Varroa mite integrated pest management

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Disclaimer – Varroa chemical control products

- *Varroa chemical control products mentioned in this Primefact are not formally endorsed until they are registered for legal import, supply and use in Australia.*
- *The following Varroa control products and registered trade names (Table 1) in this guide are not endorsed by the Varroa Mite Management Program specifically, rather are included for educational purposes.*
- *All chemical control products for Varroa management can have negative effects on honey bee health. Additionally some chemical control products can have significant, negative human health impacts if they're not used according to the product label.*
- *To ensure beekeeper and bee hive safety, always use chemical control treatments according to the product label.*

Chemical control treatments for Varroa mite in Australia

Active ingredient	Registered trade name
Amitraz	Apivar
Amitraz	Apitraz
Fluvalinate	Apistan
Flumethrin	Bayvarol
Formic acid	Formic Pro
Thymol essential oil	Apiguard

Table 1. Varroa control treatment active ingredients and registered trade names currently permitted or registered for use in Australia

Introduction

Varroa destructor (Varroa) mite is a parasite that feeds on honey bees and reproduces in honey bee brood cells. Varroa (*V. destructor*) was first detected on mainland Australia in NSW in June 2022, triggering the Varroa Mite Emergency Response. Where Varroa is established, its numbers must be regularly monitored and reduced to prevent colony death.

Failure to manage Varroa numbers below a damaging threshold will make the colony more susceptible to pesticides, viruses, and other stressors and reduce production. Without timely and appropriate Varroa control, infested colonies will steadily weaken and eventually die.

Where Varroa is newly established, large numbers of feral colonies and neglected registered and unregistered colonies are a major source of mite invasion into actively managed colonies. This invasion results in rapid increases in mite numbers in managed colonies, making monitoring mite levels across all apiaries a minimum of four times a year critical.

As Varroa is currently in the early stages of establishing, we don't have good information about the population development of Varroa in Australian honey bees and conditions. With time we will understand Varroa population development in Australian honey bee colonies given our unique climates, length of brood rearing and honey production season.

Until then, we are guided by New Zealand and North American resources on Varroa monitoring, decision-making and control, as they are most applicable to the conditions and management styles of beekeeping in Australia.

Varroa populations can be reduced through knowing your Varroa levels and applying preventative, cultural, mechanical and chemical control tools as much as necessary. These monitoring, decision-making, and control methods are all part of the beekeeper integrated pest management (IPM) toolkit, which will be described in this factsheet.

Integrated Pest Management (IPM) and Varroa control

Integrated pest management (IPM) uses a variety of techniques to keep Varroa numbers below a level where they cause economic damage to the colony and beekeeper. IPM involves:

1. **Understanding** the Varroa life cycle
2. **Rigorously monitoring Varroa levels** (minimum 4 times a year and before and after treatment. During peak production, monthly monitoring is best practice) and evaluating

results

3. **Applying integrated pest management controls** appropriate to your beekeeping operation, environment and colonies' developmental phase if Varroa levels are too high
4. **Repeat monitoring and management** as much as necessary, rotating different types of chemical controls to prevent Varroa from developing chemical resistance

1.Understanding the Varroa life cycle

Varroa's life cycle and development follows the seasonal development and breeding of its honey bee host. Honey bees and varroa typically cycle through four phases over time. The length of each phase can vary widely between climate types.

For example, timing and type of control measures required in cold temperate versus tropical beekeeping conditions may be different. In some locations, there is one cycle of the four phases per season while, in other locations, more than one cycle may occur or a cycle may be skipped altogether.

Four life cycle phases of honey bees and Varroa (Figure 1):

- **Dormant (**occurs only if there is a broodless period**)**
- **Population Increase**
- **Population Peak**
- **Population Decrease**

Varroa mite populations increase and decrease with the seasonal changes in colony population. Mite populations reach their highest levels soon after the brood and adult honey bee populations reach their peak. When the bee population and the amount of bee brood decline, mite numbers drastically increase on adult bees. Where Varroa has been established in a state or country for several years, seasonally Varroa numbers may eventually decrease, along with the adult bee population. The size of the mite population at the start of the bee 'Population Decrease' phase is critical because the colony needs to be healthy enough to rear enough bees to survive the 'Dormant' phase. During broodless periods, all mites are carried on adult bees. However many locations in Australia will not have the 'Dormant' phase. When the 'Dormant' phase is skipped or absent and there is reduced, continual brood rearing, mite reproduction may be continuous. This is likely the case in most mainland Australian conditions.

