Avocado Pollination

Best practice guidelines 2006

Introduction

The following guidelines have been developed to provide guidance to avocado growers and those offering avocado pollination services to achieve the best pollination possible during the avocado flowering period.

In these best practice guidelines pollination is defined as:

the transfer of pollen from one flower to the next.

The information in these guidelines has been collected from scientific publications and the practical experience of New Zealand avocado growers and apiarists. The guidelines have been developed co-operatively by the Avocado Growers' Association and the Kiwifruit Pollination Association. The recommendations presented in this manual represent best practice for avocado pollination in New Zealand conditions based on the best information available to the author. It is the author's intention that this document be reviewed periodically as new information becomes available and pollination practices change.

The guidelines outlined below are specifically for the use of managed honey bee colonies for avocado pollination. Later versions of the guidelines may cover the use of bumble bees and other potential insect pollinators. For more detailed information relating to the biology of avocado flowering interested readers are referred to the review published in the second volume of the Avocado Growers' Association Annual Research Report.

Important Note: these guidelines do not describe best practice for fruit set.

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Dr Jonathan Dixon
Scientist
Avocado Industry Council Ltd

The importance of avocado pollination

Pollination is the first step in the process to setting a commercial crop. Poor or inadequate pollination during the flowering period will result in light and erratic crops. Avocado flowering behaviour is designed to require pollen transfer from one flower to another.

To transfer the pollen something must physically take the pollen from a flower in the male sex phase to a flower in the female sex phase. The most common method of transfer worldwide is by honey bees. Even in Mexico, where the avocado tree evolved and native avocado pollinators are present, the avocado flowers are still primarily pollinated by managed honey bee colonies.

Avocado flowering, flower opening and bee activity is strongly influenced by temperature with the warmest days and nights being most favourable to pollination. Therefore ensuring there are large numbers of bees available in the orchard to pollinate flowers when weather conditions are right is a key management activity each year.

Following the introduction of the Varroa bee mite in April 2000 the feral bee population, that used to provide substantial free pollination for many avocado orchards, has been reduced to very low levels. Management costs for the managed bee colonies have increased due to the control measures needed to control Varroa mites and these costs are being passed onto avocado growers.

By following the guidelines in this manual, avocado growers should be able to achieve the best pollination they can for their orchard conditions and beekeepers provide the best pollination service they can to avocado growers.

Avocado pollination best practice

The best measure of pollination success is the number of fruitlets set

A failure to set fruitlets can be regarded as pollination failure, lots of fruitlets even if these later all fall off can be regarded as a pollination success.

Pollination best practice guidelines have been divided into two sections, those for the avocado grower and those for the apiarist.

The avocado trees

Avocado Flowering

Mow the orchard before introducing bees to reduce competing bloom

Tree size

- Avocado trees grow in size every year eventually reaching 10 m in height
- Tree numbers are reduced as the trees increase in size

Use more hives for large trees
Never use less than 4 hives to the hectare
Use 8 equivalent hives (managed & feral) to the hectare for 6 to 10 m trees
Use 10 equivalent hives (managed & feral) to the hectare to trees over 10 m in height

Bee numbers

To determine if bee numbers are adequate use the following procedure:

- Divide the tree into 6 sectors
- For each sector count the number of bees actively working the flowers in 15 seconds
- Add the numbers for all sectors together
- If there are less than 20 bees active on the tree more bees are required
- If there are 20-30 bees working on a tree bee numbers are adequate
- If there are more than 40 bees working on a tree bee numbers are ideal
- On cold days <17°C, wet days, windy days and very cloudy days there will be little bee activity and no pollination

Assess the number of bees actively working the avocado flowers to check the number of bees in the orchard is adequate for pollination

Floral morphology

- Avocado trees produce very large numbers of small flowers
- Flowering is on the previous seasons growth
- An alternate bearing cycle will affect the number of flowers on a tree
- In an ‘off’ year flowering will be less than an ‘on’ year

- Each flower opens twice, once as female, once as male within 48 hours
- Flowers do not set fruit without pollination
- Each flower sheds between 4000 to 7000 pollen grains
- Many flowers have abnormalities and dysfunctional pollen
- Only about 20% of flowers, in some cultivars, can develop a strong seed

Change your requirement for hive numbers according to the alternate bearing cycle of your orchard

Flower opening

- Flowering lasts 5 to 8 weeks
- Flowering can start in September in early orchards and last to December in late orchards
- Peak flowering typically occurs in October and November
- The early flowering runs the greatest risk of frost damage and cold weather

