

Blueberry

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

Blueberries are flowering plants of the genus *Vaccinium* that are commonly grown for their much sought-after dark berries which can be consumed raw, added to breakfasts, baked goods, yogurts or made into jams. A number of species of blueberries occur naturally in the northern hemisphere in particular in North America where cultivation of these species first occurred. The berry colour ranges from maroon to purple-black and the flesh remains semi-transparent and encases tiny seeds. Cultivated berries are usually mildly sweet, whereas those which grow in the wild have a more tangy flavour. Blueberries are also one of the richest sources of antioxidants available as well as being a rich source of vitamins and minerals.

Blueberries were first introduced into Australia in the early 1970s. The cold climate varieties such as 'northern highbush' are suited to southern Australian regions such as Victoria, Western Australia, South Australia, and the southern highlands of New South Wales and Tasmania. By 1978 it was recognised that the

warmer climate 'southern highbush' and 'rabbiteye' varieties from the southern states of the USA would grow on the New South Wales north coast and produce high value, early season fruit. For this reason over 80% of Australia's blueberry production now comes from the New South Wales north coast (Figure 1).

Both in Australia and overseas, blueberry producers have traditionally relied on feral bees for pollination (Sampson and Cane 2000; Rhodes 2002; DPI 2008). In the USA, several native bee species have been identified as highly efficient pollinators with single visits to virgin flowers setting up to 40% fruit and repeated or unrestricted visits further improving fruit set and size (Sampson and Cane 2000). Honey bees (*Apis mellifera*) managed by commercial beekeepers are currently the most suitable insect for commercial pollination of blueberries in Australia (Rhodes 2006).

Blueberry production in Australia

Blueberries were first grown commercially in Victoria in 1974, followed by plantings a decade later on the north coast of New South Wales (DPI 2008). Currently, production continues to increase in all states of Australia. In 2003/04 Australia produced an estimated 2,400 tonnes of blueberries, with a farm gate value of \$24 million (DPI 2008). Approximately 50% of blueberries are sold as fresh market fruit into the Australian domestic market, 30% is exported to Asia and Europe, while the remain-

ing 20% of fruit is processed, principally as frozen product (DPI 2008).

Due to the geographic spread of the industry in Australia, fresh blueberries are available for most of the year, with most production from October to March. Demand for blueberries has been enhanced by wide promotion of the fruit's health benefits. The three most commonly grown types of blueberries in Australia include the 'northern highbush', 'southern highbush' and



the 'rabbit eye' blueberry (Rhodes 2006) with each of these with types having several subvarieties (Goodman and Clayton-Greene 1988). The 'northern highbush' types can only be grown in areas with cold winters, whilst the 'southern highbush' and 'rabbit eye' types can be grown in areas with warmer winters

Australia's production in 2008 totalled 2,315 tonnes with the biggest producers being New South Wales and Victoria (Table 1).

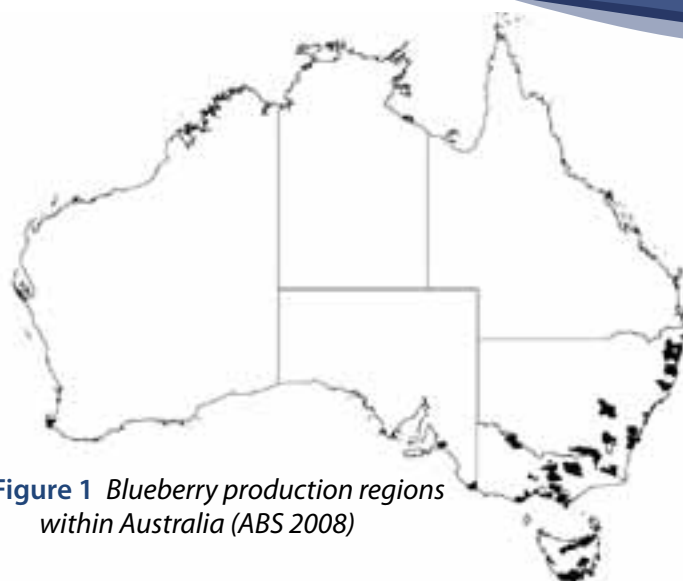


Figure 1 Blueberry production regions within Australia (ABS 2008)

Table 1 Blueberry production areas and tonnes (ABS 2008)

	NSW	QLD	SA	TAS	VIC	Total
Blueberries – production (tonnes)	1,996.0	0.4	9.7	75.0	234.0	2,315.1
Blueberries – total area (ha)	512	2	10	28	116	668

