Farm Production & Practice

Ministry of Agriculture and Fisheries

Honey Bees
Pollination of Crops
Economic Significance and Management

Other index entries: bees; pollination; hive renting.

Honey bees are the single most important pollinators of agricultural and horticultural crops in New Zealand. Most fruit and small seeds and many vegetable crops require cross-pollination for the production of economic yields.

Pollination is a prerequisite to the fertilisation of ovules within flowers, which leads to the growth of seeds and fruit. The value of the honey bee as a pollinator is far greater to the New Zealand economy than its value as a honey producer.

Pollination Process

Pollination is the transfer of pollen from the male reproductive part of the flower (anther) to the female reproductive part (stigma) of the same or different flower of the same species.

Within this broad definition several specific types of pollination occur:

- *Auto-pollination* is the transfer of pollen within a flower without the intervention of an external agent.
- *Self-pollination* is the transfer of pollen within the flowers of the same plant by external agents such as wind, insects, or birds.
- *Cross-pollination* is the transfer of pollen between different plants of the same species.

Self-sterile plants require cross-pollination for viable seed production. Self-fertile plants do not require cross-pollination, but some self-fertile crop yields increase with cross-pollination.

Insect Pollinators

A few wind-pollinated crops are grown in New Zealand, e.g. grass seed, maize, corn. Most crops either require or benefit from insect pollination (table 1).

Fig. 1: Pollen-laden honey bees at hive entrance.

A significant number of insect species in New Zealand pollinate, but those of most importance to agriculture and horticulture are bees.

Native bees: These are solitary bees of little significance to commercial agriculture or horticulture. The native bees cannot be managed or relied on to be sufficiently populous for adequate pollination of a target crop.

Native bees show a preference for native plant species.

Bumble bees (Bombus spp.): Four species were introduced in the late 1800s to increase red clover seed production. They are effective pollinators of some crops, e.g. especially red clover, lucerne, and blueberries. However, bumble bees are difficult to manage and are of limited economic significance to most growers.

Lucerne leafcutter bee (Megachile rotundata): This species was established in NZ in 1971, specifically for lucerne pollination.

Fig. 2: An expanding hive 1 month prior to pollination.

The leafcutter bee is easily managed and is readily moved to its main target crop, lucerne, at the appropriate time for maximum benefit.

Alkali bee (Nomia melanderi): Also established in 1971 for lucerne pollination, this species is both difficult and costly to manage.

Honey bee (Apis mellifera): First introduced in 1839, this species is easily managed and is the most important pollinator in New Zealand today.

Honey Bee

There are good reasons why the honey bee is an effective pollinator:

- It is wholly dependent on pollen and nectar as a source of food.
- Its hairy body is specially adapted for pollen collection and transfer.
- It specialises as a pollen or a pollen and nectar gatherer.
- It shows a remarkable constancy in usually foraging on only one plant species during any trip from the hive.
- It has an efficient communication system to recruit more foraging honey bees to a particular plant source.
- Honey bees maintain very populous colonies, unlike other bees, so each colony must visit a vast number of flowers to collect the food it needs to complete its life cycle. An average pollination hive has at least 30 000 worker bees, of which more than 12 000 may be foragers.
- Each honey bee colony may require as much as 25 kg of pollen a year to rear its brood, with bees making over 2 million pollen foraging trips alone to collect this pollen. Producing 1 kg honey may involve more than 175 000 trips from the hive.

Use of Honey Bee Colonies for Pollination

Honey bee colonies used for pollination must be managed as efficiently as possible to ensure that

TABLE 1: SOME COMMERCIAL CROPS REQUIRING INSECT POLLINATION

Crop	*Insect pollination**	*Hives per ha*
almond	xx	2
apple	xx	1–3
apricot	xx	2
asian pear (nashi)	xx	2–4
asparagus†	xx/x	2+
avocado	xx	4–6
bean, broad	x	2+
bean, green	x	2+
blackberry	xx	2
blueberry	xx	8–10
boysenberry	xx	2
brassica	xx	3–5
broccoli†	xx/x	2+
brussels sprout†	xx/x	2+
cabbage†	xx/x	2+
carrot†	xx/x	1+
celery†	xx/x	1+
cherry	xx	2–3
citrus fruit (some cultivars)	x	0.5
clover, red†	xx	2–5
clover, white	xx	1
courgette/zucchini	xx	1
cucumber	xx	1
currants	x	3–5
eggplant	xx	?
feijoa (mostly bird pollinated)	x	1
garlic†	xx/x	5–10
gherkin	xx	4–6
gooseberries	x/xx	?
grape	x	1–2
guava	xx	?
kiwifruit (mature vines)	xx	5–8
leek†	xx/x	1+
loganberries	xx	2
loquat	xx	?
lotus species	xx	2
lucerne	xx	3
macadamia	xx	?
marrow	x	1
melon, rock	xx	2
melon, water	xx	2
nashi (asian pear)	xx	2–4
nectarine	xx	0.5
onion†	xx/x	4–10
parsnip†	xx/x	1+
passionfruit	xx	1
peach	xx	0.5
pear	xx	2–5
pepino	x/xx	?
persimmon	x/xx	2–3
plum	xx	2–5
pumpkin/squash	xx	2+
quince	xx	1
rape	xx/x	1–2
raspberry	xx	2–4
sapote	xx	?
squash/pumpkin	xx	2+
strawberry	x	1
sunflower	xx	2
swede†	xx/x	2+
tamarillo	x	1
tomato	x	?
turnip†	xx/x	2+
zucchini/courgette	xx	1

