Surviving Varroa Destructor

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Varroa in Australia

In 2016, 2019 and 2020, *Varroa jacobsoni* was detected on recently arrived hitchhiker Asian honeybees in Townsville. Under the National Varroa Mite Eradication Program, the bees were declared eradicated in February 2021.
On a later occasion, *Varroa destructor* mites were detected in sentinel hives in NSW on 22 June 2022. This was during routine surveillance by NSW Bee Biosecurity Officers at the Port of Newcastle. NSW traced the centre of the outbreak further away from the port, within the Newcastle area.
Initially two main areas of infestation had been identified as the greater Newcastle area and the Hunter Valley. In the ensuing 2 years, Varroa can now be found in areas covering the Sydney basin, Greater Newcastle area, Hunter Valley and Central Coast region, Kempsey, Lismore, East of Gunnedah, East of Lismore, and now in the almond growing area in southern NSW. These locations make up the newly established Management Zones for varroa mite.
While varroa mite has continued to spread in NSW, and is now present in northern Victoria, believed to be from hives deployed for almond pollination, in early 2025 Varroa was first detected in Queensland in the Lockyer Valley. Varroa mites have now been detected at multiple sites in SE Queensland and around Quilpie in SW Queensland. It is expected that these detections will continue to expand in Queensland
New South Wales Heat Map: NSW DPI website

What are varroa mites?

Varroa mite (*Varroa destructor*) is a tiny parasite that affects European honeybees. It's considered the greatest threat to Australia's honey and honeybee-pollinated plant industries and has been found in New South Wales since 2021.

During June 2022, *Varroa destructor* were detected in the sentinel hives at the Port of Newcastle. NSW DPI have determined the source was from the Newcastle area, meaning varroa were established in Australia before it was found in the sentinel hives. We may never know who was responsible for varroa being in Australia.

By October 2023, it was determined that Australia was no longer in a position to eradicate this pest, therefore we need to transition to a national management strategy. Sadly, at this point of time, the assumption is that varroa cannot be eradicated from Australia and will be managed by commercial and recreational beekeepers with the support of Federal, State and Territory governments. Education and training for all beekeepers, regardless of where you live and operate, will be crucial to long term management success.

Experiences of NSW beekeepers, in dealing with the outbreak in that state, show that the apiculture industry and Governments were severely unprepared both in terms of knowledge, experience and resources. In effect, Australia has been caught with its pants down, despite the fact that varroa have been active in New Zealand since 2002.

The Varroa mite (*Varroa destructor*) is an ectoparasite of the honey bee *Apis mellifera* L. Varroa is the most serious pest of honey bees inflicting more damage and higher economic costs than all other apicultural insects or diseases. Varroa is an invasive species that originated in Asia where the Asian honey bee, *Apis cerana* Fabr. was the host. The mite does little harm to *A. cerana* colonies and maintains a stable host-parasite relationship largely because mite reproduction occurs in drone brood, that comprises <5% of the colony's brood population. When mites attempt to infest worker brood cells, the parasitized pupa and mites are removed by adult bees exhibiting "hygienic behaviour". Adult bees also remove and kill mites on nestmates ("grooming behaviour"). In the 1950s, Varroa shifted hosts from A. *cerana* to the European honey bee (*Apis mellifera* L.). In *A. mellifera*, Varroa parasitizes and reproduces in worker and drone brood. Adult workers and drones also can be parasitized, but Varroa are seldom found on queens.

What do they look like?

Adult female varroa mites are oval, flat, red-brown and around 1.1 mm long and 1.5 mm wide. They can be seen with the naked eye. Varroa mites complete their life cycle in honey bee brood and can be observed in both drone and worker bee brood. Examining the brood involves uncapping brood (preferably drone) to check for the dark mites in the cell and against the pearly white bodies of the developing brood. They can also be observed between the sclerites and between the head and thorax on adult worker bees and drones.

What can they be confused with?

Varroa mites could be confused with the braula fly (*Braula coeca*) which is red-brown, 1.5 mm long, covered in spine like hairs and has six long legs. This pest is currently only present in Tasmania and is generally considered quite harmless. Varroa mites could also be confused with pollen mites (*Mellitiphis alvearius*) which are light brown and are around 0.75 mm long and 0.75 mm wide. Pollen mites are not harmful to honey bees but are sometimes found in hives. Varroa mites could also be confused with other exotic parasitic mites, most notably Tropilaelaps mites (*Tropilaelaps clareae* and *T. mercedesae*). If any mites are observed on adult honey bees or in their brood, call the Exotic Plant Pest Hotline immediately on 1800 084 881.
Images (Left to Right) Tropilaelaps, Braula fly, Pollen mite


0.5 mm


idiosoma
hypertrichous
Melittiphis alvearius (female, dorsal view)

What should beekeepers look for?

Symptoms are dependent on the level of varroa mite infestation, the level of brood within the colony and the potential of viral infections transmitted by the varroa mites. Colonies with low infestation generally show very few symptoms. As varroa mite infestation grows, it results in the significantly reduced weight of worker bees and drones, impaired flight performance and a lower rate of return to the colony after foraging, a reduced lifespan. If exotic viruses are present in the mites, they can then transmit them to bees. One such disease is Deformed wing virus which is a very serious disease of honey bees. Colony symptoms, commonly called parasitic mite syndrome (PMS), include a reduction in the adult honey bee population, loss of coordinated social behaviour, distorted and deformed honey bees, scattered brood with dead or uncapped brood and rapid honey bee de-population in the colony.

