

Lychee and longan

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 lychee (*Litchi chinensis* Sonn.) and longan (*Dimocarpus longan* Lour.) are both subtropical trees from the Sapindaceae family and thought to be native to southern China. Both produce delicious fruit on evergreen trees that eventually grow to heights of more than 20m. The lychee fruit is a drupe, 3–4cm long and 3cm in diameter, covered by a pink/red roughly textured rind which covers an inside layer of sweet and sour, translucent white flesh which surrounds the inner seed. The longan fruit is similar to those of the lychee, but smaller, smoother, yellowish in colour and has only a sweet flavour and very little aroma. Both fruits have many culinary uses predominantly associated with dessert-type dishes and both can be sold fresh or canned.

The major world producers of lychee and longan are China, Thailand and Taiwan, however, important crops also exist in India

and Vietnam with further expansion in these regions occurring as a result of increased demand created by increased regional wealth (Menzel and McConchie 1998). Australia is a minor producer; however it has the advantage in the international market because it produces fruit during the northern hemisphere 'off season' including the lucrative Christmas and Chinese New Year festivities (Menzel and McConchie 1998).

Pollen transfer in lychee and longan may be by a combination of autogamous self-pollination, wind or insects, however, for commercial crops pollination by insects (in particular by the honey bee) is considered crucial to obtain a good yield (Badiyala and Garg 1990; DuToit 1994; McGregor 1976; Menzel and Waite 2005).

Lychee and longan production in Australia

Both the lychee and longan were introduced into Australia more than 60 years ago but commercial production did not begin until around the 1970s. With production steadily increasing over the past few years, the lychee industry is now one of Australia's leading expanding industries and is expected to contribute \$1,730 million to the Australian economy between 2002 and 2011 at the current rates of industry growth (Leu and Dixon 2005). There are approximately 450 lychee growers whose farms extend down the east coast of Australia for almost 2,500km from Cooktown

in far north Queensland to Coffs Harbour in New South Wales (Menzel and McConchie 1998). About 50% of plantings are found in northern Queensland, 40% in southern Queensland and the balance in northern New South Wales. Longan is a far smaller industry with approximately 45 growers producing 450 tonnes a year worth roughly \$2 million. Longans are mainly grown on the Atherton tableland in north Queensland, however, smaller plantings also occur as far south as Byron Bay in northern New South Wales.



Photo - Luc Viatour - www.lucnix.be



Although there are over 40 different cultivars of lychee and 20 different longan cultivars grown in Australia, both industries are based predominantly on a few key variants.

Both crops can be quite difficult to grow and yield consistently, with major production problems occurring in lychee due to irregular flowering and poor fruit retention, and in longan, alternate bearing and small fruit size can reduce grower returns (Menzel and McConchie 1998). Significant contributions are, however, made to the economy, for example, in 2004 the lychee industry was reportedly producing approximately 3,000 tonnes per annum at a value of around \$15 million. The bulk of production is sold domestically, however, excess supply (ap-

proximately 35%) is exported overseas to a number of countries including Hong Kong, Singapore, the United Kingdom, France, Belgium, the United Arab Emirates and Canada (Leu and Dixon 2005).

Australia has an advantage in the lychee and longan international markets because, as noted above, it produces fruit during the northern hemisphere 'off season' including during the lucrative Christmas and Chinese New Year festivities. Demand for high quality product far exceeds Australia's ability to supply thus the industry has the potential and incentive to grow to meet this demand.

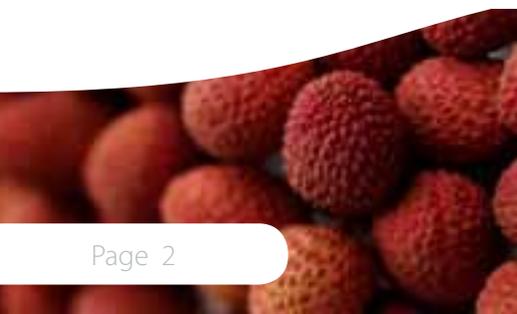
Pollination in lychee and longan

Self-pollination may occur in lychee, however, flowers are generally recognised as self-sterile and require insects to transport pollen from anther to stigma for fruit to set (Badiyala and Garg 1990; DuToit 1994; McGregor 1976). Only partial overlapping between male and female flowering occurs within a cultivar and so inter-planting of at least two different cultivars is necessary for adequate fruit set. Several insects have been reported to visit lychee flowers overseas including Coleoptera, Hemiptera, Homoptera and Lepidoptera; however, the honey bee has been widely recognised as the principal pollinator (McGregor 1976). In Australia, both honey bees and *Trigona* spp. were found on lychee blossoms, but preliminary studies suggest that *Trigona* may be too small to be effective pollinators of the fruit (King et al. 1989).

There have been few studies relating to longan flowering and subsequent pollination, although its botany is similar to that of the lychee (Menzel and McConchie 1998). As with lychee, there is an overlap of flower types on individual trees, since not all inflorescences develop at the same time. Pollination is similarly

carried out by insects from early morning to mid-afternoon, particularly by the honey bee and unlike the lychee, longan crops have been shown to be effectively pollinated by *Trigona* species in Queensland (Blanche et al. 2006).

Many studies have shown significant increases in yield of lychee crops as a result of honey bee pollination. Badiyala and Garg (1990) introduced four honey bee colonies into a lychee orchard in India at the start of flowering and recorded fruit set two to three times higher in inflorescences open to honey bees compared to those that were bagged to exclude them. Similar results were recorded in South Africa by DuToit (1994) with a fruit set three times greater when inflorescences were open to honey bees. In Queensland, Blanche et al. (2006) established that pollen transfer in longan is by a combination of self-pollination and pollination by wind and bees. Both honey bees and stingless bee (*Trigona* spp) visited the flowers, however, only stingless bees, which were in high numbers due to a nearby rainforest, were found to have a positive relationship with fruit set. On the other hand, upward of 30% increases to longan yields have been



reported in Thailand as a result of honey bee pollination (DAF 2005).

