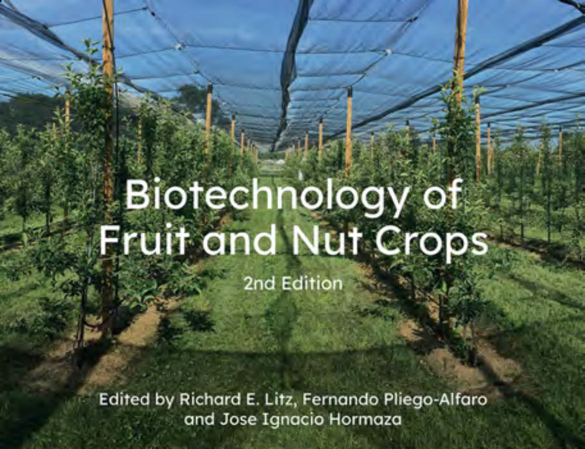

Biotechnology of Fruit and Nut Crops

2nd Edition

Edited by Richard E. Litz, Fernando Pliego-Alfaro and Jose Ignacio Hormaza

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Contents

16 *Oleaceae*

16.1 *Olea europaea* Olive

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1. Introduction

1.1. Botany and history

The olive (*Olea europaea* L.) belongs to the *Oleaceae* family, which is divided into two subfamilies, *Jasminoidaceae* and *Oleideae*, based on chromosome number. The olive is included within the *Oleideae* subfamily, *Olea* genus, *Olea* subgenus and *Olea europaea* species. The family comprises *c.* 25 genera and 600 species distributed in temperate and tropical regions (Besnard *et al*., 2009). Besides the olive, other known species in the *Oleaceae* native to Europe include ash (*Fraxinus excelsior* L. and *Fraxinus angustifolia* Vahl.), privet (*Ligustrum vulgare* L.) or phyllirea (*Phillyrea angustifolia* L., *P. media* L. and *P. latifolia* L.). A few species are cultivated or used as ornamentals, e.g. jasmine (*Jasminum fruticans* L.), lilac (*Syringa vulgaris* L.), *Fraxinus ornus* L., *Forsythia* × *intermedia* Zabel and *Osmanthus fragrans* Lour. Only *O. europaea* is cultivated for its edible fruit. Following a thorough revision by Green (2002), the genus *Olea* includes 33 species and 9 subspecies. Six of these subspecies form the *Olea* subsection or complex: (i) *O. europaea* ssp. *europaea* (2n) of the Mediterranean region, where cultivated (*O. europaea* L. ssp. *europaea* var. *sativa*) and wild olive, oleaster, (*Olea europaea* ssp. *europaea* var. *sylvestris*) are included; (ii) *O. europaea* ssp. *laperrinei* (2n) *and* (3n) (Batt. and Trab.), Ciferri, of the Sahara massifs; (iii) *O. europaea* ssp. *cerasiformis* (4n) (Webb. and Berth.) Kunk. and Sund., of the Madeira Islands; (iv) *O. europaea* ssp. *guanchica* (2n), of the Canary Islands; (v) *O. europaea* ssp. *maroccana* (6n) (Greuter and Burdet) of Morocco; and (vi) *O. europaea* ssp. *cuspidata* (2n) (Wall. Ciferri), of Asia (China, India, Pakistan, Iran, south Arabia) and south-east Africa (Green and Wickens, 1989; Green, 2002).

