Pollination Aware

Pear and Nashi

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

Pear trees (*Pyrus* spp., family Rosaceae) are native to coastal and mildly temperate regions of western Europe, North Africa, and extending east across parts of Asia. The two main types of pear cultivated around the world are the European pear (*Pyrus communis L*) and the Asian pear or 'nashi' (*Pyrus pyrifolia*). For the purpose of this study the European pear is referred to as the 'pear' and the Asian pear as the 'nashi'. The fruit mainly carry the distinctive 'pear shape', technically referred to as pyriform (a narrow stem area and full bulbous-like base); however, the nashi generally has a more spherical shape. Skin colour varies between varieties and may be smooth yellow, green or red, or may exhibit colours ranging from tan to brown and a rough texture. Both types grow easily, produce sweet and juicy fruit that are a low calorie source of carbohydrates, fibre, and pectin.

Most pear varieties are considered self-infertile and require cross-pollination with another variety to set fruit. Honey bees are regarded as the most efficient and most important pollinators of pear trees (McGregor 1976; Stern et al. 2004). This is despite the fact that pear flowers produce very little nectar, with bees primarily foraging on them for pollen (McGregor 1976).

Pear and nashi production in Australia

On a global scale Australia is insignificant as a pear producer, ranking twentieth in the world and producing just 0.6% of global production (FAO 2009). Nonetheless, Australia produced approximately 140,000 tonnes of pears and 3,400 tonnes of nashi in the year 2005/06 (ABS 2008) (Table 1). Both pears and nashis are grown in very similar regions (Figure 1) with the majority of production concentrated in Victoria (88.7% for pear production and 88.5% for nashi production) around the Goulburn and Yarra Valleys. Western Australian is the next largest producer with growing regions in the south-west around Donnybrook and Manjimup, followed by South Australia's Adelaide Hills, and smaller amounts in Queensland, Tasmania and New South Wales.

Table 1 Australian production and percentage of European and nashi pears grown per state (ABS 2008)

	ACT	NSW	QLD	SA	TAS	VIC	WA	Total
Pear (t)	1.5	419.2	785.8	5,270.1	730.8	123,350.3	8478.1	139,036.1
Nashi (t)	0.6	26.7	5.6	183.6	4.2	2,993.6	168.6	3,382.9

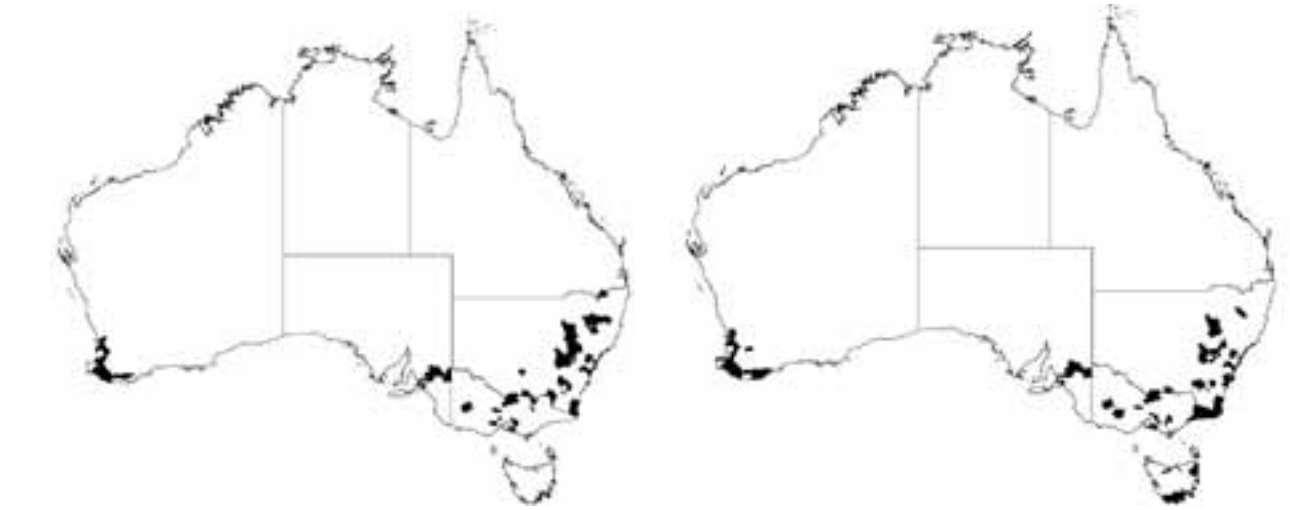


Figure 1 *Production regions within Australia for pear (left) and nashi (right) (ABS 2008)*

