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EXPOSURE OF TECHNETIUM-99M (TC-99M) ON SEEDS OF SOME CROPS FOR THE MANAGEMENT OF ROOT INFECTING FUNGI

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Abstract

Gamma radiation gave suppressive effect on root infecting pathogens such as *Macrophomina phaseolina* (Tassi) Goid, *Rhizoctonia solani* (Kühn) and *Fusarium* spp., and inducive effect on growth of chickpea (*Cicer arietinum* L.) sunflower (*Helianthus annuus* L.) and mash bean (*Vigna mungo* L.). Seeds of all tested hosts were treated with gamma rays Technetium (TC-99M) at time periods of 0, 1, 2, 4 and 8 minutes. When seeds of chickpea treated with the gamma rays for 2 minutes showed significant increment in height and weight of plant as compared to control where as sunflower treated seed at the same time interval showed significant suppression of root infecting fungi and enhanced the shoot length and weight. Two and four minutes treatment of all tested seeds with gamma radiation were best for significant increase in growth parameters as well as reduction in colonization of root rot fungi.

Key words: Gamma radiations, Leguminous and non-leguminous crops, Root rot fungi, Exposure time.

Introduction

Plant diseases are due to, fungi, bacteria and viruses. Most diseases are caused by fungal pathogens that tend to become a problem in terms of severe crop losses, root infecting fungi causes root rot disease such as *Macrophomina phaseolina* (Tassi) Goid causes seedling blight, root rot as well as cause charcoal rot of more than 500 crop and non-crop species (Smith & Carvil, 1977). Many plants are attacked by this pathogen. *Rhizoctonia solani* (Kühn) produce foot rot and root rot. 63 hosts of *R. solani* have been reported from Pakistan (Mirza & Qureshi, 1978; Ghaffar, 1988). *Fusarium solani* causes collar and root rot of cowpea. *R. solani* (Kühn) and *Fusarium* spp., cause wilting of different crop plants. Chemical treatments to control the root infecting fungi are hazardous for environment, so it is necessary to develop alternative controlling methods for root rot infecting fungi to reduce environmental risks (Conway *et al*., 2004). Downes & Blunt (1878) was the first who use radiant energy from sun as germicidal effects. Pre-sowing treatment of seeds with UV radiations was effectively used in the increment of crop productivity by improving the growth parameters and suppressed root infecting fungi (Jdanova, 1962; Dubrov, 1977; Ghallab & Omar, 1998). There are variety of ways to avoid these pathogens by the use of fungicides, soil drenching, soil amendment, use of microbial antagonists, crop rotation, use of resistant varieties and plant extracts (Al-Obaedi *et al*., 1987). Hydropriming, biopriming and use of plant extracts play vital role in disease management and increases crop yeild. Seed treatment with biocontrol agents are important in root rot control (Jahn & puls, 1998).

For sterilization and preservation of food, radiations are found to be an excellent tool providing benefits to the human society (Ivanov *et al*., 2001; Hyun- Pa *et al*., 2006; Sameh *et al*., 2006). Numerous controlling measurements used like chemicals in order to avoid the yield losses caused by root infecting pathogens (Spadaro & Gullino, 2005). Although chemicals have been an effective method in inhibition of pathogens but also have some hazardous effect. Nowadays alternative strategies are applicable due to increased global demand for chemical- free fresh food (Korsten, 2006). There is a need of methods that control the diseases and also beneficial for our environment and eco friendly microorganisms without disturbing an equilibrium of useful and harmful composition of environment and ecosystem. To increase the production and to overcome the diseases there is a need to disinfect economical important crops. Gamma radiations are considered to be most penetrating than other radiations like alpha and beta rays (Kovacs & Keresztes, 2002). These rays produce free radicals in cells when comes in contact with atom or molecule which can damage or modify important components of plant cells depending upon exposure time (Hamideldin & Hussin, 2014). Al Salhi *et al.* (2004); Hameed *et al.* (2008) observed that exposure of seeds to gamma rays effects protein synthesis, changes in antioxidative system, leaf gas exchange, enzymatic activity and hormone balance. Exposure of gamma radiations exhibits two types of effect in a biological system. One is direct effect in which electron excitation occurs results in production of secondary oxygen species (ROS) while other is indirect effects in which DNA helix affects leads to DNA breakage (Blagojevic, 2015). Depending upon the positive effects of radiations, present work was conducted on effect of gamma radiation in the management of root infecting fungi and improvement of crop plants.

