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Full Length Research Paper

Assessment of dissimilar gamma irradiations on barley (*Hordeum vulgare* spp.)

S. Sarduie-Nasab[2], G. R Sharifi-Sirchi[1]* and M. H. Torabi-Sirchi[3]

[1]Horticulture and Dates Research Institute, College of Agriculture, Shahid Bahonar University of Kerman, Kerman, Iran.
[2]Graduate student of Agronomy and Plant Breeding Department, Shahid Bahonar University of Kerman, Kerman, Iran.
[3]Department of Agriculture Technology, Faculty of Agriculture, University Putra Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia.

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***Hordeum vulgare* (barley), is an important agricultural crop for food, feed and also has been used virtually worldwide as a model plant for biological research. It is a diploid crop with a low chromosome number (2n = 14) and targeted as a proper crop for intense research on mutagenesis, mutagens and mutants (Khattak and Klopfenstein, 1989). Recently, heavy-ion beams have been used as novel and efficient mutagens in plant breeding. Many plant variations were induced by irradiation and many novel experimental materials and practical cultivars were generated. The present research aimed to estimate the effect of different gamma radiation on germination and emergence indexes of Barley variety Nosrat. Barley seeds were treated with 4 different gamma ray doses (0, 200, 700, 1200 Gy) from 3 angels. Results of this study expressed that high gamma ray doses decreased emergence index compare with control treatment and also, radiation has inhibitory effect on stem height and width. Base on experimental and green house studies doses of 700 and 1200 Gy strongly decline plant growth and treated plant seeds with these radiation doses did not emerge in the field. Therefore we suggest that 200 gamma ray dose was the best treatment to screen mutant Barley.**

Key words: Barley, emergence index, gamma ray, germination index, *Hordeum vulgare*. mutation.

INTRODUCTION

Barley (*Hordeum vulgare* spp.) belonging to family of "*Poaceae*" order of *poales* genus of *Hordeum* it has cultured from 7000 B.C. till yet (Khattak and Klopfenstein, 1989). This annual plant is the second strategic agricultural crop subsequent of wheat that is utilized for feeding and brewery purpose moreover, defines 91 million ha of agricultural world farm lands to itself. Nosrat variety cultivated as one of most feed crops in temperate area of Iran, it has some important characters like: high yield, resistant to drought stressed and cool environments. Nosrat variety breeds from crossing of Karon and Kavir that these are from commercial varieties of Iran. Due to artificially induced mutation, not only a broader variation of desirable traits was obtained but also, in the results of breeding, many mutation varieties were released. Mutation technology for development of new hybrid varieties tends to make new plants with high better quality and quantity characters, resistant against biotic and abiotic stresses (ASTM, 2007). It is well established that seedling growth reveals a significant influence on nutrient value of the plant part/seed, which is consumed as food (Adilson et al., 2002; Satter et al., 1990). The quality or nutritional value of any consumable plant part, including seeds, depends on its basic constituents, including proteins, carbohydrates, minerals and vitamins (Al-Kaisey et al., 2003; Khattak and Klopfenstein, 1989). Mutation breeding with molecular techniques and *in vitro* methods are suitable techniques to improve food industries (Selim and Banna, 2001). From the end of 1930 decade, ionization radiation to create mutations on agro plants is carried out. Physical parameters like electromagnetic radiation with wave length between 1 - 10 angstrom (gamma ray) could cause genetic changes with permanent differentiations on plant genome. Gamma ray with ionization molecules,

*Corresponding author. E-mail: sharifisirchi@yahoo.com, sharifi-sirchi@mail.uk.ac.ir.

