Securing Raspberry Pollination

Michele Buntain, Stephen Quarrell & Jonathan Finch, Tasmanian Institute of Agriculture (TIA),
Raylea Rowbottom, seedPurity

KEY POINTS

- Raspberries are mostly self-fertile but yields of some varieties are improved by cross pollination
- Fungicides can reduce pollen germination in some crops, but this has not been evaluated in raspberries
- Polytunnels can confuse bees, so that they have less energy for foraging. Bees also prefer the edges of tunnels. Improvements to ventilation and air flow could improve foraging in the centre of tunnels and bee health
- Alternative pollinators can include wild or managed pollinators. Alternate pollinators are regionally specific. Useful wild pollinators recorded in raspberry include feral European honey bees, reed bees (Victoria) and stingless bees (NSW). They can be encouraged by planting habitat close to tunnels
- Managed commercially available alternate pollinators with potential in berry crops include stingless bees and flies including the hoverfly *Eristalis tenax* and the Eastern golden blow fly
- Providing areas of permanent natural vegetation near to production areas and minimising the use of agrochemicals during flowering are key ways to encourage and protect pollinators

Securing raspberry pollination has never been more important. The Varroa mite outbreak in July has exposed the vulnerability of horticulture and there is renewed interest in protecting our pollination resources, especially honey bees.

In this article we look at how important bees are for raspberry pollination, how we can help strengthen the resilience of honey bees and what alternatives there are if hives become scarce.

Raspberry pollination – how important are bees and other insects?

In raspberries, self-pollination can take place without the help of insects but is usually limited to the outer stigmas that receive pollen passively from nearby anthers. Without insects, particularly bees, the inner pistils are not fertilised, and fruit are small misshapen and crumbly (Figure 1).

So, our flying friends are incredibly important to raspberry fruit production. In fact, measures of fruit set in the absence of bees show that 71-82% fewer drupelets are produced. (Willmer, Bataw & Hughes 1994; Cane 2005)

Self-pollination or cross pollination – which pollen is best?

Unlike wild raspberries, commercially grown raspberry flowers are self-fertile. Modern raspberry cultivars can 'self-pollinate' using pollen from anthers of the same flower, pollen from a different flower on the same plant, or pollen from flowers of neighbouring plants of the same cultivar. However, raspberry flowers have an inbuilt floral timer that encourages cross pollination. Pollen and stigmas on the one flower develop at separate times with most pollen maturing and released before the stigmas become receptive. For some relatively modern cultivars such as *Glen Ample and Polka*, cross pollination with a different cultivar can significantly increase fruit size and improve productivity.