Flowering too early can occur when the previous crop is very light review your orchard management to try and to avoid early flowering

- Flower opening is dependant on temperature
- A significant percentage of flowers will open in continuous warm weather

Make sure you have bees present at all times during flowering for pollination

Timing of flower opening in the different sex phases

- It is common to have male and female phase flowers open at the same time
- In cool temperatures (<15°C day time) flowers may not open in the female sex phase
- Flowers are only open for a short time (about 12 hours) in each sex phase

Bees need to be present every day there are flowers open

Nectar flow and flower perfume

- Each flower only produces a small amount of nectar that is rich in sucrose
- Different amounts of nectar are produced at the different sex phases
- Heavily flowering well resourced trees can have a strong smell
- Avocado nectar is not well liked by bees when there is competing bloom

Manage trees to have high carbohydrate (starch) reserves
Ensure trees are well watered to encourage good nectar flow

Opportunity for cross pollination

- There is only a limited time for cross pollination

- This time period depends on the temperature
- Below 15ºC there is no opportunity for cross pollination
- Pollinizer trees need to be close to the main crop trees

Use pollinizer trees that flower at the same time as your main crop
Plant pollinizer trees close to the cropping trees (at a ratio of 1:9)
Manage bee flight paths so they visit both pollinizer and cropping trees
Have bees present at all times

Avocado pollen

- When shed is wet and sticky but soon dries
- Bees do not prefer avocado pollen as a food source
- In some cultivars a lot of pollen can be defective

Provide alternative sources of pollen to ensure bee numbers increase

Pollen quality

- Boron is the most important element for pollen health
- Other elements such as Zinc and Nitrogen are also important
- Pollen remains viable for up to 72 hours after shedding

Maintain leaf Boron levels above 28 ppm, Zinc leaf levels above 50 ppm
Apply a foliar Boron spray at flowering only if the leaf Boron level is below 22 ppm in April
Maintain bee numbers for up to 3 days after flower opening

Pollen germination and the beginnings of fertilisation

- Pollen grains germinate in as little as 10 minutes when deposited onto the stigma at temperature above 17ºC
- Growth of the pollen tube is rapid and can reach the endosperm within 4 to 6 hours when temperatures are above 17ºC
- The more pollen grains deposited on the stigma the better
- Competition between pollen tubes gives the strongest seed

Keep bee numbers high, aim for 40 bees actively working a 5-6 m tall tree at all times

Sprays

- Spraying in avocado orchards is the single biggest cause of problems between beekeepers and avocado growers
- Build a good relationship with the beekeeper
- Notify your spray contractor, if one is used, there will be hives in the orchard
- Read and understand the contract with the apiarist that specifies what the penalty will be if an unapproved spray is applied
- Notify the beekeeper of any intention to apply sprays at any time hives are in the orchard
- Bees will not pollinate sprayed flowers

Do not apply any sprays within 10 days before introducing bees to the orchard

Do not apply any sprays without consultation with the beekeeper

Avocado grower responsibilities

- To discuss with the beekeeper the requirement for bee hives before the avocado flowering season
- Allow the beekeeper access to the orchard at any time to service their bee hives
- Provide a suitable place for hives that also allows good vehicle access
- Provide 48 hours notice of when then bees are required
- To be available when hives arrive to help with placement and location
- To identify hazards
- Not to move or touch the hives
- Before spraying ensure there are no bees in the general area (approx. 3km radius of the orchard) especially on neighbouring orchards
- To comply with the 1996 Hazardous Substances and New Organisms Act and Hazardous Substances Regulations 2001

Do not spray open flower, even flower on the orchard floor

- Clean spray equipment of insecticide residues
- To notify the beekeeper if there is any thing wrong with the hives
- To carry public liability insurance

Beehive management

Before hiring hives to avocado growers it is recommended that the apiarist scouts the orchard and looks for potential problems
Discuss any issues with the avocado grower before hives are delivered

Hive hire

- A signed contract with the avocado grower is essential and should specify at least the following:
    - Names and addresses
    - Date of agreement
    - Orchard location
    - Number of beehives
    - Strength of beehives
    - Location of hives in the orchard
    - Notice to be given before shifting the bees
    - Fees and terms of payment
    - Management practice
    - Disputes resolution
    - Independent auditor
    - Consequences of a failed audit
    - Remedial action
    - Witness