Note: Wind-pollinated crops, e.g. grass seeds, maize, and corn, do not generally require insect pollination.
* Under *Insect pollination*, x = beneficial; xx = essential.
† Pollination required/beneficial where crop grown for seed production.

maximum populations of bees visit the crop to be pollinated.

A pollination hive should have at least:

- Thirty thousand bees (more than a full-depth honey super full of bees).
- A young vigorous queen with a high egg-laying capacity.
- The equivalent of four or more full-depth frames (7000 sq. cm) completely covered with brood in all stages of development, i.e. egg to pupa. Four full frames is equivalent to seven "good" (i.e. 60% full) full-depth frames.
- One or two full-depth frames of pollen.
- 1–2 empty combs to encourage colony expansion.
- Three full-depth frames full of honey.
- No disease (American foulbrood).

Maximising Pollination—Before Pollination Begins

For good pollination high numbers of pollen-collecting bees must visit the target crop when it is in bloom. The following practices should ensure that large pollen gathering populations will be available.

Stimulate colonies: Colony stimulation to maximise honey bee population should start 6–8 weeks before the pollination period (fig. 3). It may be necessary to provide colonies with supplementary protein (pollen supplement) and/or carbohydrate (sugar or honey) to encourage colony expansion prior to the pollination period.

Colonies must have young queen bees capable of laying large numbers of eggs each day.

Encourage pollen collection: Pollen collection is encouraged by ensuring there is plenty of brood in the colony (at least four full-depth frames with brood, or equivalent). This stimulates a demand for foraging in general and pollen-gathering in particular. Pollen-gathering bees are more efficient pollinators than bees collecting nectar because both their behaviour on the flower and the greater amount of pollen on their bodies make the transfer of pollen to the flowers' stigmas more likely.

Arrange for the returning foragers to come into contact with brood by placing as many brood combs as possible in the bottom box near the hive entrance. This further stimulates pollen collection and also increases the proportion of pollen foragers (provided there are sufficient honey stores, i.e. not less than 5 kg, or 2–3 "solid" full-depth frames).

Feeding colonies with sugar syrup can also increase pollen gathering by reducing the demand for nectar-gatherers. Only large colonies with

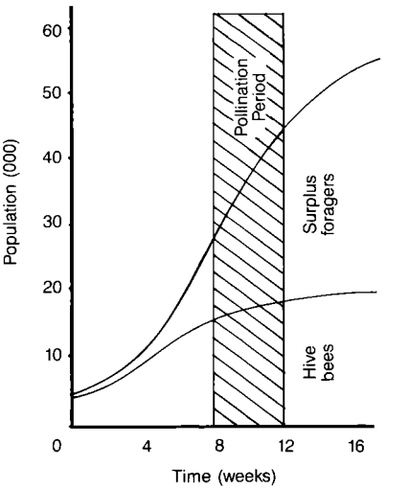

Fig. 3: Honey bees available for pollination.

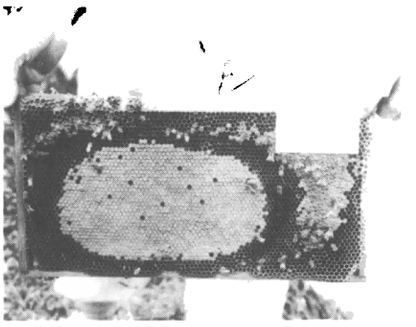

Fig. 4: A full-depth frame, 60% covered with brood (1050 sq. cm).

ample pollen stores or with rich pollen sources available will benefit from this technique. Weak or poorly provisioned colonies can weaken further by having to convert the syrup to honey without adequate nutrition or bee populations.

Maximising Pollination—In the Orchard

Move hives to the target crop: Colonies should be placed as close as possible to crops needing pollination. This shortens the honey bees' flight time and maximises the pollination period available per flight.

When hives are sited even a short distance from the target crop pollination can be greatly diminished.

Poor foraging weather or competition from more attractive crops, e.g. clover in kiwifruit orchards, can reduce the number of target crop visits made by bees.

