Melons

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

Melons are fleshy fruit, sometimes referred to as culinary vegetables that are members of the Cucurbitaceae family and are thought to have originated in Mexico and Central America. Three major melon species are produced and consumed around the world including the watermelon (*Citrullus lanatus*), honeydew (*Cucumis melo indorus*) and rockmelon (*Cucumis melo reticulatus*); however, many different cultivars of these species are grown according to consumer preferences and market conditions (i.e. seedless varieties, good shelf life etc.). When ripe, the sweet juicy pulp is predominantly eaten fresh, however, the rind is sometimes preserved and seeds can be roasted as a snack or ground into an ingredient used in oils and sauces.

Melon plants are grown as a ground vine and depending on the cultivar, the shape of the fruit may change from oblong to round, the rind from light green to dark green, the flesh from red to yellow and the seeds from white to yellow, brown or black (McGregor 1976).

China is the world's largest producer of melons. In 2004 China accounted for over 50% of world production by weight, followed by Turkey with 6.1% and Iran with 4.4%. In the past, melons were considered to be a 'seasonal delight' because of their limited availability throughout the year, however, as production flexibility and imports have increased availability, melons have become available year round and gained in popularity (Boriss et al. 2006).

Melon production in Australia

The Australian Melon Industry consists of approximately 300 growers producing some 217,000 tonnes of melons annually across an area of around 8,500 hectares. The major cultivars produced in Australia are rockmelons, honeydew melons and watermelons (AMA 2006).

Melons are grown across all states and territories within Australia, however negligible amounts are grown in Tasmania and none are grown commercially in the Australian Capital Territory. Queensland, Western Australia and New South Wales are major producers of melons with the Northern Territory, Victoria and South Australia producing lower but still significant volumes (ABS 2008). Percentage of total production for each state is shown in Figure 1. The main production regions are shown in Figure 2.

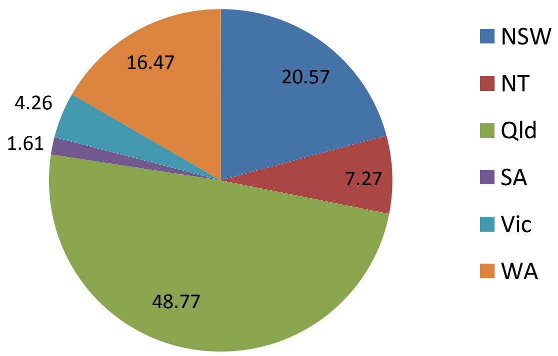
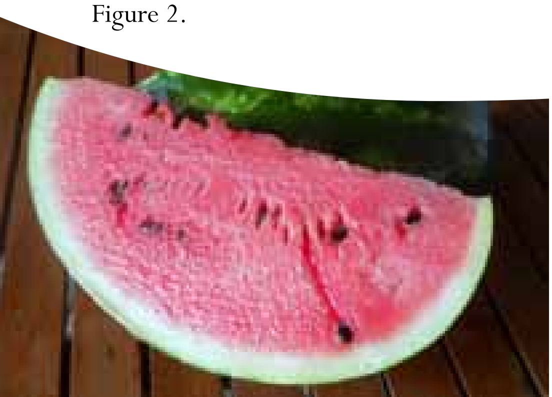


Figure 1 *Melon production by state as a percentage of national total (ABS 2008)*



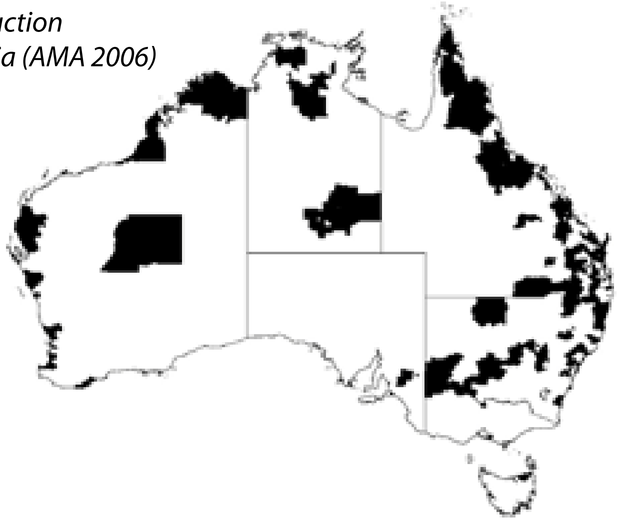


Figure 2 *Melon production regions within Australia (AMA 2006)*

Most fruit is marketed at capital city wholesale markets in Sydney, Melbourne, Brisbane, Adelaide and Perth. An export industry exists predominantly for rockmelons; however, the industry is relatively minor (i.e. approximately 5% of fruit produced). In 2000/01 some 11,500 tonnes were exported to predominantly Singapore (30%), Hong Kong (35%) and New Zealand (19%). Processing of melons also makes up an insignificant section of the industry in Australia with no accurate figures available on this market (AMA 2006).