Materials and Methods

Exposure of seeds to radiation: Seeds of mash bean (*Vigna mungo* L.), chick pea (*Cicer arietinum* L.) and sunflower (*Helianthus annuus* L.) were surface sterilized with 1% $Ca(OCl)_2$ for 3 minutes, dried under laminar flow hood, then were exposed to radiations with Technetium (TC-99M) emitting gamma-rays for different time intervals (0, 1, 2, 4 and 8 minutes). Seeds were irradiated at the Department of cardiology, civil hospital, Karachi.

Experimental setup: Sandy loam soil (60: 22:18 sand, silt, clay) was collected from experimental plots of Botany Department, University of Karachi. pH of soil estimated as 7.2- 7.4, moisture holding capacity (MHC) as 28% (Keen & Raczkowski, 1922), total nitrogen as 0.067- 0.089% (Mackenzie & Wallace, 1954). Wet sieving, dilution technique and baiting technique were performed for observation of soil borne root infecting fungi like *M. phaseolina* (3- 4 sclerotia/g), 5-9% *R. solani* on sorghum seeds using as baits and *Fusarium* spp., (3500 cfu g^{-1}) (Sheikh & Ghaffar, 1975; Wilhelm, 1955; Nash & Synder, 1962). The seeds were irradiated with gamma-rays (TC- 99M) at 0, 1, 2, 4 and 8 minutes and non treated seeds used as control. Irradiated and non irradiated seeds (treated with sterilized distilled water) were sown in pots (8 cm diameter), containing 300 g soil and watered regularly upto thirty days after germination. Each treatment was replicated thrice and arranged in screen house in completely randomized manner.

Determination of root infecting fungi: Roots of each treatment were surface sterilized using 1% $Ca(OCl)_2$, cut into 5 pieces and plated on PDA plates (5 pieces/plate) provided with antibiotics (Penicillin @ 200 mg/litre and streptomycin @ 200 mg/litre). Petri dishes were incubated at room temperature for 5-7 days and observed the colonization of roots by root infecting fungi.

Analysis of data: Experimental data were subjected to one way ANOVA and Duncan's multiple range test (DMRT) at 5 % level of probability were determined for least significant difference (LSD) (Gomez & Gomez, 1984).

Results

Sunflower: Gamma irradiated (TC-99M) sunflower seeds showed remarkable increment in growth parameters and reduction of root infecting fungi. Shoot length ($p<0.05$) and root weight were increased by gamma rays (TC-99M) for 2 minutes treatment while root length and shoot weight were significantly improved ($p<0.01$; 0.05) due to gamma rays treated seeds for 4 minutes. Colonization of roots by *R. solani* showed complete reduction in all treatments compared to control ($p<0.001$). However, *M. phaseolina* and *Fusarium* sp., were significantly ($p<0.05$) reduced when seeds were irradiated for 2 minutes (Fig. 1).

Mash bean: In case of mash bean, significant ($p<0.01$) icrement was recorded in root, shoot length and root weight when seeds were treated with gamma rays for 4 minutes. However shoot weight was increased by all treatments as compared to control. *M. phaseolina* and *Fusarium* spp., ($p<0.05$) were reduced when seeds treated with gamma rays for 8 minutes were used while *R. solani* ($p<0.001$) was completely inhibited by all treatments (gamma rays treated seeds for 1, 2, 4, 8 minutes) (Fig. 2).

Chickpea: Shoot length, shoot weight and root length ($p<0.05$) were improved due to seeds treated for 2 minutes while 4 minutes seeds treatment significantly ($p<0.01$) increased the root weight of chickpea plant (Fig. 3). Complete reduction of *R. solani* was recorded when seeds were treated with gamma rays for 2 minutes ($p<0.01$). *M. phaseolina* and *Fusarium* spp., were significantly reduced ($p<0.01$) when seeds treated with gamma rays for 1 and 4 minutes respectively (Fig. 3).

All treatments were effective in improvement of growth parameters and reduction of root infecting fungi of chick pea, mash bean and sunflower but progressive results were recorded by seed treatment for 2 and 4 minutes followed by 8 minutes.