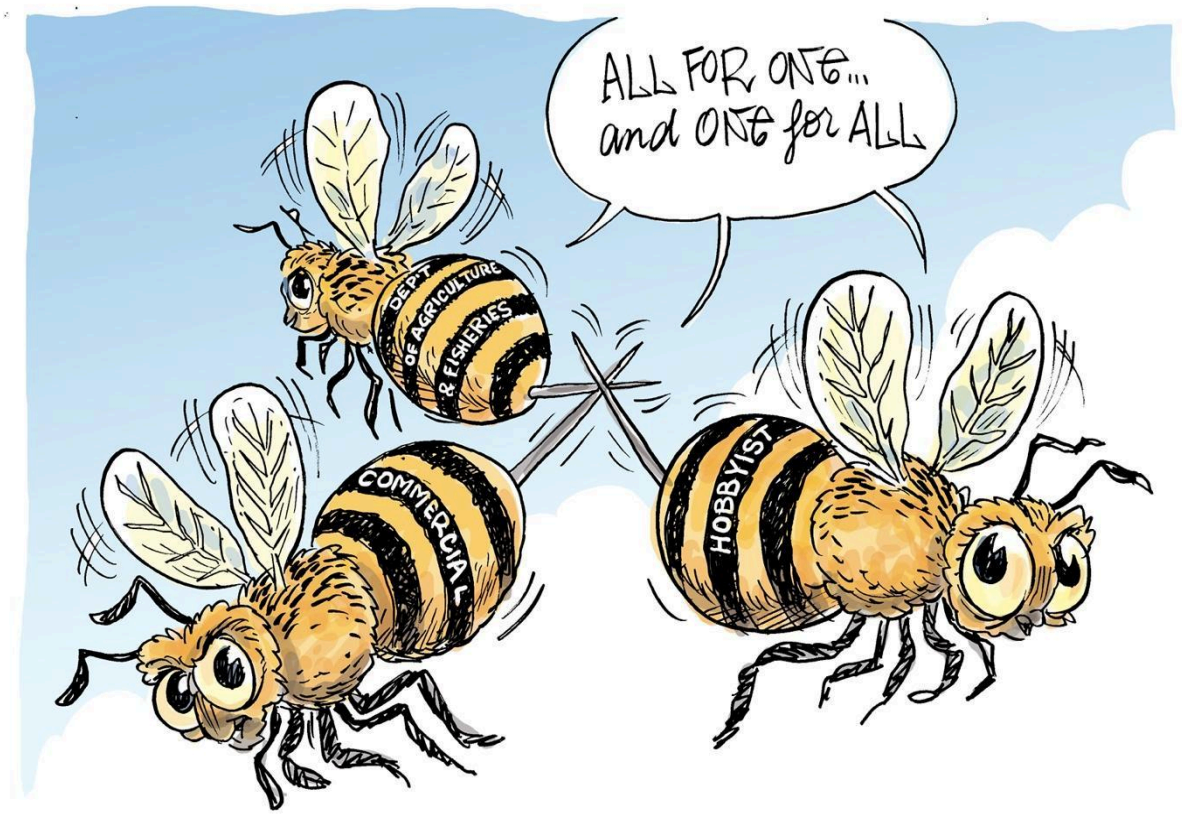
Some of the white deposits (varroa defecation) on the walls of the cells.

How do they spread?

Varroa mites typically spread through drifting drones and worker bees as well as through swarms and absconding colonies. Overseas experience indicates that the transport and movement of hives, used beekeeping equipment, packaged bees and queen bees are also effective means of spread.
The rapid expansion of the varroa in NSW in the early stages, was largely due to beekeepers shifting infected hives from hot spots.

Biosecurity

All beekeepers, from commercial operators to backyard enthusiasts, to people starting up their first hives, form part of the honey bee industry. Each and every beekeeper has a role to play in protecting honey bees from established and exotic pests.



(Cartoon supplied by Harry Bruce).

Incorporating recommended biosecurity processes into day-to-day operations is the best way to protect individual beekeepers, regional biosecurity and the Australian honey bee industry as a whole.

What is biosecurity?

Biosecurity is the protection of livelihoods, lifestyles and the natural environment, all of which could be harmed by the introduction of new pests, or through the impact of pests already established in Australia.
Biosecurity is a national priority, implemented off-shore, at the border, on-farm or in an apiary. Biosecurity is essential for a successful beekeeping business.

Australia's geographic isolation has meant that we have relatively few of the pests that affect honey bee industries overseas. Freedom from these exotic pests is a vital part of the future profitability and sustainability of Australia's honey bee industry. Biosecurity preserves existing trade opportunities and supports new market negotiations.

What is honey bee biosecurity?

Honey bee biosecurity is a set of measures designed to protect a beekeeper's honey bees from the entry and spread of pests. Honey bee biosecurity is the responsibility of every beekeeper and every person visiting or working in an apiary.

Implementing honey bee biosecurity is essential for a beekeeper's business. If an exotic or endemic pest establishes in an apiary, business costs will increase (for monitoring, cultural practices, additional chemical use and labour), productivity will decrease (yield and/or colony performance) and markets may be lost. The health of the honey bee industry also ensures the continued success of many other plant industries that rely on honey bees for pollination.

Early detection and immediate reporting increases the chance of an effective and efficient eradication.

Regional biosecurity

The biosecurity measures of an individual beekeeper can be enhanced by collaborating with others in a particular region. Through this collaborative approach, biosecurity threats to all apiaries in a region can be minimised. Promotion of honey bee biosecurity at the regional level can be enhanced through the engagement of the community and by understanding the area's vulnerability, and the potential source and nature of threats. Neighbouring apiaries (managed or abandoned), feral colonies and/or unregistered hives are examples of potential biosecurity threats.

Regional biosecurity efforts are strengthened by identifying what resources and expertise are available, and by having a commitment from stakeholders to implement biosecurity measures and surveillance programs. Implementation of honey bee biosecurity strategies underpins regional biosecurity, which in turn underpins national biosecurity.(Source: Beeaware.org.au)

What are my General Biosecurity Obligations

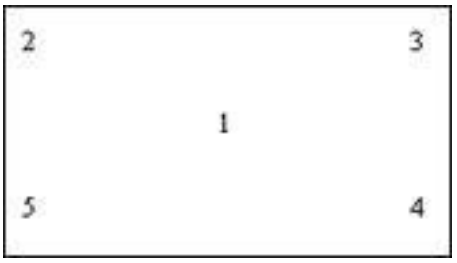
1. Register as a biosecurity entity and mark your hives with your hive identification number.

Each registrable biosecurity entity is allocated a hive identification number (HIN). The HIN replaces the old apiary brand. Only 1 HIN is allocated for each biosecurity entity, which is assigned to all hives owned.

Branding hives

You are required to brand at least 1 out of every 50 hives with your HIN, but we recommend marking all your hives as proof of ownership and to help with recovery in the event of loss or theft. This is particularly important if your hives have old brands.
You must ensure the HIN stays legible.
You must brand the hive with your HIN:

- on the front of the hive
- in block letters, at least 25mm high.



The first HIN on a hive must be placed in the centre of the front of the hive (position 1).
If a hive is already branded, you must place any subsequent brands of the HIN in the corners of the front of the hive in a clockwise sequence, starting from the top left corner (position 2).

2. Check your hives regularly for pests and diseases.

Current legislation suggests a minimum of every 16 weeks. New advice from both DAF and the QBA is to monitor your mites monthly. Recent experiences from NSW beekeepers indicate that those who did not monitor their hives monthly had suffered significant varroa mite infestation levels, almost uncontrollable infestation requiring multiple acaricide applications, and even complete loss of hive/s.

3. Report any notifiable pests and or diseases.

Queensland Department of Agriculture and Fishing has a dedicated on line reporting system for varroa referred to as Bee123 online. It's imperative that you report both positive and negative findings. The link is below
https://survey123.arcgis.com/share/e7fb92e833744be7b2b32d25981779bf?portalUrl=https://qportal.information.qld.gov.au/arcgis.

4. Practise come clean go clean.

Try to develop a system whereby you significantly reduce any potential to spread pests and/or diseases. Clean your equipment and your PPE on a regular basis. If you run multiple yards, then wherever possible, keep hive infrastructure to that particular yard only. Should you have visiting beekeepers, ensure that their gear is clean before they enter.

