The Value of Pollination

Pollination is perhaps one of the most important factors in fruit production. Many types of commonly grown fruit, including avocados, require pollination in order to bear satisfactory marketable crops. Some fruit trees may carry thousands of flowers, but unless there is adequate pollination, little if any fruit will be produced. So what does the process of pollination involve? Here are some details.

65% of Australia's agricultural production relies on pollination by honeybees. Photo by Janelle Lendrum.

Pollination means the transfer of pollen from the male part of the flower, the anthers, to the receptive female part, the stigma (Goodman, 1994). It is a delicate process but the aim is to get the right pollen to the right place at the right time. In some plant species pollination is achieved by pollen grains carried in the wind however most fruit species require some insect to carry pollen to the flowers.

Fertilisation occurs when the pollen grains on the stigma germinate and grow down the stem of the stigma (the style). The sperms of the pollen unite with the ovules in the ovary of the flower and subsequently produce seed. Flowers may be fully pollinated but not necessarily fertilised because they have received incompatible pollen in which case the pollen does not germinate or grow on the stigma or reach and fertilise the ovules. In such a case, unless the species is parthenocarpic, no fruit will result.

Not all plants require pollination and fertilisation, as some are able to produce fruit parthenocarpically, that is, the fruit will develop without fertilisation of the flower and production of a seed.

Types of Pollination

There are two types of pollination that may occur: self-pollination and cross-pollination.

Self-pollination refers to the transfer of pollen from the anthers to the stigma of flowers of the same plant. In most cases a carrier is needed to transfer the pollen for maximum pollination. Trees that bear fruit through self-pollination are called 'compatible' or 'self-fruitful' as their own pollen is quite compatible.

Cross-pollination refers to when a flower is fertilised by the pollen from another plant of the same species. Carriers or vectors (e.g. wind, insects, birds) are always needed for cross-pollination. In farming the most important carrier of pollen from anther to stigma is the honeybee.

Some plants cannot produce seed and fruit unless they are pollinated by a different variety of the species and these plants are referred to as being 'self-incompatible', 'self-sterile' or 'self-unfruitful'. This process is thought to have developed to ensure out-crossing to create more diversity in the species and thus a greater propensity over time to evolve and out-compete other species and be better able to adapt to different environments. In horticultural production other varieties that flower at the same time must be planted next to these self-incompatible plants to allow successful pollination.

Pollination in Avocados

Avocado is described as being 'compatible' but the avocado flower opens in two stages. If weather conditions are relatively stable then in 'Type A' cultivars (e.g. Hass) the female stage of the flowers is open in the morning and the male stage is open in the afternoon. In 'Type B' cultivars (e.g. Fuerte, Shepard), the male stage is open in the morning and the female stage is open in the afternoon. This flowering system is called 'dichogamy' and means theoretically that avocado trees have a low chance of pollinating themselves (probably for the same evolutionary reasons described for self-incompatible species above), fortunately weather in spring is often changeable and this throws out the timing of flower opening and allows some overlap of male and female flower stages (see Figure 1, page 23). In environments which are marginal for avocado production (usually where temperatures are often too cool at flowering to allow successful pollination) the chances

of achieving successful pollination and fruitset can be significantly enhanced by interplanting the orchard with a variety of the opposite flower type to ensure good overlap of male and female flower stages (see Figure 2 page 23). Avocados do require insects for pollination.