Discussion

In the present study, seed irradiated with gamma rays (TC-99M) showed significant reduction in root colonization by *M. phaseolina, Fusarium* spp., and *R. solani* in chickpea, sunflower and mashbean. Gamma radiations not only useful with respect of sterilization but also for storage of food (Mokobia & Anomohanran, 2005). *Cucumis melo* seeds when treated in microwave oven, *Fusarium oxysporum* significantly declined (Soriano-Martin *et al*., 2006), whereas *Phaseolus vulgaris* seed contamination with *Penicillium* spp., significantly declined in microwave treated seeds as compared to control (Tylkowska *et al*., 2010). Treated seeds of chickpea and sunflower with TC-99M for 2 minutes showed marked improvement in plant height and weight as compared to control. Complete inhibition of *R. solani* was recorded when seeds were treated with gamma rays for 2 mins. Sunflower seeds treated with gamma rays showed significant increase in shoot weight and shoot length as well as significant suppression of *M. phaseolina, Fusarium* spp., and *R. solani* infection on the roots of sunflower plants. Our observation supported by the results of Ikram *et al.* (2010) that colonization percentage of root rot fungi completely suppressed when sunflower seeds irradiated with gamma rays (^{60}Cobalt). Observation showed that the growth rate for the chickpea and sunflower seeds decreased with increase in the radiation doses of (TC- 99M) gamma rays. According to Mokobia & Anomohanran (2005), 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}Cobalt) gamma rays viz., 150, 300, 500, 700, 900, 1000 Gy. Present results suggested that seed treatment with (TC- 99M) gamma radiations at 2 and 4 minutes time interval was effective in increment of plant weight and height and suppressing the root infecting fungi. It has been reported that the higher exposures of gamma radiation was usually non effective (Bora, 1961; Radhadevi & Nayar, 1996; Kumari & Singh, 1996). Gymnosperm and angiosperm seeds when exposed to gamma rays for a longer period, inhibited germination (Thapa, 1999) whereas lower exposures are sometimes stimulatory (Chauhan & Singh, 1980; Taylor, 1968). Thapa (2004) reported that root, hypocotyl, and epicotyl elongation decreases as the exposure time increases.

TC-99M gave positive effect on growth of plants by increasing length and weight of tested crops. Root infecting fungi were also reduced using seed treatment with gamma irradiations particularly *R. solani* which was completely inhibited in all tested crops. However, this treatment must be applied upto field level for obtaining good yield of crops.

