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Variability of morphological characters among Tunisian apricot germplasm

Lamia Krichen[a,*], Jean-Marc Audergon[b], Neila Trifi-Farah[a]

[a] LR99ES12, Laboratoire de Génétique Moléculaire, Immunologie et Biotechnologie, Faculté des Sciences de Tunis, Université Tunis El Manar, Campus universitaire Tunis-El Manar, 2072, Tunis, Tunisia
[b] INRA UR1052, Unité de Génétique et Amélioration des Fruits et Légumes, Centre de Recherches d'Avignon - Domaine St Maurice, BP94 84143 Montfavet Cedex, France

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ABSTRACT

Morphological characters were assessed for 112 Tunisian apricot accessions using 42 qualitative and quantitative traits according to the UPOV descriptor. The results showed a distinction among all the accessions, and each morphological variable tested was polymorphic except mucron and rootstock. This characterization revealed that Tunisian apricot germplasm complied with many of the listed UPOV descriptor modalities, with the exception of a rectangular-plate fruit shape, which is characteristic of six Tunisian cultivars and not included in the UPOV apricot testing guidelines. The morphological characters with the best discriminatory ability included fruit size, fruit shape, over color of the fruit skin and flesh, and leaf size.

The variability structure highlighted two different apricot categories: (i) Bargougs characterized by very small fruit size with high FW/FLW and absence of over color, (ii) grafted cultivars characterized by medium to relatively large fruit and the presence of over color.

Morphological variability was structured according to the geographical origin of the plant material. Four regions were clearly distinguished: north, center, south and oasis.

The assessed Tunisian apricot germplasm presented great variability, similar to that of Turkish, Spanish and Italian apricots.

1. Introduction

Apricot (*Prunus armeniaca* L.) belongs to the Rosaceae family, Pronoideae subfamily, *Prunus* genus and *Prunuphora* subgenus (Neck). This fruit species exists on five continents and shows high adaptability to several climates, ranging from arid to Siberian conditions. It is worth noting that around 80% of fresh fruit production is located around the Mediterranean Basin (FAOSTAT, 2013). A main characteristic of apricot species is its high variability partly described through its ecological requirements. Concurrently, another important particularity is the specificity of existing cultivars to areas of cultivation, as described by Bailey and Hough (1975) and Faust et al. (1998).

One particularity of apricot species is the clear separation of the germplasm according to the two main modes of propagation commonly used: (i) apricot cultivars are often propagated by grafting and exist especially in western Europe and America, (ii) several forms are propagated by seeds in Central Asia and North Africa (Bailey and Hough, 1975; Faust et al., 1998; Kostina, 1969; Mehlenbacher et al., 1990).

In Tunisia, apricot is a traditional fruit species cultivated in several areas and adapted to different climates and soils (Krichen et al., 2008). Two modes of propagation coexist: propagation by grafting and by seeds. Grafting is devoted to traditional cultivars and to cultivars selected in breeding programs, while oasis material is propagated by seeds.

The Tunisian local name for apricots derived from grafted cultivars and cultivated for the edible fruits is 'Mechmech', while 'Bargoug', which is propagated by seeds, is an integral part of the oasean cropping system.

In Tunisia, four different cropping systems have been developed: intensive, extensive, promiscuous and oasean cropping systems.

The latter corresponds to the superposition of several vegetative stages of fruit trees and seasonal crops. The highest stage is date palm; the second one corresponds to fruit trees such as

* Corresponding author. Tel.: +216 98654866.
E-mail addresses: krichlam@yahoo.com, Lamia.Krichen@fst.rnu.tn (L. Krichen).

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pomegranate, fig, citrus, olive, Bargougs and apricot cultivars. The lowest stage, however, corresponds to annual cereals and vegetable crops, which benefit from the microclimate created by shade from the tree cover. Bargougs provide most of the shade under date palm trees due to their large heart-shaped leaves and dense foliage. They are essential to maintain the vegetative equilibrium of the oasean staged cropping system.

The promiscuous system is found all around the Mediterranean Basin, as first identified by Ribeiro (1945). It corresponds to the coexistence of several trees from different fruit species (olive, apple, peach, plums, apricot, almond, grape, and pomegranate), intercropped and planted closely together. The promiscuous cropping system is still maintained in traditional orchards of Testour (north) and is beginning to disappear in Ras Jbel (north).

The intensive system exists essentially in the center of the country, especially in Kairouan, which is the most recent area of apricot cultivation (planted in 1950), as well as in a few orchards of Testour. However, the extensive system is well suited to non-irrigated crops especially in Sfax, Gabes and Jerba (south-east coastal areas). In extensive and promiscuous systems in traditional orchards, where rare traditional varieties may be found, the apricot trees are very old and left until they die.

