment conditions are most essential for genetic manipulation through induced mutation. Mutation breeding makes extensive use of deviations from the norms to improve the characteristics of many important crops including wheat. Induced mutagenesis is a significant tool to break through the limitations of variability and to create variability in a short period of time. For the induction of mutations in breeding programs, determining the most suitable doses of physical and chemical mutagens is important. High doses induce physiological injuries which causes death of a plant. Therefore, most effective dose which will induce high variability at morphological as well as genetic level but did not produce more than 50 % lethality of plants is the main and most important goal of the mutation studies.

Wheat is the world's largest and most important food crop for direct human consumption after rice and maize. In India, it is the second major food crop after rice [1]. Wheat is a staple food for 40% (nearly half) of the world's population, mainly in Europe, North America and the western and northern parts of Asia, occupying 17% (one sixth) of the crop acreage worldwide and providing 20% (one fifth) of the total calories and protein in human nutrition [2]. Hence, its future genetic improvement as a high quality nutritional food is a paramount for feeding the everincreasing human population. Induced mutagenesis is an efficient method for the induction of morphological and genetic variabilities in plants [3]. The induction of mutation has been accepted as a useful tool in the plant breeding program. One of the chief advantages of mutation breeding is its ability to improve a single feature in a variety without significantly altering the otherwise desirable make up of agronomic characters.

Physical mutagens (such as X-rays and gamma rays) have recently received much attention as the most effective mutagenic agents in higher plants. Hundreds of useful mutants have been induced for various plant characters in a variety of crops including wheat through physical and chemical mutagens [1, 4,5, 6, 7]. Nayeem [8] found nine irradiationally induced mutants in wheat with improved pattern of gluten protein that could be used successfully as breeding material for the improvement of protein quality in bread wheat. In addition, Reddy and Viswanathan [9] induced stem rust resistance in hexaploid wheat variety “WH 147” by using gamma rays and EMS.

Thus, keeping the above encouraging results in mind, the present study was conducted to determine the effects of different doses of gamma radiations on various quantitative traits in M1 generation of common wheat in order to identify the most effective dose for further mutation studies. The present study also aimed in inducing additional as well as beneficial genetic variability of this crop which will be successfully used for further mutagenic research studies and improvement in the future.

MATERIALS AND METHODS

1.1. Plant material

“WH-147” bread wheat cultivar has been used in the present study. Five hundred dry seeds of this bread wheat cultivar were subjected to gamma rays at Bhabha Atomic Research Center, Mumbai with the treatment doses 5, 10, 15, 20, 25 and 30 kR. After irradiation, ninety seeds of each dose were then sown in pots with ten seeds in each pot. Data was calculated by taking the random plant samples for each trait. Data on morphological and agronomic traits such as seed germination, plant survival, seedling height, spike number per plant, spikelet number per plant, seed number per plant and seed weight has been recorded and compared with control.

The data on seed germination was recorded right from the emergence of first shoot in each treatment including control. Germination percentage was determined by counting the seedlings emerged in each pot per total number of seeds sown, multiplied by hundred.

1.2. Plant height (cm)

Seedling height was estimated on 12th day of germination by measuring the irradiated and non-irradiated of 25 randomly selected sample seedlings from each treatment. The height was measured from the base of the plant to the tip of flag leaf.

For collecting the data of the other parameters, the sample plants of each treatment were randomly selected and the recorded data was subjected to statistical analysis to assess the extent of induced variations. Standard deviation was computed by applying the following formula

$$SD = \sqrt{\frac{1}{n}\sum\left(X_i - \overline{X}\right)^2}$$

Where $\overline{X}$= Mean of observations involved
X_i = Observations
n = Number of observations

RESULTS AND DISCUSSION

1.3. Effect of gamma radiations on seed germination: The seed germination was observed higher in control when compared with the treated plants (Fig-1). After the data was compared, it was observed that with the increasing dose, there is decrease in not only germination percentage but delay in the germination time also. Maximum decrease in seed germination (74.44%) was noted in 30 kR of radiation dose (Table-1). The lower doses did not show much effect on the percentage of seed germination. The results also coincide with those of Borzoueiet*al.,* [7], Chaudary [10], Irfaq and Nawab [11, 12] and Din *et al.,* [4, 13] who observed progressive decrease and delay in the germination in wheat genotypes after treated with various gamma rays. Reduced germination percentage with increasing doses of gamma radiations has also been reported in Rye [14] and Chickpea [15, 16]. The decrease in seed germination at higher doses may be attributed to disturbances at cellular as well as physiological levels.

