Technology Transfer Program

BC Honey Producers' Association

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Spring 2022: Colony Mortality and High Varroa destructor Levels

At different paces, the beekeeping season is arriving in different regions of BC. Some beekeepers are still looking at hives covered in snow and looking for signs of activity (like dead bees in front of the hive or signs of cleansing flights). Others are already opening their hives (10°C) or inspecting frames (>15°C). Spring is a critical time to inspect for brood diseases, like American Foulbrood, and to start monitoring for *Varroa destructor*. *Varroa destructor* is an ectoparasite that feeds on the hemolymph and fat body of bees, and acts as vector for a number of viruses like Deformed wing virus A and B. The parasitosis caused by *V. destructor* is not easy to control; the best way to treat honey bee colonies against varroosis is by implementing Integrated Pest Management (IPM). IPM has different components, including: a) incorporating a resistant stock against *V. destructor*, b) monitoring mites every 4-6 weeks, c) using cultural and mechanical methods to disrupt the biological cycle of the mite, and d) applying treatments (acaricides/miticides).

There are two types of acaricides based on the origin of the active ingredient: non-synthetic acaricides and synthetic acaricides.

1. Non-synthetic acaricides

1.1 Essential oils (Thymovar®, Api Life VAR®)

Essential oils are volatile compounds extracted from plants. A number of essential oils have shown to be effective against *V. destructor*, and some are available as commercial products like thymol and menthol (Table 1). The products are formulated in different matrices, including impregnated wafers, tablets, and strips.

Mode of action: thymol and menthol likely kill *V. destructor* by binding to GABA or octopamine receptors, but we need more studies to understand their acaricidal effect. Essential oils should be applied using the commercial products, which contain the dose necessary to kill the mites.

Advantages: low risk of *V. destructor* mites developing resistance, low cost, and low risk to human and environmental health.

Disadvantages: variable efficacy, their delivery depends on outside temperature to evaporate and reach adequate concentrations inside the hive, and they have low efficacy against mites inside capped cells.

1.2 Beta acids (Hop Guard II®)

Beta acids are compounds derived from hop plants, only one product is commercially available in combination with essential oils (Table 1).

Mode of action: their mode of action is not fully understood, but they have been shown to have repellent effect on some arachnids (e.g. two-spotted spider mites) and to be effective for the control of varroa mites. Beta acids and essential oils should be applied using the commercial product, which contain the dose necessary to kill the mites.

Advantages: low toxicity to honey bees and mammals, and the product is relatively easy to apply (strips).

Disadvantages: their efficacy is variable and depends on outside temperature (reported efficacy from 43-88%).

Table 1. Non-synthetic acaricides registered to treat for *V. destructor* parasitism in Canada.

Product	Active ingredients	Formulation	Outside Temperature	When	Honey flow
Thymovar®	Thymol	Impregnated wafer	20-30°C	Spring, late summer to early fall.	Do not use during honey flow
Api Life VAR®	Thymol, eucalyptus, menthol, and camphor	Impregnated tablet	18 - 35°C	Spring, summer, fall, winter.	Do not use during honey flow
Hopguard II®	Hop beta acids	Strip	11-33°C	Spring, late summer, and fall.	Do not use during honey flow

1.3 Organic acids

There are two organic acids used for varroa control: oxalic acid and formic acid.

1.3.1 Oxalic acid. Oxalic acid comes in crystals, and it can be applied by tricking a solution of oxalic acid (dissolved in sugar syrup) or using an electric evaporator (Table 2).

Mode of action: its acidic nature seems to be responsible for mite mortality upon contact, but their mode of action is not fully understood.
Advantages: if used properly, it has a >90% efficacy, and there is no evidence of resistance of the mites to oxalic acid.
Disadvantages: it is not effective for mites inside capped cells, and it can have negative impacts on brood development.

1.3.2 Formic acid. Formic acid can be applied as a gel or as a liquid solution (Table 2).

Mode of action: the mode of action is not well understood, but it appears to have an effect on energy metabolism by inhibiting electron transport in the mitochondria.
Advantages: it is effective at killing mites during the dispersal phase (when the mites are attached to adult workers or drones) and mites inside capped cells. Formic Pro® and MAQS® are the only treatments that can be used during the honey flow.
Disadvantages: its efficacy is variable (35-90%); it depends on outside temperature and the amount of brood. It can cause high honey bee mortality if the outside temperature is high.

When using oxalic and formic acid, make sure to wear Personal Protective Equipment. Ask for help if you are not familiar with the use of organic acid treatments.

Table 2. Organic acids registered to treat for *V. destructor* parasitism in Canada.

