

ADVANCES ON THE RADIOINDUCED MUTATION BREEDING PROGRAMME ON
AVOCADO AT CICTAMEX

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Abstract

The recent advances on the avocado radioinduced mutation breeding programme with ^{60}Co gamma rays at CICTAMEX are presented. It has been found a different response to radiation among selections being the radiosensitivity in direct proportion to the budwood moisture content. The LD_{50} for cv. Hass is estimated in 20 Gy, and the optimum dose for breeding purposes, ranges from 13 to 17 Gy.

1. Introduction

The use of radiation in plant breeding has allowed the obtention of 1300 new varieties worldwide, corresponding 559 to cereals, 136 to legumes, 67 to industrial crops, 397 to ornamentals and 80 to fruits and vegetables.

Notwithstanding that the application of radiation in plant breeding goes back to 1922 (Pirovano, 1924), and that several studies have been done on grapes, pears, apples, and other fruit trees by Granhall, et al.,(1949), and Donini *et al.*, (1982), which have conducted to the development of more than 40 new varieties in fruit trees, the application of the radioinduced mutation technique in avocado breeding is relatively new, with the dwarfing rootstock "D-9" being the first avocado induced mutant obtained by fast neutrons irradiation (Pliego and Bergh, 1992).

In Mexico, as a part of a collaboration agreement between the Centro de Investigaciones Científicas y Tecnológicas del Aguacate en el Estado de México (CICTAMEX) and the Instituto Nacional de Investigaciones Nucleares (ININ), studies related to radiosensitivity on avocado began in 1989 (Sánchez *et al.*, 1989), finding different response among varieties to ^{60}Co gamma irradiation, in a dose range between 0 and 70 Gy, detecting individuals with compact growth and early flowering in doses close to 10 Gy (Rubi, *et al.*, 1992).

During 1993 and 1994 the studies continued on the following aspects:

- Effect of the moisture content of avocado budwood on the radiosensitivity of varieties and selections, and
- Assessment of the optimum radiation dosage for avocado cv. Hass breeding.

2. Material and methods

- Effect of the moisture content of avocado budwood on the radiosensitivity of varieties and selections.

Budwood obtained from seven CICTAMEX' avocado selections plus three varieties were considered as the first study factor, being the radiation dosage between 0 and 60 Gy, the second factor of analysis (table 1).

Irradiations with a ⁶⁰Co source (Gammacell 220) were performed at ININ, the buds were afterwards grafted on Mexican seedling rootstocks and grown at CICTAMEX' nursery, under a completely randomized design, with four replications per treatment, and being four scions the experimental unit.

Budwood moisture content at irradiation and percentage of survival 150 days after grafting, were the registered variables.

- Assessment of the optimum radiation dosage for avocado cv. Hass breeding.

Hass avocado budwood were irradiated at dose ranges from 0 to 45 Gy, with 5 Gy intervals among treatments, resulting 11 treatments with 20 replications each, being one scion the experimental unit. Irradiations were performed with Gammacell 220 at ININ, and material was afterwards grafted at CICTAMEX on Mexican race rootstocks.

Both survival percentage as well as graft growth in centimeters were registered six months after grafting.

3. Results

3. 1. Effect of the moisture contents of avocado budwood on the radiosensitivity of varieties and selections.

On table 2, are presented the medium squares from the analysis of variance for the parameter percentage of survival after 150 days from grafting.

Highly significant differences were observed regarding to factor A (varieties), factor B (doses) and interaction (varieties x doses), indicating that the response of each variety or selection to the variation of the factor doses is different.

The percentage of graft taking in function of dose, 150 days after grafting, exhibited that doses superior to 45 Gy were lethal even for the materials with low radiosensitivity (Colinmex and Fuerte), meanwhile the materials highly sensible to radiation not survived to doses higher than 15 Gy (131 PLS, 137 PLS, 175 PLS, Rincoatl and Hass). These results are in accordance with previous findings reported by Sánchez et al.,(1989) and Rubí *et al.*, (1992).

By correlation analysis among budwood moisture content and graft taking, it was detected a significant correlation coefficient $r=-0.73$, indicating that budwood with more moisture content is more sensible to radiation as stated previously by Ehrenberg et al.,(1953), and attributed among other factors, to higher interaction between water molecules and radiation.

3.2. Assessment of the optimum radiation dose for avocado cv. Hass breeding.

As shown in the previous experiment each avocado material exhibit different radiosensitivity , thus being necessary to test each variety in a dose range according to the preliminary results, and in shorter intervals in order to determine the optimal range of doses with breeding purposes. Table 3 shows the response of cv. Hass budwood to gamma radiation.

Lethality increases with the dose (Table 3), from 0 in control to 100% at 30 Gy; conversely the graft taking is reduced from 100% on the control to 0% at 30 Gy. The effect of radiation on the scion growth on the first development stages (four months after grafting) is drastic, being reduced from 8.45 cm in the control to 3.25 cm at 25 Gy.

4. Discussion

It has been stated that in radioinduced mutation breeding, moderated doses (those resulting in 60%-70% of survival), yield the most favorable results (Visser, 1973); in consequence the regression dose-survival percentage was effectuated, finding a highly significant correlation coefficient ($r=-0.94^{**}$), estimating the medium lethal dose (LD50) in 20.31 Gy, and the optimal irradiation range with breeding purposes from 13 to 17 Gy (70% and 60% of survival respectively). This dose range is in accordance with the doses applied by Paprstein and Blazek (1985) in their works tending to obtain dwarf apple mutants.

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Table 1.-Factors and study levels

Factor	Level	
1.-Avocado selection or variety	S ₁ .-Colinmex	S ₆ .-C-39 PMe
	S ₂ .-Colín V-101	S ₇ .-Rincoatl
	S ₃ .-C-131 PLS	S ₈ .-Colín V-33
	S ₄ .-C-137 PLS	S ₉ .-Fuerte
	S ₅ .-C-175 PLS	S ₁₀ .-Hass
2.-Dose (Gy)	D ₁ .-0.0	D ₄ .-4.5
	D ₂ .-1.5	D ₅ .-6.0
	D ₃ .-3.0	

Table 2.- Medium squares and significance level for percentage of budwood survival after 150 days from grafting.

Source of variation	Deareeb of freedom	Medium squares	Significance level
Factor A	9	20.83	0.01
Factor B	4	65 804.69	0.01
Interaction	36	1 018.23	0.01
Error	150	170.83	
Total	199		
Variation coeficient		36.05	

Table 3.-Response of avocado cv. Hass budwood to ⁶⁰Co gamma irradiation.

Dose (Gy)	Lethality (%)	Survival (%)	Growth (cm)
0	0	100	8.45
5	10	90	7.64
10	10	90	7.76
15	15	85	4.98
20	45	55	4.45
25	80	20	3.25
30	100	0	0.0