Table 1: The percentage of seed germination, plant survival and plant height in M_1 generation of common wheat after different doses of gamma radiations

Treatment dose	Number of seeds sowed	Seed Germination			Plant Survival		
		No.	%age	R.V.*	No.	%age	R.V.
Control	90	84	93.33	100.00	81	96.43	100.00
5kR	90	82	91.11	97.62	78	95.12	98.64
10kR	90	79	87.77	94.04	75	94.93	98.44
15kR	90	77	85.55	91.66	73	94.80	98.31
20kR	90	74	82.2	88.09	68	91.89	95.29
25kR	90	70	77.77	83.32	63	90.00	93.33
30kR	90	67	74.44	79.76	59	88.05	91.31

** R.V. = Relative value*

Table 2: The spike number, spike length, spikelet number, seed number per spike, and 100 seed weight in M_1 generation of common wheat against different doses of gamma rays

Treatment Dose	Plant Height (cm)			Spike number/plant			Spike length (cm)			Spikelet number/Plant			Grain number/plant			100 grain weight (gm)		
	Mean	±SD	CV	Mean	±SD	CV	Mean	±SD	CV	Mean	±SD	CV	Mean	±SD	CV	Mean	±SD	CV
Control	15.86	±2.13	13.43	3.45	±1.23	35.78	11.21	±2.43	21.68	16.05	±4.21	26.23	26.20	±7.91	30.22	6.35	±0.51	8.06
5kR	14.36	±2.73	19.05	3.35	±1.38	41.40	10.41	±2.23	21.49	15.55	±4.16	26.75	22.65	±7.02	31.03	6.17	±0.45	7.34
10kR	13.39	±2.75	20.59	3.15	±1.18	37.52	9.82	±2.07	21.12	13.9	±3.75	27.00	21.95	±6.80	30.98	5.84	±0.13	2.29
15kR	10.86	±2.36	21.78	4.15	±1.46	35.20	7.72	±2.10	27.27	11.05	±3.21	29.13	18.8	±6.06	32.26	6.83	±0.30	4.45
20kR	9.32	±2.00	21.52	2.2	±1.19	54.38	7.15	±1.85	25.88	10.05	±2.94	29.31	16.7	±7.55	45.23	5.26	±0.59	11.22
25kR	7.30	±3.43	47.09	1.95	±1.27	65.45	6.19	±0.82	13.37	8.7	±2.36	27.17	9.6	±4.67	48.67	5.0	±0.58	11.64
30kR	5.95	±3.07	51.65	2.1	±1.58	75.53	4.56	±1.52	33.32	6.4	±2.11	33.00	5.55	±5.53	99.63	4.48	±0.55	12.36

