Plant material of loquat in Mediterranean countries

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SUMMARY – Most authors around the world now believe loquat originated in China. The loquat cultivated in Japan was introduced from China in ancient times. From there, loquat was introduced into several countries of the Mediterranean, in the same areas where citrus can be grown. The loquat was one of the most important species included in the European Project RESGEN-CT95-029 (1996-99), which aimed to study the genetic resources of minor fruit trees in Mediterranean countries. The conservation and characterization of loquat genetic resources and the most common cultivars and rootstocks in these countries are reported. Some of the most interesting cultivars from the IVIA collection are also described. The main problems of loquat plant material in the Mediterranean basin are: (i) the loss of genetic diversity, due to the loss of local cultivars that did not meet the market requirements; and (ii) the crop relies on a unique or a few cultivars. In order to solve these problems, it is necessary to carry out two complementary research projects: (i) to keep working on collection, conservation and characterization of genetic resources; and (ii) to start loquat breeding programmes aimed at obtaining new cultivars that could extend the range of cultivars available adapted to the market demands.

Key words: *Eriobotrya japonica* Lindl., genetic resources, collection, characterization, cultivars, rootstocks.

RESUME – *"Matériel végétal de néflier dans les pays méditerranéens". La plupart des auteurs du monde pensent maintenant que le néflier est originaire de Chine. Le néflier cultivé au Japon avait été introduit depuis la Chine dans des temps reculés. A partir de là, le néflier a été introduit dans plusieurs pays de la Méditerranée, dans les mêmes zones où l'on peut cultiver des agrumes. Le néflier est l'une des espèces les plus importantes incluses dans le Projet Européen RESGEN-CT95-029 (1996-99), qui vise à étudier les ressources génétiques d'espèces fruitières mineures dans les pays méditerranéens. Cet article présente la conservation et caractérisation des ressources génétiques de néflier ainsi que les cultivars et porte-greffes les plus courants de ces pays. Quelques-uns des cultivars les plus intéressants de la collection de l'IVIA sont également décrits. Les principaux problèmes du matériel végétal de néflier dans le bassin méditerranéen sont : (i) la perte de diversité génétique, due à la disparition de cultivars locaux qui ne répondaient pas aux exigences de marché ; et (ii) la culture repose sur un seul ou quelques cultivars. Afin de résoudre ces problèmes, il est nécessaire de mener deux projets de recherche complémentaires : (i) poursuivre le travail sur la collection, conservation et caractérisation des ressources génétiques ; et (ii) lancer des programmes d'amélioration génétique du néflier afin d'obtenir de nouveaux cultivars et élargir la gamme de cultivars disponibles adaptés aux demandes du marché.*

Mots-clés : Eriobotrya japonica *Lindl., ressources génétiques, collection, caractérisation, cultivars, porte-greffes.*

Introduction

Loquat (*Eriobotrya japonica* Lindl., *Rosaceae, Maloideae*) is a subtropical evergreen fruit tree that blooms in fall and early winter. Most authors around the world now believe loquat originated in China. The Dadu River Valley is considered the center of origin for the genus *Eriobotrya.* Records on loquat in China span over 2000 years; there many loquat species occur in the wild state. The loquat cultivated in Japan was introduced from China in ancient times and loquat cultivation in Japan was described as early as 1180. From there, loquat was introduced into the National Garden at Paris, France, in 1784 and into the Royal Botanical Gardens at Kew, England, in 1787. From this beginning, loquat was distributed around the Mediterranean to various countries, in the same areas where citrus crop can be grown. Sometime between 1867 and 1870, loquat was introduced to Florida from Europe and to California from Japan. Cultivation spread to India and southeastern Asia, Australia, New Zealand, Madagascar and South Africa. Loquats are now distributed in many Asian and American countries. Generally, loquats are found between latitudes 20 and 35º North or South, but can be cultivated up to latitude 45º under maritime climates (Lin *et al*., 1999).