The production of pears is a great deal larger than nashi production with pears grown for both the processed and fresh fruit industry. Major European pear varieties grown in Australia include the 'William's Bon Chrétien' (approximately 47% of production), which is used mainly for processing, the 'Packhams Triumph' (approximately 39%) which is used for the fresh market and the 'Buerré Bosc', 'Josephine' and 'Corella' which are also grown for the fresh market (Intensive.Pear 2009). The nashi was brought to Australia by Chinese gold miners in the 1850s and has been in commercial production for the last 25 years. All nashis are grown for the fresh fruit market with the major cultivar being 'Nijisseiki' (Intensive.Pear 2009).

Pollination in pears and nashi

Most pear and nashi varieties are considered self-infertile and require cross-pollination (DPI.VIC 2008; Sakamoto et al. 2009). Therefore a transportation agent (i.e. wind, insects) is required to transfer pollen from a pollinising variety to the stigma of a fruit-bearing variety. The literature does give credit to a number of pollinating insects including several from the orders of hymenoptera, diptera and coleoptera, however it has been well established that honey bees (*Apis mellifera*) are the primary pollinators of pears and nashis (McGregor 1976; Stern et al. 2004).

Numerous authors have demonstrated the value of honey bees in pollinating pears, some dating back as far as 1900 have been cited by McGregor (1976) and demonstrate increases in yield and fruit shape/quality of pears when bees are put onto a flowering crop. Although the same amount of literature is not available for nashis, given that both pears and nashi share very similar planting and growing needs and it is well known that honey bees have been used extensively in the pollination of nashi in Victoria (DAF 2005) and New Zealand (Rohitha and Klinac 1990), the pollination requirements for nashi are considered to be very similar to that of pears.

High concentrations of foraging bees in the crop have not only been shown to ensure a good fruit set, but will also increase seed numbers in each pear and nashi fruit. This in turn ensures better, even-shaped fruit and improved storage qualities (DPI. VIC 2008). Langridge and Jenkins (1975) considered the role of honey bees in the transport of pollen for fertilisation of 'Winter Nelis' pears in a pear orchard in Victoria. Trees were open pollinated and caged to exclude honey bees. Results revealed that enclosing the trees in bee-proof cages caused a marked decline in fruit yields and number of seeds per fruit (Table 2).

Table 2 Pollination of 'Winter Nelis' pears (Langridge and Jenkins 1975

	Open trees	Caged trees	Statistical significance
Fruit set/100 clusters	52.75	4.95	P<0.01
Yield per tree (kg)	87.8	11.5	P<0.01
Seeds per fruit	5.0	2.9	P<0.01

Pollination management for pears and nashi 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 most common tree arrangements for intensive pear/nashi production are single row or open tatura trellis (double row) systems. Tree density is one of the most important factors influencing the production of fruit in an orchard and many studies with various varieties and rootstocks have shown that increasing tree densities increases earlier production and yields because of greater light interception by the orchard canopy. The classification of what constitutes high and low density planting varies between production regions but in general low density is anything with less than 1,000 trees per hectare, high density is anything between 2,500 and 5,000 trees per hectare and very high density is 5,000 trees per hectare and above (Intensive.Pear 2009).
- *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

Most pears/nashi's are considered self-infertile (cannot produce fruit from their own pollen) and require cross-pollination with another cultivar. If cross-pollination is insufficient then there may be reduced yields and misshapen fruit. It is important to ensure that compatible varieties (pollinisers) have a flowering period that coincides with the bearing variety and are planted within the orchard in a suitable configuration so that honey bees can effectively and efficiently pollinate an orchard. Bees also tend to fly down rows and not across them so full-row systems of pollinisers (often used in older low-density orchards) may have limited effectiveness in intensive production systems. A more effective layout is one that has pollinisers evenly planted throughout every row. There are sometimes numerous pollinisers recommended for the different pear/nashi varieties available (Intensive.Pear 2009).

Density of bees

It has been stated that 10 to 15 bees per tree per minute are required for the adequate pollination of pears (Stern et al. 2004). To reach this density, the number of hives that has been recommended ranges from one hive per hectare for low-density orchards and five colonies per hectare for high-density orchards (DAF 2005; McGregor 1976; Stern et al. 2004). Higher stocking rates will be needed if there are more attractive flowering species present and therefore growers should consult an apiarist with local expertise to determine honey bee requirements for their orchard (DAF 2005; Intensive.Pear 2009).

