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Effect of Gamma Irradiation on Yield and Yield Components of Barley (*Hordeum vulgare* L.)

Kiramat Khan, Muhammad Iqbal, Abdul Azim, Bashir Ahmad, Fazli Karim and [1]Hassan Sher
Central Crops Research Institute, Pirsabak, Nowshera (NWFP), Pakistan
[1]Department of Botany, Government Jehanzeb College, Swat, Pakistan

Abstract: Effect of gamma radiation doses; 10, 20 and 30 Krads on yield and yield components of barley was studied in a replicated experiment during the year 2001-2002 at Cereal Crops Research Institute (CCRI) Pirsabak Nowshera NWFP. Except for 1000-grain weight, significant decrease in grain yield and yield components was observed with radiation doses. However, 1000-grain weight showed an increase as the radiation dose was increased. The findings of the study suggested that low doses up to 30 Krads of gamma radiation have direct inhibitory effect on some yield related traits in vegetative growth stage of barley. However, inhibitory effects on yield components related to reproductive stages in barley could not be fully understood which suggests further investigation.

Key words: Gamma irradiation, yield, barley, yield components

INTRODUCTION

Improvement of barley (*Hordeum vulgare* L.) has been carried out through conventional breeding procedures. It is generally accepted that conventional breeding procedures produce only new gene combinations from the already present genes in the parental stock. However, mutation breeding, especially the use of ionizing radiation, has become an important tool for the improvement of many crops including barley through creation of new genes. Davies and Mackay (1973) studied the effect of gamma irradiation on wheat, barley and potato plants. They found that grain yield of wheat and barley was reduced by about 50 and 80%, respectively, when the parental plants received a 2 Krad dose of gamma rays late in the life cycle. Bottino *et al.* (1979) irradiated germinating seeds of barley with gamma rays in various combinations of total exposure (400-3200 R) and exposure rate (30-2400 R ha^{-1}). They observed 20 to 35% growth inhibition at each exposure rate. Chandra and Makde (1985) obtained a new mutant from barley, which was characterized by three ears per stem, short stature, strong tillering and high yields. Chauhan *et al.* (1985) observed 5 high yielding mutants of six-rowed barley M_2 generation using 25 krad dose. While Siddique *et al.* (1985) observed inhibitory effects on yield and yield components of barley and triticale with higher doses of gamma rays.

Knowledge of the optimum radiation dose and its effects on yield and yield components is important for mutation breeding programs for the improvement of barley. The present study was initiated with the objective to study the effect of various doses of gamma rays on yield and yield components of barley under field conditions.

MATERIALS AND METHODS

The present research work was carried out at Cereal Crops Research Institute, Pirsabak, Nowshera, NWFP during the year 2001-02. Seed of barley variety C-63 was irradiated with gamma rays, using 10,20 and 30 krads doses from radioactive element cobalt, ^{60}Co, source at Nuclear Institute for Food and Agricultural (NIFA) Tarnab, Peshawar.

The experiment was laid out in a randomized complete block design with 4 replications. The area of each replication was divided into four plots, 3 radiations doses and one for control. A plot size of 5 rows, each 3 meter long and 30 cm apart, was used. Twenty seeds each at a distance of 15 cm, were planted in each row.

Data for number of tillers per plant, spikes per plant, spike length and grains per spike were recorded on 10 randomly selected plants in each plot. Data on thousand grain weight and grain yield per plot were recorded in grams.

Appropriate comparison of treatment means for grain yield and yield components was carried out by using orthogonal contrasts for such treatments (Steel and Torrie, 1980).

RESULTS

Mean values for control treatment and 3 radiation doses for grain yield and its 5 components (number of tillers/plant , number of spikes/plant, spike length, number

Table 1: Means of control and three radiation doses for number of tillers/plant, number of spikes/plant, spike length, number of grains/ spike, 1000 grain weight and grain yield/plot of barley evaluated at CCRI Pirsabak Nowshera during rabi, 2001-2002

Radiation Dose (Krad)	Tillers per plant (No.)	Spikes per plant (No.)	Spike length (cm)	Grains per spike (No.)	1000 grain weight (gm)	Grain yield per/plot (gm)
0	19.66	17.88	7.0	66.80	38.73	2259.24
10	18.03	16.39	6.5	63.50	42.19	2088.31
20	17.46	16.23	6.4	61.74	44.34	1822.10
30	16.96	15.61	6.1	62.86	46.40	1453.02