Pollination in blueberries

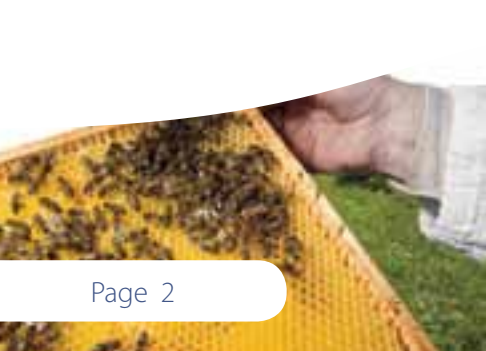
Several studies both overseas and within Australia have demonstrated the value of having insect pollinators in blueberry plantations (Rhodes 2006; Goodman and Clayton-Greene 1988; DPI 2008; Sampson and Cane 2000). Goodman & Clayton-Greene (1988) showed that plants visited by honey bees have a greater percentage fruit set, increased fruit numbers and more fruit by weight than plants caged to prevent access by bees and larger insects. Inter-planting of varieties capable of cross-pollinating one another has also increased fruit set and size over single-variety plantings (DPI 2008). Insect-pollinated fruit has been found to mature 4–12 days earlier and to be up to 50% larger, depending on the variety (Rhodes 2006; DPI 2008) and fruit size has also been found to be directly related to seed numbers with seed counts of 3–75 per fruit (Goodman and Clayton-Greene 1988).

Studies in the USA have demonstrated the value of having bee hives within plantations to improve fruit set (DPI 2008; McGregor 1976); however, some overseas authors suggest that commercial honey bees are not the most efficient pollinators of blueberries (McGregor 1976). For the case of Australia, honey

bees are the most widely available and easily managed insect pollinator (DPI 2008). Several other insects and smaller native bees may also assist in pollination although these species are not readily available in Australia due to quarantine and are thus a non-viable option.

'Northern highbush' cultivars generally don't require cross-pollination with the exceptions of the 'Brigitta' variety, which is usually inter-planted with 'Blue Crop' and 'Rabbiteye' cultivars which are flanked on either side by another variety, ensuring that flowering times overlap to ensure maximum pollination and fruit set.

The role of honey bees in the pollination of 'highbush' blueberries was studied in an experimental planting at Knoxfield, Victoria. Honey bees comprised 95.4% of all insect visitors to this crop, and their foraging activity made them efficient pollinators (Goodman and Clayton-Greene 1988). On a per plant basis, fruit set, numbers of fruits harvested and total weight of fruit harvested all showed significant improvements when open pollinated by honey bees (Table 2).



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Table 2

Effect of caging (to exclude larger insects) on fruit set in blueberries (mean of 6 plants) (Goodman and Clayton-Greene 1988)

Attribute	Uncaged plants	Caged plants	Significance of difference (t-test, 10d.f.)
Flower setting fruit (%)	60.7	17.9	$P < 0.001$
No. of fruit harvested	1156.6	143.7	$P < 0.001$
Total weight of fruit harvested (kg)	1.63	0.19	$P < 0.001$
Individual fruit weights (g)	1.41	1.32	n.s.

Pollination management for blueberries in Australia

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

Crop layout

- Plant and blossom density:* For 'southern highbush', rows are generally planted 3m apart with plants spaced at 1.2–1.5m within rows (2,200–2,750 plants/ha). 'Rabbiteye' varieties, due to their greater vigour, are planted at spacings of 1.2–1.4m within rows (2,500–2,100 plants/ha) (DPI 2008). Inter-planting varieties capable of cross-pollinating one another has also increased fruit set and size compared to single variety plantings. Growers need to order the right number of plants of each variety to ensure they have the correct varietal mix for 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.

Density of bees

Numbers of hives required to pollinate blueberry crops varies considerably. According to the plant variety and pollination requirements, hive density in blueberry crops varies between 1.25 and five hives per hectare (Rhodes 2006). Two to five hives per hectare should be adequate for most orchards and can be introduced at or before 5% flowering (DPI 2008). A general guide to honey bee population numbers in the crop is two bees per metre of row is considered satisfactory (Rhodes 2006).