Studies confirm that olive was present in the Mediterranean region for several thousand years, particularly in the Middle East, before its domestication (Besnard *et al*., 2013; Newton *et al*., 2014). Palynological, anthropological and archeological evidence (García *et al*., 2017) demonstrate the presence of some sporadic forms of olive during the last glaciation (18,000 BC) in the western and eastern Mediterranean regions. Olive was probably domesticated in the Middle East, north of the Dead Sea in the Jordan River valley *c.* 5700–5200 years BC (Zohary and Spiegel-Roy, 1975; Liphschitz *et al*., 1991; Kaniewski *et al*., 2012). It has been suggested that oleaster contributed to olive domestication and is continuing to do so (Angiolillo *et al*., 1999; Besnard *et al*., 2001; Terral *et al*., 2004; Carrión *et al*., 2010; Besnard and Rubio de las Casas, 2016). Thus, the wild olive could be considered as the main progenitor of the cultivated olive, based on similar morphology, ecological requirements and ploidy level (Green, 2002; Besnard and Rubio de Casas, 2016); however, palaeobotanical, archaeological, historical studies and molecular data have enabled the reconsideration of the biogeography of the wild olive and the history of its cultivation (Besnard and Rubio de Casas, 2016; Mousavi *et al*., 2017a). Based on comprehensive samplings, independent research revealed that olive cultivars belong to three main genetic pools that approximately match three geographic areas corresponding to the west (Q1), centre (Q2) and east (Q3) of the Mediterranean region (Haouane *et al*., 2011; Belaj *et al*., 2012;

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rate. Inclusion of hormones in post-thaw medium allowed Lynch *et al*. (2007) to maintain growth for 10 weeks. Histological examination of shoot apices showed damage in subapical cells, which could be the reason for the failure of shoot recovery. Results on cryopreservation of shoot tips appear promising for germplasm conservation (Benelli *et al*., 2013).

Shibli and Al-Juboory (2000) used encapsulation–vitrification or the encapsulation–dehydration procedure to cryopreserve embryogenic cultures of juvenile origin. In both protocols, a dehydration step was required. Survival rates were 68% (encap-vitrif) or 58% (encap-dehyd) which was similar to controls. Sanchez-Romero *et al*. (2009) used the droplet vitrification method to cryopreserve somatic embryos derived from radicles of mature zygotic embryos. Bradai *et al*. (2017) indicated that 1–6 mm somatic embryos were the optimum explants; recovery following cryopreservation was improved when cultures had been grown in liquid medium for 28 days.

Embryogenic 'Canino' cultures, consisting of PEMs and somatic embryos at various stages of development, can be cryopreserved by vitrification (Lambardi *et al*., 2002). Thirty-eight per cent of the cryopreserved cultures can survive. Cryopreserved cultures showed enhanced proliferation and morphogenic potential. The encapsulation–dehydration procedure has been ineffective for crypropreservation of 'Frantoio' (Benelli *et al*., 2001a) and 'Arbequina' (Martinez *et al*., 1999).

Somatic embryos of 'Canino' were pretreated with sucrose and incubated in a cryoprotectant mixture. Slow freezing at a controlled rate (0.5°C/min to −35°C prior to plunging into liquid nitrogen) allowed Lynch *et al*. (2011) to successfully recover viable somatic embryos. Pretreatments enhanced the content of endogenous antioxidants, proline and sugar levels in tissues.

8. Conclusions

Molecular markers are being used for evaluating the level and distribution of olive germplasm variability as well as for the identification, through genetic mapping, of QTLs controlling important agronomic and quality traits. New next-generation sequencing technologies will make a significant impact on molecular olive breeding.

Several olive cultivars have been successfully micropropagated, and the technique is used commercially. Significant progress has also been made to refine somatic embryogenesis from mature phase tissues of elite cultivars. Promising results with respect to medium- and long-term conservation of olive by slow growth storage and cryoconservation will be useful for the establishment of *in vitro* repositories, which could safeguard olive biodiversity.

The potential of manipulating genetic information in a precise manner and the development of improved plants not only provide the opportunity to create novel phenotypes but also facilitate gene function studies for better understanding of different biological mechanisms (Limera *et al*., 2017). Identification of useful genes and optimization of regeneration protocols for important cultivars remains difficult and is a bottleneck. Sequencing of the olive genome will be a key tool for identifying genes of interest. For cultivars that are recalcitrant *in vitro*, a method is available based on: (i) gene modification in cells close to the root system of *in vitro* plantlets; (ii) transplant of the plantlets in the field; and (iii) selection of mutant suckers spontaneously grown from putative genetically modified cells in the crown area of the plant.

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