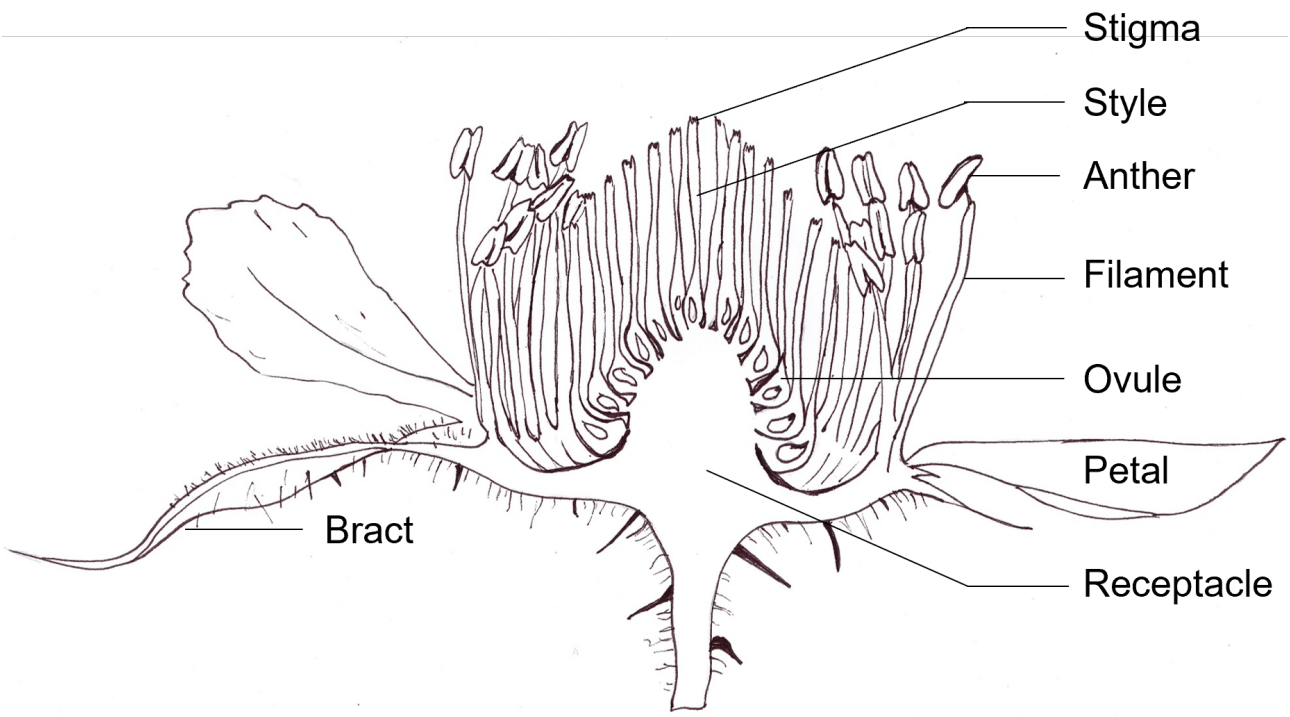

Figure 1. Longitudinal section of 'Willamette' raspberry flower (recreated from McGregor 1976)

Keeping bees healthy

Fungicides, pollination & bee health

PhD candidate, Meng Yong Lim from the Tasmanian Institute of Agriculture (TIA) is helping to keep bees healthy and resilient with his research on how fungicides impact pollination, bee health and behaviour.

In preliminary trials in cherries, Mr Lim found that some fungicides reduce pollen tube germination by half to one quarter. Whilst this research is specific to cherries, it rings alarm bells as to the potential impact of some common raspberry fungicides on pollination and fruit set.

Mr Lim will also be investigating the health of bees exposed to fungicides and how this relates to field relevant fungicide concentrations.

"I will follow up this research to see how certain common fungicides affect bee foraging and their gut health which is closely linked to how they respond to many diseases," he said.

Helping bees stay healthy and work better under covers

It is widely accepted that placing bees under protective crop covers , whether netting, plastic or glass, negatively affects their health and foraging behaviour.

In Tasmania, TIA PhD candidate Ryan Warren has been closely monitoring bees carrying mini-RFID backpacks. These tags are just like the RFID microchips used to track all sorts of activities and objects including fruit picking and retail clothing.

Whilst his main study compared bee behaviour under Voen, Cravo and nets, his findings have relevance to polytunnel grown raspberries and blackberries. Figure 2

Bees took longer 'orientating' - making a mind map of how to get home again - when placed under covers compared to bees in open situations. TIA's Dr Steve Quarrell explained that bees can be confused by both complex overhead protected cropping structures and the light polarising effect of polytunnel plastic.

TIA PhD candidate Ryan Warren, honey bee researcher. Photo credit: TIA

> **When bees are confused by structures such as polytunnels they can expend a lot of energy getting their bearings rather than foraging. This is likely to adversely affect pollination and hive health, he said.**

At Costa's Corindi raspberry farm, researchers found both honey bees and stingless bees (*Tetragonula* spp) prefer to work flowers at the edges rather than the centre of 100m long polytunnels. Difficulty navigating under plastic tunnels, higher temperature and humidity in the centre of tunnels and potentially lower nectar sugar concentration are all thought to be factors (Hall et al 2021).

Improving ventilation or airflow at the centre of tunnels may be a practical option to improve bee visits to flowers and the health of bees working under plastic.