Preparations of bees

Early-flowering varieties start flowering in late winter, with later-flowering varieties starting up to mid-spring (DPI 2008). Pollination hives are required at a time of year when the bees are coming out of winter and generally have low populations. For adequate pollination, hives with four frames containing brood on both sides and eight frames covered with bees are the minimum strength required for blueberry pollination (DPI 2008). What is important is the number of honey bees and other insects actually working the flowers (DPI 2008)



Pollination Aware

Arrangement of hives

Most seed is set within a 100m radius of a colony. Research has suggested colonies should be deposited in groups of 12–18 per location with about 150m between locations (Somerville 2007). Whatever the distribution pattern, hives should be placed in shady areas to avoid extreme temperatures. Honey bees collect significant amounts of water for use in the hive and as temperatures rise, the need for water increases, diverting many field bees into water gathering duties. Ensuring hives are located relatively close to water and in shady areas will significantly reduce stress levels of colonies, aiding in optimal pollination of the target crops.

Timing

Introducing hives into the crop at 5% flowering and remaining until petals begin to drop will ensure optimal pollination from honey bees (DPI 2008).

Attractiveness, nutritional value of pollen and nectar

Blueberry varieties vary in their ability to attract pollinators with some varieties being more attractive to honey bees than others. Attractive varieties may produce more nectar or nectar with higher sugar content.

Blueberry nectar usually contains between 12 and 21% sugar (Rhodes 2006). Some varieties produce more pollen than others, increasing their effectiveness when used for cross-pollination as they attract more pollen-gathering bees.

Blueberry pollen may itself be a satisfactory food source for honey bees. The crude protein level of one sample was 13.9%, and all amino acids were balanced, but colonies could not be expected to remain viable over a number of generations (Rhodes 2006).

Availability of bees for pollination

Pollination hives are required at a time of year when the bees are coming out of winter and generally have low populations, thus the fee a grower pays to a beekeeper to provide pollination services can vary. One important factor is the extra cost to the

beekeeper in managing his bees to produce hives of a suitable strength at the time of year when the hives are to be placed on the crop. Also, if it is necessary to remove the hives and return them at a later date to allow pesticide spraying to be applied then an extra amount per hive may be charged to cover the cost (Rhodes 2006).

Feral bees

Orchardists relying on feral bees for part or all of their pollination services should be similarly aware first, that feral colonies are unlikely to be at full strength at the time that blueberries flower and, second, that even if they were, foraging by these bees is unlikely to be sufficiently intense to achieve the level of pollination required for optimal production especially if there are alternative floral resources available to the bees in the same vicinity.

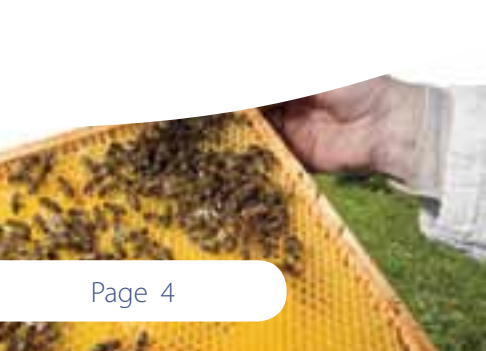
Risks

Pesticides: Bees will be killed by a number of pesticides that may be used and care should be taken when spraying for pests or diseases. The apiarist should be consulted before spraying and if it is necessary, only sprays of very low toxicity to bees should be used and applied at evening. Pesticides should be sprayed in late afternoon when bee pollinators are less active.

One of the biggest drawbacks of placing bee near any agricultural crop is the possibility of colonies or field bees being sprayed 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



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- 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

Flowers always open by day break. The length of time flowers remain open is dependent on temperature and humidity. If temperature is low (10–12.8°C) and the humidity is over 75%, the flowers may remain open until midday.

Opportunities for improvement

Overseas researchers have found several efficient insect pollinators of blueberries (Sampson and Cane 2000), although these species are not available in Australia and present little potential given strict quarantine and the relative ease and efficiency of managed honey bee pollination services already available.

Potential pollination service requirement for blueberries in Australia

Optimal use of managed pollination services in all blueberry plantations in Australia would require a service capacity as indicated in Table 3 below.

Table 3 Potential pollination service requirement for blueberries in Australia (ABS 2008)				
State	Peak month	Area (ha)	Average hive density (h/ha)*	Estimated number of hives required
NSW	September	512	3	1,536
QLD	August	2	3	6
SA	September	10	3	30
TAS	October	28	3	84
VIC	September	116	3	348
Total		668		2,004

Notes: Area sourced from ABS (2008), flowering times from DPI (2008) and average hive density from Rhodes (2006).



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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.



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Notes





Australian Government

**Rural Industries Research and
Development Corporation**



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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