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Effects of different doses of radiation on bean seeds

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ABSTRACT
BACKGROUND*: We have started a study investigating the effect of radiation on bean seeds since radiation can be used to produce more and higher quality products.*
MATERIALS AND METHODS: *Five groups were formed in this study. In each group, 20, 40, 50 and 60 Gy radiation was applied to the seeds in each group, respectively. No radiation was applied to the in the 5th group (Control group).*
RESULTS: *The earliest germination was seen in 20 Gy and control groups and it was the 3rd day. The latest germination was in the 60Gy group at the earliest on the 8th day and at the latest on the 16th day.*
CONCLUSION: *Because of germination and growth rates with seed radiation done with doses above 60 Gy, these findings should be confirmed with larger studies.*
Seed breeding, radiation seed, radiation bean
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Conflict of interest: *None*

INTRODUCTION

Radiation applications in seeds are widely applied for product breeding. Scientists are concerned because there are not enough risk analysis studies on this issue. Possible negative effects of radiation-treated seeds in living organisms may cause genetic, biochemical, biological and pathological results. Studies for product breeding are called mutation breeding. The most commonly used mutation breeding method is Cesium137 (137Cs) and Cobalt-60 (60Co) from gamma ray sources (1-3).

Germination rate of plants in mutation breeding studies, such as seedling length. The appropriate mutagen dose and application methods are determined by evaluating the properties (4, 5). The lowest dose should be determined for the appropriate mutants by the measurements made during the seedling period (6-8).

It was determined that high dose Gamma rays negatively affect the germination rate, seedling length and root length in wheat parallel to the dose increase and linearly (9).

Nowadays, as it constitutes an important part of the daily food source, it has been studied on the grains such as rice, corn and chickpea in the breeding works to be made for plant production, but the most researched product is wheat (10, 11).

As there is not enough work on this subject, we started a preliminary study in our clinic for this purpose. With the new studies to be carried out in this phase after the preliminary study, the possible damages of mutation breeding methods will be tried to be analyzed.

MATERIALS AND METHODS

In 2018, a study on bean seeds and radiation was initiated in the Bezmialem Vakif University Faculty of Medicine, Department of Radiation Oncology. Dried bean seeds were irradiated with Co60 teletherapy device (Co60 Teletherapy machine, France, source Ucraine and activity 8800 Curie 2003, the current activity 2000 Curie) with 1.25 MV gamma rays.

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Study groups: The study consists of 5 groups. In 1 to 4 group, 20, 40, 50 and 60 Gy radiation were applied to the seeds in each group, respectively. These seeds were planted in a 15cm wide and 15 cm deep pot at a depth of 3-4 cm and poured 70 ml of water. It was placed at the window edge at a temperature of 24 degrees and a humidity of 51%. As the soil dried, 70 ml of water was added.

No radiation was applied to the 5th group (Control group). These seeds were planted in a 15 cm wide and 15 cm deep pot at a depth of 3-4 cm and poured 70 ml of water. It is placed at the window edge in 24 degree temperature and 51% humid environment. As the soil dried, 70 ml of water was added.

Preparation of seeds and pots: Seeds were planted at a depth of 3-4 cm to plastic pots filled with sand and peat evenly. 3-12 days after planting the number of plants on the soil was counted and the rate of sprout was calculated as %. Sprout numbers, seedling length, loss of color foliage, lacrimation level were measured and evaluated in 7-90 days after planting.

Radiation application: Using a 45 cm SSD, the seeds were irradiated between 20 and 60 Gy in each of the 4 groups treated with a single frontal area of 10x10 cm on a flat plate floor. The first group received 20 Gy, 20 group 2, 50 group 3, and 60 Gy groups.

RESULTS

4 different gamma doses (20, 40, 50 and 60 Gy) in the applied and untreated group of bean seed varieties output rate (%), seedling length (cm) amounts, table 1 is shown. The earliest sprouting was observed in the median 3-3.5 days and in the first group and the control group, respectively (Figure 1).

Figure 1. Sprouting in control group

Plant length is in the longest 1st group and control group and it is 41 and 37 cm. At the latest, germination was observed in the median 0.5-.5 days and in the 4th and 3rd groups respectively. Plant length is shorter in 4th and 3rd group and it is 13 and 20 cm.

Figure 2. Bean plant lengths in 50 Gy group on day 15

Figure 3. Bean plant lengths in 60 Gy group on day 15

Table 1. Median aspect ratios of growing in days with different doses of radiation applied groups

Grow.	1. day (m)	7. day (m)	10. day (m)	15. day (m)	20. day (m)	30. day (m)	40. day (m)
1.gr 20Gy	0	3.5	12	17	25	33.5	41
2.gr 4 Gy	0	2.5	3	10	15	20	21
3.gr 50Gy	0	1	2.7	9	12.5	20	20
4.gr 60Gy	0	0.5	2.5	7	11	13	13
5.gr C	0	3	7	12	15	28	37

m: Median

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The time and rate of germination in 20-60 Gy radiation groups were shown in Table 2.

Table 2. Time and rates of germination in groups with different doses of radiation

Germ.	Germ. time (day) (m)	Germ. rate	%
1.group 20 Gy	6.	6/7	85
2.group 40 Gy	8.	5/7	71
3.group 50 Gy	9.	3/7	42
4.group 60 Gy	10.	2/7	28
5.gorup control	6.	6/7	85

Germ.: Germination m: Median

In the 1-3th group, a linear increase in size was observed after sprouting and after 40th day flowering and product production began. In the 50-60 Gy applied groups, the length of the elongation was decreased and the ricketing started after the 30th day (Figure 1).

Figure 3. Dullness and color fading in beans

Table 3. The rates of median attenuation in days with different doses of radiation treated groups

Attenuation	Median (gün)	%
1.group 20Gy	83	85
2.gorup 40Gy	55	71
3.group 50Gy	40	85
4.group 60Gy	13	100
5.group Control	85	85

It was seen in the early germination control and 20 Gy group and it was the 3rd day. The latest germination was in 60Gy group at the earliest at 8 days and at the latest 16 days.

DISCUSSION

Mutagenesis in agriculture has been used in many plants for the engineering of new properties. The irradiation of soybeans with X-rays or thermal neutrons is effective on plant height, flowering, seed size, protein, fat content and yield (12-14).

50% of the replicated genes in the soybean genome show a loss of function (15). Ionized radiation was used for mutagenizing soybean in 2005 and 2010 and mutant mutant products were shown (16).

As the gamma ray doses increased, the rate of the shoot output decreased. In a study conducted with wheat, the highest germination rate was obtained in the control group with 100% and the lowest germination was obtained with 300 Gy gamma dose (65%). Similar results were obtained in other studies (17, 18).

In this study, a linear increase was observed in group 1-3 after sprouting and flowering and product was given after 40th day. In the 50-60 Gy applied groups, the rate of height increase gradually decreased and after the 30th day skinning began. Although radiation doses were quite low compared to other studies in the literature, the product germination and height growth rates were found to be lower even at 60 Gy radiation dose. The use of pots in our study may have affected the growth rates negatively. However, significant differences in growth between the doses of 20 Gy and 60 Gy were found to be significant in pot. This is a preliminary study. In this study, biologists, radiophysics and radiation oncologists worked together. To achieve healthy outcomes, the team should be further expanded to carry out much larger work.

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