Arrangement of hives

There are number of general recommendations when placing hives within an orchard that will help to increase flight and foraging activity of the honey bees and thus maximise pollination. Recommendations include, placing hives in sunlight to increase foraging during the morning bloom, placing the hives on stands to keep them off the ground and away from low-lying areas where moisture will settle, and making sure hives are not placed too far apart (bees like to forage within 100m of their hives). Moreover, honey bees also tend to restrict their mobility along a row rather than between rows and therefore greater numbers of hives should be placed along rows accordingly (DAF 2005).

Timing

The period of ovule longevity minus the time between pollination and fertilisation is very short with pears/nashis and usually only lasts 1–2 days. Thus although the stigma remains receptive for longer periods of time, pollination needs to accomplished in 1–2 days for fertilisation to occur before ovule degeneration (Stern et al. 2004).

The timing of colony introduction in relation to the stage of blooming has also been shown to strongly influence the number of bees that visit the trees. If hives are placed too early they may abandon the target crop for more attractive floral resources in the vicinity. Hives should therefore be brought in two waves at approximately five-day intervals (DAF 2005). Stern et al. (2004) conducted a pollination study in a pear orchard in Israel and found that when hives were introduced sequentially (i.e. 1.25hives/ha at 10% flowering and another 1.25hives/ha at full bloom), fruit set and yield increased 50–80%.

Attractiveness, nutritional value of pollen and nectar

Despite the fact that pear/nashi trees rely heavily on insects for pollination they are not very attractive to honey bees (DAF 2005; McGregor 1976; Stern et al. 2004). The reason for their low attractiveness is the low volume of nectar secreted from the flowers (3microlitres or less) and its low sugar concentration (25% or less sucrose) (Stern et al. 2004). This low attractiveness is, however, somewhat compensated for by the abundance of pollen grains (1.2mg per flower) which does tend to be very attractive to honey bees (McGregor 1976; Stern et al. 2004). Because pear/nashi trees may be less attractive than other floral resources an important step in orchard management is to control flowering weeds (Intensive.Pear 2009).

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 pears and nashi in Australia

Optimal use of managed pollination services in all pear and nashi orchards in Australia would require a service capacity as indicated in Tables 3 and 4 below.

Table 3 Potential pollination service requirement for pears in Australia

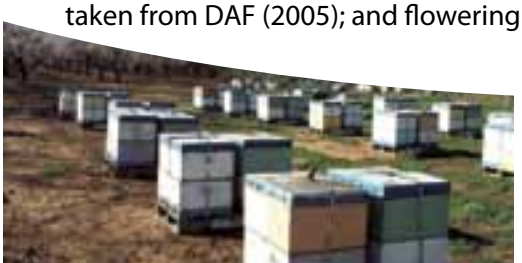
State	Peak month	Area (ha) total	Average hive density (h/ha)*	Estimated number of hives required
VIC	October	674	3.5	2,359.0
NSW	October	10	3.5	35.0
QLD	October	11	3.5	38.5
WA	October	75	3.5	262.5
TAS	September	11	3.5	38.5
SA	October	46	3.5	161.0
Total		**827**		**2,894.5**

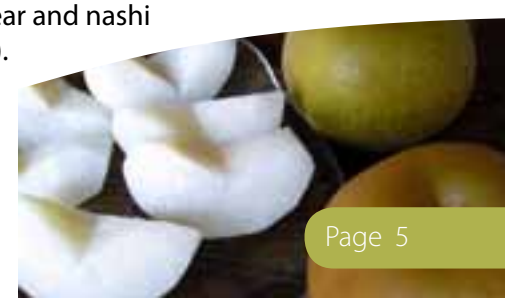
Notes: Hectares calculated from total number of trees per state multiplied by high tree density (2500 trees/ha) taken from Intensive.Pear (2009); hive density for both pear and nashi taken from DAF (2005); and flowering from McGregor (1976) and DPI.NSW (2009).

Table 4 Potential pollination service requirement for nashi in Australia

State	Peak month	Area (ha) total	Average hive density (h/ha)*	Estimated number of hives required
VIC	October	117	3.5	409.5
NSW	October	2	3.5	7.0
WA	October	7	3.5	24.5
SA	October	7	3.5	24.5
Total		**133**		**465.5**

Notes: Hectares calculated from total number of trees per state multiplied by high tree density (2500 trees/ha) taken from Intensive.Pear (2009); hive density for both pear and nashi taken from DAF (2005); and flowering from McGregor (1976) and DPI.NSW (2009).





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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

Australian Government

Rural Industries Research and Development Corporation

HAL

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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