Morphological characterization is useful for cultivar identification, selection, differentiation and germplasm management. The assessment and description of trait variations are essential in startup of programs designed for the selection of genotypes with high field performance and the qualitative traits required for markets. Several studies have focused on variability in European apricots where interesting cultivars have been identified and used to generate interesting new selections through breeding programs (Couranjou, 1977; Della Strada et al., 1989; Fideghelli and Monastra, 1977; Forte, 1971; Guerriero, 1982; Lichou and Audubert, 1989; Lichou, 1998).

Morphological characters of 48 cultivars from the principal locations of apricot cultivation in the north, center and south of Tunisia were assessed by Carraut and Crossa-Raynaud (1974), Crossa-Raynaud (1960) and Valdeyron and Crossa-Raynaud (1950). These authors focused especially on the Ariana, Sfax, Ras Jbel and Testour cultivation areas. However, these cultivars are not being maintained because of their low economic potential and the huge genetic erosion that has affected autochthonous apricot germplasm. Moreover, 25 among the 48 studied cultivars were not identified during the last surveys (Krichen et al., 2009). Consequently, many local cultivars are currently endangered and could soon disappear.

Considering this alarming report on Tunisian apricot diversity, it was essential to conduct a study on the Tunisian apricot core collection in order to preserve this rich and diverse germplasm (Krichen et al., 2012).

The present study was carried out to:

(a) Assess the morphological characters of apricot germplasm in Tunisia,
(b) Structure the morphological variability regarding its relation to the most discriminating character and to the geographic origin of the accessions.

2. Material and methods

2.1. Survey

In order to maximize the variability of the collected plant material, surveys were conducted in intensive, extensive, promiscuous and oasis systems. The main cultivation areas investigated were under several climatic regimes and cropping systems: Ras Jbel and Testour (north); Kairouan, Mahdia and Sfax (center); Gabes, Mareth, and Jerba, (south-east), and the Gafsa, Tozeur, Nefta, Degache, Tameghza and Midess oases (south-west) (Table 1). To cover the maximum available apricot diversity in Tunisia, we focused on orchards that were the most representative in each area, with the assistance of the Tunisian Ministry of Agriculture.

2.2. Plant material

Grafted cultivars were collected from the north, center and south-east regions. Bargougs, however, were collected from the south-west. A total of 112 apricot accessions were collected, including 76 grafted cultivar accessions and 36 Bargougs accessions (Table 1). The 76 grafted cultivar accessions represented 47 different cultivar names. Given the fact that some accessions with the same nomenclature showed morphological differences, they were sampled for assessment to elucidate these nomenclature confusions.

2.3. Morphological characterization

Representative samples were collected as follows:

- Leaf samples from the median part of long-year shoots.
- Fruit samples according to the procedure described by Audergon et al. (1991, 1993) and Monestiez et al. (1990), where each tree was divided into four faces (north, south, east, west) and each face was divided into three levels (up, middle, down). Thus, each unit was represented in the collected sample.

The morphological characterization was carried out using the UPOV descriptor (1979; released in 2005). Hence, fruit morphological characterization was assessed during May and June, whereas leaf characterization was carried out in September. The studied characters were distributed as follows:

- 17 qualitative ordinal and 12 qualitative nominal variables.
- 13 quantitative morphometric parameters were measured.

Morphological characterization was thus conducted on a set of 42 quantitative and qualitative morphological traits, as described in Table 2.

2.4. Statistical analysis

An analysis of variance (ANOVA) was conducted on replicate measurements of fruit and leaf characters to assess the variation range of the studied variables.

Histograms representing the frequency distribution of available modalities among the studied material were plotted.

The quantitative and qualitative variables synthesized the data matrix of mean values which was used for the statistical calculations.

Descriptive statistics represented the data distribution and identified the variability level within each interval (between maximum and minimum observed values).

In addition, Pearson correlation coefficients (Dagnelie, 1988) and correspondence analysis were applied to identify a putative redundancy and to discriminate the relevant informative traits.

Moreover, the Euclidian coefficient was used to estimate the distance between paired accessions. Standard deviation was used to scale the interval, ordinal, and ratio variables for the calculation of Euclidian distances.

Hierarchical clustering was also done using Ward's clustering method based on standardized Euclidian distances. Ward's method was chosen mainly because it minimizes the sum of squares within groups and maximizes the sum of squares between groups.