Historically, loquat species was an ornamental tree with small fruits and as ornamental was

spreaded to Europe. Later, in 19th century, since selection of cultivars with larger fruits were available, the fruits were used by consumers. However, it is still used for landscaping (McConnell, 1989). Nowadays most of the production is for fresh market. Loquat fruits have a melting and refreshing flesh, aromatic, sweet and sour. They are also consumed in syrup, jams juice and spirits (Rodríguez, 1983; CTIFL, 1988). Leaves and fruits of loquats traditionally have been considered to have high medicinal value and there is evidence of pharmaceutically active compounds (Lin *et al*., 1999). Loquat is highly nectariforous, with a heavy fragrance and high honey potential. Unifloral loquat honey is very appreciated in several regions (Sabatini *et al*., 1995).

Genetic resources in Mediterranean countries

Loquats have formed various ecological types in different zones over the course of their cultivation and acclimatization. From these types, a large number of varieties emerged in different countries where loquat was grown. Very often, current varieties are selected as mutations or as chance seedlings resulting from natural hybridization.

To study the genetic resources of minor fruit trees in Mediterranean countries an European project was carried out between 1996 and 1999 (RESGEN-CT95-029) with the following objectives:

(i) To establish a basis for the conservation and utilization of minor fruit tree species of the Mediterranean basin.

(ii) To create a first database on germplasm collections comprehensive of both first and advanced characterization descriptors.

(iii) To develop an agronomic evaluation of collected material.

The loquat was one of the most important species included in this project. The results are shown in http://www.unifi.it/project/ueresgen29 and included (for 16 species):

(i) The first European inventory of collected accessions.

(ii) The definition of descriptors lists.

(iii) The European Minor Fruit Tree Species Database.

(iv) The description and pictures of species.

For loquat, there were 3 European collections within the RESGEN29 (Table 1).

Table 1. Loquat collections within the European project RESGEN29

Institution	Responsible	No. Accessions	% Native
Instituto Valenciano de Investigaciones Agrarias (IVIA), Moncada (Valencia), Spain	Gerardo Llácer	47	60
Dipartimento di Produzione Vegetale, Università della Basilicata, Potenza, Italy	Vitale Nuzzo	21	76
Subtropical Plants and Olive Trees Institute, Agrokipion, Chania, Crete, Greece	Spiros Lionakis	17	59

Out of these collections, in several countries (Italy, Spain, Israel, Portugal, Turkey) surveys and selection of local varieties have been done, along with evaluation of those varieties compared to foreign cultivars.

The rationalization of Mediterranean collections means to improve them by finding gaps and duplicates and implies the following tasks:

(i) Complete characterization and evaluation of the collections.

(ii) Identify the most important gaps and duplicates.

(iii) Introduce plant material from other Mediterranean and non Mediterranean origins.

(iv) Define a final "core collection".

A "core collection" is a part of the collection that include the minimum number of accessions that can represent by themselves the total variability of the whole collection. According to that, a first core collection has been defined at the IVIA. The conservation and utilization of suitable germplasm and the definition of a representative core collection requires an accurate characterization of the material. At IVIA we have studied 3 types of traits for characterization of the loquat accessions from our collection:

(i) *Phenological traits*: a first step was to define phenological growth stages of loquat tree using the extended BBCH scale, which has several advantages over the traditional Fleckinger scale for fruit crops (Martínez-Calvo *et al*., 1999).

(ii) *Pomological traits*: 29 traits from tree, shoots, leaves, flowers, fruits and seeds were used to describe the variability of the collection, to determine the correlation among traits and to identify the most useful variables for discriminating among accessions (Badenes *et al*., 2000).

(iii) *RAPD molecular markers*: 36 primers were used to screen 33 accessions. Twenty-three out of them were polymorphic, they generated 29 polymorphic amplification fragments which were selected as markers. Out of 33 accessions, 22 were identified by unique combination of RAPD markers (Vilanova *et al*., 2001).

Most common cultivars and rootstocks

Traditional loquat culture in the Mediterranean basin consisted in isolated trees located in gardens, family orchards or small plantings destined to local consumption. This type of culture resulted in a great number of local cultivars. Recently, as the culture has been located in some counties in regular plantings, the number of local cultivars grown was lower as a consequence of grower selection. Growers selected cultivars with larger fruit size, earlier in the season and better adapted to the market requirements. This selection resulted in lost of genetic resources and diversity within the species. In the last years, tasks focused on surveys, collection of plant material and conservation of the genetic resources in germplasm collections have been initiated.