Pollination in melons

In general, rockmelon and honeydew plants are andromonoecious, meaning individual plants bear both staminate (male flowers) and hermaphrodite (having both male and female reproductive organs) flowers (McGregor 1976). Several studies have shown that isolation of rockmelon and honeydew plants from pollinating insects results in little to no pollination of flowers. Rockmelon and honeydew flowers can be considered self-fertile but not self-fertilising; therefore pollen must be transferred from the anthers to the stigma by insects. Cross-pollination has also been shown to produce slightly heavier fruit (McGregor 1976).

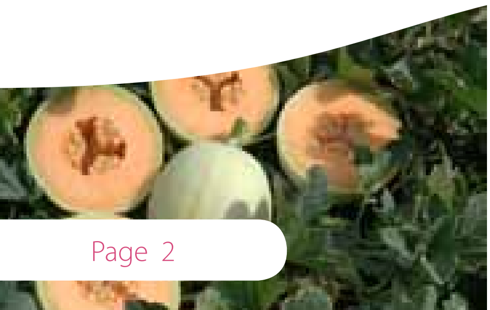
At least one viable pollen grain must be deposited on the stigma and fertilise an ovule if a seed is to be formed, thus if insufficient pollination occurs those melons with small numbers of seeds may be culled from the crop. The effective period in which pollen can be deposited on the stigma is no more than a few hours in the morning, and if the temperature is high, the period may only be a few minutes (McGregor 1976).

The benefits of honey bee pollination to rockmelon and honeydew production has been firmly established (Mann 1953; McGregor 1976). Growers in the Waroona areas of Western Australian have also reported that using honey bees as pollinators increased production of rockmelon by up to 40%, from 600 to 1,000 cartons per acre annually. Lemasson (1987) found that pollination of rockmelon using honey bees improved percentage fruit set and fruit weight significantly (Table 1).

Watermelon is self-fertile with the female flower being pollinated equally well by pollen from a male flower on the same or a different plant. The pollen grains are sticky and insects are

Table 1 Rockmelon grown in greenhouse (after Lemasson 1987, as cited in DAF 2005)

	Honey bees	No honey bees	Significance (P = 0.05)
Fruit set (%)	18.5	2.5	Yes
Fruit weight/plant (g)	2664	1469	Yes
Average fruit weight (g)	621	491	Yes
Average no. of fruits	4.3	2.9	Yes



required to transfer pollen to receptive stigmas. Fruit abortion in flowers bagged to exclude insects is 100% (Stanghellini et al. 1997) and each stigma needs 1,000 pollen grains spread evenly over the three lobes in order to form a large, well-shaped fruit (McGregor 1976). Fruit will be misshapen and devalued if even one stigma lobe receives an insufficient amount of pollen. It has been shown that honey bees are the most abundant pollinators of watermelon with lack of pollination linked to poor yields and thus low incomes for growers (McGregor 1976). More recently Kazafy et al. (2009) showed the value of honey bees as pollinators on summer seed watermelons. Those plants that were freely pollinated by honey bees (open pollinated) produced significantly higher numbers of mature fruits and seed yield as compared with caged plants which failed to produce any fruits at all (Table 2).

Table 2 **Honey bee pollination of summer seed watermelon (Kazafy et al. 2009)**

Treatment	Number of fruits/m2	Mature fruit weight (g)	Seed yield (g/m2)
Open pollinated	30.07	8.56	243.79
No pollination	0.00	0.00	0.00

Pollination management for melons in Australia

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

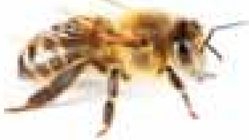
Crop layout

- *Vine and blossom density*: Rockmelon and honeydew plants are most commonly planted in rows spaced 40 to 60cm apart and can have up to 500 staminate and 40 hermaphrodite flowers per vine (QLD.DPI 2009). This ratio of staminate to hermaphrodite flowers may vary, however, and will have an effect on pollination characteristics of specific varieties. For example, a plant spacing of 1.5m by 0.5m between plants gives 13,330 plants per planted hectare. Plant spacing is generally similar for all the varieties, though large-fruited varieties are sometimes planted closer together to reduce fruit size (QLD.DPI 2009).

  Watermelons are planted in rows with enough space so that vehicles can access between them. Row spacing and plant spacing can be 2.5 x 1.2m (row spacing x plant spacing), 3 x 1m, or 4 x 0.75m, all of which give a density of 3,300 plants per hectare (Graham and Gratte 2005).
- *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).

