



Short communication

BEHAVIOR OF “BARNA”, CULTIVAR OF POTATO (*Solanum tuberosum* L.) AT DIFFERENT DOSES OF GAMMA RAYS COBALT-60 SOURCE

Comunicación Corta

Comportamiento de “Barna”, cultivar de papa (*Solanum tuberosum* L.) ante diferentes dosis de rayos gamma de fuente Cobalto-60

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ABSTRACT. The present work had as objective to know the effect of gamma rays of source ^{60}Co in the agronomic and reproductive traits to obtain mutants of potato (*Solanum tuberosum* L.). Seed-tubers of the cultivar “Barna” imported from Holland with a weight (20 g), with six treatments: five irradiation doses 10, 20, 30, 40, 50 Gy and one non-irradiated control (0 Gy). In this study a strong reduction of plant emergence was observed, as the dose was progressively increased the emergency decreased. It is suggested not to apply doses higher than 50 Gy in seed-tubers, for works directed to the use of radiomutagenesis in the potato breeding of the potato, due to the negative effect in the emergency and in other important characters. Doses applied to potato seed tubers between 20 and 40 Gy could be evidence of induction of mutation, while at 10 Gy a stimulation of flowering was observed in the cultivar “Barna”.

Key words: application rate, flowering, yield, seed, tubers, genetic variation

RESUMEN. El presente trabajo tuvo como objetivo conocer el efecto de los rayos gamma de fuente ^{60}Co en los caracteres agronómicos y reproductivos para la obtención de mutantes de papa (*Solanum tuberosum* L.). Se utilizaron tubérculos-semilla del cultivar ‘Barna’ importada de Holanda con un peso promedio de 20 g, a los cuales se le aplicaron seis tratamientos: cinco dosis de irradiación 10, 20, 30, 40, 50 Gy y un control sin irradiar (0 Gy). En este estudio se observó una fuerte reducción de la emergencia de las plantas, a medida que se incrementó progresivamente la dosis la emergencia disminuyó. Se sugiere no aplicar dosis superiores a 50 Gy en tubérculos-semilla, para trabajos dirigidos al uso de radiomutagénesis en el mejoramiento genético de la papa, debido al efecto negativo en la emergencia y en otros caracteres importantes. Dosis aplicadas a los tubérculos-semilla de papa entre 20 y 40 Gy pudieran estar evidenciando inducción de mutación, mientras que a 10 Gy se observó una estimulación de la floración en el cultivar ‘Barna’.

Palabras clave: dosis de aplicación, floración, rendimiento, semillas, tubérculos, variación genética

INTRODUCTION

The use of mutations is today a successful tool in agriculture to feed a growing human population nutritionally more and more demanding (1).

The physical availability and economic accessibility of food are important in food security. Induced mutations have

played a large role in increasing global food security, as new varieties of food crops have contributed to the significant increase in production and access to people in many regions (2).

Mutations are defined as hereditary changes in the DNA sequence. These when induced by gamma radiations from source ^{60}Co are currently an important route that can be used by the breeder to induce genetic variability that does not exist in nature to create new and better varieties (3-5).

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The potato is the fourth most important staple food in the world (6). For this reason, permanent efforts are made to improve it and to combat the losses caused by diseases, insects and weeds, among other difficulties (7).

Genetic variability is the basis for domestication and crop improvement, as well as genetic research. While some species have a rich genetic diversity, others have limited (8).

The determination of gamma ray doses of cobalt 60 is the first step to be carried out in the genetic improvement by induction of mutations (9).

Taking into account the above, it is proposed to know the effect of gamma rays on agronomic and reproductive traits in the potato cultivar 'Barna' for obtaining mutants within the Genetic Improvement Program for tolerance to high temperatures.

MATERIALS AND METHODS

Seed tubers were used from the cultivar 'Barna' imported from Holland with a diameter of 28 mm and an average weight of 20 g, to which five doses of source gamma rays of ⁶⁰Co were applied: 10, 20, 30, 40 and 50 Gy and an unirradiated control (0 Gy). The irradiation of the seed tubers was carried out at the Center for Technological Applications and Nuclear Development (CEADEN) in Havana, Cuba. For this purpose, an MPX25 device with 0,517 kGy/h power was used. The seed tubers were planted on January 25th, 2016 under semi-controlled conditions within a cultivation house located in the area of the National Institute of Agricultural Sciences (INCA). The cultural and phytosanitary attention to the trial was carried out according to the Technical Instructions for the production of potatoes in Cuba (10).

It was evaluated 20 days after planting the seed tubers, the percentage of emergence (%); after 35 days, height of the plants (cm), number of stems, percentage of flowering plants and numbers of flowers per inflorescence were evaluated. The total number of tubers per plant and the total mass of the tubers per plant were evaluated 90 days after planting once the experiment was harvested. The experimental design was completely randomized with five repetitions; the experimental unit consisted of 25 seed-tubers. The statistical analysis was carried out using the statistical package SPSS version 16 (11) and in the significant differences were applied the Multiple Comparison Test of Tukey Means ($P \leq 0,05$) (12).