Product	Active ingredients	Formulation	Outside Temperature	When	Honey flow
Formic Pro®	Formic acid (42.25%)	Gel strip	10-29.5°C	Spring, summer, and fall.	Yes, in accordance with label instructions
Mite Away Quick Strips® (MAQS)	Formic acid (46.7%)	Gel trip	10-29.5°C	Spring, summer, and fall.	Yes, in accordance with label instructions
MiteGone®	Formic acid 65%	Kit/pads	10-30°C	Spring and late summer.	Do not use during honey flow
Formic acid 65%	Formic acid 65%	Liquid	10-30°C	Spring and late summer.	Do not use during honey flow
Oxalic acid	Oxalic acid	Solid	>3°C	Early spring and late fall.	Do not use during honey flow

2. Synthetic acaricides

The three synthetic acaricides registered to use in Canada are Apivar® (amitraz), Apistan® (tau-fluvalinate), and Bayvarol® (flumethrin) (Table 3). These products have been on the market since the 90's and were very effective to control mite levels (>99% efficacy). There is growing concern that synthetic acaricides are showing a reduced efficacy to control mites through the development of resistance. To confirm suspected low efficacy an appropriate bioassay, like the Pettis test, should be done. Additionally, to prevent the development of resistance by the mites to the synthetic acaricides and to prevent environmental pollution, it's important to follow the instructions of the products and dispose of the plastic strips adequately when the treatment is completed.
Mode of action: The active ingredients of these synthetic acaricides are neurotoxic (tau-fluvalinate and flumethrin act by inhibiting gated sodium channels, and amitraz by interacting with octopamine receptors in the mite's central nervous system).
Advantages: easy to apply and relatively low cost.
Disadvantages: decreased efficacy has been reported for some of these products in parts of North America, they can leave residues in the hive and the environment, and they are toxic to mammals.

Table 3. Synthetic acaricides registered to treat for *V. destructor* parasitism in Canada.

Product	Active ingredients	Formulation	When	Honey flow
Apistan®	Tau-fluvalinate	Plastic strip	Early spring or fall	Do not use during honey flow
Apivar®	Amitraz	Plastic strip	Early spring or fall	Do not use during honey flow
Bayvarol®	Flumethrin	Plastic strip	Early spring or fall	Do not use during honey flow

Main Recommendations When Treating for Mites:

1. Don't rely only on treatments, use an Integrated Pest Management (IPM) strategy to control mites by:
   - Monitoring mites every 4-6 weeks.
   - Monitoring mite levels before and after mite treatment (check if the treatment worked!).
   - Using cultural and mechanical methods to control *V. destructor* population growth.
   - Incorporating a resistant stock (honey bees bred for *V. destructor* resistant traits).
2. Apply only registered products in Canada and consider:
   - Mite levels; if mite levels are 3% or higher in the fall, the colony is at high risk of not surviving the winter.
   - Outside temperature.
   - If there is capped brood present.
   - If the product can be applied during honey flow.
3. Follow the label's instructions.
4. Follow the Ministry of Agriculture and Food recommendations.
5. Use Personal Protective Equipment.
6. Ask for help if you don't have experience, especially with organic acids.

Invitation to Participate in the Citizen Science Study

BC-TTP will be conducting a **Citizen Science Study** to revise *Varroa destructor* economic thresholds (ET). Through three brief online surveys, we will be collecting information on varroa mite levels and health parameters (i.e. colony strength, honey yield, and overwinter mortality). We invite all in the BC beekeeping community to participate. The data that we collect from small and large-scale beekeeping operations will help us revise varroa ET and understand more about the impacts of varroosis on bee health. These projects will lay the foundation for future studies on new varroa treatments and methods to control *V. destructor*.

The first 30 beekeepers to submit their Spring data will receive a surprise gift from BC-TTP!

All the information on how to get involved is in our website www.ttp-bchpa.ca <click on Get Involved>

New Team Member

Tim Wang
Honey Bee Health
Intern 2022

Tim is passionate about beekeeping and researching pollinators in British Columbia. Fascinated by the complex yet vital connections between pollinators, plants and the ecosystem they are a part of, he is keen to aid the efforts in investigating health factors of honey bees. Tim lives in the Lower Mainland, BC, and he got his undergraduate degree at the University of Toronto, where he gained an interdisciplinary perspective on science communication. He will align both his passion and communication skills to assist in field work and social media of the BC-TTP.

For more information on BC-TTP
www.ttp-bchpa.ca
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Social media: @bc_ttp

BC-TTP Team
Nuria Morfin, Program Lead
Becky Miller, Admin Staff
Tim Wang, Honey Bee Health Intern New Team Member

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