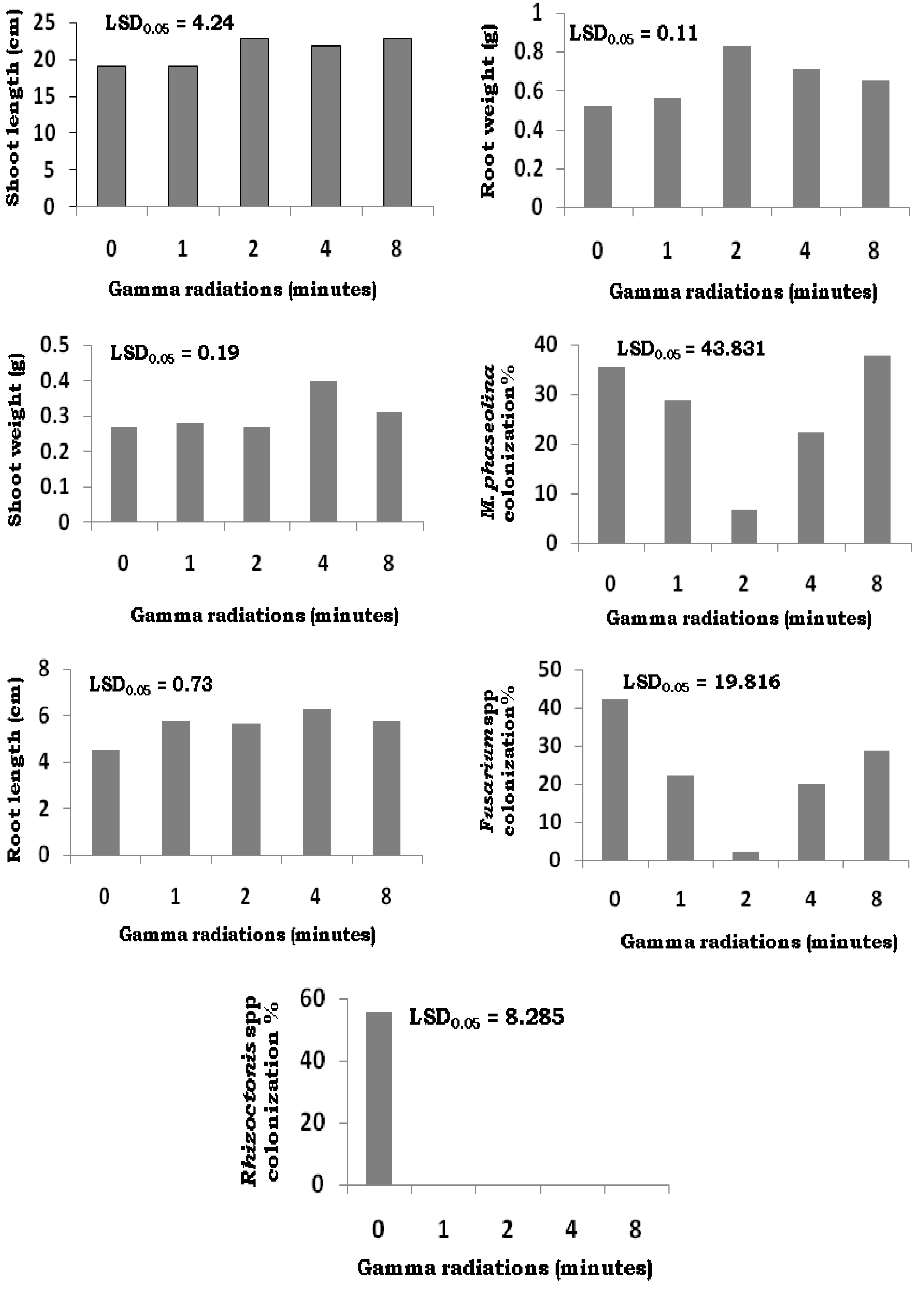

Fig. 1. Effect of seed treated with gamma radiations on growth and colonization of root rot fungi on sunflower.

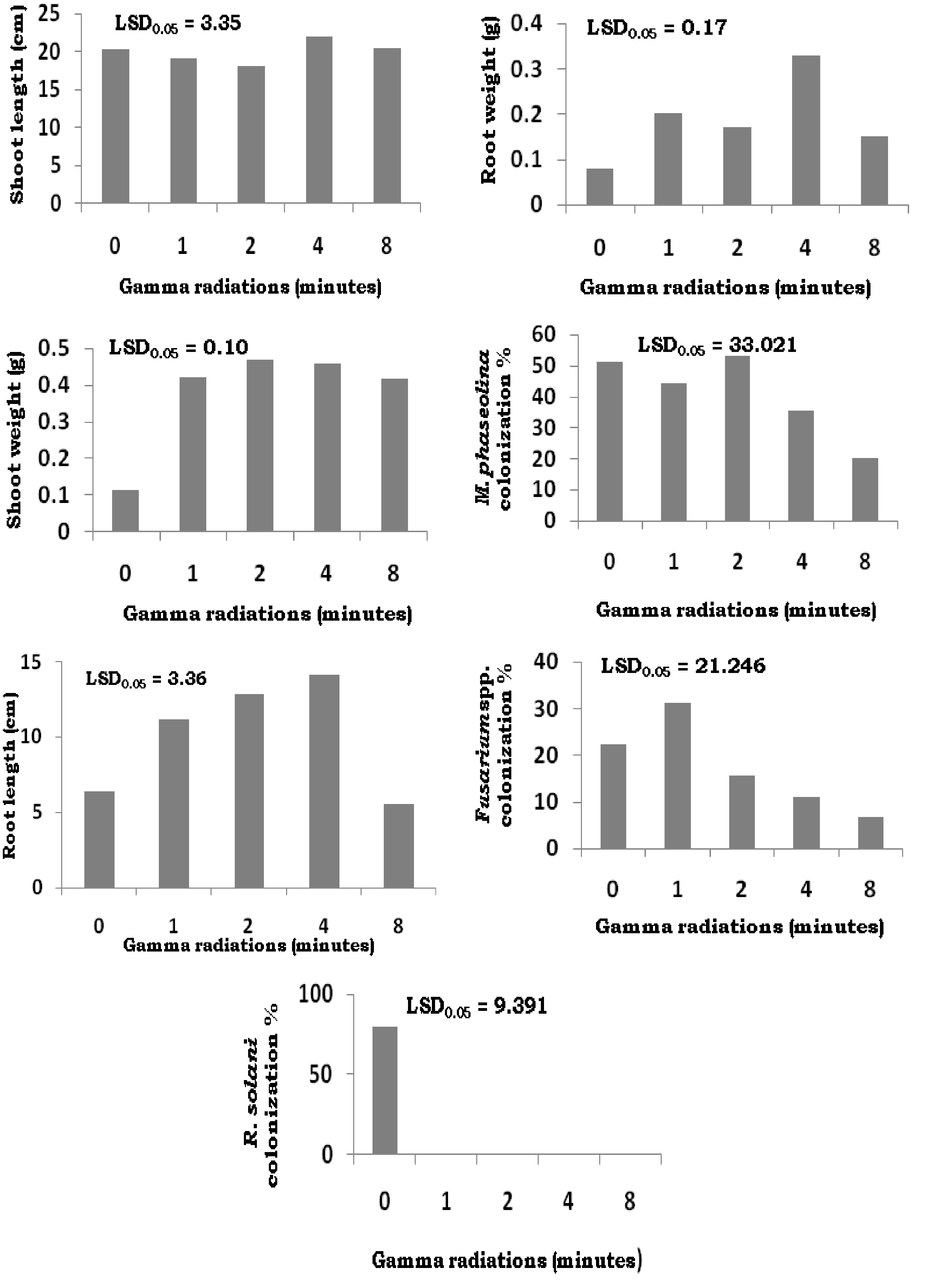

Fig. 2. Effect of seed treated with gamma radiations on growth and colonization of root rot fungi on mash bean.

