Identification of Pollen Donors for Olive Cultivars

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Contents

Abstract

The olive industry has emerged as an important industry in Australia with increasing demand for both olive oil and table olives. To meet the domestic demand for olive products, it is necessary to increase production. Studies have shown that only 1-2% of olive flowers mature into fruits (Martin, 1990). Insufficient pollination due to self and cross incompatibility is a major factor affecting fruit set.

The various methods used for studies on compatibility relationships have often shown conflicting results, with the same cultivar being found to be self-compatible in some studies, and self-incompatible in others (Sibbett *et al.*, 1992; Caruso *et al.*, 1993). Also, most of these studies have been conducted in the northern hemisphere where the environmental conditions and combination of cultivars growing nearby are expected to be different from Australia. It is therefore necessary to carry out studies on compatibility relationships under natural conditions in the Australian environment.

The use of molecular markers has been found to be an effective and reliable method for paternity analysis studies. Using polymorphic and codominant markers, fingerprints of embryos may be compared to markers present in the mother plant, and therefore, the paternal contribution of alleles may be identified. By comparing these alleles with the genotype of all the potential pollen donors the pollinating genotype can be identified.

The aim of this project was to identify the most compatible pollen donors for five olive cultivars (Barnea, Corregiola, Koroneiki, Kalamata, and Mission) and to observe the effect of morphological characters (bloom time, percentage pollen vitality, and percentage of complete flowers) and weather conditions (temperature, rainfall, and wind direction) on pollination. The study was conducted in a mixed olive orchard in Gumeracha, South Australia over the 2002-2003 and 2003-2004 growing seasons.

Prior to the study, the genotypes of the trees were compared with the standards in the database (Guerin *et al.*, 2002) and it was found that most of the trees matched with the standard cultivars. However, the trees considered to be Manaki by the grower did not match with the standard Manaki and were therefore referred to as atypical Manaki. Also, some Pendolino, Corregiola, and Kalamata trees did not match with the standard and were also referred to as atypical.

The maximum and minimum temperatures, rainfall, and wind direction were recorded for the bloom period of both the years. The range of maximum temperature minimum temperatures during the bloom period was similar in both years. There was more rainfall in the bloom period during the first year than during the second year. Wind direction data during the bloom period showed that the wind direction was similar in both years. The winds were mainly easterly or westerly in the mornings and mainly westerly in the afternoon. However, there were winds of lower intensities blowing in the other directions as well, thus ensuring adequate wind movement for pollen dissemination.

Dates of the start of bloom, full bloom and end of bloom for each cultivar were recorded for both years. It was observed that most of the cultivars overlapped in their bloom time, although some such as Kalamata flowered late in both years. Bloom time dates for replicate trees of a cultivar were similar, but there were differences in the dates between cultivars.

The percentage of complete flowers was recorded for all cultivars in both years and it was observed that King Kalamata had the lowest value (42.5%) in the first year and Koroneiki had the lowest value (29%) in the second year. Leccino, atypical Manaki, and Corregiola had high percentages of complete flowers in both years.

Percentage pollen vitality observations ranged from 23.5% in King Kalamata to 72.3% in Koroneiki in the first year. In the following year, UC13A6 had the lowest percentage pollen vitality (19.7%) and Leccino had the highest value (65.5%). The flowers sampled from Verdale and atypical Manaki did not contain pollen in both the years.

Paternity analysis showed that: Barnea embryos were mainly fertilised by Pendolino and Mission; Corregiola embryos were mainly fertilised by Mission, Kalamata, and atypical Manaki; Koroneiki embryos were mainly fertilised by Mission; Kalamata embryos were mainly fertilised by Koroneiki; and Mission embryos were mainly fertilised by Koroneiki. There were also unidentified pollen donors pollinating a significant proportion of embryos. No apparent effect of direction of canopy and distance of pollen donors was observed and it was concluded that wind movement was not a limitation for movement of pollen in the orchard. Temperature and rainfall

did not have any apparent effect on the overall bloom period. Pollen vitality, time of flowering, number of trees in the orchard, and tree age may have affected the effectiveness of some cultivars as pollen donors.

The results highlighted the importance of cross-pollination for fruit set. Only two instances of self-pollination were observed suggesting that cross-pollination is more effective than selfing. The results also suggest that there is genetically controlled compatibility relationship operating among the cultivars and this determined which pollen type lead to successful fruit formation. However little is known about the mechanism of incompatibility operating in olives. There were differences in the effectiveness of some pollen donors over the two years which suggests that having more than one compatible pollen donor in the orchard is important.

The results obtained in this study may be used as a basis for studying the mechanism of incompatibility in olives. The compatible pollen donors identified can be used to make recommendations to olive growers regarding the combinations of olive cultivars that will maximise yield and hence boost the production of olives in Australia. The method can also be extended to other cultivars to identify compatible pollen donors and also to compare the effect of different environmental conditions on pollination.