CONCLUSIONS

The author has tested various *Rhodochlamys* species over 15 years in Finland and found that they were suitable for indoor and greenhouse culture, and also can be grown outdoors during the growing season. As in their natural habitats, these species are seasonal plants with flowering, fruiting, and dormant period; they flower easily every year. Grown as indoor potted plants, they normally go into dormancy during the darkest winter months. During this period when growth ceases, soil should be kept slightly moist; plants will not lose their leaves even without extra lighting. In the greenhouse, plants normally go into semi dormancy in the winter with very slow growth even under good growing lights. When grown outdoors in temperate climates, plants should be cut before the freeze and corms stored in a cool basement without soil totally dry. However, corms can be potted and stored as indoor plants.

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HORTICULTURAL SCIENCE NEWS

Loquat: An Ancient Fruit Crop with a Promising Future

Shunquan Lin, Xuming Huang, Julián Cuevas and Jules Janick

Loquat (*Eriobotry japonica* Lindl., syn. *Mespilus japonica* Thunb., Rosaceae. Maloideae), despite its name is indigenous to southern China (Lin et al., 1999). The species is subtropical, evergreen, and blooms in fall or early winter. The handsome tree is cold-hardy to -10°C but fruits freeze at minimum temperatures of about -3°C. The fruit in longitudinal cross section is round, obovate, or elliptical (Fig. 1); diameter is about 2-5 cm and average weight is about 30 to 40 g but some large fruited cultivars average 70 g and can reach 170 g. The thin peel is white or orange. Flesh is white or orange and soluble solids content varies from 7 to 20%. The seeds, usually about 3 to 4 per fruit, are relatively large, each about 1.2-3.6 g, and are annoying when the fruit is consumed fresh. The flesh, not exceeding 70% of the fruit, is aromatic, juicy, and delicious, and can be consumed fresh or processed in various forms including wine. Loquat is the first fruit to ripen in the spring and has been a favorite in China since it bears close to a significant holiday (Spring Festival). The name in China is *"Pipa"* or *"Luju"*; the English name "loquat" takes the Cantonese pronunciation of *"Luju"*. In the US it has also been known as Japanese plum or Japanese medlar; in Italy as nespola, in France as neflier du Japon, in Germany as Japonische Mispel, in Spain as Nispero and in Portugal as ameixa do Japao.

HISTORICAL

Loquat has been cultivated for over 2000 years (Sima, 100 BCE). The loquat cultivated in Japan was introduced from China in ancient times and loquat cultivation in Japan was described

Figure 1. Loquat fruit: 'Zaozhong No.6' (left), 'Dawuxing' (right).

as early as 1180 (Ichinose, 1995). People beyond eastern Asia first learned of the loquat from the German traveler and physician Englebert Kaempfer, who observed it in Japan and described it in *Amoenites Exotica* in 1712, while the Swedish botanist, Carl Peter Thunberg, in *Flora Japonica* (1784), provided a more ample description of loquat under the name *Mespilus japonica*. In 1784, the loquat was introduced from Guangdong, China into the National Garden at Paris, and in 1787 was introduced into the Royal Botanical Gardens at Kew, England. From this beginning, loquat was distributed around the Mediterranean to various countries, including Algeria, Cyprus, Egypt, Greece, Israel, Italy, Spain, Tunisia, and Turkey. Sometime between 1867 and 1870, loquat was introduced to Florida from Europe and to California from Japan. Chinese immigrants are assumed to have carried the loquat to Hawaii (Morton, 1987). By 1915, it had become quite well established in Florida and southern California and several new cultivars had been named. Cultivation spread to India and southeastern Asia, the East Indies, Australia (Goubran and El-Zeftawi, 1988), New Zealand (Burney, 1980), Madagascar, and South Africa. Loquats are now distributed in many Asian countries, for example, Laos, Nepal, Pakistan, South Korea, and Vietnam; in Armenia, Azerbaiian and Georgia (Safarov, 1988); and in the Americas including Argentina, Brazil, Chile, the mountains of Ecuador, Guatemala, Mexico, and Venezuela (Endt, 1979).

Japan has contributed greatly to the development of loquat. Japanese horticulturists selected two important cultivars, 'Mogi' and 'Tanaka', from the offspring of seedling introduced from China. 'Tanaka' has been introduced to many countries due to its large fruit size; it was introduced prior to 1900 to the United States and Israel, and later spread to Algeria (Lupescu et al., 1980), Brazil (Godoy and Rodrigues Amaya, 1995), India (Testoni and Grassi, 1995), Italy (Monastra and Insero, 1991), Spain (López-Gálvez et al., 1990) and Turkey, as well as China. Before World War II, Japan used to be the largest loquat producing country in the world. After the war, the area under loquat in Japan reduced gradually because development of food crops became more important and loquat cultivation was too labor-consuming.

