Propagation of avocado seedlings of the cultivar "Quintal" by grafts irradiated

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SUMMARY

Due to difficulties of vegetative propagating in avocado, many tests were performed with ionizing radiation aiming the modification of the characteristics of the plants for obtaining of the improved genotypes and of smaller size. Rootstock "Nimlioh" cultivar of the Guatemalan race, were used to obtain avocado seedlings of "Quintal" cultivar. The cuttings were irradiated with different doses of gamma radiation: 0 (control), 10, 20 and 30 Gy, in a source of Cobalt-60 type Gammacell-220, installed in the Center for Nuclear Energy in Agriculture, CENA-USP. After irradiation, was performed the grafting type cleft graft. Were performed four evaluations of height of the plants from the budding grafting every 60 days. Was also calculated the average growth rate and volume of the plant canopy after 8 months. Data were subjected by statistic program (SAS) and the means were compared by Tukey test ($p < 0.05$). From the results obtained can be concluded that the dose of 10 Gy stimulated growth of the plants and 30 Gy reduced.

Key words: *Persea americana* Mill., Rootstock, Gamma radiation, Avocado orchards.

INTRODUCTION

According to Silva, (2013) the avocado culture have a wide adaptation to differents conditions of soil and climate, its cultivation occur in countries as Mexico, Chile, USA, South Africa, Spain, Israel, Australia, New Zealand and Peru. In the Brazil, the avocado culture occupies the 7th position, producing 152,181 tons in 11,637 hectares spread across the country, especially in the Southeast, Northeast and South. The state of São Paulo is the main producer, with 82,014 tons, representing 53.9% of production national, followed by Minas Gerais, with the participation of 18.7%, Paraná (10.4%) and the Northeast (6.2%). The avocado orchards are distributed in all the State of São Paulo, but 75% of the total planted area is concentrated in 39 municipalities, the main are: Mogi-Mirim, Jardinópolis, Bauru, Santo Antonio da Posse, Araras and Tupã. The avocado is cultivated in almost all states of the Brazil, being one of the most productive fruit per acreage units (Tango & Turatti, 1992).

According to Arthur, Cantuarias-Aviles, Ferrari, (2012) to gamma irradiation has been used with the aim of plant breeding to induce mutations which gave rise to numerous commercial cultivars. The difficulties of vegetative propagation in avocado has been reason for seeking alternative methods and one that is currently being widely used is the use of ionizing radiation in order to modify the characteristics of plants and their standard of vegetative growth to obtain improved genotypes and smaller. The irradiation of plants and seeds with low doses of ionizing radiation can promote acceleration or increase germination, larger plant growth, increased agricultural production, etc. The gamma radiation doses used to achieve these benefits are not enough to cause changes in the gene pool of irradiated organism, being these low radiation doses applied on plants calls of hormesis. (Bovi *et al*, 2000), (Harder *et al*, 2012), (Fontes *et al*, 2013).

The ionizing radiation is being used since a long time as an alternative method for inducing mutations in seeds, stems, tubers, cuttings, tissue culture annual plants, ornamentals and some fruit species, as part of a breeding program that originated many commercial cultivars (Przbyla, 1994, Maluszynsky *et al*, 2000). Works with avocado also were conducted to evaluate the effects of radiation to obtain mutations induced in plants with improved genotypes (De la cruz *et al*,1992, De la cruz *et al*, 1998, De la cruz *et al*, 1995) Rubi *et al*, 1995).

The irradiation with gamma rays of a product consists in its exposure to a source of isotopes for a time sufficient for have absorption of radiation dose required (Chitarra & Chitarra, 2005). Among the gamma radiation sources, the Cobalt-60 is the most used because it is an insoluble metal in water, with larger environmental safety (Vieites 1998).

The radiation dose are measured in terms of energy absorbed by the irradiated product, using as the unit the Gray (Gy) which corresponds absorption of 1 joule of energy per 1kg of mass.

