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LOW DOSES OF GAMMA RADIATION IN SOYBEAN

José G. Franco[1,2], Suely S. H. Franco[1,2] , Caio H. Franco[3], Valter Arthur[1,2] Paula B. Arthur[1,2] and Anna L. C. Villavicencio[1]

[1]Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP, Brasil, E-mail:
zegilmar60@gmail.com, gilmita@uol.com.br, villavic@ipen.br

[2]Centro de Energia Nuclear na Agricultura, CENA/USP, Universidade de São Paulo, Av. Centenário, 303, Piracicaba, SP, Brasil, CEP: 13400-970, E-mail: arthur@cena.usp.br

[3] Departamento de Microbiologia, Imunologia e Parasitologia, Universidade Federal de São Paulo (Unifesp) Rua Botucatu 862, São Paulo, Brasil, 04023-062

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. Dry soya seeds were exposed to low doses of gamma radiation from source of Cobalt-60, type Gammecell-220, at 0.210 kGy dose rate. In order to study stimulation effects of radiation on germination, plant growth and production. A treatment with four radiation doses was applied as follows: 0 (control); 12.5; 25.0 and 50.0 Gy. Seed germination and harvested of number of seeds and total production were assessed to identify occurrence of stimulation. Soya seeds number 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 the doses of 12.5 and 50.0 Gy. The results show that the use of low doses of gamma radiation can stimulate germination and plant production.

Keywords: radiation, low doses, stimulate, production

1. INTRODUCTION

Soybeans crops are the main grains produced in the world, ranking fourth in global production volume and first among the "major oil seeds," participating in the worldwide 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 stimated data for the 2013/14 show 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 different doses (6.25, 10.2 and 60 Gy) on germination process and plant development of distinct maize varieties wheat, barley, oat, lupine, colza and turnip in order to verify if the increase 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 were 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 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.

Four treatments radiation doses were applied as follows: 0 (control); 12.5; 25 and 50 Gy. Seed germination harvest, 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 the following post-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 4 different treatments (3 doses of gamma radiation and control). For the numerical data collected during observations the Tukey test was used to compare the mean values of the different blocks [10, 11].

2. RESULTS

Listed in Table 1, the mean values of the percentage of the total emerged sprouts and obtained seeds of treatments with increasing doses of gamma radiation from Cobalt-60. The table results indicate that the treatment with dose of 50.0 Gy was the one that presented the best result in all evaluated parameters when compared to other treatments. But in the parameter mean number of healthy seeds no significant differences were observed when compared to 25.0 Gy dose. These results are similar to those of when irradiated seeds of soya with doses of 25, 50 and 75 Gy [13].

Table 1. Average number of seeds harvested germinated plants, f number of pods and production parameters from seed irradiated with increasing doses of gamma radiation from Cobalt-60.

Doses Gy	Mean number of seeds planted	Mean number of germinated seeds	% mean of germina -ted plants	Mean Number of pods per plant	Mean number Weight of seeds	Mean number of seeds	Mean number of healthy seeds
0	6	4.0b	66.6c	33.3a	6.6b	60.0b	36.3b
12.5	6	4.6b	77.7b	22.3b	6.7b	55.3c	49.0a
25.0	6	3.6c	61.1d	19.0b	3.9c	34.0d	22.6c
50.0	6	5.0a	83.3a	36.0a	7.5a	67.3a	52.3a

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 benefic 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 (data now shown). 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 results we can conclude that soybean seeds irradiated with the low doses of 12.5 - 50 Gy significantly increased the number of germinated seeds and the production of grains.

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