Time the movement of hives carefully: The proportion of foragers visiting a crop will be greatly enhanced by not shifting the hives to the crop until it has begun to flower. When colonies are shifted earlier most foragers become conditioned to visiting other floral sources in the vicinity and may not readily visit the target crop when it blooms. This is especially true where the target crop is less attractive than the competing floral sources.

As a guide, honey bees should not be introduced until the crop is at least 10% in bloom. For kiwifruit it is

preferable to wait until there is 15–20% female bloom.

Where strong competition exists from more attractive flowers, it may be necessary to introduce some hives at 15% bloom and the balance at 50% bloom.

Reduce floral competition: Competing nectar and pollen sources must be kept to a minimum. Bee visits to the target crop will be encouraged if competing floral sources are removed before the arrival of the pollination hives, e.g. by mowing clover swards under kiwifruit vines.

Site hives carefully: The siting of hives in the target crop can also affect pollination. They should be in sheltered areas where they are warmed by the early morning sunshine and the hive entrances are protected from the wind.

It is beneficial to place hives 1 m off the ground in cold, flat, or low-lying areas with poor air drainage. Fruit packing bins are ideal for this.

Hives should be clustered in large groups in the immediate vicinity of the target crop or distributed throughout the crop in equidistant groups.

Provide landmarks: To help bees orientate to their new location, hives should be randomly arranged, with the entrances facing different directions. In locations without significant landmarks, honey bees can be assisted by using various coloured symbols randomly placed on the hive tops, the ground adjacent, or the shelter belt behind. Hive boxes should be painted different colours.

To be effective all landmarks and water sources must be placed before or during the shift of the pollination hives on to the target crop. Once the hives are sited they *must not* be shifted about the target crop. The resultant deaths of lost foraging honey bees will greatly diminish pollination.

Provide clean water: The provision of fresh water close to the hives provides bees with a nearby water source. Drip irrigation or a hose allowed to drain slowly across concrete or sand are recommended.

This may reduce the number of pollen-gatherers being diverted to distant water sources during hot weather, or creating a nuisance around swimming pools, taps, etc.

Remove hives promptly: All hives should be removed from the pollinated crop at 90–95% petal fall or seed set. Moving hives on to target crops at flowering and movement out at petal fall enables pest control measures to be undertaken without the loss of pollination or honey bees.

Obtaining Pollination Hives

Commercial growers are advised to rent pollination hives from professional beekeepers. Conditions and regulations affecting owners of beehives are contained in AgLink FPP 372. Beekeepers' associations can provide names of suppliers of honey bee colonies.

Fig. 5: Hives carefully sited in a sheltered spot.

Fig. 6: Foraging honey bee, blackcurrants.

There are numerous benefits in dealing with reputable professional beekeepers, many of whom belong to pollination associations, with their own code of ethics and quality assurance schemes.

Hive rental payments should account for the pollination services provided, and in some crops may also compensate the beekeeper for a potential loss of honey crop production. Other costs incurred include transportation, labour, additional hive manipulations and feeding, pesticide damage, depreciation, and a reasonable return on investment.

Generally the pollination fee is minimal when compared to the potential loss of saleable crops resulting from inadequate pollination. Often the cost of pollination is the least of all production costs.

Agreements between a grower and beekeeper should be in writing and should stipulate:

- Names and addresses of the parties concerned and the date of the agreement.
- Number and condition of colonies required.
- Distribution of hives throughout the crop.
- Advance notice required for hive shifting (both in and out of the crop).
- Permissible spray programmes.
- Rental fee and terms of payment.
- Any special management practices required, including rights of access to beehives.
- An arbitrator in the event of dispute.
- Witnesses to the agreement.

Pesticides

Growers can control crop pests and protect beneficial insects at the same time by taking a few elementary precautions:

- Use all pesticides according to label instructions — ***Read them carefully.***
- Some pesticides may be applied to crops in bloom late in the day and after bee activity ceases, e.g. legumes and strawberries and raspberries — ***Read the label directions carefully.***
- Avoid chemical drift on to any other flowers near the target crop.
- Flowering plants in the undergrowth such as the yellow-flowering weeds or clover should be mown before applying any material toxic to bees.
- Check with neighbours or local Fruit Federation office map schemes for presence of beehives before spraying.
- Consult MAF if you are in doubt.

Other AgLinks

HPP 76: Avocados/Orchard Management/Layout, Planting, Pollination, and Nutrition.
HPP 97: Subtropical Fruit/Pollination/An Introduction
HPP 233: Kiwifruit/Pollination/Male to Female Ratios and Bee Activity
HPP 260: Kiwifruit/Hand Pollination/For Fruit Size Improvement
FPP 107: White and Red Clover Seed/Under Irrigation/On Canterbury Soils
FPP 124: Brood Diseases/In Honey Bees/Significance and Control
FPP 372: Beekeeping/Establishment and Management/An Introduction
FPP 730: Pesticides/Pesticides Act 1979/Controlling Sale and Use

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