The dose rate corresponds the radiation emitted by the source per unit of time and per hour measured in gray (Gy-1). Therefore, to irradiate a product with a particular dose is necessary know the dose rate of the source to calculate the exposure time needed to achieve the required dose absorbed (Luckey, 1980). Nevertheless, products exposed to the gamma rays do not become radioactive, because they do not come into direct contact with the radioactive source and because the absorbed energy is not sufficient to induce radioactivity in order that the application of the radioactive treatment is safe and leave no residues (O'Beirne 1989).

In Brazil studies conducted with gamma radiation in avocado has been made to prolong the life of fruit post-harvest (Germano *et al*, 1996; Kanesiro *et al*, 2001; Tremocoldi, 2011) and as a quarantine treatment (Silva *et al.,* 2007). In the Antillean varieties of hybrid races and Guatemalan obtained locally, there is variation in the response with radiation cobalt-60. In fruits of variety Fortuna, gamma radiation prolonged shelf life, while the quintal variety showed no sensibility to radiation (Germano *et al.,* 1996), which corroborates that there is no a single dose

of radiation that may be recommended for all varieties . However, when local varieties are exposed to high radiation doses which exceed 100 Gy, occur physiological disorders and dark spots on the peel (Kanesiro 2001; Silva *et al*, 2007).

Already (Arthur *et al*, 2013) used the gamma radiation in seeds of different cultivars avocado for propagation of plants and concluded that in the dose of 15 Gy was an increase in the tillering of avocado sprouts without affecting the germinative capacity and the the final size of the obtained sprouts, thereby reducing the amount of seed required for propagation. Furthermore the exposure avocado seeds at high radiation doses to propagation effects is not recommended because it reduces the germination and decreases the size of the germinated plants. Because of this the objective of the work was utilize avocado cuttings of Quintal variety irradiated in the propagation of seedlings.

MATERIAL AND METHODS

The experiment was performed in department of plant production of the Luiz de Queiroz College of Agriculture - ESALQ / USP. The experiment was conducted in a greenhouse. For the formation of rootstock, seeds of the variety Nimlioh Guatemalan race were used, the seeds were placed for germination in asbestos boxes. And then transplanted in pots with 14 cm diameter by 31 cm height containing soil latosol medium in March 2014, Figure 1.

Figure 1. Vases with avocado seedlings transplanted.

The grafts Quintal variety were irradiated with gamma radiation doses: 0 (control), 10, 20 and 30 Gy, in a source of Cobalt-60 type Gammacell-220, installed in the Center for Nuclear Energy in Agriculture, CENA-USP under a dose rate of 0.323 kGy / hr. After the irradiation was performed the grafting of grafting type cleft when the rootstocks were on average 25-30 cm height, and the diameter ranged of 0.5 to 0.7 cm. The graft length was 6.0 cm. The grafting height was taken to 5 cm. After grafting, plastic bags were placed over the stem grafted of the plants to conserve the humidity Figure 2.

Figure 2. Details of bags without grafts to keep the humidity.

Were performed four evaluations of the plants height from the sprouting of the grafting, every two months after grafting of the plants. Was also calculated the average growth rate (GR) by the variation of canopy volume (V), calculated by: $V = (\pi/6) \times H \times Dl \times Dr$, where H= plant height in meters(m) and and Dl and Dr = Diameter of the plant in directions parallel and perpendicular the crop planting line(m), respectively second (Zekri, 2000), the values were expressed in volume / meter / cubic. The experiment was in randomized blocks, with four treatments and six replicates by each treatment, data were submitted to analysis of variance and the means were compared by Tukey test ($p < 0.05$).

RESULTS

The four evaluations of the plant height of avocado plants of the Quintal variety from sprouting of the grafting after 2,4,6 and 8 months, the results are showed in the tables1, 2, 3 and 4. By the results of these Tables we observe that the values of the heights of the plants in the first

evaluation showed statistical significance only in the dose of 20 Gy between repetitions in the lines, already in comparison with the treatments in the columns all showed statistically significant differences between the heights of the plants. In the second evaluation only the dose of 30 Gy showed a significant difference between the repetitions, between treatments in columns all showed significant difference.

