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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 7 (6): 981-983, 2004
ISSN 1028-8880

Effect of Gamma Radiation on Growth and Yield of Barley under Different Nitrogen Levels

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Abstract: An experiment was conducted at Cereal Crops Research Institute Pirsabak Nowshera during 2000-01 to study the effect of gamma radiation at the rate of 10, 20 and 30 Krads on growth and yield of barley fertilized with 30,60 and 90 kg ha^{-1} of nitrogen. Nitrogen was applied in split doses at sowing and tillering stages with 100 kg ha^{-1} of Single Super Phosphate (SSP) as a basal dose. Nitrogen significantly increased plant height, straw yield, 1000-grain weight and grain yield. The application of 90 kg N ha^{-1} produced 3875 kg of grain and 13667 kg ha^{-1} straw yield. Irradiation had positive effects on grain yield with maximum production at the rate of 10 krads of gamma rays. An increase in straw yield was also observed with increase in radiation doses, where maximum straw yield was recorded with 30 krads of radiation. Moreover, spike length and 1000-grain weight were also significantly increased with radiation. The interaction of both variables in most cases was significant with positive relation ships with the characters studied in the experiment.

Key words: Gamma radiation, barley, nitrogen, 1000-grain weight

INTRODUCTION

Induced mutations, in the recent years, have been successfully employed for the improvement of many important field crops. Gamma rays have been proved economical and effective as compared to other ionizing radiations because of its ease in availability and power of penetration. This penetration power of Gamma rays helps in its wider application for the improvement of various plant species. Goswami[1] reported an increase in number of spikes at lower doses of radiations. Seisbaev *et al.*[2] reported increase in spike length with gamma radiation.

Of the macro nutrients usually applied in commercial fertilizers, nitrogen has the quickest and most pronounced effect. It encourages above ground vegetative growth, increases the plumpness of the grains and acts as growth regulator, which may govern the utilization of potassium and phosphorus etc. Moreover, its application tends to produce succulence, a quality particularly desirable in crops used as feed for animals. Misra *et al.*[3] concluded from there study that the application of 50 kg N ha^{-1} significantly increased and spike length. Similarly, Siddique *et al.*[4] and Ockays[5] reported that higher doses of nitrogen increased grain yield significantly compared to control.

Evolution of barley possessing high yield potentials, stability of performance and better nutritive properties will be a major step in solving good and feed problems, of the country. The objective of this study was to explore the possibility of increasing forage and grain yield of barley with different radiation doses and nitrogen levels.

MATERIALS AND METHODS

An experiment was conducted under irrigated conditions during 2000-01 at Cereal Crops Research Institute Pirsabak Nowshera to study the effect of gamma radiations and nitrogen doses on growth and yield of barley cultivar 'Frontier-87'. Experiment was conducted in randomized complete block design with spit plot arrangement. The treatments were barley irradiated with different doses of gamma rays as main plots and different nitrogen doses as the sub plots. Main plot and sub plot sizes were 1.8 by 22 and 1.8 by 5 m, respectively.

Dry seed of barley were subjected to gamma radiation at the rates of 10, 20 and 30 krads. Nitrogen (N) as urea was applied to the field at the rates of 30,60 and 90 kg ha^{-1} to the sub plots of 1.8 by 5 m. Radiation doses were allotted to main plots of 1.8 by 22 m. Recommended dose of phosphorus (P) at the rate of 100 kg ha^{-1} was applied as a basic dose before sowing to all the plots. Planting was done on October 30, 2000 in 6 rows with a distance of 30 cm between rows in subplots. Data on plant height and spike length were gathered before crop harvest. Crop was harvested on April 15, 2001 and 1000 grain weight, grain and straw yields were recorded after crop harvest in an area of 3.6 m^2. Statistical analyses were conducted according to appropriate method for split plot design. Mean of different treatments were separated by Duncan's Multiple Range test at P=0.05, where appropriate Steel and Torrie[6].

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RESULTS AND DISCUSSION

Plant Height: The results of the effect of gamma radiation on plant height (Table 1) indicated an increase in plant height with increasing nitrogen doses. Tallest plants were observed in plots to which the highest dose of 90 kg ha^{-1} was applied. Plant height probably increased because of nitrogen which stimulated and increased the vegetative growth. These results were in conformity with those of Latif and Salamah[7] who reported similar increases with increasing nitrogen doses. There was however, a decreasing trend in plant height with increasing radiation doses. Shortest plants were observed in plots to which 30 krads of radiation was applied. Khalil *et al.*[11] and Savov and Krapecheu[8] reported similar findings.