Table 2: F-values of three contrasts for number of tillers/plant, number of spikes/plant, spike length, number of grains/spike, 1000 grain weight and grain yield/plot of barley evaluated at CCRI, Pirsabak Nowshera during rabi 2001-2002

	F-Values					
Contrasts	Tillers per plant (No.)	Spikes per plant (No.)	Spike length (cm)	Grains per spike (No.)	1000 grain weight (gm)	Grain yield per/plot (gm)
Control vs Average of all doses	4.20*	3.36NS	3.31NS	3.43NS	30.33**	51.10**
Control vs 30 Krad dose	4.31*	3.55NS	4.02*	2.11NS	38.20**	99.64**
10 Krad vs 20 Krad dose	0.19NS	0.02NS	0.05NS	0.42NS	3.00NS	10.86*

* Significantly different at 0.05 probability level
** Significantly different at 0.01 probability level
NS Non significant at 0.05 probability level

of grains/spike and 1000 grain weight) are given in Table 1. The data revealed a gradual decrease in grain yield and yield components with increase in radiation dosage except for 1000 grain weight. However, the 1000 grain weight showed an increase as the radiation dosage increased. The F-values of contrasts (control vs average of three radiation doses, control vs 30 Krad dose and 10 Krad dose vs 20 Krad dose) for grain yield and yield components are presented in Table 2. Significant difference ($P<0.05$) between control and 30 Krad radiation dose was observed for three yield components i.e. number of tillers/plant, spike length and kernel weight. Significant difference ($P<0.05$) between control and average of three radiation doses was found only for number of tillers/plant and 1000 grain weight. None of the other comparisons and for any component of yield revealed significant difference ($P<0.05$). For the grain yield itself, mean comparisons of control vs average of three radiation doses and control vs 30 Krad radiation dose indicated highly significant difference ($P<0.01$), while difference between 10 Krad and 20 Krad radiation dose treatment was significant at the 0.05 probability level. Although mean comparison for number of spikes/plant and number of grains/spike was not significant but a general trend of decrease in number for these yield components with increase in radiation dose was obvious.

DISCUSSION

The mean values (Table 1) and F-values for contrast (Table 2) between control and radiation doses and those between radiation doses indicate that gamma radiation had pronounced inhibitory effect in early growth stages of barley, thereby reducing the number of tillers/plant and decreasing the spike length. Similar inhibitory effects of gamma radiation have been reported by Khamankar (1982), who observed decrease in number of tillers in wheat with higher doses of gamma radiation and Ghafoor *et al.* (1968) found decreased number of tillers in barley with 30 Krad dose of gamma radiation.

The non significant differences ($P<0.05$) between control and radiation treatments (Table 2) for number of spikes/plant and grains/spike reveal that gamma radiation doses up to 30 Krad had very little or no inhibitory effect on yield components related to reproductive stage in barley. The increase in 1000 grain weight with the increase in radiation doses, however, appears to have been a correlated response of grain weight with number of tillers/plant and the spike length than a direct effect of radiation on grain size. In other words, decreased tillering and spike length due to radition might have resulted in heavier kernels due to decrease in the number of grains/plant rather than grains/spike which revealed no significant difference between control and radiation treatment in this study. Khalil *et al.* (1985) observed a negative correlation of spike length with number of grains and grain weight/spike in a large number of mutants in a wheat variety subjected to 25 and 30 Krad doses of gamma radiation.

Significant reduction in the grain yield for radiation treatments, 2259 gm for control vs 1453 gm for 30 Krad radiation dose indicates that increase in 1000 grain weight with radiation was probably not enough to compensate for the decline in other yield components due to radiation. This significant decrease in grain yield could be the indirect effect of reduced tillering and spike length which were found significantly reduced with radiation doses. Inhibitory effects of gamma radiation on grain yield and yield components have been reported in other investigations. Siddique *et al.* (1985) observed 39.38% reduction in tillers/plant and 1.93% in grain yield with gamma radiation doses, ranging from 5-40 Krads, in barley and triticale. While Shams (1985) reported significant reduction in total biological yield in a study on the effect of gamma radiation doses, ranging from 10-35 Krads, on growth and yield of wheat variety Pak-81.

The findings of present and those of earlier studies suggest that low doses of gamma radiation, up to 40 Krads, have direct inhibitory effects on some yield related traits in vegetative growth stage in barley. However, the exact nature of such inhibitory effects on yield components in reproductive stage is not well understood and requires further investigation.

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