Best food for bees

Raspberries produce generous quantities of nectar, but pollen quantity and quality can be limiting when a bee's diet is just raspberries. Ryan Warren investigated bee foraging behaviour at a polytunnel raspberry crop in the Coal Valley, Tasmania. He found that despite ample nectar in the crop, bees were actively seeking out other forage. At the Coal Valley site bees only carried around 10% raspberry pollen whether actively seeking pollen or nectar. They foraged at some distance from the crop for prickly box, mallow and eucalyptus.

It is still not well understood what makes a quality floral diet for bees. Growing raspberries in monoculture may be like eating one food group for bees and not be nutritionally ideal. However, in the absence of other forage, this may force them to visit crop flowers more often to obtain enough nutrition. Having small areas of carefully selected diverse flowering species within the cropping area is likely to lead to healthier bees, larger forager populations and crop pollination. Access to a diverse flora is also likely to encourage a range of other pollinators and beneficial insects.

Back up for bees

The AgriFutures Rural R&D for Profit program funds research investigating bee health and ways to enhance pollination including mechanical pollination and the use of alternative pollinators.

Mechanical pollination

Mechanical pollination is where pollen transfer is assisted by mechanical means. Mechanical pollination research at TIA in cherries and vegetable seed crops uses people power and sprayers to collect and apply pollen rather than bees. TIA's Associate Professor Alistair Gracie said mechanical pollination's future use is really designed to supplement bee pollination.

"Bee assisted pollination is not always perfect. Moving many of our horticultural crops under nets and plastic covers has put added pressure on our bees, particularly their navigation systems, upsetting both pollination and bee health," he said.

The mechanical pollination system is a more natural fit for cherries and vegetable seed crops which require cross pollination, often when two cultivars are not flowering in synchrony.

However, for raspberries a less intensive method is being explored by Romina Rader's team (University of New England and Costa Group personnel), using a leaf blower to mechanically move raspberry pollen around flowers.

Alternative pollinators

In many crops wild (feral) European honey bees provide an abundance of free pollination services. In the field, it is impossible to distinguish whether a honey bee is wild or if it has come from a managed hive. This makes it difficult to measure their real contribution to pollination.

If the current Varroa incursion cannot be eradicated, it is anticipated that these free pollination services could be decimated within five years (Hafi et al 2012) leaving the horticulture sector solely reliant on both beekeepers and alternative pollinator species.

Alternative pollinators can be thought of as coming from two camps, alternative managed pollinators, and wild pollinators. However, there is some overlap between these groups. The selection of an alternative managed pollinator depends on where you are located.

Managed pollinators

Stingless bees

Growers on Australia's east coast have access to a variety of native stingless bee species that can be purchased or rented as hives from specialist suppliers. Stingless bees are social bees that form dense colonies like honey bees and are highly effective pollinators for some crops. However, these species will not be suited to very hot or cold climates, where they may struggle to forage or even perish.

Flies – the big hairy pollinators

Flies are the second most important group of pollinators after bees. Various species of fly can also be purchased at low cost and released to perform pollination services (e.g. Sheldon's Baits, South Australia).

The eastern golden blow fly (*Calliphora stygia*) is a large fly that can be imported and released in all states apart from WA, where it does not occur naturally. This fly performs well at pollinating strawberries under glasshouse conditions but may need regular releases to maintain populations within crops.

The hoverfly, *Eristalis tenax*, is another fly candidate under development as a managed pollinator to compliment honey bees. This large fly, commonly mistaken for a honey bee given its similar appearance, is widely distributed along the east coast of Australia in cool temperate climates. Eristalis has good potential as a pollinator in covered and open field cropping systems and works well in complement to honey bees.

Tasmanian agricultural research provider, seedPurity Pty Ltd, is working with the vegetable seed industry to develop mass rearing systems for Eristalis. This work is being funded by industry, Tasmanian Government Agricultural Development Fund and Hort Innovation through the Pollination Frontier Fund Project PH16002 "Managing Flies for Pollination". Development of prototype mass rearing and deployment systems is well underway and small-scale commercial pollination of vegetable seed crops using this species has shown promising results.

When considering using alternative managed pollinators it is important to discuss your needs with suppliers and confirm which species are suitable to import and release in your growing area.