Table 1: Effect of gamma radiation on plant height (cm) at maturity of barley under different levels of nitrogen

Gama Radiation	Nitrogen kg ha^{-1}				Mean
Krads	Control	30	60	90	kg ha^{-1}
Control	94	94	104	106	99.29
10	93	96	100	103	97.95
20	86	92	102	102	95.61
30	90	93	97	101	95.51
Mean	90.87c	93.89b	100.62a	102.97a	

Any two means not sharing a letter in common are significantly different, using Duncan's multiple range test

Table 2: Effect of gamma radiation on spike length (cm) of barley under different levels of nitrogen

Gama Radiation	Nitrogen kg ha^{-1}				Mean
Krads	Control	30	60	90	kg ha^{-1}
Control	5.37	5.45	5.63	5.55	5.50 b
10	5.60	5.57	5.66	5.62	5.61 ab
20	5.58	5.93	5.63	5.88	5.76 a
30	5.78	5.53	5.69	6.14	5.79 a
Mean	5.58	5.62	5.65	5.80	

Any two means not sharing a letter in common are significantly different, using Duncan's multiple range test

Table 3: Effect of gamma radiation on 1000 grain weight (gm) of barley under different levels of nitrogen

Gama Radiation	Nitrogen kg ha^{-1}				Mean
Krads	Control	30	60	90	kg ha^{-1}
Control	48	49	50	50	49b
10	49	49	52	52	51ab
20	51	52	51	53	52ab
30	53	53	55	52	53a
Mean	50	51	52	52	

Any two means not sharing a letter in common are significantly different, using Duncan's multiple range test

Table 4: Effect of gamma radiation on straw yield Kg ha^{-1} of barley under different levels of nitrogen

Gama Radiation	Nitrogen kg ha^{-1}				Mean
Krads	Control	30	60	90	kg ha^{-1}
Control	10111	7194	12250	12361	10472b
10	9500	9917	10861	12806	10778ab
20	8361	11167	13361	13333	11555ab
30	11028	11972	11277	16167	12861a
Mean	9750c	10062c	12187b	13667a	

Any two means not sharing a letter in common are significantly different, using Duncan's multiple range test

Table 5: Effect of gamma radiation on grain yield (Kg ha^{-1}) of barley under different levels of nitrogen

Gama Radiation	Nitrogen kg ha^{-1}				Mean
Krads	Control	30	60	90	kg ha^{-1}
Control	3407	3222	4056	4972	3917a
10	2833	3278	3722	4278	3528ab
20	1889	2889	3278	3500	2889bc
30	18065	2250	2472	2750	2319bc
Mean	2486d	2910c	3382b	3875a	

Any two means not sharing a letter in common are significantly different, using Duncan's Multiple Range Test

Spike Length: The results of the effect of gamma radiation on spike length (Table 2) indicated significant increases in spike length with 30 krads of gamma radiations and produced maximum spike length. These findings were similar to those of Seisbaev *et al.*[2]. Nitrogen application caused a linear increase in spike length, the maximum increase was with 90 kg ha^{-1}. This increase in spike length was probably because of an increase in the vegetative growth of barley crop and enhancement in the metabolic activities of the spikes. These findings were in conformity with those of Misra *et al.*[3] who concluded from their studies that an application of 50 kg ha^{-1} of nitrogen increased significantly biological yield, spike length and number of grains per spike.

1000-Grain Weight: The results on 1000-grain weight (Table 3) indicated the significant effects of radiation. An increase in radiation dose increased 1000-grain weight. Thirty Krads of radiation increased 1000-grain weight by 8.4% over untreated control. These results agreed with those of Savov and Krapecheu[8]. An increase in nitrogen application did not increase 1000-grain weight in this study, however, Rhyctarik and Simonova[9] reported an increase in 1000-grain weight with increasing nitrogen dose.

Straw Yield: The results of radiation rates and nitrogen doses (Table 4) indicated significant increases with increasing radiation and nitrogen levels. An increase of 22.8% was observed with 30 krads of radiation. This increase may have been caused by an interaction between nitrogen doses and radiation rates. The results agree with those of Misra *et al.*[3]. Nitrogen at 90 kg ha^{-1} increased straw yield by 29% over untreated control. This increase was probably caused by an increase in grain yield. These findings agreed with those of Latif and Salamah[7] who reported maximum straw yield with 90 kg ha^{-1} of nitrogen application.

Grain Yield: The results on grain yield (Table 5) indicated significant effects of nitrogen and radiation on grain yield. Grain yield decreased with an increase in radiation doses. A maximum decrease of 40% was observed with 30 krads of gamma rays. The decrease may be because of lethal effects of gamma rays, which may have induced sterility in plants. Davies[10] reported 50% decrease in grain yield with gamma radiations. There was a tendency in wheat yield increases with an increase in nitrogen levels. An increase of 36% was recorded with the highest dose of 90 kg ha^{-1} of nitrogen. This increase was probably because of vigorous plant growth and maximum number of spikes per unit area. Siddique *et al.*[4] and Ockays[5] reported that higher doses of nitrogen increase grain yield significantly compared with control.

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