5. Only buy/ use equipment that you know has come from a clean source, or irradiate before use.

Purchasing second hand equipment is considered high risk, if you don't know the history of the equipment. Contact this company to arrange irradiation of your equipment.

Steritech Queensland
180-186 Potassium Street,
Narangba QLD 4504

P.O. Box 376,
Burpengary QLD 4505
T: 1800 714 244

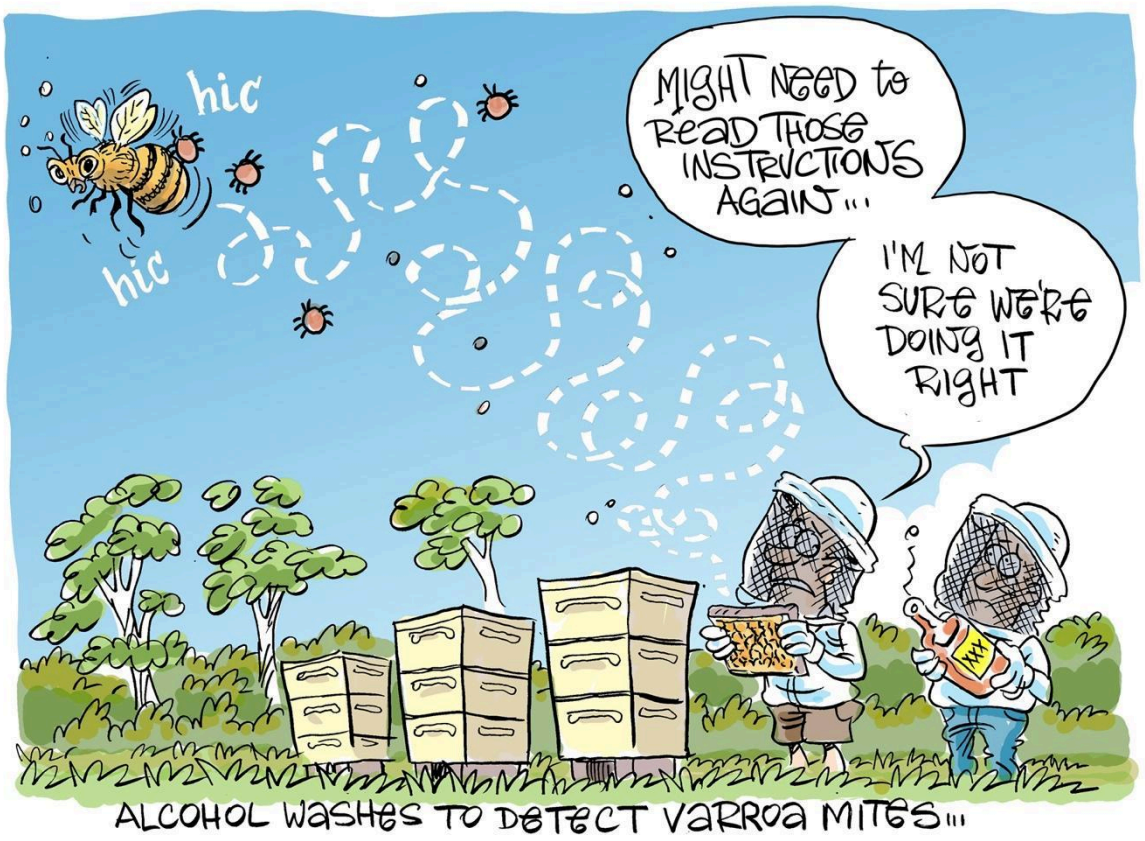
6. Practise good bee husbandry. Now is as good a time as any to update your skills and knowledge in bee husbandry. Poor husbandry can lead to disastrous outcomes as evidenced from this NSW beekeeper;

Case Study .
Beekeeper did not monitor in a Varroa dense area.
VDO's were called when beekeeper noticed bees crawling on ground in front of hives.
Substantial impacts on colony health were observed.
Treated with Bayvarol™, but colonies may not survive.

Summation:
Beekeeper monitoring at an earlier stage would have identified the need for treatment and reduced the risk of colony failure.

7. Instigate a barrier system.

The working definition is simple: 'there is a degree of segregation of hives and apiaries within a beekeeping operation whereby material from one hive/group/apiary is only interchanged with that hive/group/apiary'.



(Cartoon supplied by Harry Bruce)

Queensland Requirements

Movement records

Queensland beekeepers who wish to move bees outside their premises must create a movement record prior to that movement. This requirement applies to:

- Buying or selling bees,
- Moving colonised beehives,
- All beekeepers—registered, unregistered, commercial and recreational.

You do not have to keep a movement record if you are moving bees within your premises.

For one-off movements of bees where a permit is not required, complete the single-use record movement form.

If you regularly move bees or hives, contact the Department of Agriculture and Fisheries to request a Movement and Apiary Record book for Queensland beekeepers.
Your records must be kept readily accessible and legible for 2 years after the movement starts, and be produced upon request by a biosecurity officer.
Penalties apply if movement records are not maintained or produced when requested by Biosecurity Queensland.

Biosecurity instrument permits

You must hold a biosecurity instrument permit issued by the Queensland Department of Agriculture and Fisheries to move bees, beehives, used beekeeping equipment or bee products (including unprocessed honey) into Queensland from states or territories where varroa mite has been found.
You must follow all permit conditions—penalties apply. The maximum penalty for a person not complying is a maximum of 2,000 penalty units or 1 year imprisonment.

Actions you can undertake prior to arrival of varroa in your area.

Monitor	Monitor your hives on a regular basis.
Be a real beekeeper	Develop good husbandry practices
Write it down	Keep accurate physical records of When, Where, Who, What and Why of your activities.
Be proactive	Learn as much as you can, join in conversations about this pest. Participate in field days, workshops and or webinars wherever possible.
Be informed	Keep up to date with information releases from sources such as Biosecurity Queensland, DAF (Sign up to E Alert), QBA, AHBIC and other leading sources.
Plan ahead	Develop and follow an IPM strategy to deal with varroa.

When to inspect your hives?

Current legislation suggests every 16 weeks (as a minmum), however this has proven in NSW to be ineffective and resulting in hive loss due entirely to varroa. Current advice from the QBA & DAFF is to monitor your hives monthly.

What do I need to Test for Varroa?

Currently there are four accepted methods, namely Alcohol Washing, Soapy Water, Sugar Shake and Drone Uncapping. A fifth method is the use of CO_2, however whilst its successful in New Zealand, authorities here in Australia suggest its less than effective. Its important to note, all tests if conducted improperly will skew the results.

Equipment required.

1. PPE (Protective clothing, Smoker, Hive tool).
2. Wash container.
3. Suitable container for shaking the bees into.
4. ½ cup measure (300 bees).
5. Alcohol (Methylated Spirits diluted to 70%).
6. Soapy water mix.
7. CO_2 gas and injector.
8. Icing sugar.
9. Magnifying glass.
10. Ziplock bag.
11. Bag or bucket for disposal.

