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GAMMA IRRADIATION EFFECTS ON SOME GROWTH PARAMETERS OF *Lepidium sativum* L.

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ABSTRACT
In order to study the effects of gamma rays on mean germination time (MGT), germination percentage, survival percentage, shoot and root length and, number of branches and leaves per plant, and fresh and dry weight of *Lepidium sativum* L current experiment was conducted. Dry seeds of *Lepidum sativum* L were irradiated with 20, 30, 40, 50, 60, 70 and 80 krad (Kr) by a ^{60}Co-gamma chamber at Nuclear Institute for Food and Agriculture (NIFA), Peshawar, Pakistan. Result showed that gamma irradiation significantly affected all the above mentioned parameters except germination percentage. Mean germination time (MGT) was significantly affected and delayed at higher doses of gamma rays. However, increasing doses of gamma rays did not have significant effects on seed germination percentage. The other growth parameters showed declining tendency with increasing doses of gamma irradiation.

Keywords: gamma irradiation, *Lepidium sativum* L., growth, seed germination.

INTRODUCTION

Nuclear techniques, in contrast to conventional breeding techniques, are widely applied in agriculture for improving genetical diversity. Unlike conventional breeding procedures which involve, the production of new genetic combinations from already existing parental genes, nuclear technology causes exclusively new gene combinations with high mutation frequency. Basic tool of nuclear technology for crop improvement is the use of ionizing radiation which causes induced mutations in plants. These mutations might be beneficial and have higher economical values.

Several positive mutations have been created in agricultural crops by using gamma irradiations Crops with improved characteristics have successfully been developed by mutagenic inductions (Rehman *et al.*, 1987; Javed *et al.*, 2000; Gustaffson *et al.*, 1971) developed a high yielding barley variety with early maturity, high protein contents and stiff straw by mutation breeding techniques.

Khatri *et a*l., (2005) collected three high grain yielding and early maturing mutants by treating seeds of *Brassica juncea* L. cv. S-9 with gamma rays (750-1000KGy) and EMS.

Shah *et al*., (2001) developed a new oil seed *Brassica napus* L cv. ABASIN-95 by induced mutation. They exposed seeds of *B. napus* L. cv. Tower to 1.0, 1.2 and 1.4 KGy gamma rays and the resulting new variety was high yielding, resistant to Alternaria blight and white rust.

The aim of the current study was to use nuclear technology for search of some beneficial mutants in *Lepidium sativum* L.

MATERIALS AND METHODS

The present study was conducted in the Experimental Field of Botany Department, University of Peshawar during 2005-06. Dry seeds of *Lepidium sativum* L. were irradiated with different doses of gamma rays (00, 20, 30, 40, 50, 60, 70, and 80 Krad) form a ^{60}Co gamma chamber at Nuclear Institute for Food and Agriculture (NIFA) Peshawar, Pakistan. Irradiated seeds along with control were sown in earthen pots of equal size. The soil samples were analyzed in the soil laboratory of Pakistan Agriculture and Research Council (PARC), Islamabad and it had 1.23% organic matter, 6.32% $CaCO_3$, 0.070% Nitrogen, and 0.796% total soluble salt. Soil sample was 23.7% clay, 38.0% silt, 38.3% sand and with Electrical Conductivity (EC) 2.67d S/m. The pots were maintained in the field in a Complete Randomized Design (CRD), each treatment being replicated four times. Growth parameters such as days to germination, days to completion of germination, germination percentage, survival percentage, shoot length, root length, number of leaves, number of branches, fresh weight, dry weight and moisture contents were recorded at different periods after sowing was done. Collected data was subjected to Analysis of Variance technique (Fisher, 1985) and LSD test at 5% probability (Steel & Torrie, 1980).

RESULTS AND DISCUSSIONS

Mean germination time (MGT)

Days to initiation of germination and days to completion of germination (Mean Germination Time) of *L. sativum* L. were significantly delayed by higher doses of gamma irradiation. Mean square for analysis of variance (ANOVA) revealed high significant differences for treatment but non-significant differences for replications (Table-1).

The data in Table-4 indicates that higher doses of gamma rays significantly increased days to germination, and days to completion of germination, recorded maximum at 80 Kr.

Delay in germination may due to be inhibitory effects of gamma rays on seed dormancy. Similar results were reported by Ahmad and Qureshi (1992) in *Zea mays* L. and Din *et al*., (2003) in *Triticum aestivum* L.

Germination and survival percentage

Mean squares form Table-1 shows that the differences for various treatment of gamma irradiation were not able to reach the level of significance.

Statistically maximum germination was recorded at 70 Kr and 80 Kr, however, survival percentage was adversely affected by higher doses of gamma irradiation. Radiation doses 20 Kr and 40 Kr had no significant effects on survivability of seedlings as compared to 70 Kr and 80 Kr (Table-4).

Increase in higher germination percentage at higher doses might be due to their stimulating effects on activating RNA synthesis or protein synthesis (Kuzin *et al*., 1975, 1976) or it could be due to the elimination of germinating bacterial populations, their spores and mould fungi (Gruner *et al.,* 1992)

Higher exposures of gamma rays may cause injury in seeds (Mehetre *et al*., 1994) and usually shows inhibitory effects on seeds of angiosperms and gymnosperms (Akhaury and Singh 1993; Thapa, 1999). These results are in line with Sahrif *et al.,* (2000), Din *et al.,* (2003) and Kon *et al.,* (2007).

Shoot and root length

Effect of gamma rays on shoot and root length in this study was adverse and inhibitory as is evident from data in Table-2 and Table-5. Seeds exposed to higher doses produced dwarf plants with reduced roots. This inhibitory effect of gamma rays on shoot and root length of plants was more pronounced at 70 Kr and 80 Kr (Table-5). Shakoor *et al*., (1978) and Khalil *et al.,* (1986) attributed decreased shoot and root lengths at higher doses of gamma rays to reduced mitotic activity in meristematic tissues and reduced moisture contents in seeds respectively.