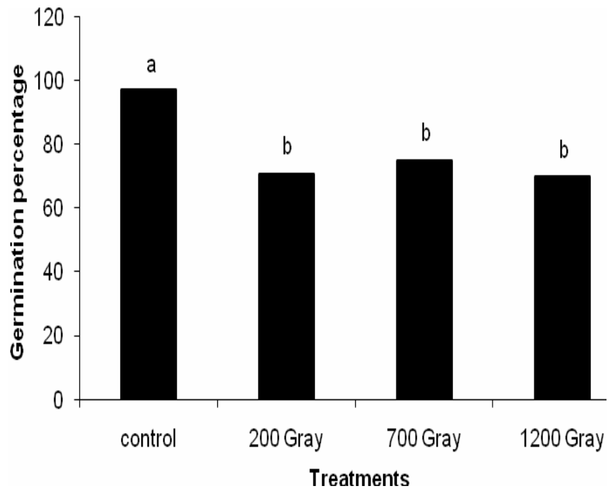

Figure 1. Effect of four different gamma radiations on percentage of seed germination after one week of culture. Different abbreviation letters showed significant different at α = 0.01

specially the water of DNA around cause to make free radicals that these free radicals attacked to DNA molecule and cause affect differentiation on one alkali but at most of cases it cause to breaking one or two chains of DNA (Hagberg and Persson, 1968; Jyoti et al., 2009). Almost 89% of mutant varieties developed by using of physical mutagens and about 60% of them were created by applying gamma ray mutants at barley caused to product high yield, resistant to mildew, strong stem, high protein and skinless seeds (Ananthaswamy et al., 1971). Great of high yield and dwarf barley mutant like, Diamant, Golden Promise cultivars had positive effect on beer brewing industry at Europe (Lundqvist and Franckowiak., 1997; Selim and Banna, 2001). The present study was conducted to evaluate the effects of gamma ray on germination index, emergence index and some phonotypic characters on barley plant variety Nosrat. Another aim of this study was defining the best Gamma ray doses to barley variety Nosrat.

MATERIALS AND METHODS

This research was carried out on 1388 at Agriculture College of Shahid Bahonar University of Kerman-Iran. Nosrat variety seeds were irradiated with Gamma rays 200, 700 and 1200 Gy at nuclear organization of Tehran-Iran. For radiation purpose, 1.0 kg seed cylinder (12 cm diameter x 14 cm height) that it considered for maintained uniformity of purposed dosages were applied and each dosage 3 times from all angels were radiated. The radiation dosages were measured with a Fricke Dosimeter (ASTM, 2007).This research was divided in two parts, experimental and Green house studies

Laboratory experiment

Seeds from each treatment were placed on one layer of 10 cm diameter Whitman No. 1 filter paper containing 10 ml of distilled water at non stress conditions at 25°C. Seeds were scored as germinated when a seed coat was broken and 2 mm of radical was emerged. Germination of individual seeds was measured for 24 h interval until no further germination exposure. Also other traits like, stem width, stem length, number of auxiliary roots and plant height were measured. Petri-dishes were arranged based on Completely Randomized Design (CRD) with three replications.

Green house experiment

Green house studies were carried out during 2008. Pots were filled with sandy loam soil with pH 7.4 that is general pH of Kerman Province soils where this study was performed. The field capacity (FC) of the soil was measured as 15% in soil science laboratory. Drainage holes (0.5 mm diameter) were made at the bottom of each pot. Then pots were arranged based on Completely Randomized Design (CRD) with three replications in the green house under controlled condition (25/15°C day/night). Hundred seeds from the same treatments that utilized in laboratory experiment were sown approximately 4.0 cm deep in 4 L pots (18 cm diameter x 30 cm height). All pots were weighed daily and irrigated twice per day with water to maintain soil moisture at field capacity (FC). Plants within each pot counted and scored as emergence percentage after 7 days of cultivation.

RESULTS

In laboratory experiment, Variance analysis of germination percentage of treatments showed significant differences between them. Non irradiated seeds had highest germination percentage (97.3%) which came to class a basis on Duncan's New Multiple Range Test (DNMRT) however, irradiated barley seed had lower germination percentage and came to class b (Figure 1). Results of analysis of variance for root number trait at Petri dish showed significant difference between

Table 1. Effect of four different gamma radiations on barley seeds at Petri dish and pot.

