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EFFECT OF (^{60}COBALT) GAMMA RAYS ON GROWTH AND ROOT ROT DISEASES IN MUNGBEAN (*VIGNA RADIATA* L.)

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Abstract

Present investigation showed that gamma rays influences suppressive effect on root rot fungi such as *Macrophomina phaseolina* (Tassi) Goid, *Rhizoctonia solani* Kühn and *Fusarium* spp., and inducive effect on growth parameters of mung bean (*Vigna radiata* L.). Seeds of mung bean were treated with gamma rays (^{60}Cobalt) at time periods of 0 and 4 minutes and stored for 90 days at room temperature to determine its effect on growth parameters and infection of root infecting fungi. All treatments of gamma rays enhanced the growth parameters as compared to untreated plants. Infection of *M. phaseolina*, *R. solani* and *Fusarium* spp., were significantly decreased on mung bean seeds treated with gamma rays. Gamma rays significantly increased the growth parameters and controlled the root rot fungi upto 90 days of storage of seeds.

Introduction

Gamma rays generally influence plant growth and development by inducing cytological, genetical, biochemical, physiological and morphogenetic changes in cells and tissues (Gunckel & Sparrow, 1961). There are some reports which showed that the higher exposures of gamma rays were usually inhibitory (Bora, 1961; Radhadevi & Nayar, 1996; Kumari & Singh, 1996), whereas lower exposures were sometimes stimulatory (Torne & Desai 1965; Taylor, 1968; Sparrow, 1966; Mujeeb & Greij, 1976; Mathew & Gaur, 1975; Raghava & Raghava, 1989; Thapa, 1999).

Gamma rays are the most energetic form of electromagnetic radiation, possesses the energy level from 10 keV to several hundred kiloelectron volts, and they are considered as the most penetrating in comparison to other radiation such as alpha and beta rays (Kovacs & Keresztes, 2002). Gamma rays belong to ionizing radiation and interact on atoms or molecules to produce free radicals in cells. These radicals can damage or modify important components of plant cells and have been reported to affect differentially the morphology, anatomy, biochemistry and physiology of plants depending on the irradiation level. These effects include changes in the plant cellular structure and metabolism e.g., dilation of thylakoid membranes, alteration in photosynthesis, modulation of the antioxidative system and accumulation of phenolic compounds (Kim *et al*., 2004, Wi *et al*., 2005).

The objectives of the present investigation were to (i) treat the seeds of mung bean (*Vigna radiata* L.) with gamma rays (^{60}Cobalt) and (ii) storage of treated seeds at different time intervals for controlling of root infecting fungi.

Materials and Methods

Exposure of seeds to radiation: Seeds of mung bean (*Vigna radiata* L.) were surface sterilized with 1 % Calcium hypochloride, dried under laminar flow hood. The seeds were then exposed to radiations with ^{60}Cobalt emitting gamma-rays with time periods of 0 and 4 mins. The seeds were irradiated at the Department of Physics, University of Karachi and the treated seeds were stored and used at different intervals of time viz., 0 and after 15, 30, 60 and 90 days of storage.

Experimental setup: Soil used was obtained from experimental plot of Department of Botany, University of Karachi. The sandy loam soil containing (sand, silt, clay, 60, 22 & 18%), pH ranged from 7.1-7.5 with moisture holding capacity (MHC) of 29% (Keen & Raczkowski, 1922), total nitrogen 0.077-0.099% (Mackenzie & Wallace, 1954), 3-4 sclerotia/g of *M. phaseolina* g^{-1} as found by wet sieving technique (Sheikh & Ghaffar, 1975), 5-10% of *R. solani* on sorghum seeds used as baits (Wilhelm, 1955) and *Fusarium* spp., 3500 cfu g^{-1} as assessed by soil dilution technique (Nash & Synder, 1962). The irradiated and non irradiated seeds were sown at 0 day and after 15, 30, 60 and 90 days of storage in 8 cm diam., plastic pots, each containing 300 g soil and watered regularly to maintain sufficient moisture required for the growth of plants. The pots were kept in screen house in randomized complete block design with three replicates per treatment. Seeds treated with sterile distilled water served as control. Growth observations both on the control and irradiated seedlings were recorded after 30 days of seed germination. The parameters taken into consideration were shoot length, shoot weight, root length, root weight and leaf area.

Determination of root infecting fungi: To determine the incidence of root rot fungi, one cm long root pieces after washing in running tap water were surface sterilized with 1% $Ca(OCl)_2$ and transferred on PDA plates supplemented with Penicillin @ 200 mg/liter and streptomycin @ 200 mg/liter at 5 pieces per plate. Petri dishes were incubated at room temperature (28˚C) and after one week, infection of roots by root infecting fungi was recorded.

Statistical analysis: Data were subjected to analysis of variance (ANOVA) followed by the least significant difference (LSD) test at $P = 0.05$ and Duncan's multiple range test to compare treatment means, using statistica software according to Sokal & Rohlf (1995).