Method 1. Alcohol Wash (Lethal to sample)

1. Place about 150ml of diluted alcohol in a glass jar.
2. Open a Hive and remove three frames from the center of your brood box.
3. Make sure the Queen is not among them, then shake your bees into the collection container.
4. Scoop 300 bees into the glass jar, screw the lid on and shake for at least 15 seconds, then drain the liquid from the jar. Inspect for mites.
5. Repeat the same test for a 2nd and 3rd test to ensure accuracy
6. If mites are present, conduct a count then divide the number by 3 to obtain your mite percentage
7. Report your results (Positive or Negative) to Bee123 online.

Method 2. Soapy Water test. (Lethal to sample)

1. Place about 150 ml of soapy water in a glass jar.
2. Open a hive and remove three frames from the centre of your brood box.
3. Make sure your Queen is not present, then shake bees into the collection container.
4. Scoop 300 bees into the jar, screw on the lid and shake for 15 seconds, wait 60 seconds before inspecting.
5. Wash the sample of bees for a 2nd & 3rd time to ensure accuracy.
6. If mites are present, then conduct a count and divide by 3 to obtain your mite percentage.
7. Report your results (Positive or Negative) to Bee123 online.

Method 3. Powdered Sugar Shake. (Non Lethal to sample)

1. Open your hive and remove up to three frames of bees from the brood box.
2. Try to ensure your Queen is not present if possible, then shake the bees into a collection container.
3. With your sampling jar, add 2 tablespoons of powdered sugar, then add a 300 bee sample. Screw the lid on and gently shake for 1 minute then allow it to rest for another minute.
4. Repeat a further 2 times and then inspect for mites.
5. If mites are present, conduct a count, then divide the number by 3 to obtain your mite percentage.
6. Report your results (Positive or Negative) to Bee123 online

Method 4. CO_2 gas testing. (Non lethal to sample)

1. Open your hive and remove three frames of bees from the brood box.
2. Try to ensure your Queen is not present if possible, then shake the bees into a container.
3. Scoop 300 bees into a jar, put the lid on and inject 8 seconds of CO2 gas into the jar, and seal off any exits.
4. Reasonably gently roll the bees around for about 30 seconds, then inspect the bottom of the jar.
5. Repeat this process for a 2nd & 3rd time on your sample of bees.
6. If mites are present, conduct a count, then divide the number by 3 to obtain your mite percentage.
7. Report your results (Positive or Negative) to Bee123 online.

Method 5. Drone Uncapping.

1. Open your brood box and find frames with drone brood present.
2. Using the comb, drive it into the drone cells and rake up and out to extract the drone pupae. Closely inspect for any potential mites including the bottom of the old cells which contained the pupae.
3. Don't forget to roll the pupae over when inspecting them.
4. Should you find mites, you now need to conduct an Alcohol wash test to ascertain the numbers.
5. If mites are present, conduct a count then divide the number by 3 to obtain your percentage of mites.
6. Report your findings (Positive or Negative) to Bee123 online.

Most important: (Source: DAF)

If this is the first time in finding mites in your colonies, then there is an additional set of steps that you need to undertake.

1. Take a photo of the suspected mite.
2. Preserve the suspect sample.
3. Report the suspect mite to any of the below listed contacts.
4. Wait for a biosecurity officer to contact you.
5. Prepare the suspect sample for sending.
6. Complete the sample submission form.
7. Send the suspect mite to the Plant Biosecurity Laboratory.

Contact details:
Bee123 online, or
DAF 13 25 23, or
Biosecurity Queensland Hotline 1800 675 888.
Qld Varroa Map
https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/animal/industries/bees/varroa-mite/surveillance-map

The Varroa mite emergency response has impacted people's mental and emotional wellbeing.

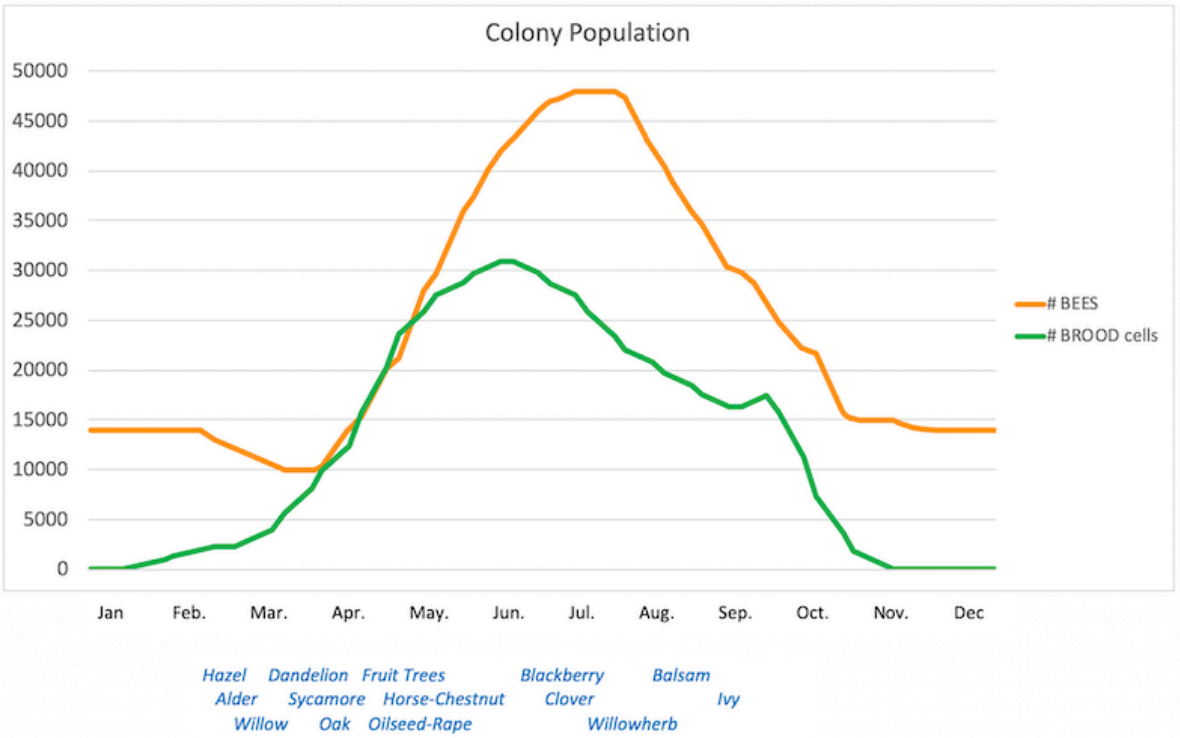
Stressful events can cause feelings of worry and unease, especially where there are levels of uncertainty involved, but there are things you can do to take care of yourself.
In tough times we need to remember to look after ourselves. As much as possible, maintaining routines with a good diet, exercise, and sleep will increase your capacity to deal with stress.
This is the time to stay connected with family and friends and seek support when you need it.
Mental health support is available from:

- Beyond Blue, 1300 22 46 36
- Lifeline, 13 11 14

After confirmation of varroa

1. At the current time of early stages of infestation of varroa in Queensland:
    a. You will be expected to very closely monitor your hives.
    b. Your written records will be inspected.
2. Acaricides are now permitted to be sold and used from commercial outlets.
3. Once you get over the shock of finding varroa, you will face the need to implement some preplanned controls, based on the following considerations;

What stage is my colony at?



