

Plums and Prunes

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

Plums are a diverse group of plants of the *Prunus* species (family Rosaceae), which are thought to have originated in western Asia around 479BC. Today there are several species and hundreds of varieties which are cultivated around the world for their fruit, which may be consumed fresh or dried. The three most common species of plums are *P. domestica* (European plum), *P. salicina* (Japanese plum) and *P. simonii* (Asian plum) none of which occur in the wild and presumably were selected and cultivated by humans (IPA 2009). A distinction is made between plums and prunes with a prune essentially being a plum that is dried whole without fermenting. The fruits used for making prunes are also used to make the fresh fruit which are called plums. Plums can be used dried, or made into jelly, jam, juice, liquor and cordials and are also used in baking and for confectionary (IPA 2009).

There are over 200 different varieties of plums grown in Australia; however, Japanese varieties are grown more extensively in

Australia than European plums and usually have larger fruit with predominantly red skin (APIA 2009). European plums tend to be smaller, have a sweet yellow flesh and their skin colour can range from yellowy-green, to deep blue or purple. The d'Agen plum, known as the 'prune plum' is ideal for drying because of its high sugar content, and most prunes in Australia are made from this variety.

The majority of plum and prune cultivars are self-incompatible and as such, cross-pollination with another cultivar is required. This is usually achieved by employing honey bees to transfer pollen from one variety to another (DAF 2005). Honey bees have been recognised as the primary pollinating agent of plums and prunes (McGregor 1976) and several studies have shown the benefit to yield and fruit quality when honey bee hives are introduced into an orchard (Calzoni and Spornanza 1998; Langridge and Goodman 1985; Benedek and Nyeki 1995).

Plum and prune production in Australia

Plums and prunes are grown in the majority of Australian states excluding the Northern Territory and with insignificant amounts in the Australian Capital Territory (Table 1). Victoria and New South Wales are the major producers accounting for 40% and

30% of fruit production respectively, followed by Western Australia with 15.9% and smaller amounts in South Australia, Tasmania and Queensland (ABS 2008) (Figure 1). The heart of the Australian prune industry is in the temperate areas of Young



and Griffith in New South Wales, which offer ideal conditions for plum orchards and nationally there are around 70 farmers who produce up to five tonnes of prunes every year (APIA 2009). Average yields for plum crops are above world averages; however, Australian production of plums has declined by 12% since the 1990s while world production has increased 26–43% (AAG 2002). One positive for the industry has been that exports of plums have experienced rapid growth over the past decade (AAG 2002).

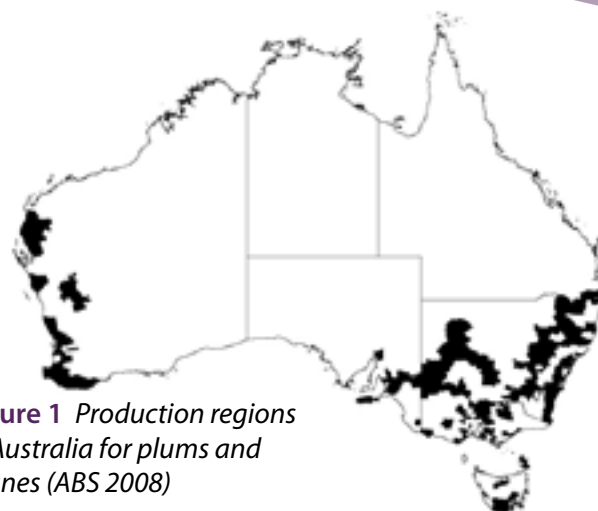


Figure 1 Production regions in Australia for plums and prunes (ABS 2008)

Table 1

Production of prunes and plums in Australia by state (ABS 2008)

	ACT	NSW	QLD	SA	TAS	VIC	WA	Total
Production (tonnes)	0.5	7,635	1,841.8	2,311.5	98.1	10,284.6	4,183.7	26,355.2
Production as a % of national total	~0	30	4.8	8.8	0.5	40	15.9	100

Pollination in plums and prunes

Plums and prunes, like other stone fruits, require that only one viable pollen tube reach the ovary to produce a fruit, but this pollen tube must, in most cases, arrive from another compatible blossom and at the right time (McGregor 1976). The majority of plum cultivars are self-incompatible (both European and Japanese cultivars), that is, no fruit will set if a tree is pollinated by its own pollen. However, a few cultivars may also be completely self-compatible where a full crop is set from the tree's own pollen (i.e. Italian prune) and some are also cross-incompatible (i.e. not receptive to pollen of certain other cultivars) (McGregor 1976). The most appreciated and highly demanded fruit from consumers are those from self-incompatible varieties that need cross-pollination, and this is usually achieved by employing honey bees to transfer pollen from one variety to another (DAF 2005). Bumble bees and other insects have been given some credit in the pollination of plums and prunes but the honey bee has been recognised as the primary pollinating agent since the early 1900s (McGregor 1976).

A review on the pollination benefits that honey bees provide to prune and plum orchards was conducted by the Department of Agriculture and Food in Western Australia (DAF 2005). References to studies showed differences in yield of 150% in Japanese plums between open and bee-excluded plots and with French prunes, trees that were caged to exclude bees only set 1.3% fruit compared with a 3.6–21.8% fruit set with open pollination and 15–19% when trees were caged with honey bees (DAF 2005).

Langridge and Goodman (1985) also looked at the pollination benefits of Japanese plums in the Goulburn Valley area of Victoria. Trees that were accessible to honey bees had a higher percentage pollination rate, greater fruit weight and more fruit than did trees that were enclosed to exclude bees and other large insects (Table 2). Honey bees were shown to comprise 88.8% of all insect visitors to the flowers (Langridge and Goodman 1985).