RESULT AND DISCUSSION

The analysis of variance showed significant differences between gamma-ray doses for all the variables evaluated. In the Table a strong reduction of plant emergence is observed, as the dose was increased. After 60 days of planting, the tubers at doses of 50 Gy presented a 0 % emergence; however, no significant difference was observed between the control (0 Gy) and the dose of 10 Gy in the sprouting of the tubers, which could be indicating that applying 10 Gy does not affect sprouting and that it could be stimulating it in tubers -seeds during the latency phase. Similar results reported a stimulation in sprouting when they irradiated microtubers with doses of 10 and 20 Gy in the cultivars 'Kondor' and 'Bototho Rosa' (13), and where the doses above 40 Gy were completely lethal for some genotypes, while that in other genotypes the budding and the growth of the plants was severely delayed. Other similar results were raised on the affectation in growth of the plants when using irradiation doses equal to and greater than 50 Gy in seed tubers in the cultivars 'Desirée' and 'Kondor' (14).

Table. Effect of radiation dose on the characters evaluated in the potato cultivar 'Barna'

Tratamientos	Br (%)	Nta/pta	Alt. (cm)	Ptafl. (%)	Nfl/pta	Ntb/pta	Mtb/T (g)
0 Gy (Control)	90 a	3,20 a	47,2 a	40,0 b	3,2 c	5,4 a	0,64 b
10 Gy	100 a	2,00 ab	39,2 b	80,5 a	8,6 a	4,7 ab	0,54 bc
20 Gy	95 a	1,80 b	29,4 c	20,0 c	5,4 b	3,5 ab	0,37 bc
30 Gy	25 b	1,20 bc	22,8 d	0 d	0 d	3,7 ab	1,14 a
40 Gy	10 bc	1,00 bc	22,8 d	0 d	0 d	3,3 b	0,30 bc
50 Gy	0 c	0 c	21,8 d	0 d	0 d	2,9 b	0,19 c
ESx	2,236	0,294	1,452	2,236	2,236	2,236	0,090

Means with the same letters do not differ significantly according to the Tukey test. ($p \leq 0,05$)

ESx = standard error of the mean, Br = sprouting, Nta / pta = number of stems per plant, Alt = height, Ptafl = flowering plants, Nfl / pta = number of flowers per plant, Ntb / pta = number of tubers per plant, Mtb / T = mass of the total tubers

This stimulation could be related to the activation of several enzymes, such as polyphenoloxidases, catalases, peroxidases and esterases, which lead to the formation of physiologically active substances that, at low concentrations, accelerate cell division together with morphogenesis in the cells of important organelles such as mitochondria and chloroplasts (15).

When evaluating the number of stems and the height of the plants, it was observed that the values of these characters decreased with the increase of radiation doses. Similar results reported in another investigation (16), found phenotypic variation in potato culture when observing a decrease in the development of the *in vitro* seedlings, where the height also decreased as the applied radiation dose was increased, as well as, in other characters they were also affected when they applied cobalt 60 gamma rays.

The highest number of flowering plants and number of flowers per plant were observed in the tubers subjected to the dose of 10 Gy surpassing the control, which could be indicating that at 10 Gy there is a stimulation of flowering in the potato variety 'Barna'. However, it was observed that from 20 Gy this flowering was decreasing until completely inhibiting the emission of the inflorescences. However, it was observed that from 20 Gy this flowering was decreasing until completely inhibiting the emission of the inflorescences.

Similar results but in another crop reported by other researchers (17), an improvement in flowering, as well as in the color and shape of chrysanthemum flowers when applying low doses of radiation.

Doses between 20 and 40 Gy have shown differences in the values of the morphological characters evaluated, which could indicate a genetic variation, or could have caused some stress in the irradiated material.

In the number of tubers per plant the applied doses of 40 and 50 Gy had the lowest values; this could be evidence that applying high as low doses of irradiation decreases the number of tubercles per plant. For the total mass of the tubers per plant the behavior was similar, both the high and low doses decreased the values in this character; however, the dose of 30 Gy reached the highest value, apparently this dose stimulates or acts on the genes that intervene in the performance or in some of its components, such as the character of the average mass of the tubers. Similar results were obtained when radio sensitivity was studied in two potato species (16,18), which showed reductions in the number, size and weight of micro-tubers produced.

CONCLUSIONS

- ◆ It is suggested not to apply doses higher than 50 Gy in seed-tubers for works directed to the use of radiomutagenesis in the genetic improvement of potatoes, due to the negative effect in sprouting and emergence among other important characters.
- ◆ Sprouting stimulation was observed was observed with doses of 10 and 20 Gy in seed tubers in dormant state. Doses between 20 and 40 Gy may be showing variation at the DNA level in the "Barna" cultivar.

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