Understanding the seasonal changes your colonies go through, particularly around brood development and broodless periods, will inform the best management control tools for your situation.

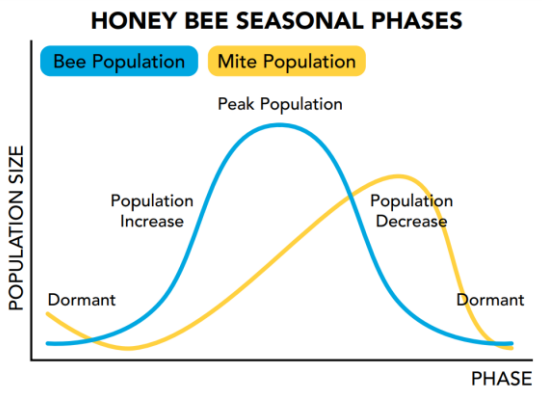

Figure 1. Seasonal phase of honey bee and Varroa population. Credit: Honey Bee Health Coalition 2022.

2.Rigorously monitoring Varroa levels and evaluating results

Routinely monitoring Varroa levels in a portion of your colonies in each apiary is critical to making good Varroa control decisions. Where Varroa is not yet established, monitoring at least 4 times per year can be done by alcohol wash, soapy water wash, or sugar shake of 300 bees per colony using methods shown here. Where Varroa is established, monitoring is recommended once a month, except during chemical treatment and winter in very cold climates.

How many hives should I monitor?

Beekeepers with only a few hives are best to monitor all their hives regularly. Beekeepers with many hives should regularly monitor a proportion of all their hives. Where beekeepers have greater than 10 hives per apiary and are only monitoring a portion of their hives, it is recommended to sample colonies both from the centre and outer edges of the apiary.

- **Small apiary**
    - Fewer than 10 colonies at an apiary = all colonies should be monitored for Varroa
- **Medium to large apiary, multiple apiaries**
    - Greater than 10 colonies per apiary = Sample 10 or more colonies in each apiary. If possible, include colonies from the centre as well as the outer edges of the apiary.

Varroa infestations will vary between colonies, even in the same apiary, so the more colonies that can be monitored, the greater accuracy you'll have evaluating your mite levels. In the early years of Varroa establishment, where populations have not stabilised and re-infestation is common, sampling more than 10 colonies per apiary and rotating which colonies are monitored is highly recommended.

Evaluating mite numbers

The number of Varroa you find will depend on your location, how long Varroa has been established in the surrounding environment, the time of year, your previous Varroa IPM, and other situation specific considerations. When your colony needs chemical treatment depends

on the brood rearing phase your colony is in and the number of Varroa you find in the results of your monitoring (i.e. alcohol wash, soapy water wash, sugar shake).

> ***EXAMPLE:*** During summer, a beekeeper alcohol washes 300 worker bees (1/2 cup or 125ml volume) from a brood frame of one hive and finds a total of 10 Varroa mites.
>
> To calculate the Varroa %: divide the # Varroa by # bees sampled and multiply by 100.
>
> 10 Varroa ÷ 300 bees = .03 X 100 = 3% (3 mites per 100 bees):
>
> $$\frac{\#\ Varroa}{\#\ Bees}\ x\ 100 = \frac{10}{300}\ x\ 100 = 3\%$$
>
> Because it's summer and the beekeeper's colony is in a 'Peak Population' phase, a 3% Varroa infestation means Varroa control is recommended.

The following Varroa treatment thresholds (Table 2) were developed by the Honey Bee Health Coalition, a group of North American beekeepers, bee researchers, government agencies and other honey bee experts. Over time, Australian bee experts will develop specific Varroa treatment thresholds for Australia's unique conditions, which may change the current recommendations.

Colony Phase	Varroa % ACTION: Wait – immediate control not needed	Varroa % ACTION: Control recommended
Dormant	Under 1% (less than 3 mites found)	Over 1% (3-5 mites found)
Population Increase	Under 2% (less than 6 mites found)	Over 2-3% (6-9 mites found)
Peak Population	Under 2% (less than 6 mites found)	Over 3% (9+ mites found)
Population Decrease	Under 2% (less than 6 mites found)	Over 2-3% (6-9+ mites found)

Table 1. Treatment Thresholds by Colony Phase: Varroa % = # Varroa/100 adult bees (adapted from Honey Bee Health Coalition 2022 by E. Frost). In brackets (# mites found) is the total mites found in an alcohol wash, soapy water wash, or sugar shake of 300 worker bees.