Table 2 shows the most common cultivars and rootstocks used in the Mediterranean countries. Data come from the First Meeting of the CIHEAM Cooperative Working Group on Underutilized Fruit Crops in the Mediterranean Region (Llácer *et al*., 1995).

Table 2. Most common cultivars and rootstocks used in some Mediterranean countries

Country	Cultivars	Rootstocks
Cyprus	'Morphou'; 'Karantoki'	Loquat seedlings
Egypt	'Early suckary'; 'Large round'; 'Advance'; 'Premier'; 'Late Victoria'	Loquat seedlings Quince
Greece	'Rozenon'; 'Troulotis'; 'Koilarato'	Loquat seedlings
Israel	'Akko 1'; 'Akko 13'	Loquat seedlings
Italy	'Nespolone di Trabia'; 'Nespolone Bianco'; 'Vainiglia'; 'Sanfilippara', 'Virticchiara'	Loquat seedlings Quince
Morocco	'Tanaka'; 'Saint Michel'; Algerie'	Quince
Portugal	'Tanaka'; 'Algerie'; 'Golden Nugget'	Loquat seedlings; Quince
Spain	'Algerie'; 'Magdal'; 'Golden Nugget'; 'Tanaka'	Loquat seedlings; Quince
Turkey	'Akko 13'; 'Golden Nugget'; 'Tanaka'; 'Hatif Çukurgöbek'	Loquat seedlings

According to the data from Table 2, in some countries as Cyprus, Greece, Israel, and Italy, most cultivars used correspond to local varieties. On the other hand, there are other countries as Morocco, Portugal and Turkey where the cultivars grown correspond to introduced varieties, although in these countries surveys for selecting local germplasm is been carried out, recently. In Spain, cultivar 'Algerie' accounts for more than 95% of total production. This name refers to the variety 'Algerie' and some selections 'Algerie-like'. 'Algerie' came from a chance seedling brought from Algeria grafted and multiplied in Spain.

In all Mediterranean countries, the rootstocks used are loquat seedlings, they are very well adapted to calcareous soils very abundant in the Mediterranean basin. Trails of quince trees (A, C, BA 29) has been studied very often. This species allows to obtain smaller and more compact trees, a shorter juvenile period and bigger fruits, with high sugar content and nice color. However, quince trees are very sensitive to calcareous soils and they show graft union incompatibility with many varieties.

Description of some cultivars included in the IVIA germplasm collection

The IVIA germplasm collection includes 90 accessions that are being studied by pomological characteristics and molecular markers (Badenes *et al.*, this volume). In this paper we will describe some of the main characteristics from some of the most interesting cultivars included in the collection. The data corresponded to the average of three cropping years. The methodology used for taking the data are those described in Martínez-Calvo *et al.* (2000) and Badenes *et al.* (2000). More information related to these cultivars can be found in those papers. Flowering season and harvest are refered to the most important cultivar of the area, 'Algerie'.

Magdal

Cultivar medium-vigorous, open habit.

Full bloom occurs 17 days in advance than 'Algerie'. The flower cluster is conic shaped with a high number of flowers per cluster (an average of 178 flowers/cluster), the flower color is white and the fruit set is 10.6%.

Fruit ripening occurs 17 days ahead of 'Algerie'. The fruit is long obovate shaped, the skin and the flesh are both yellow-orange, the average fruit weight is 45.5 g, fruit diameter is 36.6 mm and flesh thickness is 7.9 mm. It is difficult to remove the skin and flavor is rather poor.

TSS (Total soluble solids): 10.6 ºBrix
T.A. (Titratable acid) : 12.3 g/l Malic acid
Firmness: 1.7 kg/cm^2

The seed shape is elliptic with an average weight of 7.8 g, there are about 3.7 seeds per fruit.

Cardona

Cultivar medium- vigorous, upright tree habit.

Full bloom occurs 19 days in advance than 'Algerie'. The flower cluster is conic shaped with a medium-high number of flowers per cluster (an average of 168 flowers/cluster), the flower color is white-yellow and the fruit set is 6.5%.

Fruit harvested occurs 14 days ahead of 'Algerie'. The fruit is round elliptic, the skin and the flesh are both yellow-orange, the average fruit weight is 45.4 g, fruit diameter is 41 mm and flesh thickness is 10.5 mm. Easy peeling from stalk end and the flavor is acceptable. This cultivar is lightly sensitive to scab.