Results and Discussion

Seeds of mung bean (*Vigna radiata* L.) were treated with gamma rays for 0 and 4 min and stored upto 90 days. Seeds at different storage time viz., 0 and after 15, 30, 60 and 90 days were sown and growth parameters and infection of root rot fungi viz., *Fusarium* spp., *R. solani* and *M. phaseolina* were observed. Mungbean seeds treated with gamma rays (^{60}Cobalt) showed significant increase in growth parameters viz., shoot length, shoot weight, root length, root weight and leaf area in all treatment of seeds ($p<0.001$) and significant reduction in infection of *R. solani, M. phaseolina* and *Fusarium* spp., ($p<0.001$) was observed (Figs. 1, 2).

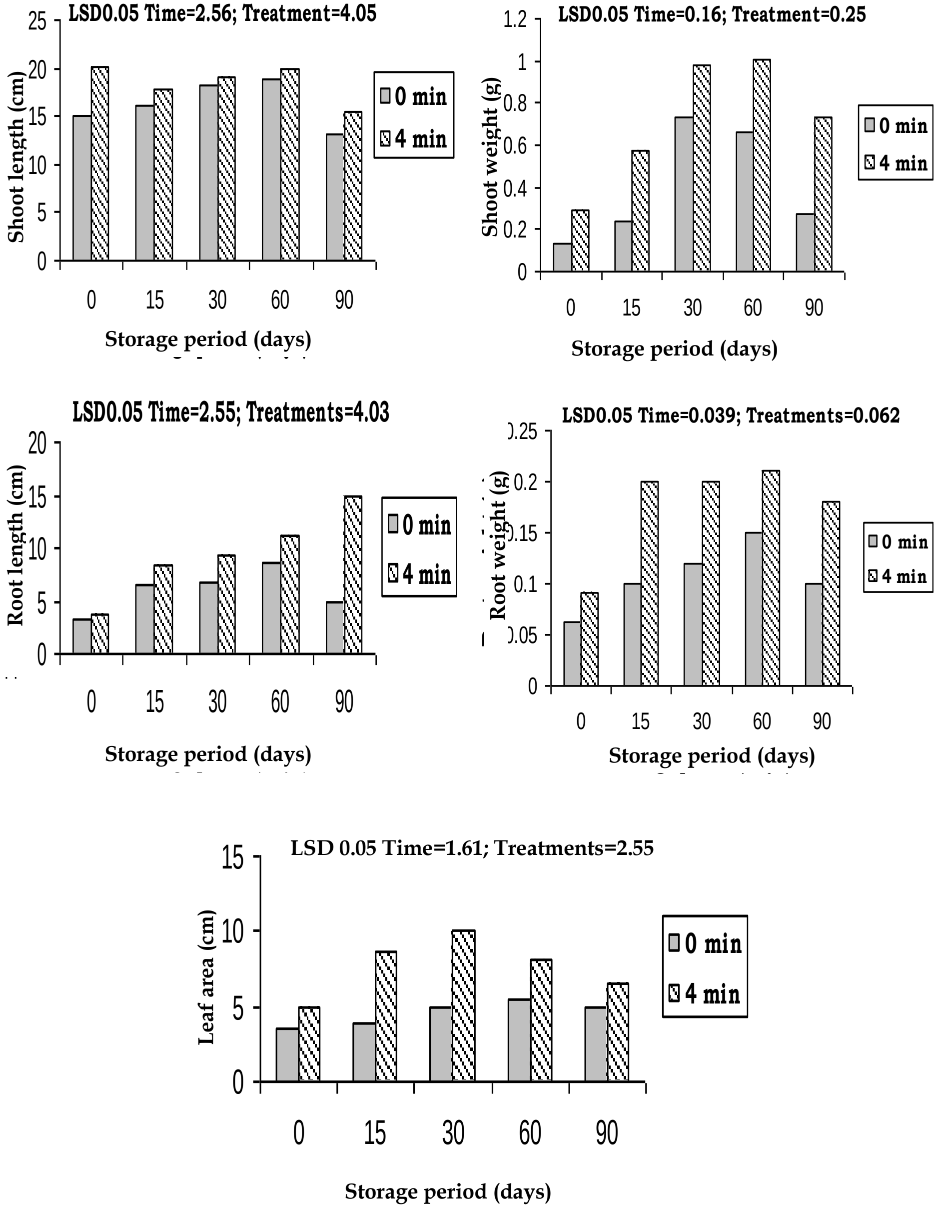

Fig. 1. Effect of gamma radiation (^{60}Cobalt) on growth parameters of mung bean plant at different storage periods.