Figure 2. Distribution of loquat in China.

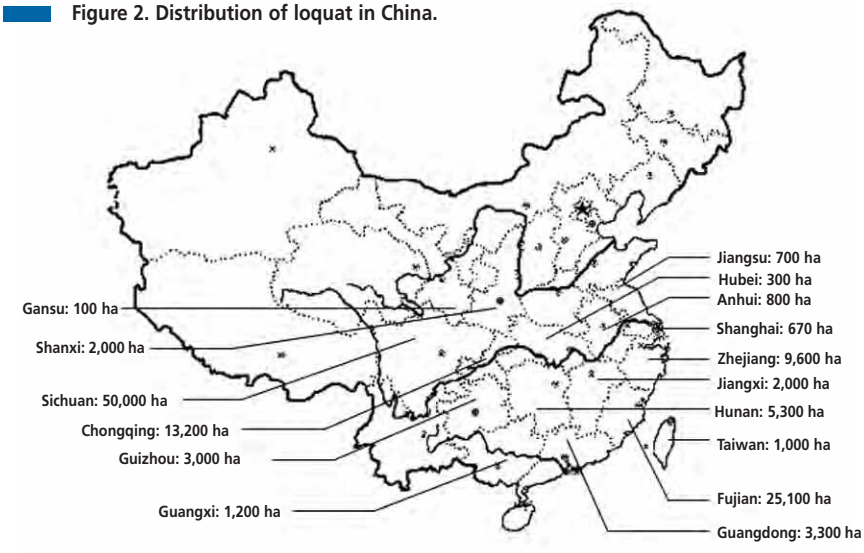

Figure 3. Fruit bagging is an important practice to produce high quality fruit in China. Fruit bagging is done cluster by cluster by hand across the orchard.

LOQUAT INDUSTRY

China

From the 1970s, loquat production in China witnessed a rapid increase from 2000 ha to 26,000 ha in 1995 and to 120,000 ha with an output of 460,000 tonnes (t) in 2005. Commercial activities are concentrated in central to south China (Fig. 2). The increase was due to new technology including: genetic improvement that resulted in new cultivars such as 'Zaozhong No.6' and 'Dawuxing' (Fig. 1), the widespread use of grafting to seedling rootstocks, an improved planting technique called the planting ditch (1 m^3 pits), flower and fruit thinning, and fruit bagging (Fig. 3). These practices enable production of large-sized high-quality fruit with high profit.

Spain

Spain is the second world producer of loquat with more than 40,000 t per year, and the leading exporting country with around 83% of worldwide exports, with the main destination being EU countries: Italy, Portugal, and France

Figure 4. Seedless selection of triploid loquat compared with seeded 'Pelluches' loquat (right). Fruit are the same relative size. (Seedless loquat by courtesy of Dr. Liang Guolu, seeded loquat by courtesy of Dr. Xuming Huang).

(Caballero and Fernández, 2004). Fruit size and earliness are the most important parameters in the commercialization of loquat in Europe. Commercial size is usually achieved by means of heavy thinning either at bloom (removing the upper two-thirds of the panicle), or in January (leaving 4-5 fruits per inflorescence). Due to the high cost of labor in Spain a chemical alternative has been developed using naphthalene acetic acid (NAA) and its derivates (Agustí et al., 2000; Cuevas et al., 2004). NAA is not yet registered for loquat in Spain. Girdling and the application of the synthetic auxins have also been proved effective for increasing fruit size and advancing maturity (Agustí et al., 2003; Amorós et al., 2004). Earliness improvement can also be achieved by protected cultivation (López-Gálvez et al., 1990) and by means of regulated deficit irrigation (Cuevas et al., 2007). Loquat in Spain occupies around 3,000 ha, mainly in the Mediterranean Coasts of Comunidad Valenciana and Andalusia regions. In the Comunidad Valenciana, the most important cultivar is the tasty 'Algerie' and its mutations, whereas in Andalusia 'Golden Nugget' is preferred due to its beautiful orange color, rounded shape, and tolerance to purple spot. Most loquat in Spain is grafted on unselected loquat seedlings leading to vigorous trees. A large size of the tree is a clear disadvantage due to the high number of hand operations in the crop such as thinning, pruning, harvesting, and bagging. Advanced farmers graft loquat on semi-dwarfing 'Provence' quince. Dwarfing rootstocks such as 'Quince C' are under evaluation (Hueso et al., 2007) to reduce spacing and management cost and therefore increase loquat profitability. High density orchards use modified central leader training instead of the most common vase training usual in standard plantations. Production is now increasing in India, Pakistan, and Turkey.