Density of bees

The effect of the number of visits to the flower is of great importance to the production of the mature watermelon. It has been found that each stigma needs over 1,000 pollen grains spread evenly over the three lobes in order to form a large, well-shaped fruit (McGregor 1976). Peto (1951) reported that



3–13 hives of honey bees were used per hectare on cucumbers, cantaloupes, and watermelons grown for seed in relatively small fields. Wadlow (1970) used 0.5 colonies per hectare of watermelons and the colonies were placed in small groups in the field (McGregor 1976). In Australian, the Queensland Department of Primary Industries (2009) gives a rule of thumb recommendation of at least two hives per hectare for efficient pollination.

Recommendations for number of hives per hectare for rockmelon and honeydew seem just as variable as for watermelon. The Department of Agriculture and Food in Western Australia (2005) has sourced information from studies in the USA recommending 7.5 hives per hectare, the USSR (0.3–0.5hives/ha), Queensland (2.5–7.5hives/ha) and New South Wales (3hives/ha).

Arrangement of hives

Hive placement within the orchard is a very important factor to consider. Bees have been observed to visit consecutive plants along a row more frequently than across rows therefore it is recommended that the majority of hives be placed between rows rather than along them (DAF 2005). Hives should also be placed no more than100m away from each other, preferably in a sunny position in order to take advantage of morning blooms (McGregor 1976).

Timing

Bees should be introduced when 10% of the crop is in flower and kept in the crops for about three weeks (QLD.DPI 2009). Pollination can be delayed at least one week from the first female flowering without negatively affecting productivity or harvest time (DAF 2005).

Attractiveness, nutritional value of pollen and nectar

Melons are moderately attractive to honey bees but the pollen is deficient as a protein source. For rockmelon and honeydew, sugar in the nectar ranges from 27 to 36% in hermaphroditic flowers and 53 to 56% in staminate flowers. Nectar production has been shown to be greatest in hermaphrodite flowers during the afternoon (DAF 2005). Honey bee activity is shown to be enhanced by the use of diet supplements for the bees such as sugar syrup and protein cakes. If there is good access to water then these supplements should be fed to hives during the pollination campaign to boost foraging activity (DAF 2005).

Preparation of bees

Strong colonies should go into melon crops given that the crops are a poor source of carbohydrate for bees. Therefore some degree of stimulation may also be required before bees are put in a crop. This may require either artificial stimulation by feeding pollen substitutes or supplements (DAF 2005).

Risks

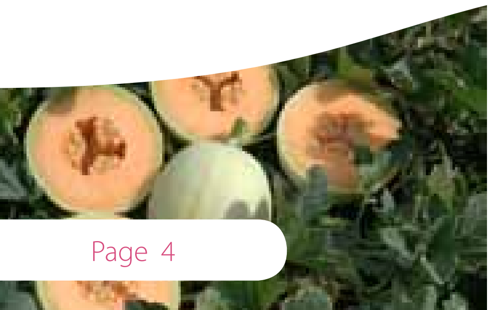
Pesticides: One of the biggest drawbacks of placing bees near any agricultural crop is the possibility of colonies or field bees being affected by pesticides. Pesticides should be kept to a minimum while hives remain on the property. Most poisoning occurs when pesticides are applied to flowering crops, 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 13ºC, with activity increasing up to around 19ºC, 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 melons in Australia

Optimal use of managed pollination services for melons in Australia would require a service capacity as indicated in Table 3 below.

Table 3 Potential pollination service requirement for melons in Australia

State	Peak month	Area (ha) total	Average hive density (h/ha)*	Estimated number of hives required
VIC	December	423	4	1,692
NSW	December	1,739	4	6,956
QLD	July	4,347	4	17,388
WA	May	1,269	4	5,076
NT	May	548	4	2,192
SA	December	142	4	568
TAS	December	3	4	12
Total	-	**8,471**		**33,884**

Notes: Area sourced from ABS 2008 *Agricultural Commodities Small Area Data, Australia 2005-06*, flowering times from AMA (2006) and average hive density from DAF (2005).

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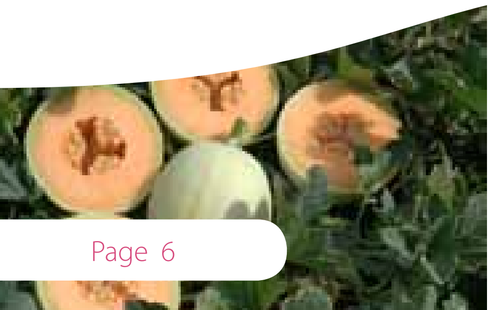
This case study was prepared as part of *Pollination Aware – The Real Value of Pollination in Australia*, by RC Keogh, APW Robinson and IJ Mullins, which consolidates the available information on pollination in Australia at a number of different levels: commodity/industry; regional/state; and national. 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

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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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