Quick mite infestation evaluation in the apiary

To simply evaluate Varroa infestation levels in the field, the beekeeper can count the number of mites detected per 300 worker bee sample and reference Table 2 control guidelines.

3.Applying integrated pest management (IPM) controls

IPM involves many different control methods for a beekeeper to use throughout the season. IPM encourages the use of non-chemical controls first, known as cultural and mechanical controls, in order to minimise chemical use and residue risk, and the risk of Varroa developing chemical resistance. When a Varroa threshold is met, chemical control is required to ensure colony survival. The type of control tools (Table 3) you use will be specific to your beekeeping scale and style, apiary environments and colonies' developmental phase (Table 4). IPM tools include the following controls.

Level	Type	Treatment (trade name) or trait	Effectiveness		
			High	Moderate	Low
Cultural Controls	Breeding for Varroa-resistance traits	Low mite population growth	X		
		Grooming/mite-biting behaviour		X	
		Mite non reproduction (which includes Varroa sensitive hygiene)		X	
		Hygienic behaviour			X
	Brood Interruption	Queen caging or splitting hives and re-queening with cells		X	
Mechanical Controls	Hive Equipment	Screened bottom boards			X
	Drone Removal	Drone brood trapping	X		
Chemical Controls	Non-synthetic	Formic acid (Formic Pro)	X		
		Thymol essential oil (Apiguard)		X	
	Synthetic	Amitraz* (Apivar, Apitraz)	X		
		Fluvalinate* (Apistan)	X		
		Flumethrin* (Bayvarol)	X		

Table 3. Effectiveness of common Varroa controls (adapted from Jack and Ellis 2021 by Nadine Chapman, Emily Noordyke, E. Frost).
*Effective where Varroa populations have not developed resistance.

The IPM cultural, mechanical and chemical controls described above (Table 3) will vary in effectiveness in Australia depending on local climates and seasonal specifics. Seasonal control recommendations for Australian conditions are outlined below (Table 4).

DORMANT PHASE (Broodless period, harsh winter or summer conditions)	
Broodless in cold temperate locations, reduced brood in mild temperate locations, or drought/monsoon-related brood break. Most Varroa on adult workers, no/little brood present.	
Highly effective controls: • Creating a broodless period	• Varroa mortality is high over long broodless periods.
Moderately effective options: If no 'Dormant' broodless phase and product temperature requirements can be met: • Apiguard • Apitraz, Apivar • Apistan* • Bayvarol • Formic Pro * Resistance to Apistan well documented in North America. Monitor efficacy in Australia.	• Apiguard, Apistan, Apitraz, Apivar, Bayvarol, Formic Pro effective only if ambient temperature sufficient to release product active ingredient dose to kill Varroa. Follow product label temperature restrictions. • Apiguard, Apistan, Apitraz, Apivar should not be used during honey production. Follow product label guidelines.
Least effective options: • Any management practice risking hive/queen survival in this phase (e.g. queen caging, major hive disturbance to apply treatment) • Screened bottom boards	• Screened bottom boards only remove a small percentage of Varroa that falls off adult bees. In cold temperate climates beekeepers may prefer to close screened bottom boards, rendering them completely ineffective.
POPULATION INCREASE PHASE **(Spring or after any broodless period)**	
Hive build-up; brood and adult worker population increasing rapidly; Varroa population increasing; brood work, biosecurity checks, and pre-honey flow supering of hives may occur.	
Highly effective controls: • Apiguard • Apistan • Apitraz, Apivar • Bayvarol • Formic Pro • Drone brood removal	• Bayvarol and Formic Pro can be used with honey supers on. • Apiguard, Apistan, Apitraz, Apivar should not be used during honey production. Follow product label guidelines. • Drone brood removal may be used 2-3 times on strong, populous hives.
Moderately effective options: • Creating a brood break (e.g. queen caging, division of hives by splitting, Demaree, etc.) • Requeening using Varroa-tolerant or resistant stock • Basic sanitation	• Dividing the hive during the Population Increase phase may reduce honey production. • Varroa-resistant stock not currently available in Australia. • Basic sanitation may help eliminate/reduce other stressors (e.g. American foulbrood, Small hive beetle, chalkbrood).
Least effective options: • Screen bottom board • Powdered sugar	• A screen bottom board is marginally effective. • There is little evidence that powdered sugar or non-registered treatments (e.g. lactic acid,