Eastern golden blow fly on avocado flowers. Photo credit: Jonathan Finch

Eristalis on blackberry flower. Photo credit: Stephen Quarrell

Wild pollinators

Wild pollinators can include other social bee species like stingless bees that are also commercially reared and managed. In the wild, stingless bees live in colonies in tree holes, most often in eucalypts. They will not travel as far as honey bees to forage, usually only flying around 500m from their nest. Maintaining stands of mature trees near to production areas is vital to encourage these species.

The Rural R&D for Profit team monitored the insects visiting raspberry and blackberry flowers in both Coffs Harbour and the Yarra Valley (Hogendoorn et al).

In the Coffs Harbour region, honey bees were the main visitors to raspberry flowers, accounting for 71% of flower visitation (Figure 2).

Stingless bees, *Tetragonula carbonaria*, were also frequent visitors to raspberry flowers, providing 26% of visits. Stingless bees are not found in Victoria, Tasmania, or South Australia. However, these states have their own unique bee fauna. In fact, Australia is home to around 1600 native bee species.

In Victorian Rubus crops, the most common native bees detected visiting flowers and carrying pollen were reed bees (*Exoneura* spp.) and furrow or white banded bees (*Lasioglossum* spp.). At one raspberry and blackberry farm, the density of reed bees was estimated at 3,000 reed bees per hectare. Reed bee nests were most abundant in small, thin (less than 8mm) raspberry canes and native vegetation.

Providing areas of permanent natural vegetation near to production areas is the best way to encourage native pollinators, including bees, flies, butterflies and moths to visit a crop. Minimising the use of insecticides and fungicides is also likely to benefit pollinator populations. Where spraying is unavoidable, application should always be performed at night when pollinators are less likely to be present in the crop. The use of more selective insecticides and those with shorter environmental persistence is also preferred.

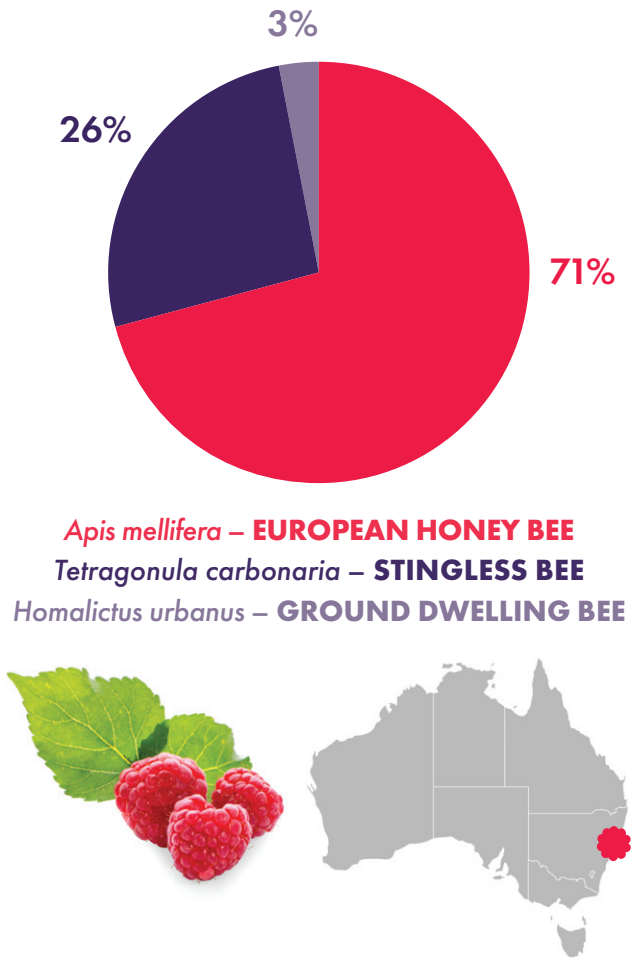

Figure 2. Relative proportions of visits to raspberry flowers by different groups of insects in the Coffs Harbour region of NSW. (Reproduced from Hogendoorn et al 2021)

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