SD = Standard Deviation; CV = Coefficient of Variation

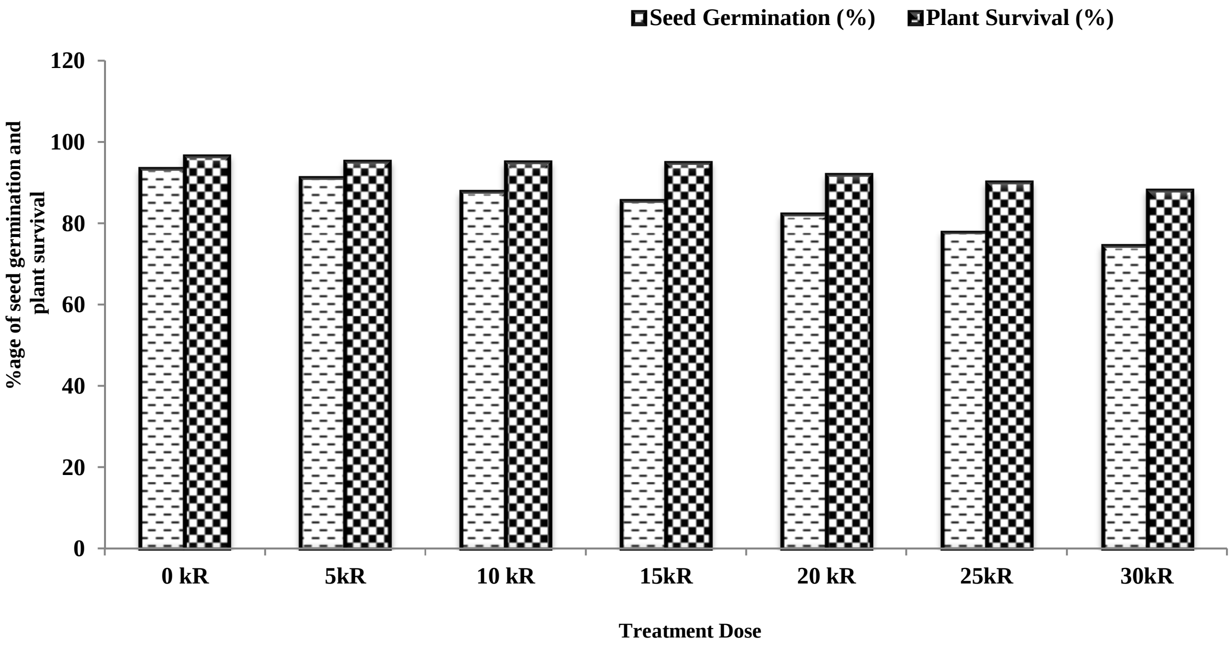

Figure-1: Effect of gamma radiations on seed germination and plant survival in M_1 generation of common wheat

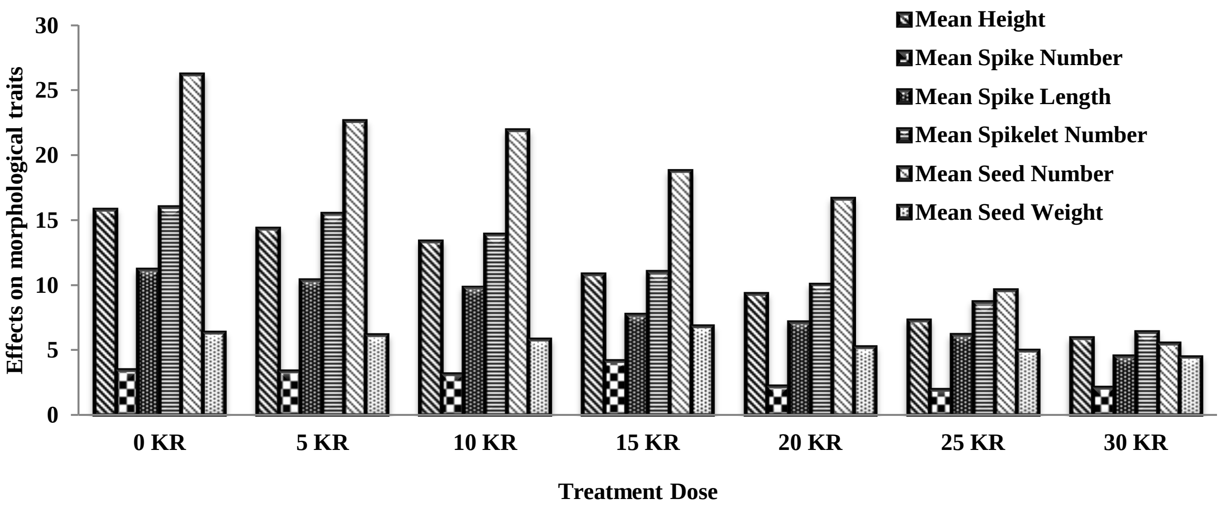

Figure-2:- Effect of gamma radiations on various morphological traits in M_1 generation of common wheat

1.4. Effect of gamma radiations on plant survival: According to the data, the percentage of plant survival decreased with the increasing intensity of gamma radiation (Fig-1). The survival percentage was found 96.43% in control which decreased consequently to 88.05% at 30 kR radiation dose (Table-1). The remaining doses also showed slight decrease in the survival percentage with respect to the control. The results are in accordance with the studies of Chaudhary [10], Irfaq and Nawab[11, 12] and Khan and Bari [17] who observed the consistent decrease in survival percentage with the increasing intensity of gamma radiations. The results of Koing*et al.*, [18] have shown that survival of plants to maturity depends on the nature and extent of chromosomal damage. The increase in the frequency of chromosomal damage with increasing radiation dose may be responsible for reduction of plant survival in the present investigation.