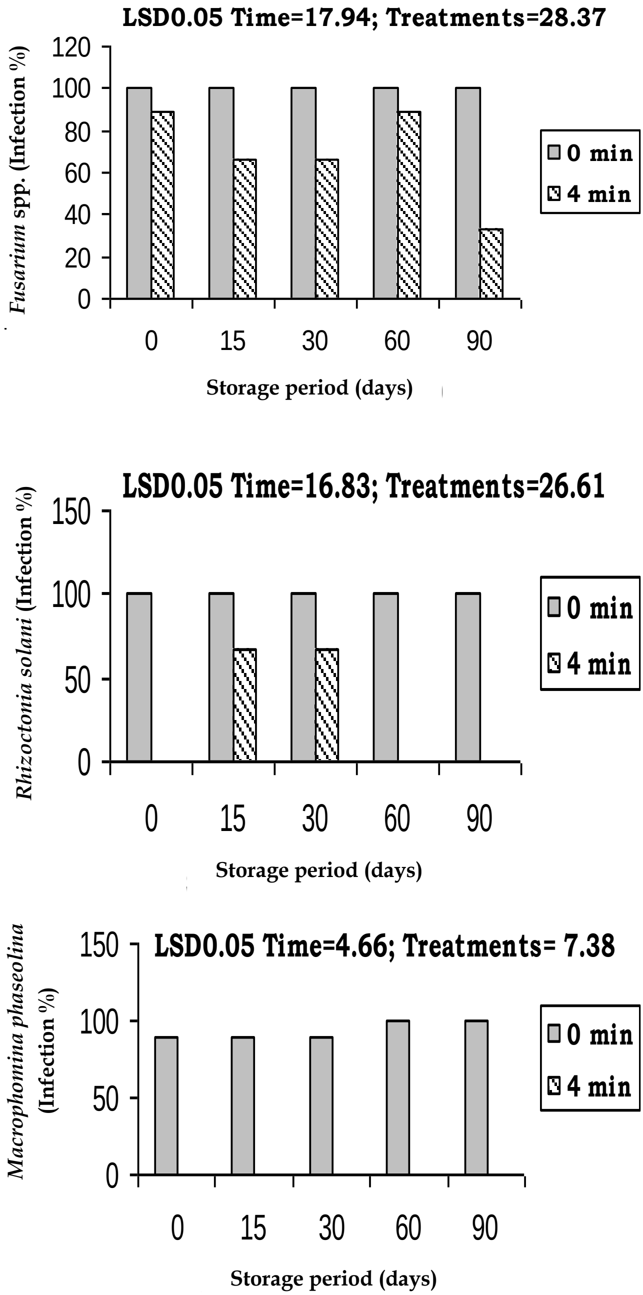

Fig. 2. Effect of gamma radiation (^{60}Cobalt) on infection % of root rot fungi of mung bean plant at different storage periods.

At 0 day of storage, shoot length increased from 15 to 20cm, shoot weight increased from 0.1 to 0.3 g, leaf area increased from 4 to 5 cm. There was significant suppression of *Fusarium* spp., and *R. solani* and complete suppression of *M. phaseolina* infection on roots of mung bean plant. Fifteen days storage of gamma rays treated seeds showed significant ($p<0.001$) increase in plant growth as compared to control and complete suppression of *M. phaseolina* was observed ($p<0.001$). After 30 days of seed storage, all growth parameters highly increased when seeds were treated with gamma radiation (^{60}Cobalt) for 4 min. *M. phaseolina* was completely suppressed as compared to other root rot fungi ($p<0.001$) (Fig 2). Plant length increased from 18 to 19 cm, shoot weight significantly increased from 0.7 to 1 g whereas *R. solani* ($p<0.05$) and *M. phaseolina* (<0.001) completely inhibited after 60 days of storage of gamma (^{60}Cobalt) treated seeds (Fig 2). After 90 days of storage root length and root weight were significantly ($p<0.01$) increased when mung bean seeds were exposed with gamma rays for 4 minutes (Fig. 1).

In the present study, treatment of mung bean seeds with gamma rays (^{60}Cobalt) for 0 and 4 mins., showed significant increase in plant height and weight as compared to control. Gunckel & Sparrow (1961) supported our observations that gamma rays are known to influence plant growth and development by inducing cytological, genetical, biochemical, physiological and morphogenetic changes in cells and tissues. Several workers have studied effect of gamma rays on seed germination of Gymnosperms. The higher exposures were usually inhibitory (Bora, 1961; Radhadevi & Nayar, 1996; Kumari & Singh, 1996). The higher exposures are usually inhibitor on seed germination of Gymnosperm and Angiosperm (Thapa, 1999) whereas lower exposures are sometimes stimulatory (Chauhan & Singh, 1980; Taylor, 1968). The pre-sowing treatment with a magnetic field showed a positive impact on seeds of soybean, maize, peas, okra and beans leading to an increase of yield for soybean by 48%, for peas by 15%, for okra by 19% and for bean by 21%. Investigations showed that magnetic field treatment of the seeds increased the germination of non standard seeds and improved their quality (Nedialkov *et al*., 1996). Mokobia & Anomohanran (2005) found that Gamma irradiation were very useful not only for sterilization of medicine but also for the preservation of food and cereals in nutrition and agriculture. Observation showed that the number of germinated seeds and the growth rate for the maize, okra and groundnut seeds decreased with increase in the radiation doses of ^{60}Co gamma rays viz., 150, 300, 500, 700, 900, 1000 Gy.

Present results suggested that seed treatment with ^{60}Cobalt gamma radiations was effective in increment of plant weight and height and suppress the root infecting fungi even after 90 days of storage.

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