TSS: 11.7 ºBrix
T.A.: 13.9 g/l Malic acid
Firmness: 1.5 kg/cm^2

The seed shape is elliptic with an average weight of 6.3 g, there are about 2.7 seeds per fruit.

Italiano-1

Cultivar very vigorous. Tree habit semi-upright.

Full bloom occurs 10 days after 'Algerie'. The flower cluster is medium in size with a medium-high number of flowers per cluster (an average of 160 flowers/cluster), the flower color is white-yellow and the fruit set is 6.1%.

Fruit ripening occurs 1 day ahead of 'Algerie'. The fruit is oblate, the skin and the flesh are both orange, the average fruit weight is 51.4 g, fruit diameter is 45.2 mm and flesh thickness is 11.3 mm. Easy peeling from stalk end. Good flavor.

TSS: 12.1 ºBrix
T.A.: 7.8 g/l Malic acid
Firmness: 0.9 kg/cm^2

The seed shape is ovate with an average weight of 6.5 g, there are about 3.9 seeds per fruit.

Algerie

Cultivar vigorous. Tree habit upright.

Full bloom occurs during the first ten days of November (November 8th, average). The flower cluster is conic shaped with a high number of flowers per cluster (an average of 200 flowers/cluster), the flower color is white and the fruit set is 6.3%.

Fruit ripening occurs during the first week of May (May 3rd, average). The fruit is round elliptic, the skin and the flesh are both yellow-orange, the average fruit weight is 65.0 g, fruit diameter is 50.0 mm and flesh thickness is 11.2 mm. Easy peeling from stalk end. Good flavor.

TSS: 10.9 ºBrix
T.A.: 13.4 g/l Malic acid
Firmness: 1.1 kg/cm^2

The seed shape is elliptic whith an average weight of 7.3 g, there are about 2.3 seeds per fruit.

Golden Nugget

Cultivar very vigorous. Tree habit semi-spreading.

Full bloom occurs 13 days after 'Algerie'. The flower cluster is intermediate in size with a high number of flowers per cluster (an average of 189 flowers/cluster), white color. The fruit set is 7.4%.

Fruit ripening occurs one day after 'Algerie'. The fruit is abovate, the skin and the flesh are both yellow-orange, the average fruit weight is 54.6 g, fruit diameter is 45.3 mm and flesh thickness is 10.0 mm. Easy peeling from stalk end. Flavor rather poor. Sensitive to scab.

TSS: 11.0 ºBrix
T.A.: 3.9 g/l Malic acid
Firmness: 0.9 kg/cm^2

The seed shape is round with an average weight of 8.1 g, there are about 3.2 seeds per fruit.

Buenet

Cultivar medium vigorous. Tree habit upright.

Full bloom occurs 5 days after 'Algerie'. The flower cluster is conic shaped, with a high number of flowers per cluster (an average of 227 flowers/cluster), white-yellow color. The fruit set is 4.1%.

Fruit ripening occurs two days after 'Algerie'. The fruit is round elliptic, the skin and the flesh are both orange, the average fruit weight is 58.2 g, fruit diameter is 43.1 mm and flesh thickness is 10.7 mm. Easy peeling from stalk end. Good flavor.

TSS: 11.0 ºBrix
T.A.: 15.6 g/l Malic acid
Firmness: 1.5 kg/cm^2

The seed shape is elliptic with an average weight of 7.2 g, there are about 2.5 seeds per fruit.

Crisanto Amadeo

Cultivar vigorous. Tree habit upright.

Full bloom occurs 3 days after 'Algerie'. The flower cluster is conic shaped, with a high number of flowers per cluster (an average of 210 flowers/cluster), white color. The fruit set is 4.3%.

Fruit ripening occurs two days after 'Algerie'. The fruit is round elliptic, the skin and the flesh are both yellow-orange, the average fruit weight is 68.7 g, fruit diameter is 50.6 mm and flesh thickness is 10.8 mm. Easy peeling from stalk end. Very good flavor.

TSS: 11.1 ºBrix
T.A.: 5.1 g/l Malic acid
Firmness: 1.0 kg/cm^2

The seed shape is round with an average weight of 7.9 g, there is about 3.6 seeds per fruit.

