Pollination Aware

Pomegranate

This case study is the primary source of information on potential pollination services for the industry. It is based on data provided by industry, the ABS and other relevant sources. Therefore, information in this case study on potential hive requirements may differ to the tables in the Pollination Aware report (RIRDC Pub. No. 10/081) which are based on ABS (2008) *Agricultural Commodities Small Area Data, Australia 2005-06.*

Introduction

The pomegranate (*Punica granatum*) is a fruit-bearing deciduous shrub or small tree that grows to between five and eight metres tall and is best suited to climates where winters are cool and summers are hot. The pomegranate is thought to have been first cultivated 5–6,000 years ago and is native to the regions from Iran through to north India (DAF 2005). It is now widely cultivated throughout Eastern Europe, Asia and the USA, the main areas of world production being in India, Iran, Spain and California. Pomegranates can be consumed as fresh fruit or used in fruit juices, teas, pharmaceutical and medicinal products and in dyes or as decoration. There are several hundred different varieties of pomegranate recognised in Iran alone and even more globally, some of the cultivars that have the greatest impact are 'Moller', 'Ahmar', 'Bhagawa', 'Wonderful', 'Hicaznar' and 'Dente di cavallo' (RIRDC 2008).

Globally, it is estimated that total production amounts to around 2,000,000 tonnes, of which India produces approximately 50% in the states of Maharashtra and Andra Pradesh. Iran is the second largest, producing around 35% of global production. Spain produces around 2.5% and the USA has around 10,000ha under production. The balance is produced by countries such as Turkey and other Mediterranean countries such as Morocco and Italy, as well as the Middle East and former Russian states (RIRDC 2008).

The pomegranate is andromonoecious, in other words, male (unfertile) and bisexual (fertile) flowers develop on the same plant. Flowers have an attractive red calyx and corolla with one flower containing about 200–350 anthers and bisexual flowers containing from 400–1,000 ovules (Derin and Eti 2001). The pomegranate can thus be self-pollinated as well as cross-pollinated. Cross-pollination can increase fruit set by up to 20% and pollen transfer can be achieved by an insect vector.

Pomegranate production in Australia

No significant pomegranate industry currently exists in Australia. It is estimated that nationally there are only approximately 200ha of land under pomegranate production, nearly all of which occurs around the Murray-Darling Basin and in some in Western Australia near Carnarvon. Virtually all fruit produced finds its way onto the market through traditional wholesale markets and farmers markets and there is no control on fruit quality or product information for the consumer. In the last four to five years, California has capitalised on the lack of local pomegranate production in Australia and has shipped 10–14 large containers annually to Australia, with a market value of around $500,000. In general the world market trend is for rapid growth in the pomegranate industry and in Australia currently there exist various stakeholders who are already investing capital into either plant material or developing a market for the expected product (RIRDC 2008).

There are suggestions that given Australia's position in the southern hemisphere, supply of fresh fruit to export markets could be feasible after India's crop is sold around March each year, with Australia ultimately competing with South Africa and South America on the world market. The eventual size of the Australian industry is unknown; however, it is expected that there will be 1,000ha more in production over the next 5–10 years worth an estimated $50 million or more (RIRDC 2008).

The most suitable areas for pomegranate production will be areas that have mild to subtropical temperatures, cool winters and hot, long dry summers. Pomegranate will also tolerate drought extremely well and has some ability to tolerate saline water. Within Australia, the areas that show the most potential for pomegranate production are Carnarvon in Western Australia, St George in Queensland, areas surrounding Menindee and Hillstone in New South Wales, and the Murray region in Victoria (RIRDC 2008).

Pollination in pomegranates

The presence of both male (unfertile) and bisexual (fertile) flowers on the pomegranate allow it to be self-pollinated as well as cross-pollinated. Several studies have shown that cross-pollination results in around about 20% increase in fruit set as well as an increase in overall fruit quality (Derin and Eti 2001). Because of its heaviness, there is very little wind dispersal of the pollen and thus insects are mostly responsible for the transport of pollen between flowers. There is little quantitative data available with regard to the efficiency of honey bees in the pollination of pomegranate; however, McGregor (1976) states that growers in California arrange for honey bee colonies to be placed in or near their fields, believing that their presence benefits pomegranate fruit production. Derin and Eti (2001) describe the honey bee as the principal pollinator of pomegranate. In addition, the Department of Agriculture and Food in Western Australia (2005) also suggest that 10% of pollination in pomegranate can be attributed to honey bees.

Whilst the evidence suggests that insect pollinators including honey bees are of significant benefit in increasing the fruit set and quality of pomegranate yields, studies have shown that sizeable yields can still be obtained from self-pollination. For example when flowers are bagged to exclude insects and cross-pollination, fruit sets of up to 45% can still be obtained (McGregor 1976). With subsequent cross-pollination, however, fruit set can increase to around 68% and additionally there is an increase in fruit quality (i.e. number of seeds per fruit, fruit size).

Pollination management for pomegranates in Australia

There are a number of factors within the orchard which have a direct bearing on the pollination efficiency of honey bees:

Orchard layout

- *Tree and blossom density*: The pomegranate has a growth habit which is scrub-like and needs to be propped up on trellises when supporting large crop loads. Orchards are planted in rows and most are planted in low number configurations ranging from 300 to 800 trees per ha (RIRDC 2008) with spacing of 4 to 6m by 2 to 6m (DAF 2005). Fruit are borne on the tips of new growth and so branches are shortened annually to encourage the maximum number of new shoots on all sides of the tree. Under orchard layouts, tree and blossom density are highest, the number of hives per hectare provided may need to be increased to ensure optimal pollination.
- *Access*: From a beekeeper's point of view, all-weather truck access is highly desirable. Limited access may lead to an increased workload for the beekeeper, uneven placement of hives and thus inefficient pollination. Ensuring the beekeeper has good access will aid in placement of hives and be mutually beneficial to the grower (increased pollination efficiency) and the beekeeper (decreased labour effort).