In the third evaluation the control and doses of 10 and 30 Gy showed significant differences between repetitions in the lines in the fourth evaluation only control showed significant difference between treatments for both evaluations all showed significant differences. With regard to plant height by the results in Tables we can observe that in the dose of 10 Gy the gamma radiation induced a stimulation of the Quintal cultivate grafts the which made with that the develop of the plants be larger reaching a greater height in centimeters in relation to other treatments, (Figure 3).

Figure 3. From left to right we have the treatments: 0 (control), 10, 20 and 30 Gy.

Already with the dose of 30 Gy the inverse occurred and there was a smaller plant development when compared to the other treatments. Also the plants in this dose showed morphological mutation fasciation Figure 4.

Figura 4. Fasciation details on the stem of the irradiated plant.

Table 1. Numeric values and medium heights in cm of the first evaluation of cultivar quintal from irradiated grafts with increasing doses of gamma radiation from cobalt-60.

Treatments	Repetitions (± S.D.)					Mean
Control	8.0 ± 1.7dA	12.5 ± 1.9dA	9.0 ± 1.8dA	7.5 ± 1.7dA	6.5 ± 1.6dA	8.7 ± 1.6dA
10 Gy	12.5 ± 1.8cA	8.5 ± 1.5cA	12.5 ± 1.8cA	8.0 ± 1.4cA	8.5 ± 1.5cA	10.0 ± 1.7cA
20 Gy	11.0 ± 1.7bB	0.5 ± 1.2bC	3.5 ± 1.3bA	6.5 ± 1.5bA	3.0 ± 1.3bA	4.9 ± 1.3bA
30 Gy	0.0 ± 0.0aA	0.0 ± 0.0aA	0.0 ± 0.0aA	0.0 ± 0.0aA	0.0 ± 0.0aA	0.0 ± 0.0aA
F	80.3					
p value	< 0.001					

Same letters are not statistically different at 5%, Tukey *For column lowercase ** Lines Caps.

Table 2. Numerical values of the height in cm of the second evaluation of the plants from the cultivar quintal grafts irradiated with increasing doses of gamma radiation from Cobalt-60

Treatments	Repetitions (± S.D.)					Mean
Control	16.0 ± 1.4dA	24.5 ± 1.8dA	20.5 ± 1.6dA	24.5 ± 1.8 dA	17.0 ± 1.5dA	20.5 ± 1.6dA
10 Gy	24.0 ± 1.8cA	22.0 ± 1.6cA	28.0 ± 1.9cA	24.5 ± 1.6cA	25.5 ± 1.6cA	24.8 ± 1.7cA
20 Gy	24.0 ± 1.5bA	20.0 ± 1.3bA	24.0 ± 1.5bA	25.5 ± 1.6bA	21.0 ± 1.3bA	22.9 ± 1.5bA
30 Gy	15.5 ± 1.5aA	14.5 ± 1.5aA	24.5 ± 1.7aB	10.0 ± 1.3aA	9.5 ± 1.2aA	14.8 ± 1.4aA
F	69,8					
p value	< 0.01					

Same letters are not statistically different at 5%, Tukey *For column lowercase ** Lines Caps.

Table 3. Numerical values of the height in cm of the second evaluation of the plants from the cultivar quintal grafts irradiated with increasing doses of gamma radiation from Cobalt-60

Treatments	Repetitions (± S.D.)					Mean
Control	27.0 ± 1.9dA	31.5 ± 2.0dA	32.5 ± 2.1dA	34.0 ± 2.2dA	18.5 ± 1.7dB	28.7 ± 1.8dA
10 Gy	31.5 ± 1.7cB	40.0 ± 2.1cA	33.0 ± 1.5cA	39.0 ± 1.9cA	37.5 ± 1.7cA	36.2 ± 1.9cA
20 Gy	27.0 ± 1.6bA	34.0 ± 1.7bA	32.0 ± 1.6bA	35.0 ± 1.8bA	27.0 ± 1.6bA	31.0 ± 1.8bA
30 Gy	22.0 ± 1.6aA	24.5 ± 1.7aA	30.5 ± 1.8aA	17.0 ± 1.4aA	19.5 ± 1.5aB	22.7 ± 1.5aA
F	75.4					
p value	< 0.01					

Same letters are not statistically different at 5%, Tukey *For column lowercase ** Lines Caps.