Whilst the chart above is for the northern hemisphere, and has a distinct brood break, we in Australia will generally have some level of brood through the winter.

What is my level of infestation?

What percentage mite of infestation is considered to be potentially harmful?

It depends on the seasonal phase.

Colony Phase	Acceptable Further control not needed	Caution Control may be warranted	Danger Control promptly
Dormant with brood	<1%	1-2%	>2%
Dormant without brood	<1%	1-3%	>3%
Population Increase	<1%	1-3%	>3%
Peak Population	<2%	2-5%	>5%
Population Decrease	<2%	2-3%	>3%

***Acceptable**: Current mite populations are not an immediate threat.*

Be aware though that if fellow beekeepers in your area are not managing their varroa mites, then there's an extreme risk of high rates of re-infestation that might occur. A few days apart is nothing to worry about, however if they are treating a month or more in date difference, then you have a real problem. Worse still if a fellow beekeeper, just down the road, is not treating at all (for whatever the reason….), your efforts will be basically wasted.

Wherever possible we should be working to get in a position to control varroa. Seasonal conditions for large districts, may not be the same, hence a difference in possible infestation rates

Are the mites predominately phoretic or breeding ?

Varroa mites can only reproduce if there are brood cells present, with developing workers and drones (Figure 2). Drone brood cells are larger and the post-capping stage is longer (15 days for drones versus 11 days for workers), which allows the mite to produce more offspring per cycle. Varroa mites do not reproduce within queen cells because of the repellence of royal jelly and the very short post-capping period of queens (7 days). When honey bee brood is present in the colony, the majority of varroa mites are in the capped brood reproducing where they can often escape chemical treatments. (Source: Penn. State University)

Note: At this stage only Formic Pro® type products can act on mites under the brood cap.

Do I have honey supers on?

Currently, only two acaricides may be used if supers are present, and even then, the use of Bayvarol™, restricts the use of comb honey.

Do I have low brood numbers?

As indicated earlier, with no significant natural brood break, fast knock down acaricides such as Oxalic acid (highly regarded in New Zealand), will require beekeepers to implement a caged queen strategy to be ultra effective.

What are the current & expected daily min & max temps?

Note that some chemicals are temperature limited as to when they might be applied. So be cautious when deciding which to apply.

What types of acaricide are available for use?

Use this link to find the latest data AHBIC Acaricide table: https://honeybee.org.au/ahbic-varroa-treatment-table/

Australian Honey Bee INDUSTRY COUNCIL

Varroa Chemical Treatment Table

Current on 25th June 2024 – check www.honeybee.org.au for the most up to date details

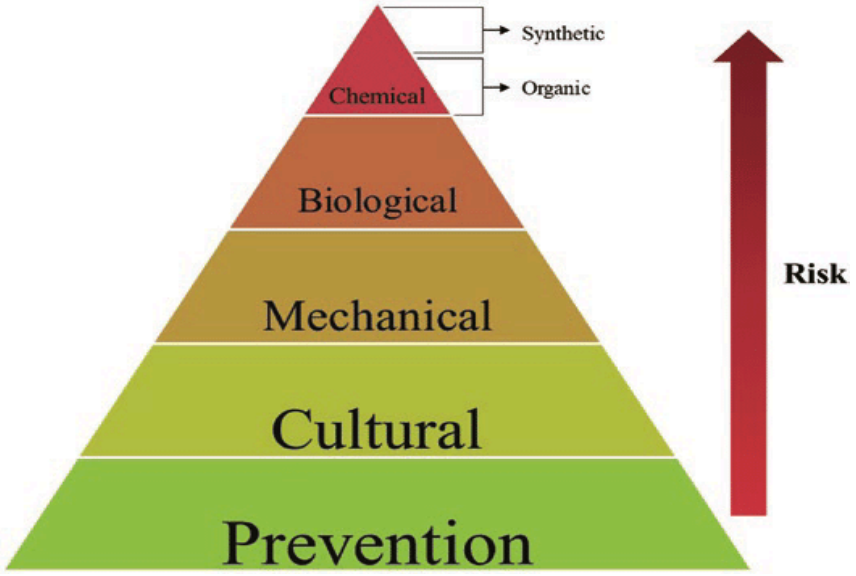
Australian Honey Bee Industry Council - Varroa Chemical Treatment Table

Current on 25th June 2024 – check www.honeybee.org.au for the most up to date details
This table is not indicative of the order of treatments, that is the responsibility of the beekeeper.
The colour code refers to the mode of action.

Product name Current 25/06/24	Bayvarol® PER94055	Apistan® PER94055	~~CheckMite+®~~ PER94055	Apivar PER94153	Apitraz PER94153	Apiguard® PER93639	~~Api-bioxal™~~ Unregistered	~~Oxuvar CAP®~~ Unregistered
Registration Status	Emergency use permit active Full Registration submitted	Emergency use permit active	Emergency use permit active (Formerly Mite Away Quick Strips)	Registered	Emergency use permit active	Registered 65570	Permit Application progressing	Full Registration Application Submitted
Active ingredient	~~flumethrin~~	Tau-fluvalinate	Formic acid	Amitraz	Amitraz	Thymol	Oxalic acid	Oxalic acid
Chemical Type	Synthetic pyrethroid	Synthetic pyrethroid	Organic acid	Synthetic formamidine	Synthetic formamidine	Organic extract	Organic acid	Organic acid
Product Type and dose for full size hive	plastic strips 4 strips per brood chamber	plastic strips 2 strips per brood chamber	gel strips 2 strips per brood chamber	plastic strips 2 strips per brood chamber	plastic strips 2 strips per brood chamber	gel product 50g per hive	dribbling, fogging TBA	Cellulose strips 4 strips per brood chamber (pending full registration)
Temperature/hive type limitations for treatment	Not critical	Not critical	Only treat when ambient daytime temps are between 10 °C & 29.5°C	Not critical	Not critical	Only treat when ambient daytime temps are between 15°C & 40°C	No	No
Treat with supers on hives	~~Yes –~~ Comb honey cannot be collected or sold if treated when supers present	No	Yes	No	No	No	TBA	Yes (pending full registration)
Treatment time	6-8 weeks	6-8 weeks	7 days	6 to 10 weeks	6 weeks	2 weeks then additional tray for 4 weeks (Total of 6 weeks)	No details - not an approved product	42 days (pending full registration)
Can nuclei colonies be treated	Yes – (2 strips per ~~QHC~~)	Yes – (1 strip per ~~QHC~~)	Colonies need to be a minimum of 6 frames of bees	Yes - (1 strip per ~~QHC~~)	Yes - (1 strip per ~~QHC~~)	Yes (25g per ~~QHC~~)	No details - not an approved product	Yes - 2 strips per ~~QHC~~ (pending full registration)
Withholding period	Not required when used as directed.	Do not have supers on ~~or harvest~~ honey when strips are in	Only harvest honey after 2 weeks from the end of treatment	0 days after removal of strips. Do not have supers on when strips are in	2 weeks from the end of treatment. Do not have supers on when strips are in	0 days	No details - not an approved product	None (pending full registration)

