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Improving the quantity of 'Malase Saveh' pomegranate fruit using gamma irradiation

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Abstract

Pomegranate (*Punica granatum* L.) is a fruit that has become very popular in many countries around the world due to its health benefits. Improving the quality of these fruits and maintaining the yield at optimal levels makes their market competitive. Gamma irradiation is one of the physical mutants that is widely used to plant breeding. In the present study, the effects of optimal dose of 36 Gy gamma irradiation on the quantity of pomegranate fruit c.v. 'Malase Saveh' were investigated. The number of 11 mutant clones were selected at m_1V_5 based on their survival in winter and disease resistance. Results showed that the application of gamma irradiation on pomegranate cuttings caused a variety in the number and weight of ripe and unripe fruits of pomegranate of m_1V_5 trees. Mutant clones 14, 16, 8 had more ripe fruit weight and less unripe fruit weight than the control.

Keywords: Induced mutations, pomegranate, fruit weight, gamma irradiation.

Introduction

Pomegranate (*Punica granatum* L.) is an important commercial fruit that is widely cultivated in Iran, India, the USA, China, Japan, and Russia [1]. The center of origin of this fruit is Iran, which today is one of the leading producers and exporters of pomegranates in the world [2]. Mutations induced in the somatic tissues of vegetatively propagated crops, especially fruit crops, are the best way to create genetic diversity because they are more economical in terms of time and space than traditional cross-breeding. Induced mutations can be used to create useful genetic mutations that are of great economic importance without destroying the useful characteristics of the genotype. In recent decades, many researchers have made advances in the application of nuclear technology in the breeding of grapes, lychees, locusts, mangoes, and other fruits [3, 4]. Therefore, the present study was planned to determine the effect of gamma irradiation on fruit quantity in pomegranate cuttings after being submitted to 36 Gy doses of 60Co gamma irradiation.

Experimental

Preparation of the materials

One-year-old shoots of pomegranate tree (*Punica granatum* c.v. Malase Saveh) were gamma-irradiated with a 36 Gy dose from a cobalt (^{60}CO) source at the Nuclear Science and Technology Research Institute, Karaj, Iran. The appropriate irradiation dose was determined in the previous experiment [5]. The irradiated young plant was then kept for about 1 year in the nursery, and then the selected mutants were moved to the main garden in Saveh, in the province of Markazi, where the rest of the study was carried out. Pomegranate mutant (Mut) and control plants were managed similarly in terms of fertilization, irrigation, and disease control. When m_1V_1 have new shoots, they will be m_1V_2. let m_1V_3 shoots emerge from m_1V_2 and m_1V_4 from m_1V_3 in the same mature plants and just tag them in each generation. A total number of 1000 cuttings were initially irradiated, from which 11 mutant clones in the m_1V_5 were selected based on their survival in winter and disease resistance. Fruit quantity characteristics of mutant colones including the number and weight of ripe and unripe fruits, the ratio of unripe to ripe fruits, were recorded and compared with the control.

Results and discussion

The results showed that the mutant clones 14, 16, 8, 11, 10 and 5 (3.25-5.05 kg per tree) had more ripe fruit weight than the control (2.86 kg per tree). Mutant clones 16, 4, 8, 14, 15, 1, 18 and 11 (0.13-0.84 kg per tree) showed less ripe fruit weight than the control (1.42 kg per tree). In general, the weight of ripe fruits was significantly higher than unripe fruits (Table 1).

The number of ripe fruit per tree in the mutant clone 14 was higher (20) than its parent 'Malase Saveh' (15.67). Mutated clones 1, 4, 7, 8, 11, 14, 15, 16 and 18 (1-14.67 fruits per tree) showed fewer unripe fruits than the control. The number of unripe / ripe fruits in all mutant clones except 5 and 7 was similar to the control.

The results of Table 2 showed that there was a good correlation between the number and weight of ripe fruits

(r=0.65**). Moreover, a positive and significant relationship existed between the number and weight of unripe fruits (r=0.47**). A study by Smith et al. [6] reported improved yield and size of mutant banana fruits. In a investigation on citrus, it was reported that for the production of marketable fruits, the best results were obtained by irradiating pollen at 200-300 g [7]. Moreover, Aney [8] found that irradiation with gamma rays at lower doses stimulated the number of capsules per plant in *Sesamum indicum*.

