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EFFECTS OF GAMMA RADIATION IN SOYBEAN

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ABSTRACT

The degree of radiosensitivity depends mostly on the species, the stage of the embryo at irradiation, the doses employed and the criteria used to measure the effect. One of the most common criteria to evaluate radiosensitivity in seeds is to measure the average plant production. Soya dry seeds were exposed to low doses of gamma radiation from source of Cobalt-60, type Gammecell-220, at 0.245 kGy dose rate. In order to study stimulation effects of radiation on germination, plant growth and production. Five treatments radiation doses were applied as follows: 0 (control); 25; 50; 75 and 100 Gy. Seed germination and harvest of number of seeds and total production were assessed to identify occurrence of stimulation. Soya seeds and plants were handled as for usual seed production in Brazil. The low doses of gamma radiation in the seeds that stimulate the production were doses of 25, 50 and 75 Gy. There are evidences that the use of low doses of gamma radiation can stimulate germination and plant production.

Key words: Gamma radiation, hormesis, soya.

1. INTRODUCTION

Soybeans are the main grains produced, ranking fourth in global production volume and first among the oil "major oil seeds," participating in the global agricultural economy. According to the United States Department of Agriculture data, soybean was grown in the 2012/13 crop in an area of approximately 103 million hectares, with total production of 239 million tons and estimates for the harvest 2013/14 shows an increase of 6.67% in the area, which may cause an increase of up to 17.87% of total world production.

Stimulation effects on germination, growth and production with the use of low doses of gamma radiation have been reported by many authors [1-5].

Studies showed the radiation effects after seed treatment with radiations (6.25, 10.2 and 60 Gy) on germination process and plant development of different maize varieties wheat, barley, oat, lupine, colza and turnip to verify if the increases on final production could be observed and predicted during germination. It was, however, concluded that

this foresight was not possible, because the stimulant dose production did not coincide with those that had stimulated germination [6].

The irradiation of plants may result in death, growth inhibition, altered metabolism, morphological abnormalities and mutations. The magnitude of the effect depends on the radiation characteristics of the studied species and age of the plants. The study of the effects of ionizing radiation in plants can be conducted in pollen, embryos, seeds, roots, etc. The analysis parameter can be plant growth, morphological and histological changes, effect on hormones, etc. [7].

During the decade between 1974 and 1984, many experiments on radio induced mutation in soybean were performed for obtaining mutant strains, some of which highly radiosensitive [8].

The degree of radio sensitivity of a plant embryo depends on the species and the developmental stage of the embryo during irradiation and the criteria used to measure the biological effect. One of the most common criteria to evaluate the seed radio sensitivity is to measure the height of the plant at a certain time after germination [7]

Dormant seeds are less radiosensitive than the seeds with developing embryos, probably due to its quiescent state characterized by diminished division or differentiation ratio and also due to their low water content [7].

LD^{100} is defined as the radiation dose required to kill all the plants studied, LD^{50} is defined as the radiation dose which kills one-half of the studied population of plants [9].

The objective this work was to evaluate the effects of gamma radiation doses to stimulate the germination, growth and production of soybean (*Glycine max* L.).

2. MATERIAL AND METHODS

Soya dry seeds were exposed to low doses of gamma radiation from source of Cobalt-60, type Gammecell-220, at dose rate of 0.245 kGy, in order to study stimulation effects of radiation on germination, plant growth and production. Five treatments radiation doses were applied as follows: 0 (control); 25; 50; 75 and 100 Gy. Seed germination and harvest of number, weight and total production were assessed to identify occurrence of stimulation. Soya seeds and plants were handled as for usual seed production in Brazil.

The seeds were sown after irradiated by the next morning in previously prepared pots. The experimental design used in the data analysis of variance was the experiments in blocks [10] proceeded with three replications (3 blocks) and six different treatments (6 doses). For the numerical data collected during observations the Tukey test was used [10,11] to compare the mean values of the different blocks.

3. RESULTS

Listed in Table 1, the mean values of the percentage of the total twinning and obtained seeds of treatments with increasing doses of gamma radiation from Cobalt-60. The table

results indicate that the treatments with doses of 25, 50 and 75 Gy showed statistically significant differences when compared to other treatments, but among themselves the values were similar.

Table 1. Average number of seeds harvested from seed irradiated with increasing doses of gamma radiation from Cobalt-60.

Doses/Gy	Number of planted seed	Germination percentage	Number of seed harvested
0 (control)	9	98	19b*
25	9	97	22a
50	9	97	22a
75	9	98	22a
100	9	95	16c

*Means by the same letter are not statistically different at the 5% Tukey test.

According to [1] low doses of radiation have the ability to stimulate bio-systems reversing the effects with increasing dosage. This theory called hormesis, still not very well understood and widely questioned, could explain the observed peak growth increasing dosages until 0.10 kGy when loss of plants height values occurs.

In total opposition to the hormesis theory is the ALARA principle of radiological protection (ICRP 60, 1990, CNEN-NE-3:01) which claims that any radiation dose is harmful to the organic material, independent of its intensity

Still citing by [1], post-harvested experiments with distinct radiation dosage yielded good results with wheat, soybeans, corn and potato among others irradiating the seeds or tubers with low doses before sowing.

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4. CONCLUSIONS

By the results we can observed that the low doses of gamma radiation in the seeds that stimulate the production of seeds were doses of 25, 50 and 75 Gy.

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