Varroa Coordinator
Bianca Giggins
bianca@honeybee.org.au - 0402 467 780

What is IPM? (Source: PennState Extension)



Cultural Approaches

Cultural approaches are aimed at reducing pest reproduction. For varroa mite control and prevention, cultural controls include purchasing mite-resistant honey bee stock, providing small cell comb, and providing a brood break.

Resistant Stock

Using mite-resistant bees can limit the reliance on chemicals for varroa mite control. To that end, various bee stocks with mite-resistant traits have been developed. Imports have emphasized European honey bees that have been in contact with varroa mites for a long time.

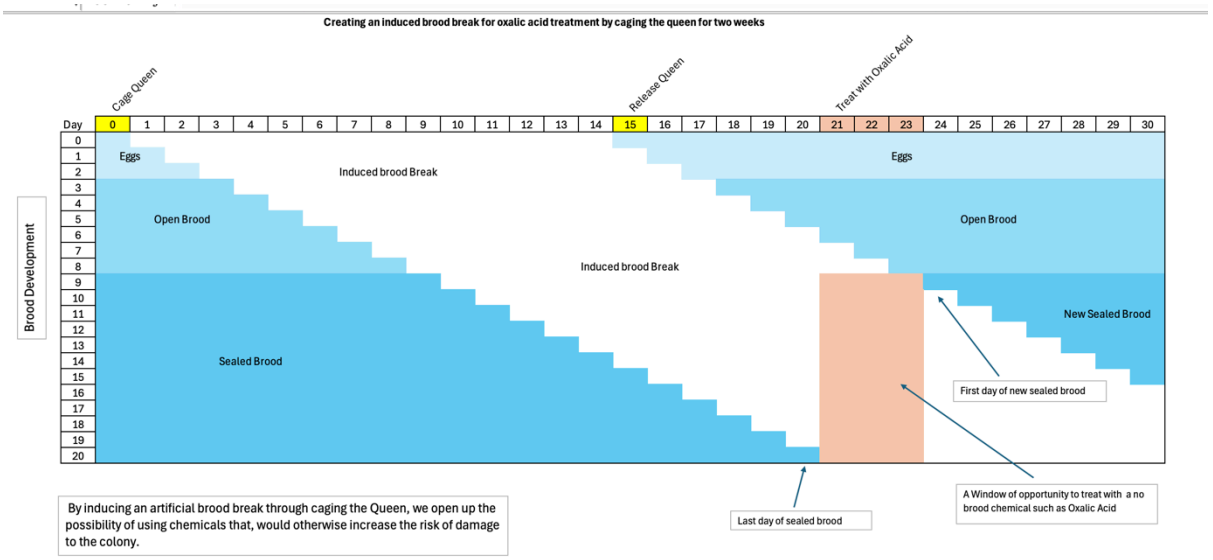
- *Russian bees* inhibit mite reproduction. Russian bees have a slower varroa mite population increase than other bees due to an ability to suppress mite reproduction. Russian bees have lower percent brood infestation and fewer multiple infested cells, and bees inoculated with the mite-vectored deformed wing virus exhibit significantly less viral replication.
- *Varroa Sensitive Hygiene (VSH) bees* can recognize and remove mite-infested pupae. Bees that remove dead brood quickly are hygienic and are thought to be better at removing mites from the hive, as well. Other desirable traits include the recognition by the bees that the mites, themselves, are present and undesirable. This trait is recognized by testing.
- *Ankle biters/leg chewers* will bite the mites, harming their bodies and/or legs. This trait is recognized by looking closely at mites that have dropped through a screen onto a sticky board, determining the proportion of the mites that have been damaged by the bees.

Small cell comb

When modern hive equipment was invented in the early 1950s, it started the beekeeping industry down a path of modernization and industrialization. Part of this process involved the production of commercial foundation with hexagons that are 5.4 mm and produce larger bees that could produce more honey. However, in wild conditions, bees tend to build comb from smaller hexagons that are about 4.9 mm in size. Some research has suggested that mite numbers decrease as cell size decreases because a shorter post-capping period in a smaller cell translates into fewer varroa mites produced in each cell. The efficacy of using small cell comb as a varroa mite control method is debated in the scientific literature, but there is no harm to honey bees from using this equipment.

Brood break

A brood break in the colony can significantly impact the number of available brood cells for mite reproduction. This break can be accomplished by caging (Scalvini cages are recommended) or removing the queen from the colony for approximately 3 weeks. During that time, all of the brood hatches, so the mites are forced out of the cells and onto adult bees. This approach on its own, or in combination with a chemical treatment, can affect varroa mite population growth. In addition, adult bees increase grooming behaviour in the absence of brood which can help decrease mite numbers in the colony, especially in combination with a screened bottom board. If a brood break is properly timed, it has the potential to ease the stress of a dearth period while providing the colony with a young queen for overwintering.



To overcome this issue, we need to be able to create an artificial brood break by containing the queen so she no longer has direct access to brood cells. 9 days after caging the queen, meaning the varroa have no where to hide under new capped brood. 12 days later all worker brood should have hatched, 3 days after that all drone brood should have hatched.

By combining this time frame and the application of an acaricide, we now have the ability to deliver a one two punch (synergistic) effect to maximise our kill rate on the mite. The only question left is, when would you carry out this type of control.

Experience overseas suggests that whilst it's an option all year round, best results are obtained when brood numbers are not critical to the hive, hence late Autumn early winter.

Mechanical Approaches

Controlling varroa mite populations via manipulations of the colony or hive can be effective, especially if several (or all) of the methods are used in conjunction. Mechanical controls include screened bottom boards, drone brood removal, and powdered sugar dusting.

Mite trapping

Drone brood removal takes advantage of the mites' preference for drone brood for reproduction, using them as a trap. Varroa mites have higher reproductive success in drone brood than in worker brood due to the post-capping period allowing mites to produce only 1.3-1.4 offspring per attempt in worker cells, but 2.2-2.6 offspring in drone cells (Figure 2). In addition, the period of attractiveness of drone brood is 40-50 hours, as opposed to only 15-30 hours in worker brood. Together, these reproductive advantages of drone brood manifest as a 6-fold increase in mites found under the cappings of drone cells than under worker cells. Adding drone comb to a colony encourages drone production that acts as a trap for mites.