Table 1. Weight of ripe fruits (WR), the weight of unripe fruits (WU), number of ripe fruit per tree (NR), number of unripe fruits per tree (NU), and NU/NR of new mutant clones pomegranate c.v. 'Malase Saveh'.

Clone No.	WR (kg/tree)	WU (kg/tree)	NR	NU	NU/NR
1	1.96 h	0.38 f	6.66 g	8.33 e	1.25 cd
4	2.33 g	0.60 e	7.33 fg	5.67 f	0.79 cd
5	3.14 d	1.72 b	3.66 h	45.00 a	12.96 a
7	2.35 g	1.72 b	4.33 h	15.67 c	3.94 b
8	4.05 b	0.59 e	13.33 c	14.67 c	1.10 cd
10	3.25 d	2.15 a	10.00 de	24.00 b	2.40 bc
11	3.51 c	0.13 h	12.00 cd	1.00 h	0.08 d
14	5.05 a	0.64 e	20.00 a	10.33 d	0.52 d
15	2.56 f	0.38 f	9.00 ef	6.67 f	0.74 cd
16	4.06 b	0.84 d	9.00 ef	10.67 d	1.19 cd
18	2.37 g	0.26 g	10.33 de	2.67 g	0.25 d
control	2.86 e	1.42 c	15.67 b	23.67 b	1.52 cd

Values within each column followed by the same letter are not significantly different at 5% level, using Least Significant Difference (LSD) test.

Table 2. Pearson correlation coefficients between the weight of ripe fruits (WR), the weight of unripe fruits (WU), number of ripe fruit per tree (NR), number of unripe fruits per tree (NU), and NU/NR of new mutant clones pomegranate c.v. 'Malase Saveh'.

Traits	WR	WU	NR	NU	NU/NR
WR	1				
WU	ns	1			
NR	0.65**	ns	1		
NU	ns	0.47**	ns	1	
NU/NR	ns	0.58**	-0.54**	0.85**	1

ns and ** present non- significant and correlation coefficients significant at 1%, respectively.

Conclusions

In general, according to the results of the present work, the quantity of mutant clones pomegranate was comparable with control. Mutant clones 14, 16, 8, and 11 were identified as superior clones due to having more ripe fruit weight and also less ripe fruit weight than the control.

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References

[1] Y. S. Mansouri, J. Khazaei, S. R. Hassan Beygi, S. S Mohtasebi, *Statistical modeling of pomegranate (Punica granatum L.) fruit with some physical attributes.* J. Food Process Technol. 1, pp. 1-4 (2010).

[2] Anonymous. *Statistical Book of Agricultural of Iran*. Iranian Statistical Centre. Tehran, Iran (2005).

[3] W. Ye, Y. Qin, Z. Ye, J.A. Teixeria da Silva, L. Zhang, X. Wu, S. Lin, G. Hu, *Seedless Mechanism of a New Mandarin Cultivar 'Wuzishatangju' (Citrus Reticulata Blanco).* Plant Sci. 177, pp. 19-27 (2009).

[4] H. Raza, M.K. Mumtaz, A. Ali-Khan, *Seedlessness in Citrus*. Inter. J. Agric. Biol. 5, pp. 388-391 (2003).

[5] S. Vedadi, B. Naserian, S. Z. Tabatabei, M. Rahimi, *Determination of Suitable Dose of Gamma Ray for Mutation Induction in Pomegranate Buds (Punica Granatum L. cv. Malase Saveh).* J. Nucl. Sci. Technol. 6, pp. 82-85. (2014) (In Persian).

[6] M.K. Smith, S.D. Hamill, P.W. Langdon, J.E. Giles,V.J. Doogan, K.G. Pegg, *Towards the development of a Cavendish banana resistant to race 4 of fusarium wilt: gamma irradiation of micropropagated Dwarf Parfitt (Musa spp., AAA group, Cavendish subgroup)*. Australian J. Expt. Agric. 46: 107-113 (2006).

[7] M. Kundu, A. Dubey, *Effect of γ ray irradiated pollen technique on fruit growth in Citrus.* J. Appl. Hortic. 19, 143-146. (2017).

[8] A. Aney, *Effect of gamma irradiation on yield attributing characters in two varieties of pea (Pisum sativum L.).* Int. J. Life Sci 1, pp. 241–247 (2013).