NEW TECHNOLOGY IN CHINA

Cultivation Practices

Labor accounts for 63% of total production costs in China. With the labor in China becoming more and more expensive, loquat development has to turn to new techniques to replace the high labor-intensive practices in order to increase returns. Major selection and breeding efforts have uncovered adapted cultivars such as 'Dawuxing' and 'Zaozhong No.6'. Seedling rootstocks of cultivated loquat cultivars produce a shallow root and as a result, large planting pits (1 m^3) have to be excavated. Even so, some trees are uprooted by typhoons. Studies and evaluation trials are being conducted using rootstocks of other *Eriobotrya* species to replace seedling rootstocks in South China Agricultural University and over 10 species have been tested. They all showed good compatibility and normal fruit set except narrow leaf loquat (*E. henryi*). These rootstocks are under evaluation for a stronger root system. A selection program for dwarfing rootstocks or interstocks has been launched in the Fruit Research Institute of Fujian Academy of Agricultural Science, and promising dwarfing rootstocks such as 'Mina's No.1' and 'Daduhe' have been found.

Seedless Loquat

The relatively large and numerous seed of loquat reduce flesh recovered, which is not larger than 70%, and make loquat somewhat difficult to consume fresh out of hand. Professor Liang Guolu and his colleagues in Northwest University have selected natural triploids, which occur from non-reduced gametes in a frequency of about 0.5%, from open populations of various cultivars. Some of these clones appear to be parthenocarpic while others may require pollinizers. Many triploids were obtained from a program of chromosome counts of seedlings and promising seedless clones are now being evaluated (Fig. 4). Breeding seedless loquat cultivars is also possible from diploid x tetraploid crosses, or from endosperm culture. It is anticipated that the selection of promising seedless loquat could have a profound effect on the loquat industry.

Medicinal Uses

Leaves and fruits of loquats have traditionally been considered to have high medicinal value

Figure 5. Loquat paste: a traditional medicine for releasing cough.

(Duke and Ayensu, 1985; Wee and Hsuan, 1992) and there is evidence of pharmaceutically active compounds (Morton, 1987; Noreen et al., 1988; De Tommasi, 1992). The ether-soluble fraction of the ethanolic extract of the leaves showed anti-inflammatory activity when applied topically to rats. Ursolic acid, maslinic acid, methyl maslinate, and euscaphic acid were isolated from this fraction. Maslinic acid was shown to be at least partly responsible for the anti-inflammatory activity of the extract. Seven glycosides, five of which are new natural products, were isolated from the methanol extract of leaves collected in Italy (De Tommasi, 1992). For at least 40 years, Chinese food stores in the United States have sold a product imported from Hong Kong and recommended for chronic bronchitis, coughs, and lung congestion (Fig. 5). Contents are listed as loquat leaves with other herbs (Duke and Ayensu, 1985; Wee and Hsuan, 1992). The traditional medical uses of loquat and relevant research involve the common cultivated loquat species. In China, there are 20 other species in the genus *Eriobotrya* and the potential medical use of these species replacing cultivated loquat is under study in South China Agricultural University. The study has found that fragrant loquat (*E. fragrans* Champ) contains far higher ursolic acid, the cough-easing component in loquat, than cultivated species. Hence, it is expected that the raw materials for processing of Chinese traditional medicine will come from the wild loquat instead of the cultivated loquat. With no more leaves taken for medical processing, fruit quality and yield of cultivated loquat will not be reduced.

Figure 6. Loquat wine.

THE FUTURE

Loquat, an ancient oriental crop, is expected to experience further development in the future. Loquat fruit attracts a premium price in Chinese fresh markets because consumers love it and there are almost no competitors during loquat season in late winter and early spring. Hence, there is huge room for the development of loquat as a profitable industry in China. Shortage of fresh fruit in spring is also seen in other countries. On a world scale, loquat is still a very minor fruit in spite of the fact that loquat is adapted to various subtropical climates and can be grown in many countries and should prove to be a profitable industry in countries other than China, Japan, and Spain. Furthermore, with the introduction of new technology, such as new cultivars, dwarfing rootstocks, fertigation, and improved postharvest handling, higher quantity and quality of loquat with better marketability will be produced at lower labor cost. Loquat industry could be a profitable fruit industry in many areas of the world. Finally, more diversified uses of loquat and advanced processing techniques will generate higher added value to the crop. Apart from fresh consumption and traditional medical uses, new processing techniques are being tested with success in making juice, tea, paste, or wine (Fig. 6). Germplasm with richer functional substances is being uncovered and new technology to purify these active compounds will upgrade the medical industry based on loquat. Developing processing industries are bound to demand a larger tonnage of loquat for raw materials further expanding production.

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