Table 4. Numerical values of the height in cm of the second evaluation of the plants from the cultivar quintal grafts irradiated with increasing doses of gamma radiation from Cobalt-60

Treatments	Repetitions (± S.D.)					Mean
Control	28.0 ± 1.5dA	35.5 ± 1.9dA	33.0 ± 1.7dA	35.5 ± 1.9dA	22.0 ± 1.4dB	30.8 ± 1.7dA
10 Gy	34.5 ± 1.7cA	40.0 ± 2.0cA	37.0 ± 1.9cA	39.5 ± 2.0cA	40.0 ± 2.0cA	38.2 ± 1.9cA
20 Gy	34.0 ± 1.5bA	35.0 ± 1.6bA	36.0 ± 1.7bA	36.5 ± 1.7bA	31.0 ± 1.3bA	34.5 ± 1.8bA
30 Gy	29.0 ± 1.6aA	28.0 ± 1.6aA	31.5 ± 1.7aA	21.0 ± 1.3aB	25.0 ± 1.4aA	26.9 ± 1.6aA
F	73.4					
p value	< 0.01					

Same letters are not statistically different at 5%, Tukey *For column lowercase ** Lines Caps.

The results of Table 5 we can observe that the numerical values and average volumes of Fortuna variety plants was higher for plants from irradiated grafts with the dose of 10 Gy and lower for plants from rootstocks irradiated with 30 Gy, same not showed statistically significant difference between repetitions in treatments in the lines and in between treatments in the columns

Table 5. Numeric values and media volumes in cubic meters of the first evaluation of cultivar quintal irradiated with increasing doses of gamma radiation from cobalt-60

Treatments	Repetitions (±SD)	Mean				
Control	0.0074 ± 0.02aA	0.0083 ± 0.03aA	0.0133 ± 0.03aA	0.0081 ± 0.02aA	0.0074 ± 0.02aA	0.0089 ± 0.03aA
10 Gy	0.0087 ± 0.05aA	0.0181 ± 0.08aA	0.0091 ± 0.05aA	0.0202 ± 0.10aA	0.0088 ± 0.05aA	0.0130±0.06aA
20 Gy	0.0081 ± 0.04aA	0.0071 ± 0.03aA	0.0073 ± 0.03aA	0.0080 ± 0.04aA	0.0077 ± 0.04aA	0.00764±0.04aA
30 Gy	0.0086 ± 0.03aA	0.0099 ± 0.04aA	0.0091 ± 0.03aA	0.0039 ± 0.01aA	0.0081 ± 0.03aA	0.00792±0.02aA
F	60.3					
P value	> 0.119					

Same letters are not statistically different at 5%, Tukey *For column lowercase ** Lines Caps.

DISCUSSION

In general the results obtained by this first phase of the experiment in the greenhouse are satisfactory in relation to effects of gamma radiation on rootstocks induced a stimulating effect with the dose of 10 Gy, however higher doses that this, caused an inversed effect slowing the growth of the plants being similar to these results (Arthur *et al*, 2013) when irradiated avocado seeds and stimulated the tillering of avocado sprouts without affect the germination capacity and the final size of the obtained sprouts, thereby reducing the amount of seed required for propagating purposes. Another important factor to emphasize is that these plants may exhibit changes in their characteristics as the increase or decrease in vegetative growth and may result in obtaining of some improved genotypes, smaller and with higher production than plants obtained from non-irradiated grafts or is control plants. To this the pointers of the plants are collected for the realization of new grafts, or propagation of generation F^1.

The seedlings of avocado quintal variety were transplanted in the field in the city of Limeira, SP., in Farm Jequitiba the neighborhood of the Tatu, owned by Mr. Mauro Batistella where we will continue the evaluations of height, canopy volume and production.

CONCLUSION

From the results obtained we can conclude that a dose of 10 Gy stimulated growth and the volume of the plants and 30 Gy reduced.

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ACTAS · PROCEEDINGS

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