1.5. Effect of gamma radiations on plant height (cm): Plant height is widely used as an index in determining the biological effects of various physical mutagens. In the present investigation, the average plant height was observed higher in control population (15.86 cm) and gamma rays decreased this average height to 5.95 at the 30 kR radiation dose (Table-2). All the doses showed decrease in the average plant height and showed inverse proportionality to the radiation intensity (Fig-2). Din *et al.* [13] conducted radiosensitivity on five wheat genotypes irradiated with 15, 25, 35 and 45 kR doses of gamma rays, where they observed significant decrease in plant height with the increasing doses of gamma rays in all the genotypes studied. The results also showed the co-linearity with the studies of Chaudhary [9], Irfaq and Nawab [11, 12],Ghafoor and Siddiqui [19], Hassan [20] and Zhu *et al.*,[21] who observed almost negative effects on most of the parameters of wheat as a result of higher doses. The irradiation of seeds with high doses of gamma rays disturbs the synthesis of protein, hormone balance, leaf gas-exchange, water exchange and enzyme activity which may the possible causes of adverse effects of gamma radiations on plant height in the present investigation.

1.6. Effect of gamma radiations on spike number: The mean values for spike number differed significantly under the influence of different doses of gamma radiations (Fig-2) and it ranged from 3.45 to 1.95 in control and 25 kR treated plants respectively (Table-2). In the present investigation, it was observed that radiations, in general, reduced the average spike number in all the cases except at 15 kR treatment where the trait showed some improvement (4.15) over the control (Table-2). Irfaq and Nawab [12] observed the stimulatory effect of all the doses of gamma rays on the number of tillers per plant except at 100 GY which produced slight decrease in the character. Similar results were observed by many other workers such as Ghafoor and Siddiqui [19], Davies [22] and Khamankar [23]. However, Din *et al.*, [13] reported quite opposite results and observed an adverse effect of radiation on the average spike number per plant which was also supported by many other previous studies [20, 24].

1.7. Effect of gamma radiations on spike length (cm): The average spike length in M_1 generation has shown a regular shift towards a negative direction (Fig-2) in treated plants with the highest being observed in control (11.21) and lowest in 30 kR (4.56) of radiation treated plants (Table-2). The mean spike length showed a gradual decrease with the increasing intensity of gamma radiations. The present findings were also in agreement with the Irfaq and Nawab [12], Molle [25], Larik*et al.*, [26] and Khalil *et al.*, [27]in which they have shown that gamma rays induced the almost significant decrease in the average spike length with respect to the control.

1.8. Effect of gamma radiations on spikelet number: In present investigation, the mean number of spikelets showed consistent decrease with the increasing dose of gamma rays. The highest average value of number of spikelets per spike was noted in control population (16.05) and the lowest mean value was observed in plants treated with 30kR (6.4) of gamma radiations (Table-2). The present investigation also shows co-linearity with the studies of Khan *et al.*, [5], Irfaq and Nawab [12], Larik*et al.*, [26] and Galal*et al.*, [28] in which they observed significant decrease of spikelet number in nearly all the radiation doses.

1.9. Effect of gamma radiations on grain number: The average values of grains per spike were reduced from that of control spikes (Table-2). The highest mean value for grains per spike was noted in control plant groups (26.20) with the progressive decrease in all the radiation treated plant groups (Table-2). The present findings are in agreement with the studies of Khan *et al.*, [5], Irfaq & Nawab [12] and Galal*et al.*, [28]who observed the regular decrease in the trait with the increasing intensity of gamma radiations.

1.10. Effect of gamma radiations on 100 grain weight: The present study observed the negative effects on average weight of grains in nearly all the cases of gamma rays doses except at 15 kR where the grain weight showed some increment over the control. A simultaneous decrease in the mean values for the trait was observed due to increase in radiation intensity. The maximum decrease in the average values of grain weight was observed at 30 kR of radiation dose (4.48) with respect to control (Table-2).In general, all the radiation doses showed adverse effects on the grain weight. The present results are in agreements with the findings of Irfaq and Nawab [11] and Khalil *et al.*, [27]who observed almost adverse effects on average seed weight. However, Ainmasaun *et al.*, [29] observed increase in the average 100 grain weight at 80 GY of radiation dose as it was found at 15 kR radiation dose in the present study. Such type of contradiction might be due to either differences in genetic material under study or due to agro-climatic variations under which the experiment was carried out.