• Failure to perform timely hive management • Non-registered treatments, 'internet remedies'	vegetable/mineral oil) has any effect on mite populations. Non-registered acids and oils can also harm honey bees.
PEAK POPULATION PHASE (Summer typically)	
Peak brood and adult bee population reached; Varroa populations still increasing, nearing peak; honey production common before, after, and at peak population.	
Highly effective controls: • Bayvarol • Formic Pro • If no honey supers on or hives are not producing honey Apiguard, Apistan, Apivar, or Apitraz can be used	• Bayvarol and Formic Pro can be used with honey supers on. • Apiguard, Apistan, Apitraz, Apivar should not be used during honey production. Follow product label guidelines. • Formic Pro, Apiguard are not suitable for use in all temperatures. Follow product label temperature restrictions.
Moderately effective options: • Requeening with Varroa-resistant stock • Creating a brood break (e.g. queen caging, division of hives by splitting, Demaree, etc.)	• Varroa-tolerant/resistance selected stock not currently available in Australia. • Requeening, dividing (splitting) hives will negatively affect honey production.
Least effective options: • Screen bottom board • Drone brood removal	• A screen bottom board removes a small percentage of mites that fall from adult bodies. Use it in combination with other techniques. • Drone brood removal restricted by availability of sufficient drone brood production and difficulty of accessing brood box beneath honey supers.
POPULATION DECREASE PHASE (Late Summer/Autumn/early Winter)	
Bee brood and adult bee population decreasing; hives rearing 'overwintering' bees. Varroa population in final growth phase, peaks and starts to decline (unless reinfestation occurs which continues to grow Varroa population). Majority Varroa transitions onto adult bees as bee brood quantity decreases.	
Highly effective controls: • Apiguard • Apistan • Apivar, Apitraz • Bayvarol • Formic Pro	• Bayvarol and Formic Pro can be used with honey supers on. • Apiguard, Apistan, Apitraz, Apivar should not be used during honey production. Follow product label guidelines. • Formic Pro, Apiguard are not suitable for use in all temperatures. Follow product label temperature restrictions.
Moderately effective options: • Requeening with Varroa-resistant stock • Creating a brood break (e.g. queen caging, division of hives by splitting, Demaree, etc.)	• Varroa-resistant stock not currently available. • Requeening and dividing hives may be difficult due to drone availability and decrease in hive populations.

Least effective options: • Drone brood removal • Screen bottom board	• Hives less likely to raise drones during this phase.

Table 4. Varroa control options by seasonal phase (adapted from Honey Bee Health Coalition 2022 by E. Frost)

4.Repeat monitoring and management as much as necessary, rotating different types of chemical controls to prevent Varroa from developing chemical resistance.

Varroa progress rapidly through their life cycle. Rotation of different chemical controls with different modes of action (such as alternating synthetic and non-synthetic treatments) is critical to ensure Varroa doesn't develop resistance. When Varroa is repeatedly challenged with a specific active ingredient, it's likely to develop resistance. Increasing dosage or use of more frequent applications may result in quicker development of Varroa chemical resistance. This reduces the number of options for effective mite control. Rotating products with different active ingredients (e.g. IPM) during the season or between different seasons, will help slow development of Varroa mite resistance to critical chemical control tools.

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Acknowledgements

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References

Cameron, J.J., Ellis, J.D., Integrated Pest Management Control of *Varroa destructor* (Acari: Varroidae), the Most Damaging Pest of (*Apis mellifera L.* (Hymenoptera: Apidae)) Colonies, *Journal of Insect Science*, Volume 21, Issue 5, September 2021, 6, doi.org/10.1093/jisesa/ieab058

Goodwin, M., Taylor, M. (2007). *Control of Varroa: A Guide for New Zealand Beekeepers.* New Zealand Ministry of Agriculture and Forestry.

The Keystone Policy Center on behalf of The Honey Bee Health Coalition (2022). Tools for Varroa management: A guide to effective Varroa sampling and control. honeybeehealthcoalition.org/wp-content/uploads/2022/08/HBHC-Guide_Varroa-Mgmt_8thEd-082422.pdf