Saval-2

Cultivar medium- vigorous. Tree habit upright.

Full bloom occurs 3 days after 'Algerie'. The flower cluster is conic shaped, with a high number of flowers per cluster (an average of 273 flowers/cluster), white-yellow color. The fruit set is 4.6%.

Fruit ripening occurs 3 days after 'Algerie'. The fruit is round, the skin and the flesh are both yellow-orange, the average fruit weight is 53.7 g, fruit diameter is 43.9 mm and flesh thickness is 9.75 mm. Easy peeling from stalk end. Good flavor.

TSS: 9.9 ºBrix
T.A.: 5.9 g/l Malic acid
Firmness: 0.9 kg/cm^2

The seed shape is elliptic with an average weight of 8.6 g, there are about 3.9 seeds per fruit.

Peluches

Cultivar very vigorous. Tree habit spreading.

Full bloom occurs 12 days after 'Algerie'. The flower cluster is conic shaped, with a high number of flowers per cluster (an average of 229 flowers/cluster), white color. The fruit set is 6.8%.

Fruit ripening occurs 4 days after 'Algerie'. The fruit is long obovate, the skin and the flesh are both yellow-orange, the average fruit weight is 95.0 g, fruit diameter is 51.2 mm and flesh thickness is 12.0 mm. Medium dificult peeling from stalk end. Flavor acceptable. Light sensitiveness to fruit cracking.

TSS: 11.6 ºBrix
T.A.: 6.1 g/l Malic acid
Firmness: 1.0 kg/cm^2

The seed shape is elliptic with an average weight of 11.2 g, there are about 3.7 seeds per fruit.

Tanaka

Cultivar medium-vigorous. Tree habit upright.

Full bloom occurs 11 days after 'Algerie'. The flower cluster is conic shaped, with a medium number of flowers per cluster (an average of 167 flowers/cluster), white-yellow color. The fruit set is 8.1%.

Fruit ripening occurs 13 days after 'Algerie'. The fruit is abovate, the skin and the flesh are both yellow-orange, the average fruit weight is 60.6 g, fruit diameter is 48.5 mm and flesh thickness is 8.9 mm. Easy peeling from stalk end. Very good flavor.

TSS: 10.9 ºBrix
T.A.: 8.3 g/l Malic acid
Firmness: 1.3 kg/cm^2

The seed shape is elliptic with an average weight of 9.5 g, there are about 3.7 seeds per fruit.

Conclusions

In the last years, in the Mediterranean basin many countries are interested in growing Minor Fruit Tree Crops (figs, loquats, persimmons, pomegranates and others) as an alternative to the traditional and more important fruit crops, very often in surplus. In the loquat case, this fact resulted in the following:

(i) Lost of genetic diversity due to the lost of local cultivars that did not meet the market requirements. For instance, those cultivars that produced small fruits and/or had bad post-harvest ability.

(ii) Loquat crop relies on a unique or a few cultivars, which resulted in a short harvest season, difficult to manage. Due to the low genetic diversity, production is more vulnerable to diseases and pests.

In order to solve these problems, it is necessary to initiate two complementary research projects:

(i) To keep working on the tasks focused on collection, conservation and characterization of genetic resources. To improve the rationalization of collections and to establish a core collection. To ensure safe and cost effective conservation of loquat materials, a reduced workload for each country and continued access to the genetic resources, the IVIA suggests the creation of a Mediterranean loquat genebank, based on the IVIA collection, where it would collect and maintain all loquat plant materials from different Mediterranean countries that are considered interesting as germplasm resources.

(ii) To initiate loquat breeding programs aimed at obtaining new cultivars that could extend the range of cultivars available adapted to the market demand. At IVIA, we are planing to initiate this year a breeding program aimed at obtaining new cultivars with the characteristics:

- Cultivars earlier in the season than 'Algerie' keeping 'Algerie' size.

- Cultivars later in the season with bigger fruit size, while keeping good fruit characteristics.
- Cultivars that produced fruits similar to 'Algerie' (size, shape, firmness, color flavor, etc.) resistants to "purple spot" and scab.
- Cultivars self-compatible or inter-compatibles with 'Algerie'.

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