Insist on a contract that lays out the terms and conditions of hive rental and that protects both the avocado grower and apiarist
Establish who will audit the hives and/or act as an arbitrator

Numbers of hives

- For avocados the recommended hive numbers are 4-10 per hectare, the more hives the better
- 10 hives per hectare are considered ideal
- Hive numbers depend on the amount of competing bloom and presence of surrounding orchards

Determine hive numbers early to help with your planning

Hive strength

- Hives should be defined in the same way as for kiwifruit
- Strength should be defined by the following standard
    - Amount of brood
    - Age of brood
    - Position of brood
    - Bee numbers
    - Empty comb
    - Honey reserves

By 10% open flower use the following minimum standard:
(7th October in Katikati)

- Three standard frames of brood in all stages at 60% full
- Eight standard frames well covered with bees
- At least 1 full depth frame of honey
- A good laying queen
- Room for colony expansion
- Free of disease, American Foul Brood
- Have a Varroa mite management programme

One month later use the following as a minimum standard:
(1st November in Katikati)

- Four full standard frames of brood in all stages (7 frames at 60% full)
- Twelve standard frames well covered with bees (approx. 30,000 bees)
- At least 3 full depth frames of honey
- A good laying queen
- Room for colony expansion
- Free of disease, American Foul Brood
- Have a Varroa mite management programme

If there are problems with the hives get them audited

Location of hives

- This is a contentious issue for beekeepers who prefer all hives to be one central location
- Growers will prefer hives spread out
- Research has shown bees don't like to move between rows of avocado trees when they are large and dense
- Take into account tree size when placing hives
- Try and place hives near pollinizer trees
- Avoid grouping too many hives together

- Ensure there is good access to the hives
- Place hives in a sheltered, warm, sunny position
- Use windbreaks and face north
- Take note of the orchard geography when placing hives, i.e. avoid the bottom of gullies etc.

Always place hives in locations that are ideal for bees
Establish hives within about 400 m of cropping trees
For orchards up to 2 hectares hives can be placed in one location
For orchards from 2 to 4 hectares split the hives between 2 locations
For orchards greater than 4 hectares add 1 location for every 4 hectares more than the first 4 hectares

Orchard environment

- Some orchards will be adding fertilizer to their irrigation water making the water unsuitable for bees to drink
- Wind speeds greater than 15 km/hr reduces bee activity

If required, provide a water source for the bees

Survey the orchard and area to identify the location of competing bloom
This will tell you where your bees are going and if there is a risk of the bees being sprayed

When to bring in bees

Bring in the bees when the avocado trees have reached 10% flowering

- This is when the flower heads have fully expanded and open flower can be seen
- Check with the grower how much flowering they have the week before the hives are due to be placed into the orchard

Don't bring in bees too early as they will find alternative flowers

Moving hives

- Do not move colonies short distances
- Check with the avocado grower that the hives will not be in the way of machinery
- Some avocado growers will be harvesting over flowering
- The hives are not exposed to being wetted by the irrigation system

Keep the avocado grower informed of changes

Introducing new hives after 4 weeks

- Some avocado growers have reported a benefit in replacing hives after four weeks with bees not used to avocado flowers
- This is thought to reduce the effects of competing bloom

Removing hives

- Take care not to remove bees too early

Remove bees at night to avoid having large numbers of bees left behind
Best time to remove is wet days or mornings

Sugaring hives

- Avocado flowers require nectar gathering bees for pollination as the bees need to be encouraged to visit as many flowers as possible when foraging

Frequent sugar feeding every day or every second day is not recommended

- Feed with sugar only as needed to maintain colony health
- Good results have been reported with sugar feeding once every 21 days
- It is possible to maintain hive health and support a strong colony build up without sugar feeding in some avocado orchards

Sprays

- Spraying in avocado orchards is the single biggest cause of problems between beekeepers and avocado growers
- Build a good relationship with the orchardist
- Before contracting to supply growers determine who will be spraying the orchard
- Add a clause to the contract that specifies what spraying can be done, what notification the beekeeper expects and what the penalty will be if an unapproved spray is applied
- Notify the contractor or orchardist that bees are going into the orchard as per their instructions

Take action if sprays are being used inappropriately

Beekeeper responsibilities

- Supply hives that meet the minimum standard
- Deliver hives in a timely manner when requested
- Place hives in a location decided by mutual agreement
- Establish the hives for a nectar gathering foraging behaviour
- Demonstrate to the avocado grower that any hive meets the standard
- Allow an auditor to audit the hives if requested by the avocado grower
- To replace defective hives within 24 hours
- To remove hives when requested by the avocado grower within three days
- To not leave large numbers of field bees when moving the hives
- To remove swarms if they arise
- To carry public liability insurance

