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Effect of gamma-ray irradiation on leaf characteristics of apricot

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Abstract

Induced mutation using ionizing mutagens such as gamma-rays has been widely employed in plant mutation breeding approaches. This project has been launched since 2010 aiming to delay flowering time in apricot. However, gamma-rays irradiation may trigger numerous physiological and biochemical changes in plants. In this study, M1V9 populations (M40 and M60 mutants) were subjected to study in terms of their probable changes in some of the leaf characteristics. Results indicated that all of the parameters studied were significantly influenced by the target population, pinpointing the highest values in M60 compared to M40 population.

Keywords: apricot, gamma-rays, leaf characteristics

Introduction

Apricot (*Prunus armenica* L.) is considered as one of the main crops of many countries with the world's total production of around 3,791,702t; among which Turkey, Uzbekistan and Iran, are accounted as the most apricot producer countries in the world accounting 44.5% of total production (FAO 2020). According to the latest database released by FAO in 2020, Iran shared 8.81% (334,408t) of the world production. However, commercial production of apricot in this country has mainly been threatened by a range of abiotic and biotic stresses. Therefore, the most important apricot breeding programs would be obtaining cultivars with desirable traits including late-blooming, frost resistance, self-fertility, high yielding, and good growth habit.

Prunus breeding programs by the conventional methods may be a very slow process because of their long juvenile phase in addition to heterogeneous genetic background. Alternatively, genetic variability can be induced by mutagenizing agents, such as chemical and physical mutagens [1]. Among different types of physical mutagens, gamma-rays and X-rays have been the most commonly used ionizing radiation types and also the most effective for fruit breeding as described by Predieri [2]. However, over the almost past half-century, the use of gamma-rays in mutation induction has become particularly prevalent with a significant decline in X-rays utilization as described by Mba and Shu [3].

Previously, *Prunus armenica* cv. Shahroodi scions were irradiated with different dosages of gamma-ray by our group in order to improve tolerant mutants to early-spring frost damage. In the present study, the growth habit of the mutant scions in terms of some important leaf characteristics were evaluated.

Materials and methods

Plant material

This research was commenced at the Plant Breeding Department, Agricultural Nuclear School, Karaj, Iran in 2010 [4]. Briefly, actively growing buds of *P. armenica* cv. 'Shahroodi' were collected from the research station of Temperate Fruits Research Center, Karaj, Iran. The establishment of M1V1 population was carried out using 50 buds irradiated at 40Gy and 400 buds at 60 Gy. The irradiated buds were grafted on apricot seedlings in three successive years in the nursery to create M1V2 and M1V3 populations. Development of M1V3-M1V9 has been carried out through transferring M1V3 mutants to the field.

Experimental conditions and data acquisition

In October 2021 five trees from M1V9 populations: control (untreated trees), M40 (irradiated at 40Gy), and M60 (irradiated at 60Gy) were randomly subjected to study and five mature leaves per tree sampled. Leaf area (LA) in cm^2 together with leaf wide (LW), leaf length (LL), and petiole length (PL) in cm were measured using leaf area meter AM350®.

Statistical analysis

Analysis of variance and means comparison by the least significant difference (LSD) test were carried out using SAS 9.1 software.

Results and discussion

Variance analysis revealed that all of the parameters were significantly impacted by gamma-ray irradiation (Table 1).

Table 1. Analysis of variance of leaf characteristics of mutant apricot.

S. O. V.	*df*	Mean Square (MS)			
		LA	LW	LL	PL
Population	2	315.59**	3.22**	6.63***	0.93*
Error	147	40.03	0.46	0.61	0.33
Total	149				
CV (%)		21.90	12.01	9.84	15.97

LA: Leaf area, LW: Leaf wide, LL: Leaf length, PL: Petiole length. Symbols *, **,*** are presentation of significant levels in 0.1, 0.01 and 0.001, respectively.

The greatest LA (31.49±0.92 cm) was attained in the control (untreated population). Whilst, the lowest LA (26.48±0.89 cm) was achieved in the mutant scions generated by 40Gy. On the other hand, the leaves of M60 trees showed an increase in the parameter compared to the M40. LW as the next parameter was affected significantly by the applied irradiation, giving the highest LW in both control and M60 and the lowest amount in M40. Whilst, gamma-ray irradiation has had a negative effect on the LL, producing the highest amount in control (Table 2).

Table 2 Effect of induced gamma-irradiation on leaf characteristics of aricot.

Population	Parameters			
	LA (cm^2)	LW (cm)	LL (cm)	PL (cm)
Control	31.49±0.92^{a}	5.93±0.08^{a}	8.35±0.12^{a}	3.62±0.1^{ab}
M40	26.48±0.89^{b}	5.42±0.08^{b}	7.69±0.09^{b}	3.51±0.05^{b}
M60	28.68±0.85^{b}	5.70±0.11^{a}	7.75±0.10^{b}	3.78±0.07^{a}

Values are the means of mature leaves of five trees per treatment, each with ten randomly sampled leaves in October 2021 (n = 50), compared by LSD Test, *P = 0.05*.
LA: Leaf area, LW: Leaf wide, LL: Leaf length, PL: Petiol length.

For the PL parameter, the longest (3.78±0.07 cm) and shortest (3.51±0.05 cm) petioles were obtained in the leaves of M60 and M40 populations, respectively (*P-value* <0.1). Recently, the effect of different gamma radiation times (DGRT) was studied on some biological traits of *P. amygdalus*, pinpointing significant variation in LA [5]. These authors, in agreement with our findings, observed the highest LA when buds were irradiated with gamma-rays for a long time (150 min) compared to either control or shorter times.

Conclusions

In this study, the primary evaluation of mutant populations revealed the considerable impact of gamma-rays irradiation on the studied traits. However, further studies must be carried out to have a clear viewpoint of the created changes on the mutant trees growth habit

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