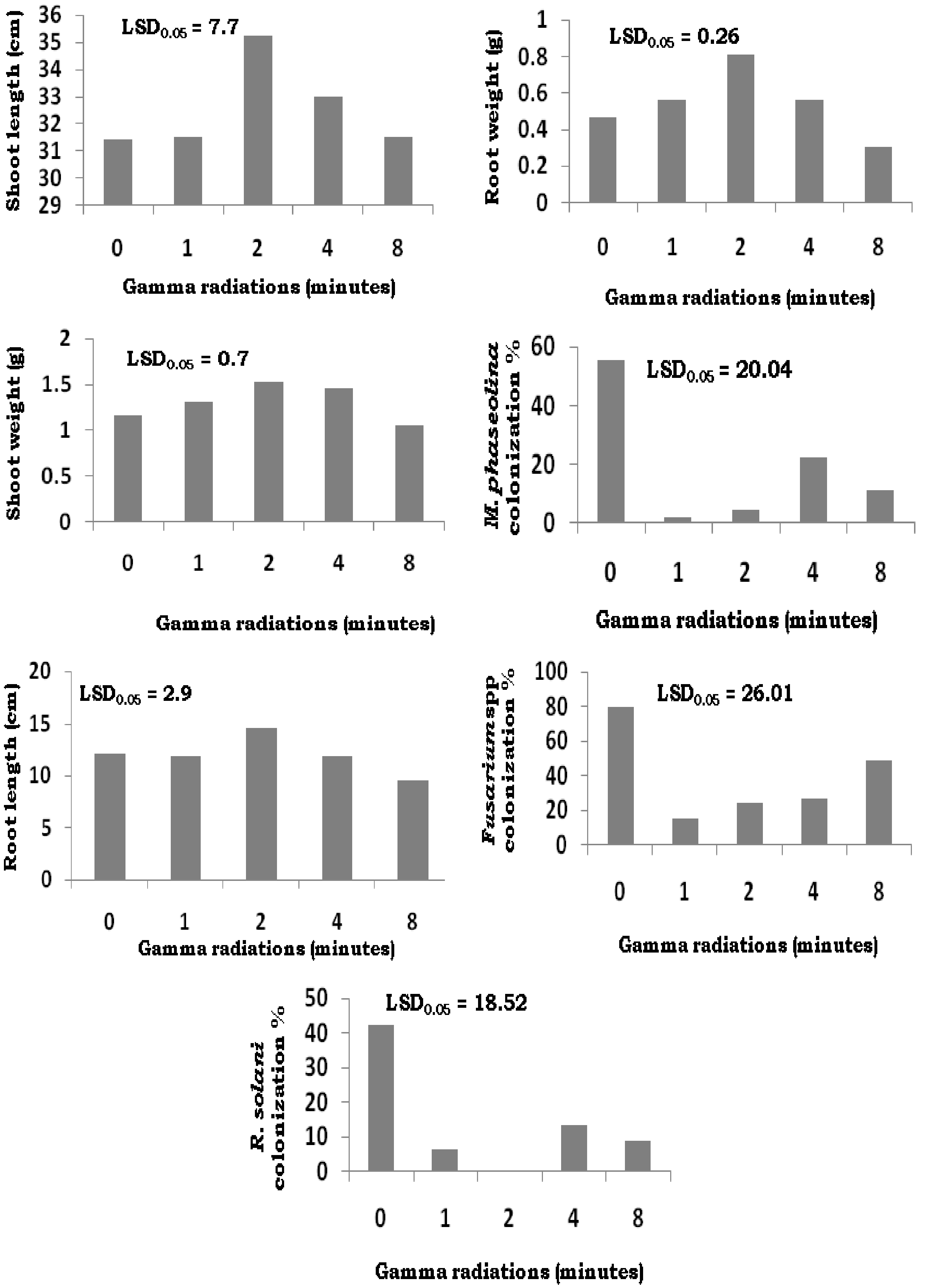

Fig. 3. Effect of seed treated with gamma radiations on growth and colonization of root rot fungi on chickpea.

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