Pollinisers

Although bisexual flowers have viable and germinable pollen allowing for self-pollination with bisexual flowers and male flowers on the same plant, cross-pollination with flowers of another pomegranate cultivar results in an increase in fruit set and fruit quality (Derin and Eti 2001). Derin and Eti (2001) studied the pollen affinity of several different pomegranate cultivars, finding that the fruit set varied in response to the type of cultivar or the type of flower (either male or bisexual) that it was crossed with and recommended that care be taken when selecting a polliniser variety. They also recommend that at least two different cultivars should be planted within an orchard.

Density of bees

Pomegranate flowers have an attractive red calyx and corolla. One flower has about 200–350 anthers and bisexual flowers contain about 400–1,000 ovules (Derin and Eti 2001). The more ovules that are pollinated the larger the fruit and the more seeds it contains. The literature reveals little by way of recommendations for the density of bees required to adequately pollinate a pomegranate crop, however, intuitively it could be assumed that the greater the amount of bees in the orchard the more ovules will be fertilised. The Department of Agriculture and Food in Western Australia recommend between two and three hives per hectare is sufficient for optimal cross-pollination (DAF 2005).

Arrangement of hives

With all orchard crops, the placement of hives is a very important factor to consider for maximising pollination. It has been shown that bees prefer to forage within 100m of their hives and also prefer locations that are warm (i.e. placed in sunlight) and away from wind. Hives should also be placed off the ground, away from low-lying areas where moisture will settle. The selection of good hive sites will ultimately increase the flight and foraging behavior of the bees and thus will help to maximise their pollination efficiency.

Timing

From a study of the floral biology of 21 different cultivars of pomegranate it was found that anthesis started around 8am in the morning and continued till 4pm with the peak period at 2pm in the afternoon (Derin and Eti 2001). It was also found that the stigma was receptive one day before anthesis and remained receptive for up to five days. Given the rather short time period in which the stigma is receptive, it should be recommended that bees are brought into the orchard immediately at the onset of flowering so that the opportunity to cross-pollinate between cultivars is not missed.

Attractiveness, nutritional value of pollen and nectar

McGregor (1976) states that the flowers of pomegranate have been referred to as 'nectarless'; however, some cultivars grown in the USA have been shown to contain several drops of nectar with 27% soluble solids (sugars). The Department of Agriculture and Food in Western Australia state that little to no nectar is produced in pomegranate flowers (DAF 2005). In cultivars where no nectar is produced, only pollen collecting bees would be of value to the blossom and so hives may require diet supplements during a pollination campaign to maintain their brood and a healthy population.

Risks

Pesticides: One of the biggest drawbacks of placing bees near any agricultural crop is the possibility of colonies or field bees being affected by pesticides. Pesticides should be kept to a minimum while hives remain on the property. Most poisoning occurs when pesticides are applied to flowering crops, pastures and weeds.

It is strongly recommended that growers take the following steps to prevent or reduce bee losses:

- follow the warnings on pesticide container labels
- select the least harmful insecticide for bees and spray late in the afternoon or at night
- do not spray in conditions where spray might drift onto adjacent fields supporting foraging bees
- dispose of waste chemical or used containers correctly
- always warn nearby beekeepers of your intention to spray in time for steps to be taken to protect the bees; give at least two days' notice
- always advise nearby farmers.

Weather

Temperature and rainfall have a marked effect on honey bee activity. Bee activity is very limited below temperatures of 13°C, with activity increasing up to around 19°C, above which activity tends to remain at a relatively high level. Decreases in both numbers of bees visiting blossoms and the distance from the hive at which bees forage occur with a decrease in temperature.

Potential pollination service requirement for pomegranates in Australia

As mentioned above, the pomegranate industry in Australia is currently insignificant with only approximately 200ha of land under production divided over the states of Victoria and Western Australia. This is, however, predicted to increase five-fold in the next five to ten years to around 1,000ha. Nonetheless, optimal use of managed pollination services in all pomegranate orchards in Australia as they stand now would require a service capacity as indicated in Table 1 below.

Table 1 Potential pollination service requirement for pomegranate in Australia

State	Peak month	Area (ha) total	Average hive density (h/ha)*	Estimated number of hives required
Total VIC & WA	November	200	2.5	**~ 500**

Notes: Area sourced from RIRDC (2008), flowering times and average hive density from DAF (2005).

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This case study was prepared as part of *Pollination Aware – The Real Value of Pollination in Australia*, by RC Keogh, APW Robinson and IJ Mullins, which consolidates the available information on pollination in Australia at a number of different levels: commodity/industry; regional/state; and national. Pollination Aware and the accompanying case studies provide a base for more detailed decision making on the management of pollination across a broad range of commodities.

The full report and 35 individual case studies are available at www.rirdc.gov.au.

Notes

Notes

Australian Government

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Know-how for Horticulture™

This project is part of the Pollination Program – a jointly funded partnership with the Rural Industries Research and Development Corporation (RIRDC), Horticulture Australia Limited (HAL) and the Australian Government Department of Agriculture, Fisheries and Forestry. The Pollination Program is managed by RIRDC and aims to secure the pollination of Australia's horticultural and agricultural crops into the future on a sustainable and profitable basis. Research and development in this program is conducted to raise awareness that will help protect pollination in Australia.

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