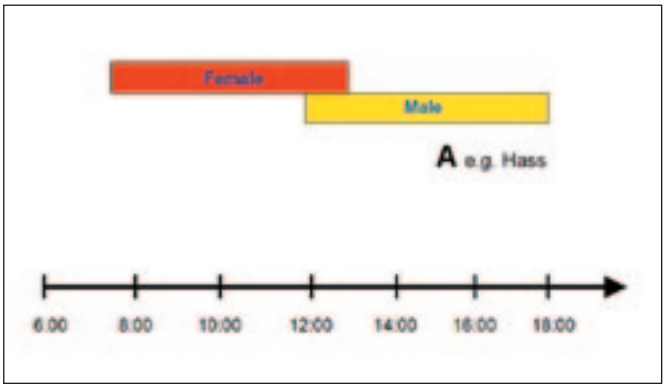

Figure 1. Limited overlap of male and female stages within the same variety

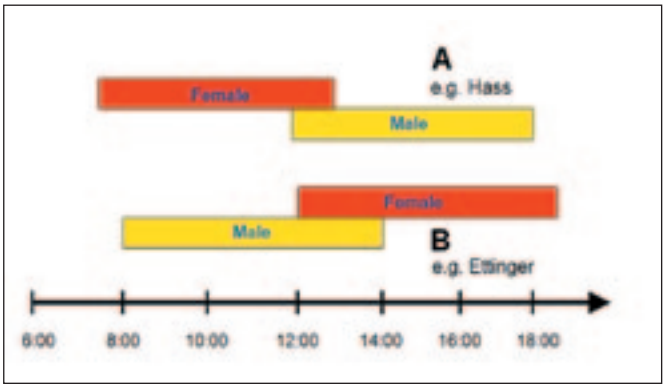

Figure 2. Significant overlap of male and female flower stages when varieties of both flower types are present

Male flower stage open

Female flower stage open

Pictures by Gad Ish-Am, Israel, 1991, sourced via *www.avocadosource.com*

Effects of weather on bee activity

Temperatures

Little if any honeybee flight activity occurs at or below 10°C. On still, clear, sunny days some flight will be seen at temperatures of 12-14°C. Flight begins in earnest at 16°C and the numbers of bees taking foraging trips increases sharply, as the temperature continues to rise. Above 19°C it tends to reach a relatively constant high level. However there is variation between hives and beekeepers are able to introduce new queens into hives in order to produce bees that will start to become active at lower temperatures for example.

Rainfall

Flight activity ceases during rain. In periods of inclement weather bees may fly between showers for short distances of up to 150 metres.

Humidity

Relative humidity, on its own, is not an important factor in bee activity. However, the combination of temperature and humidity is most important in the ripening of the anthers of the flowers and the availability of pollen to visiting insects. Optimum conditions for pollen release are temperatures of 20°C and over and humidities of 70% or less (although not too hot and dry as to cause the flowers to wither as occurred during the dust storms in 2009). Therefore low temperatures and high humidities have the double effect of reducing bee activity and slowing the release of pollen.

Wind

High winds tend to slow the flight speed of bees and hence reduce the number of flights per day. Bees begin to lose interest in foraging when the wind speed reaches 24 km per hour.

Light

Flight activity is reduced during periods of heavy cloud cover. When the cloud cover is seven-tenths or more, bees begin to lose interest in foraging. Cool, dull, showery conditions will limit bee flights up to about 150 metres from the hive.

The Value of Pollination continued

Plant factors affecting pollination

Temperature, humidity and wind affect the quantity and sugar concentration of the nectar which the flowers secrete, and hence their attractiveness to bees. Most flowers of fruit trees, being open in shape, are very susceptible to changes in temperature, humidity and wind. In general, the higher the sugar concentration the more attractive a nectar is to bees. Higher temperatures (not extreme), low humidities and some air movement are conducive to high nectar sugar concentrations.

Sugar concentration plays a greater role in bee attraction than the proportions of the various sugars in the nectar. Weather conditions aside, different plants naturally produce nectar in different quantities and concentrations. For example, apple nectar is more attractive to bees than pear nectar because it has a higher sugar concentration. Different plants compete for bee visits.

Avocado growers seeking more information about bees and pollination can find this online by logging on to Avocado Australia's Best Practice Resource at ***http://bestpractice.avocado.org.au***.

The Pollination Program website also contains useful research reports, and details of past and current projects you can access this at ***www.rirdc.gov.au/pollination***.

Acknowledgements

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For more information about the Best Practice Resource please email *supplychain@avocado.org.au* or call toll free 1300 303 971.