Shoot length (pot)	Stem diameter (Petri dish)	Torque diameter (Petri dish)	Root Number (Petri dish)	Treatment
20.20 a	0.83 a	0.93 a	5 a	Control
19.78 a	0.77 a	0.88 a	5 a	200 Gray
10.36 b	0.73 a	0.87 a	4 ab	700 Gray
-	0.70 a	0.75 a	3 b	1200 Gray

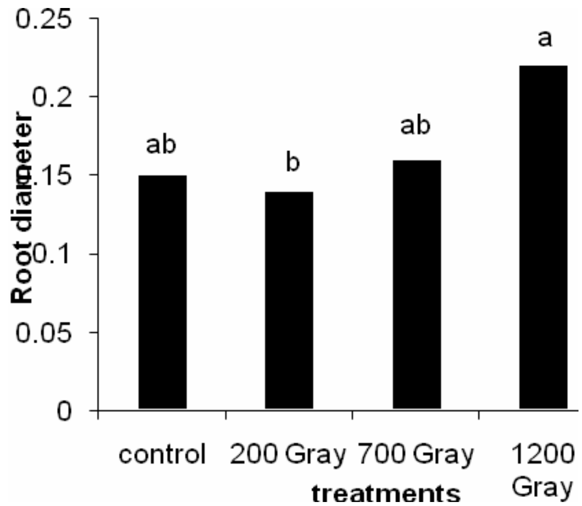

Figure 2. Effect of four different gamma radiations on root diameter after one week of culture. Different abbreviation letters showed significant different at α = 0.01

treatments (control, 200, 700, 1200) at 1% level of signification (Table 1). Base on data analysis, root number of treated seeds had a reverse relationship with dosage of Gamma radiation. So that in treated seeds with 1200 Gy Gamma ray number of root decreases to 3. Analysis of variance for stems and torque width traits showed no significant differences between treatments and control at 1% level of signification (Table 1). Statistic analysis for root diameter trait showed significant difference between control and irradiated plants at 1% level, so that irradiated plant with 1200 Gy had highest root diameter (0.22 mm) which came to class a (Figure 2). Analysis of shoot length trait showed significant difference between the treatments and non irradiated plants had highest shoot length (4.95 cm class a) but in irradiated plant, shoot length decrease with increase of gamma ray dosage, thus shoot length at 1200 Gy decrease to 1.15 cm and came to class d (Figures 3 and 5). In green house experiment, analysis of obtained data from shoot length trait showed that there was significant difference between treatments on irradiated plants and irradiated plants with 200 Gy which had highest shoot length (20.20 and 19.78 cm length) respectively which basis on Duncan's New Multiple Range Test (DNMRT) these two came to class a and irradiated plants with 700 Gy had lower length (10.36 cm) as class b (Table 1). However, Irradiated plant with1200 Gy died after short period of growth (1.0 cm) in the green house. Variance analysis of emergence percentage; data showed significant difference between treatments at 1% level of signification. None irradiated plant with 81% and irradiated plant with 56% had highest (class a) and lowest (class d) emergence percentage respectively (Figure 4).

DISCUSSIONS

In the present study observed for the first time, the effects of different gamma radiations on the growth of Iranian variety of barley (Nosrat). Results of this experiment revealed that with increasing gamma ray dosage, the percentage of germination and emergence, plant height, root number, root length, torque and stem width decreased (Ananthaswamy et al., 1971). The highest implement gamma ray dosage 1200 Gy had negative and hazardous effects on barley morphology and growth compared to control. Base on previous researcher reports, the total protein and carbohydrate contents decrease with increasingly higher dosages of gamma irradiation due to higher metabolic activities and hydrolyzing enzyme activity in germinating seed