CONCLUSION

Generally, retardation of morphological and growth parameters is one of the most common responses of plant subjected to ionizing radiation. The favorable gamma rays dose in the present study was found to be 15kR, which produced the stimulatory effect on the tiller number and seed weight suggesting that it could be successfully used in the future for its improvement.

REFERENCES

[1] SinghNK,BalyanHS,*Advances in Biological Research*,**2009**, 3, 215-221
[2] PelegZ, FahimaT, KorolAB, AbboS, SarangaY, *Journal of Experimental Botany*,**2011**, 62, 5051-5561.
[3] VermaRC, ShrivastavaP, *Cytologia*, **2014**, 79, 541-545
[4] DinR, KhanMM, QasimM, JehanS, KhanMI,*Asian J. Plant Sci.*,**2003,** 2, 1179-1182.
[5] KhanMM, DinR, QasimM, JehanS, IqbalMM, *Asian J. Plant Sci.*,**2003**, 2, 1183-1187.
[6] NjauPN, KinyuaMG, KimurtoPK, OkwaroHK, MaluszynskiM, *J. Agri., Sci. and Tech.*,**2005**, 7, 18-29.
[7] BorzoueiA, KafiM, KhazaeiH, NaseriyanB, MajdabdiA, *Pak. J. Bot*.,**2010**,42, 2281-2290.
[8] NayeemKA, DevokuleSN, BhagwatSG, *Indian J. Gen. Plant Breed.*,**1999**, 59, 371-373.
[9] ReddyVRK, ViswanathanP, *Crop research*,**1999**, 18: 443-445.
[10] ChoudhryRK, *Wheat Information Sci.*,**1983**, 57, 21–3.
[11] IrfaqM, NawabK, *Int. J. Biol. Sci.*,**2001**, 1, 935-937.
[12] IrfaqM, NawabK, *Asian J. Plant Sci*.,**2003**, 2, 999-1003.
[13] DinR, QasimM, AhmadK, *Int. J. Agr. & Biol.*,**2004**, 6, 898-900.
[14] Akgun I, Tosum M, *Pak. J. Biol. Sci.*,**2004**, 7, 827-833.
[15] KhanMR, QureshiAS, SyedAH, IbrahimM, *Pak. J. Bot.*,**2005**, 37, 285-292.
[16] TokerC, UzenB, CanciH, CeylanFO, *Radiation Physics and Chemistry*,**2005**, 73, 365-367.
[17] KhanAH, BariG, *Pak. J. Sci.*,**1971**, 23, 236-239.
[18] KiongA, Ling PickA, Grace LaiSH, HarunAR, *Am-Eurasian J. Sustain. Agric.*, **2008**, 2, 135-149

[19] GhafoorA, SiddiquiKA, *Pak. J. Bot.*, **1976**. 8, 1–7
[20] HassanS, *Sarhad J. Agric.*,**1986**, 2, 173–9.
[21] ZhuXD, ZhangZ, WangGW, *J.S.W. Agri. Univ.*,**1991**, 13, 421-423
[22] DaviesCR, *Rad. Bot.*,**1970**, 10, 19-27.
[23] KhamankarYG, *PVK. Res. J.*,**1989**, 13, 1-5
[24] MilladoZ, TrajiloMA, MendozozFR, *Agro. Sci.*,**1972**, 8, 41–65.
[25] MolleKrG, *International Journal of Applied Radiation and Isotopes*,**1965**, 16, 397-404
[26] LarikAS, SiddiquiKA, SoomroAH, *Pak. J. Bot.*,**1980**, 12, 31-41
[27] KhalilSJ, RehmanS, AfridiK, JanMT, *Sarhad J. Agri.*, **1986**, 2, 45-54
[28] GalalS, IbrahimJrAF, AbdulhamidAM, MahmoodIM, *Z. Plfanzenzuchtg*,**1975**, 74, 189-198.
[29] AnimasaunDA, MorakinyoJA, MustaphaOT, *J. Appl. Biosci.*,**2004**, 75, 6164-6172.