Decrease in shoot and root lengths of a number of crops has already been reported by Thimmaiah *et al*., (1998), Muhammad and Afsari, (2001), Al-Salhi *et al*., (2004), Token *et a*l., (2005), Kon *et al*., (2007) which supports present investigations.

Number of leaves and number of branches

Both number of branches and number of leaves were highly significantly reduced by radiation doses (Table-2). LSD values showed that maximum means were observed 0 Kr (control) and minimum values for number of branches and number of leaves were recorded at 80 Kr (Table-5) confirming the findings of Yaqoob and Ahmad (2003) in mung beans.

Fresh and dry weight of shoot

Present investigation regarding fresh weight and dry weight of shoot revealed highly significant effects of gamma rays (Table-3). Fresh and dry weight of shoot/plant first increased at 20 Kr then gradually decreased when radiation doses got increased. Minimum mean values for fresh and dry weight of shoot/plant were recorded at 70 Kr and 80Kr (Tble-5). Present results can be compared with the studies of Veeresh *et al*., (1995) who recorded an increase in shoot fresh weight of winged bean at lower doses, however, decrease at higher doses. Similarly Kon *et al.,* (2007) also reported a declining tendency in dry weight of shoot of long beans when exposed to higher gamma radiation doses.

Reduction in fresh and dry weights of shoot might be due to reduced plant stature or reduced moisture contents in shoot due to radiation stress.

Table-1. Mean square values mean germination time (MGT), germination (%) and survival (%) of *Lepidium sativum* L.

Source of variation	Degree of freedom	Days to germination	Germination completion	Germination (%)	Survival (%)
Replication	3	0.865^{NS}	0.198^{NS}	50.000^{NS}	53.125^{NS}
Doses	7	72.103**	20.067**	35.714^{NS}	1624.554**
Error	21	0.674	2.531	73.810	110.268

NS = Non significant; ** = Highly significant

Table-2. Mean square values for shoot length/plant (cm), root length/plant (cm), number of branches/plant and number of leaves/plant of *Lepidium sativum* L.

Source of variation	Degree of freedom	Shoot length (cm)	Root length (cm)	No. of branches/plant	No. of leaves/plant
Replication	3	17.949^{NS}	1.814^{NS}	0.583^{NS}	5.281*
Doses	7	1191.977**	23.433**	20.857**	13.888**
Error	21	19.881	1.442	2.583	1.519

NS = Non significant; * = Significant; ** = Highly significant

Table-3. Mean square values for fresh weight, dry weight and moisture content of shoot/plant of *Lepidium sativum* L.

Source of variation	Degree of freedom	Fresh weight of shoot/plant	Dry weight of shoot/plant
Replication	3	1.880^{NS}	1.228^{NS}
Doses	7	212.298**	149.159**
Error	21	8.422	7.667

NS = Non significant; * = Significant; ** = Highly significant

Table-4. Effect of various doses (Kr) of gamma irradiation on Mean germination time (MGT), germination (%) and survival (%).

Doses	Days to initiation of germination	Days to completion of germination	Germination %age	Survival %age
00	6.000^{D}	5.750^{D}	92.50^{A}	87.50^{A}
20	6.000^{D}	7.250^{CD}	90.00^{A}	87.50^{A}
30	6.500^{D}	7.500^{CD}	95.00^{A}	85.00^{A}
40	8.750^{C}	8.000^{CD}	90.00^{A}	55.00^{B}
50	10.75^{B}	8.250^{BC}	95.00^{A}	52.50^{B}
60	11.25^{B}	10.50^{AB}	92.50^{A}	47.50^{B}
70	15.75^{A}	11.25^{A}	97.50^{A}	45.00^{B}
80	16.75^{A}	12.25^{A}	97.50^{A}	42.50^{B}
LSD value for doses	1.207	2.339	12.63	15.44

Mean values in vertical columns followed by different letters are significantly different at 5% level of significance using LSD test.

Table-5. Effect of various doses (Kr) of gamma irradiation on shoot length (cm), root length (cm), number of branches/plant, number of leaves/plant, shoot fresh weight (g) and shoot dry weight (g) of *lepidium sativum* L.

Doses	Shoot length (cm)	Root length (cm)	No. of branches/ plant	No. of leaves/ plant	Shoot fresh weight (g)	Shoot dry weight (g)
00	76.42^{A}	10.89^{A}	11.75^{A}	15.25^{A}	22.92^{A}	19.45^{A}
20	68.95^{B}	9.063^{B}	11.75^{A}	15.00^{AB}	23.67^{A}	20.42^{A}
30	63.20^{BC}	7.517^{B}	11.75^{AB}	14.50^{AB}	15.57^{B}	13.78^{B}
40	56.85^{C}	7.555^{B}	11.00^{AB}	13.25^{BC}	11.70^{BC}	10.38^{BC}
50	45.22^{D}	5.568^{C}	10.00^{AB}	13.25^{BC}	9.250^{CD}	8.150^{CD}
60	41.08^{D}	5.340^{CD}	9.350^{BC}	11.75^{CD}	7.550^{CD}	6.800^{CD}
70	34.05^{B}	4.628^{CD}	7.000^{CD}	10.75^{D}	5.400^{D}	4.900^{D}
80	28.20^{B}	3.678^{D}	5.750^{D}	10.50^{D}	5.950^{D}	5.525^{D}
LSD value for doses	6.557	1.766	2.363	1.812	4.268	4.072

Mean values in vertical columns followed by different letters are significantly different at 5% level of significance using LSD test.

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