Removing that comb prior to drone emergence effectively removes the varroa mites reproducing in the cells. The drone brood can then be frozen and returned to the colony or scraped off of the frame (Figure 4). This practice reduces mite reproduction, which prolongs the length of time before the population reaches the threshold. However, it may not be effective enough to act as the only means for controlling varroa mites.

In the graphic above the beekeeper is removing predominately drone brood from the frame, as a method of controlling varroa.

Screened bottom board

Mites naturally fall off of bees as a result of movement within the colony and honey bee grooming behaviour. If a screened bottom board, rather than solid wood one is used (Figure 5), mites fall onto the ground and are less likely to climb back onto the bees. Screened bottom boards decrease mite invasion into brood cells, resulting in a lower percentage of the population being found in the brood reproducing. Mite loads often still reach economic thresholds in hives with screened bottom boards, so this physical method to control varroa mites must be used in combination with other control techniques.

Powdered sugar

Sprinkling or applying powdered sugar on bees can serve as a method for mite control as this stimulates grooming behaviour, resulting in more mites collected on bottom boards. Its use can be effective on bees removed from the hive equipment, but this is labour intensive, so beekeepers should weigh the costs and benefits when considering this practice. This treatment will not likely control the mite population on its own, but it can be used to increase mite drop in combination with screened bottom boards.

Chemical Approaches

Varroa mite reproduction throughout the spring and summer often leads to a large population in the fall. If the economic threshold is reached, one will have the best overwintering success if a chemical miticide is applied prior to the production of the winter bees. In an IPM system, soft chemicals are used when possible and rotation of acaricides from different modes of action chemical groups should be practiced.

Soft Chemicals

Organic acids, essential oils, and hop beta acids are considered soft chemicals because they are naturally derived. These treatments are effective without leaving chemical residues in hive products, such as wax. However, just because they are called soft does not mean they are harmless and some are dangerous to use if not used with the proper protective equipment. If chemicals are used in the hive, it is recommended to apply soft chemicals first prior to considering the use of hard chemicals, providing rotation of acaricides with different chemical modes of action is practiced. In addition, colonies should be treated only after monitoring efforts have indicated that they are needed.

Formic acid. Formic acid occurs naturally in the venom of honey bees and is a natural component of honey. This chemical is commonly used because, at high concentrations, this organic acid penetrates the wax cappings and effectively kills reproducing mites. One limitation is that the use of formic acid is temperature dependent and can cause damage to the colony if used at ambient temperatures higher than 30ºC, as it can increase brood mortality and the potential for queen loss. Additionally, when used below 10ºC, formic acid results in low efficacy.

Oxalic acid. Oxalic acid is a naturally-occurring compound found in plants, such as rhubarb, kale, beets, and spinach. As a chemical for mite control, oxalic acid can be used in two formulations: vapor and dribble. Because it does not penetrate the capping's, oxalic acid is most effective during broodless periods making it a useful component to an integrated varroa mite control program as a winter or early spring method. However, it should not be used as a stand-alone treatment. If overused or used at high dosages, oxalic acid can harm bees by crystallizing in the midgut of larvae, increasing larval mortality, and reducing brood area. Overuse of this treatment can also decrease the activity and longevity of workers.

Thymol. Essential oils are natural compounds distilled from plants. The most popular essential oil for varroa mite control is thymol (from a thyme plant). While thymol treatment can effectively control mites on adult bees, it cannot penetrate the cell capping's, so it does not control mites in brood cells.

Efficacy of thymol is dependent on colony strength as well as ambient conditions. During treatment, the workers react by emptying cells near the product so this treatment can reduce the overall area of brood in colonies when applied in the spring. In addition, thymol treatment can induce robbing behaviour and increase aggressiveness of colonies. Efficacy of thymol treatment can be low so it should be combined with other treatment methods.

Hop beta acids. Potassium salt of hop beta acids are derived from the hops plant and it is safe for use any time of the year, even during the honey flow. However, it is more effective as a mite control treatment when there is less brood because it does not go through the cell capping's. Use during brood rearing requires multiple applications. Ambient temperature does not impact Hopguard treatment. Efficacy varies, but it is generally not as high as other soft chemical treatments.

Hard Chemicals

Chemical control of varroa mites can be achieved through the use of various acaricides/miticides. Synthetic miticides are generally effective, killing up to 95% of the mite population. Historically, fluvalinate and coumaphos have been the most widely used mite treatments in the United States, but mites have developed resistance to these chemicals and residues persist and accumulate in wax. While fluvalinate is now legal to apply in Australia, we do not recommend it and will not discuss it here. Miticide residue in wax can harm bees directly and makes bees more susceptible to nosema disease. In addition, these residues can be found in bee products, which makes them less desirable to consumers. Synthetic chemicals should be a last resort for beekeepers practicing IPM.

Amitraz. One of the most popular synthetic acaricides in New Zealand is amitraz and is now registered in Australia (sold as Apivar® or Apitraz®). Amitraz does not, in its original form, persist as a contaminant of honey or wax. However, some metabolites of amitraz have been found to persist and there is a synergistic effect of amitraz and viruses that has been linked to increased bee mortality. In addition, resistance to amitraz has

been documented, so its efficacy must be monitored closely and it should only be used once a year.

Flumethrin. Flumethrin has been the most widely used acaricide in New South Wales, and is very effective. It is sold as Bayvarol™and can be used when supers are present. However it is a synthetic pyrethroid and must be rotated with acaricides from other chemical modes of action due the risk of resistance development.
Although it can be used when supers are present, comb honey and beeswax should not be harvested for human consumption.

Summary:

There are many available options to control varroa mite populations in honey bee colonies. Each option has advantages and disadvantages, but understanding the implications of each choice is an important part of decision-making. In an IPM approach, beekeepers should heavily rely on cultural and mechanical practices for mite control before using soft or hard chemicals. Mite monitoring and rotation of treatments is critical for effective management and reduction of resistance to chemicals in these pests. Understanding and considering all of the options before deciding on how to proceed will help to improve the success and the well-being of the honey bees.

Currently, the APVMA & AHBIC are trying to register multiple acaricides in a safe ethical manner. There is an issue with enabling the registration of Oxalic acid utilizing the method of Fogging. The EPA have concerns regarding beekeepers not using the correct PPE at the time of application.

These sorts of delays need to be sorted as quickly as possible, as experience from overseas countries show this method is highly successful when applied correctly.

There will always be a minor number of examples of differences between administrators and practical beekeepers, but by keeping the lines of communication open, they should be overcome.

Modes of Action. (Source: Ontario Beekeepers Association)

This phrase is used often when discussion turns to the various methods of controlling varroa. Mode of action, refers to the biochemical pathway of the insecticide/miticide to kill or repel mites and insects. Why is this important? Scientific evidence has shown that continual use of the same chemical with the same mode of action in sequential applications leads to resistance in mites. There is less potential for mites to develop resistance to products classed in the UN (unspecified class).
The modes of action classification will be shown on the label of the products to be used.