Table 2

Honey bee pollination of Japanese plums in the Goulburn Valley, Victoria (Langridge and Goodman 1985)

Measurement	Caged trees (no bees)	Open pollinated	% Difference (benefit)	Significance (P<0.01)
Fruit set (%)	1.85	5.9	219	Yes
Weight of fruit (kg)	14.7	38.4	161	Yes
Number of fruit	306	1,020	233	Yes

Pollination management for plums and prunes 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:* Plantings of low density are equal to around 300 trees per hectare (DAF 2005), medium density at 830 trees per hectare and high density at 1,380 trees per hectare (Peppelman et al. 2004). One-year-old branches have between 12 and 117 flowers per m², whilst those of two years or more have 96 to 153 flowers per m² (DAF 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).

Pollinisers

The inter-planting of polliniser cultivars with longer flowering periods ensures more efficient pollination in case of rainy days or other unfavourable conditions that occur during the period of pollination (DAF 2005). Szabo and Nyeki (1996) noted that

because of the effect of temperature and the difference between years of the flowering period (which can be three or four days) there should be at least two pollinisers for self-sterile plum cultivars – one polliniser beginning to flower two days before and the other two days after the self-sterile cultivar (Szabo and Nyeki 1996).

Density of bees

With an expanding brood nest, bees have a greater need for pollen to feed their larvae. Therefore, they show far more enthusiasm for flying (Somerville 1999). Two-storey colonies with at least eight frames of brood placed in a plum orchard have been shown to have a minimum of 52 bees per minute exiting the hive, reaching a maximum of 267 bees per minute (Langridge and Goodman 1985). A stocking rate of between two and four hives per hectare is considered adequate to pollinate plum crops (DAF 2005; Langridge and Goodman 1985; Somerville 1999). These figures may need to be increased in high-density orchards.

Arrangement of hives

Hive placement in an orchard is very important and will dictate the level of bee foraging activity and thus degree of pollination achieved. In insect pollination of Japanese plums, it was found



that foraging activity of honey bees decreased at a linear rate with increasing distance from the apiary (Calzoni and Spornanza 1998). In orchards greater than 20 hectares it may be desirable to place bees in more than one location, i.e. hives in groups of threes and fours and up to 20 per site is considered acceptable (Somerville 1999). Hives should not be placed in long rows, for example along a fence line. This leads to increased drifting and non-uniform colony strength, particularly with a large number of hives. Irregular layout patterns are best with the hives spaced apart and facing different directions. It is important when planning the orchard layout to remember that, where spacing of trees across rows is greater than along, the bees will tend to work along rather than across the rows (Somerville 1999).

Timing

Flowering of plums occurs in Australia between August and October and the duration of the blossom can be 4–15 days, depending upon the year and the cultivar. For most plum cultivars however the period after flowering (anthesis) suitable for pollination is only short – from three to seven days (DAF 2005). Care should be taken when placing bees in orchards and in general the introduction should be made when sufficient blossom is evident (approximately 5%) to encourage bees to start working it right away during the short flowering period. Once foraging has begun, bees will show a marked fidelity to the plum and may stay on the blossom for a considerable time. However, if bees are introduced too early they may search for other sources of nectar and may become fixed on these rather than the intended fruit blossom (Somerville 1999).

Preparation of bees

For a hive to be able to adequately pollinate fruit blossom, the colony strength must be above a minimum. Hives left on orchards for 12-month periods seldom do a good job of pollination, primarily because of lack of management and the resulting small bee population at blossom time. Well-managed bees are usually stimulated well before blossoming starts by moving them onto other floral sources in late August/early September (Somerville 1999).

Because of the early flowering, and the fact that most of the bees visiting flowers soon after opening are pollen gatherers,

stimulation of the hives with sugar syrup is probably required, together with hives being used with plenty of unsealed brood (DAF 2005).

Attractiveness, nutritional value of pollen and nectar

A significant amount of nectar is secreted at the base of the style column and although quite dilute in the morning becomes more concentrated as the day proceeds. The anthers will also only shed pollen slowly at temperatures below 14°C but will open quickly and release a lot more pollen at temperatures above 20°C (McGregor 1976). As a source of pollen and nectar for honey bees, plums are attractive but are only considered of moderate value due to the short flowering period and low sugar content (21% sucrose) of the nectar (DAF 2005).

Although attractive to bees, plum flowers may have competition from other species of flora which will thus reduce the foraging level on the plum blossom. The main cause for bees drifting from the plum blossom is usually the ground flora species such as capeweed, Paterson's curse and white clover which are often in flower at the same time as *Prunus* species. Every effort should be taken to reduce this problem by slashing between rows and other areas of significant blossom before bees are placed in orchards (Somerville 1999).

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



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- 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 plums and prunes in Australia

Optimal use of managed pollination services in all plum and prune orchards in Australia would require a service capacity as indicated in Table 3 below.

Table 3 Potential pollination service requirement for plums and prunes in Australia

State	Peak month	Area (ha) total	Average hive density (h/ha)*	Estimated number of hives required
VIC	August	1,001	4	4,004
NSW	August	1,000	4	4,000
QLD	August	189	4	756
WA	September	828	4	3,312
TAS	August	29	4	116
SA	August	129	4	516
Total		3,176		12,704

Notes: Hectares calculated from total number of trees per state (ABS 2008) multiplied by medium tree density (830trees/ha) taken from Peppelman et al. (2004); flowering and 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.



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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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