

Maximise your papaya crop with better pollination



What you need to know

PAPAYA AND PAWPAW POLLINATION BASICS

1



The fruit of *Carica papaya* is known as papaya if it has red flesh or pawpaw if it has yellow flesh. Historically, red papaya orchards consisted of plants that were either male or female, but production has shifted to using plants with flowers that contain both male and female parts. Yellow pawpaw orchards are still mostly planted with separate male and female plants.

Papaya with both male and female flower parts

Papaya plants do sometimes set fruit without pollination, but the fruit is generally seedless and small. To consistently produce marketable fruit, some pollen must move from the male to the female parts within the flower.

Most papaya varieties that have both male and female flower parts (hermaphrodites or mixed sex flowers) are self-fertile to some degree.

The female stigmas can be receptive to pollination several days before the flower opens, and they stay receptive until several days after flowering begins, so they are able to self-pollinate before the flower even opens.

It's not known how much the yield from this type of papaya plant benefits from cross-pollination.

Pawpaw with separate male and female plants

In pawpaw orchards where you have separate male and female plants, pollen must be moved between the male and female plants for pollination to occur. While wind pollination does occur, insects are a more important way to pollinate these flowers.

It's usual to have about 10 per cent of the orchard as male plants for pollination, but planting ratios and arrangements vary from one male plant for every eight female plants, to one male for every 25 female plants.

- Papaya and pawpaw pollination depends on the cultivar.
- Orchards with separate male and female trees (generally pawpaw) need male plants inter-planted among female plants to ensure enough pollen is available.
- Papaya and pawpaw pollen can be moved by wind, but generally not enough to ensure pollination.
- For plantings with both male and female plants, hawk moths are probably the most important pollinators.
- Hawk moths depend on particular native host plants for their development. Changes to land use on or around the farm may affect populations of pollinating hawk moths.
- For mixed sex flowers of papaya, the role of honey bees and stingless bees in strengthening pollination is not yet fully understood.
- Weather extremes and plant management can affect the formation of female or mixed sex flowers, or pollen viability.



Papaya (*Carica papaya*) L. fruit and flowers of a female plant (left) and a male plant (right). Image courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org

INSECT POLLINATION

2

Papaya and pawpaw flowers are large and tubular and are open both day and night. Pollen is released from the male anthers at the entrance of mixed sex flowers, and male-only flowers. Nectar is produced at the base of these flowers, but bees are not able to reach it. Female-only flowers lack both pollen and nectar.

Honey bees (*Apis mellifera*) and Australian stingless bees (*Tetragonula* species) visit hermaphrodite (mixed sex) flowers of papaya to collect pollen, and probably contribute to self-pollination.

Bees rarely, if ever, visit papaya and pawpaw plants with female flowers because they receive no pollen or nectar as food rewards. For these plants, hawk moths are important pollinators, including at least five species in Queensland (all from the family Sphingidae).

Hawk moths have large bodies and fly fast, but they rarely land while foraging. Instead, they hover near flowers, probing for nectar with their long tongues.

They also visit the nectarless female flowers which mimic the male flowers.



Hawk moth (*Hippotion celerio*) larvae on taro leaves (*Colocasia esculenta*). Image courtesy of Amy Carmichael, Queensland University of Technology, PaDIL www.padil.gov.au

ENCOURAGING NON-MANAGED POLLINATORS

3

Adult hawk moths are known to lay eggs on native host plants. Their larvae are very host specific and need these plants to complete their development.

Host plants of hawkmoths known to visit papaya include both native and introduced species of grape (*Cissus*) and gardenia (*Atractocarpus*).

In other parts of the world, the numbers of hawk moths on papaya farms are highest when they are close to natural vegetation.

Changes in the orchard may alter the population of pollinating moths. In some cases, caterpillars may develop on weedy plants within the orchard and some adult moths may shelter within the crop.

As a result, these insects may be more vulnerable to pesticide treatments than managed bees that are in a colony or hive at night.

It can be hard to know if you have hawk moth pollination happening in your orchard because of the limited time they are active and their rapid flight.

Peak hawk moth activity often occurs just after sunset, so look for them at this time. They may also decline in number or disappear during winter or after extreme weather.

Studies trying to create hawk moth habitat by planting their host plants in orchards have not always increased crop pollination.



Hawk moths, including at least five species in Queensland, are important pollinators for papaya and pawpaw with female flowers. Dorsal view (left) and ventral view (right) of hawk moth (*Hippotion celerio*) adult. Images courtesy of Amy Carmichael, Queensland University of Technology, PaDIL www.padil.gov.au

VARIABLE FLOWERING AND POLLEN VIABILITY

4

Papaya and pawpaw plants flower and produce fruit year-round in Queensland but the quality of flowering can be affected by a number of things which can make production variable.

A sudden environmental change caused by extreme weather (heat, cold, wet or dry), plant nutrition or plant damage can lead to sterility. Flowers that are not pollinated make no fruit, or misshapen and unmarketable fruit. Irrigation and fertiliser application may overcome this problem.

In hot weather pollen may not be viable, even though female flowers look normal. During these times, it is possible to artificially pollinate flowers with pollen that has been collected and stored in the freezer at -5 to -18°C.



Several species of hawk moths in the family Sphingidae are important pollinators of dioecious pawpaw. Although numerous and important, the short period when they are active makes them difficult to find. Many species are most active just after sunset.



Top tip

Pawpaw (male and female plants) are highly dependent on native moths as pollinators.

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Mixed sex papaya flowers may self-pollinate but benefit from visiting bees.

5 CHECKLIST

DEVELOP A POLLINATION PLAN FOR YOUR CROP

ACTION	YES	NO	COMMENT
An adequate ratio of pollen-providing and fruiting plants is available (ratios are cultivar-specific).			
Crop yields (e.g. number and quality) are recorded over multiple years, providing a benchmark to assess changes in pollination.			
Orchards with multiple varieties are regularly checked, with flowering intensity, weather conditions and yield recorded to understand flowering patterns and to make adjustments if required.			
Presence and number of hawk moths confirmed by looking at flowers with a torch just after sunset.			
Staff are aware that changes to surrounding vegetation may affect populations of hawk moths.			

HIVE MANAGEMENT

ACTION	YES	NO	COMMENT
Managed colonies of honey bees or stingless bees are introduced to papaya orchards with male and female plants to boost pollination.			
Pollination agreements are drawn up with beekeepers, detailing respective responsibilities.			



Joe Zappala

Goodwin (2012) *Pollination of Crops in Australia and New Zealand* 121 p.
 Images courtesy of Brian Cutting of Plant & Food Research Australia, unless otherwise stated.