Mode of Action 3A

- Tau-Fluvalinate & Flumethrin (Synthetic Pyrethroids)
- Method: Insects are generally very sensitive to pyrethroids, but can be resistant to these chemicals if over used, but are highly effective on susceptible Varroa mites.
- Works by blocking the nerve signals from being sent, resulting in the mite becoming paralysed and then dying.

Product Names: Apistan, Bayvarol

Mode of Action 19.

- Ingredient: Amitraz
- Method: Octopamine in Varroa is important for movement, feeding, egg laying, metabolism and learning/memory.
- Amitraz binds to and blocks octopamine receptors which leads to loss of activity, metabolism, weakness and eventually paralysis and death.

Product Names: Apivar, Apitraz

Mode of Action UN.

- Ingredient: Organic Acids. (Type 1)
- Method: Acts on Electron transport chain (Cellular respiration), protein synthesis, cells and cell contents.
- Mites get weak and tremble, stop feeding, and eventually die as their organs shut down and cells are destroyed.

Product Names: Formic Acid, Formic Pro, Mite Away Quick Strips (MAQS)

Mode of Action UN

- Ingredient: Organic Acids. (Type 2)
- Method: Acts on Cells and Cell contents, not fully understood. Needs to be absorbed but is more easily absorbed through the mites tarsal pads (feet) than the cuticle.
- Stops cells (through the neurotransmitters) from sending signals. Effects are the destruction of cells and cell contents.

Product Names: Oxalic Acid.

Mode of Action UN

- Ingredient: Natural (Monoterpoids)
- Method: Acts on GABA activated receptors, cells and cell contents, octopamine receptors and acetylcholinesterase
- GABA is a neurotransmitter and binds to voltage gated chloride channels, which deactivate muscles and glands.
- Monoterpenoids leads to loss of activity, weakness, paralysis and death

Product Names

- Thymovar, Api Life Var, Hop Beta

Please keep the following information under consideration when obtaining acaricides!!

Do not treat unless you actually have mites. Apart from being a complete waste of money, if you were unlucky enough to have mites infest your hives at a time when the acaricide applied has a low residual level, you automatically allow the surviving mites to build a level of resistance.

Do not buy or stockpile products in anticipation. Products have an expiry date after which it's been determined that they start to lose their efficacy, even if stored correctly.

Follow the label as to recommended dosage and treatment times. Horror stories coming out of the United States, of beekeepers batching their own brews, has resulted in higher levels of resistance in mites, acaricides not working correctly due to mixing, and in a few cases, significant health issues to the actual beekeeper.

Consider your financial status – can you afford to treat all your hives when the time comes? The reality is that you will need to treat all of your hives in each location (yard), even if only one has tested positive to varroa. Based on NSW's beekeepers having to apply multiple acaricides in an effort to combat the tidal wave of infestations, the first few years will be expensive.

Fence sitting is not an option. If you or someone you know, are not managing their bees, please consider the industry by either rehoming the hive/s or seriously consider exiting the industry. Hard words indeed, but we will be facing a significant effect until all local feral colonies succumb to varroa, we don't need mis managed domesticated colonies to also become mite bombs.

If it works overseas, why can't we just apply it here?

Based on overseas experience we know basically how chemicals are meant to work, except;

What we don't know is how they work (including residual effects) in our Australian climatic conditions.

It's critical we understand the experiences of NSW beekeepers.

It's also super critical that we understand why resistances are building in chemicals, in use overseas, so we can minimize the effects here in Australia.

Managed applications to help stop the resistance buildup.

When possible, rotate the use of miticides to reduce selection pressure as compared to repeatedly using the same product, with the same mode of action. If multiple applications are required, use a different mode of action each time before returning to a previously used one. The Southern Beekeepers Association in Toowoomba has developed a Varroa Mite Resistance Management Strategy (VMRMS) to assist in making decisions on what products to use throughout the year to minimise the possibility of resistance development to acaricides from Varroa mites.

Base miticide use on your Integrated Pest Management (IPM). This includes proper pest identification, monitoring for locality specific economic threshold and economic injury levels, record keeping, and utilizing all available control practices (cultural, biological and chemical).

Maximize efficacy by following all label instructions including dosage and timing of application, and safe disposal of the left over chemical and or the empty containers is required

Other Alternative Options

Managing the brood temperature as a control. (Source: Scientific Beekeeping)

Evidence suggests that Varroa can survive in brood at 18°C, however the host brood will most certainly not.

Once the brood temp gets significantly below the optimal brood temp (33°C to 37°C) the colony attempts to heat the hive. If this is unable to be achieved, they will sacrifice certain areas by “balling up” in the middle frames of the brood box to ensure survival.

The surviving varroa attach themselves to bees to await the arrival of spring.

Scientific testing has shown that by increasing the brood temperature above 34ºc, the varroa become distressed.

Increasing brood temperature to as high as 44°C for short periods of time can kill varroa but the risk is damage to your colony.

ble 1. Temperature tolerances of varroa and honey bees.				
Effect on varroa	°F	°C	Effect upon the bees	
In-hive emperature range eferred by varroa	80	26.7	Adult bee comfort zone	
	82	27.8		
	84	28.9		
	86	30.0		
	88	31.1		
Optimal varroa reproduction	90	32.2		
	92	33.3		
Varroa mites stressed	94	34.4	*A. mellifera* broodnest temperature	
	96	35.6		
	98	36.7	Adult bees and brood relatively tolerant of temperature	
Varroa unable to reproduce	100	37.8		
	102	38.9		
	104	40.0		
Mites seriously stressed	106	41.1	Typical thermal treatment	Adult bee and brood short-term temperature tolerance
	108	42.2		
Mites die fairly rapidly	110	43.3		
	112	44.4		
	114	45.6	Increasing danger to adult bees and brood	
Mites die rapidly	116	46.7		
	118	47.8		

For further reading:
https://www.varroa-controller.com/wp-content/uploads/2020/05/Handbook-of-heat-treatment-against-the-Varroa.pdf

Use of Lithium Chloride

A successful trial involving using small amounts of Lithium Chloride mixed in sugar syrup has proven to be successful. With >95% mite fatalities within 48 hours, this method could very well be successful, but is not yet registered in Australia and should not be used until it is.

For further reading:
https://scijournals.onlinelibrary.wiley.com/doi/full/10.1002/ps.8311 -:~:text=Owing to its systemic mode,bee anatomy for lithium accumulation.

Acknowledgements:

The above information has been collected from a vast number of sources from the Internet. To the best of my knowledge, the information is accurate at the time of compiling, and has been done in an effort to increase your interests and skills in managing varroa destructor mites.

If anyone believes there are errors, please feel free to contact the Southern Beekeepers Association.