Contact details for Kiwifruit Pollination Association members

Kiwifruit Pollination Association
Sheree Silson
Secretary
Kiwifruit Pollination Association
Phone: 07 549 1532
E-mail: kcaltd@xtra.co.nz

Alpha Bees
Dave West and Phil Proverbs
C/- NZ Post Centre
Ohaupo
Phone/Fax: 07 823 6563
Mobile: 0274 768 524
E-mail: dave-west@xtra.co.nz

Peter Burt
725 Back Ormond Road
RD 1
Gisborne
Phone: 06 868 4771

PR & BA Carroll
Ross Carroll
78 Laurel Drive
RD 6
Tauranga
Phone/Fax: 07 552 4585
Mobile: 025 978 930
E-mail: rcarroll@clear.net.nz

Boondock Honey
Lee Crawshaw
18 Williams Drive
Te Puke
Phone/Fax: 07 573 5288
Mobile: 027 270 7239
E-mail: lee.the.bee@xtra.co.nz

Bay Bees
Dennis Crowley
PO Box 9170
Tauranga
Phone/Fax: 07 541 3323
Mobile: 027 286 3124
E-mail: Crowleys@win.co.nz

De Graaf Apiaries

Bennie De Graaf	or Gino De Graaf
Lund Road	PO Box 3118
RD 2	Tauranga
Katikati	
Phone: 07 549 0030	07 543 2713
Fax: 07 549 4031	07 543 0218
Mobile:	
E-mail:	gino.lyn@twelveacrewood.co.nz

Tawari Apiaries
Barry Foster
695 Aberdeen Road
Gisborne
Phone/Fax: 06 867 4508
Mobile: 0274 497 131
E-mail: bjfoster@xtra.co.nz

Hillcrest Apiaries
Tony Lorimer
258 Tauwhare Road
RD 3
Hamilton
Phone: 07 856 9625
Fax: 06 867 4508
Mobile: 025 969 889
E-mail: hunnybee@wave.co.nz

Pongangina Valley Honey
Robin McCammon
Utuwai
RD 14
Ashhurst
Phone: 06 3294 824
Fax:
Mobile: 025 606 0186
E-mail: robin.mc@clear.net.nz

Dave Sawden
5 Lumsden Street
Tauranga
Phone: 07 541 0601

Dick & Berta Schoneveld
93 Walker Road
RD 1
Opotiki 3092
Phone/Fax: 07 315 4640
Mobile: 025 270 3742
E-mail: d.b.schoneveld@xtra.co.nz

Kiwicoast Apiaries Ltd
Mark & Sheree Silson
69 Lund Road
RD 2
Katikati
Phone: 07 549 1532
Fax: 07 549 1562
Mobile: 025 955 082
E-mail: kcaltd@xtra.co.nz

A.G. Silson Apiaries Ltd
Glenn Silson & Wendy Sutton
113 Lund Road
RD 2
Katikati
Phone: 07 549 1777
Fax: 07 549 1780
Mobile: 025 279 4380
E-mail: amberglenn@xtra.co.nz

Golden Grove Apiaries Ltd
Bruce & Jason Stanley
196 Fosters Road
RD 1
Whakatane
Phone/Fax: 07 312 9028
Mobile: 025 209 4944
E-mail: honeybee@clear.net.nz

Lakeview Honey 2002 Ltd
Andrew Stratford
12 Rimu Street
Taupo
Phone: 07 377 2203
Fax: 07 377 2204
Mobile: 027 243 5654
E-mail: Andrew@lakeviewhoney.com

Kernow Apiary
Peter & Alison Townsend
827 Old Coach Road
RD 6
Te Puke
Phone: 07 533 3658
Fax: 07 533 3110
Mobile:
E-mail: p.a.townsend@enternet.co.nz

Apiflora NZ
Steve Weenink
RD 1
Tauranga
Phone: 07 543 0984
Fax: 07 543 0989
Mobile: 025 923 937
E-mail: apiflora.nz.ltd@xtra.co.nz

Independent Auditor:
Neale Cameron
5 Bonnieglen Road
Omanama
RD 1
Tauranga
Phone: 07 543 3421
Fax: 07 543 3425
Mobile: 0274 991 300
E-mail: neale@maxnet.co.nz