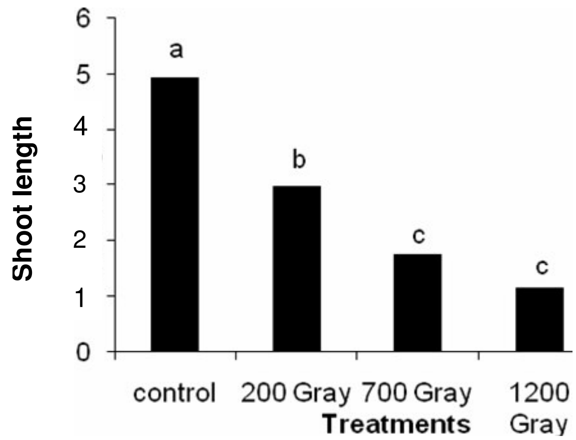

Figure 3. Effect of four different gamma radiations on shoot length after one week of culture. Different abbreviated letters showed significant different at α = 0.01.

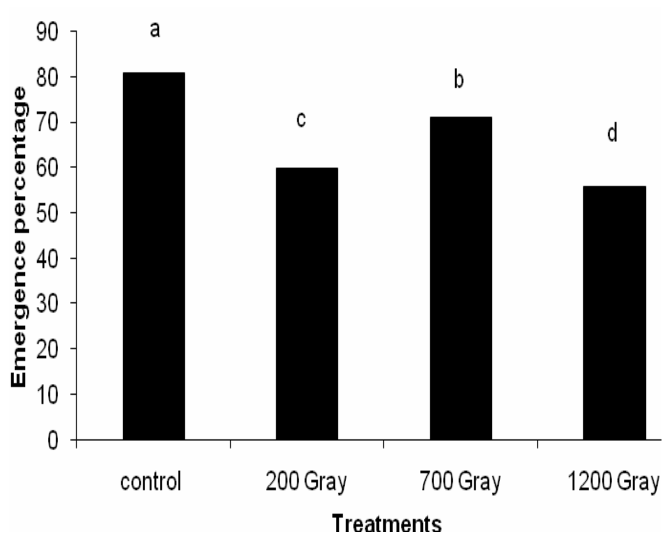

Figure 4. Effect of four different gamma radiations on percentage of seed emergence after one week of culture. Different abbreviation letters showed significant different at α = 0.01.

Figure 5. Effect of four different gamma radiations on barley seedlings germination after one week of culture (Bar=1.4cm). (A) 1200 (Gy) (B) 700 (Gy) (C) 200 (Gy) (D) control.

(Adilson et al., 2002; Maity et al., 2004). The gamma ray breaks the seed protein and produces more amino acid (Adilson et al., 2002; Maity et al., 2004; Tipples and Norris, 1963).

This process may also cause inhibition of protein synthesis. The total protein and carbohydrate was decreased with increasing gamma ray dosage at wheat and rice plants too (Hagberg and Persson, 1968; Inoue et al., 1975). The total DNA content and bonds intension decreased with increasing gamma ray dosage that is anticipated main effect of gamma irradiation on viability of Barley seed (Jyoti et al., 2009).

Bilge and Ersoy 1972, defined that low dosage of gamma ray such as 20 Gy, resulted to increase plant height at barley, furthermore high dosages such as 40, 80 and 120 Gy decreased plant height (Hagberg and Persson, 1968) Also, the results of this study were consistent with Hell fundings (1974) on *Phaseolus valgari* whom observed that under treatment seeds with high gamma ray had low seed germination (Hell and Silveria, 1974).

Conclusion

Base on present study results authors suggest that gamma ray with 200 Gy dosage is the pre-eminent applied gamma ray dosage among all dissimilar dosages used, in this case is advisable for further researcher studies which looking for dominant and recessive mutation on barley Nosrat variety plant seed, to have mutant plants and mutant screening for biotic and abiotic stresses.

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