Lychee and longan yields are commonly unreliable, erratic and rarely approach the capacity of the tree. Crossed fruit are generally heavier and yields in rows with two cultivars adjacent to each other have been shown to be 36% higher in lychee (McGregor 1976). All of these studies clearly show that lychee

and longan require at least one other cultivar and an abundance of insect pollinators for pollen transfer. Although *Trigona* species have been shown to be good pollinators of longan in Queensland when an orchard is near a rainforest, bringing in honey bee hives could be necessary to increase pollinator numbers, increase

crossing between cultivars and produce a good quality yield.

Pollination management for lychees and longans 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:* Lychee and longan orchards are laid out in rows. Traditionally, orchards were planted at low densities of 100 to 200 trees per hectare and the trees were thinned out when they began to crowd each other. Sometimes other crops were planted between rows to make use of the land during the early life of the orchard. Many countries are now adopting high density plantings with 300 to 1,500 trees per hectare. These orchards have double the returns of other plantings but must be pruned every year after harvest to keep the trees small (FAO 2009). These types of high density orchards have only been trialled in Australia and are not the commonly used design.
- *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

Given both lychee and longan have partial overlapping of male and female flowering, it is considered necessary to plant at least two different cultivars to provide optimal overlap of floral stages and thus ensure the maximum yield (McGregor 1976).

Density of bees

There are a few recommendations regarding specific numbers of honey bee colonies required per hectare of lychee or longan orchard; however, many authors have emphasised that supplying honey bees in orchards is an important and practical step to assuring adequate pollination and fruit set. The Department of Agriculture and Food, Western Australia (DAF 2005) have recommended that 2–3 hives per hectare is adequate for optimal pollination of lychee.

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 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).

Timing

Little information is available for longan flowering in general however the botany for lychee and longan is considered very similar (Menzel and McConchie 1998). Lychee flowers are present from mid-August to September in the southern hemisphere and duration of flowering on any given tree can be 20–45 days (McGregor 1976). The flowers open throughout the day; however, most are open before 6am. Flowers will discharge pollen around day 2 to day 5 and although anthers will release pollen throughout most of the day, they will reach their peak around 10am. Bloom periods may be significantly reduced when temperatures are unusually high (McGregor 1976).

Attractiveness, nutritional value of pollen and nectar

Lychee and longan have nectar that is highly attractive to honey bees and is secreted on all flowers. Nectar production is highest in the morning (around 6am) before honey bee foraging has peaked (mid-morning). Nectar volumes of 6–29 microlitres for lychee have been reported for female flowers and 0.3–6 microlitres for male flowers, with sugar concentration following a similar pattern (McGregor 1976). Honey bee colonies can produce a substantial surplus honey crop from lychee and longan stands; and the honey is described as very high quality and finely granulated (DAF 2005).

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 when lychees and longans 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 of especially if there are more attractive floral resources available to bees in the close vicinity.

Risks

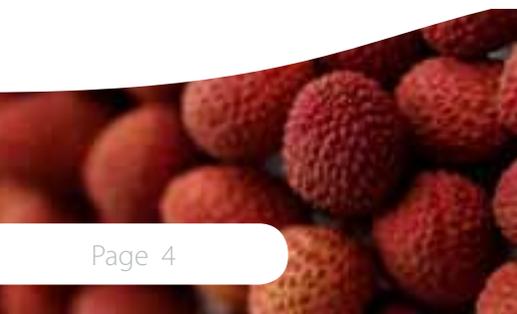
Pesticides: One of the biggest drawbacks of placing bees near any agricultural crop is the possibility of colonies or field bees being affected by pesticides. Pesticides should be kept to a minimum while hives remain on the property. Most poisoning occurs when pesticides are applied to flowering crops,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

Optimal use of managed pollination services in all lychee and longan orchards in Australia would require a service capacity as indicated in Table 1 below.

State	Peak month	Area (ha)	Average hive density (h/ha)*	Estimated number of hives required
QLD	August/ September	1,737	2.5	4,342.5
NSW	August/ September	193	2.5	482.5
Total		1,930		4,825.0

Notes: Area sourced from Menzel and McConchie (2004), flowering times from McGregor (1976) and average hive density from DAF (2005).

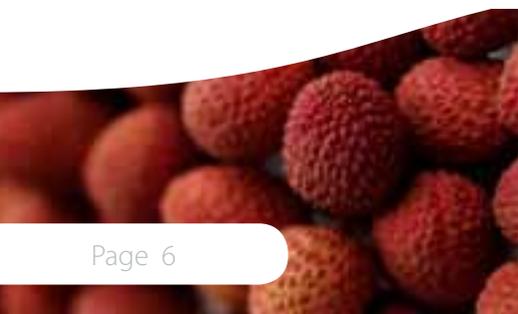


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This case study was prepared as part of *Pollination Aware – The Real Value of Pollination in Australia*, by RC Keogh, APW Robinson and IJ Mullins, which consolidates the available information on pollination in Australia at a number of different levels: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





Australian Government
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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.

RIRDC funds for the program are provided by the Honeybee Research and Development Program, with industry levies matched by funds provided by the Australian Government. Funding from HAL for the program is from the apple and pear, almond, avocado, cherry, vegetable and summerfruit levies and voluntary contributions from the dried prune and melon industries, with matched funds from the Australian Government.

RIRDC Publication No 10/125

ISBN 978-1-74254-095-5