TOOLS FOR VARROA MANAGEMENT

A GUIDE TO EFFECTIVE VARROA SAMPLING & CONTROL

HEALTHY BEES · HEALTHY PEOPLE · HEALTHY PLANET™

HONEY BEE HEALTH COALITION™

Eighth Edition - August 1, 2022

ABOUT THE HONEY BEE HEALTH COALITION

The Honey Bee Health Coalition was formed in 2014 as a cross-sector effort to promote collaborative solutions to honey bee health challenges. The diverse Coalition brings together diverse stakeholders including beekeepers, growers, researchers, government agencies, agribusinesses, conservation groups, manufacturers and brands, and other key partners dedicated to improving the health of honey bees and other pollinators. The Coalition's mission is to collaboratively implement solutions that will help to restore and enhance the health of honey bees while also supporting the health of native and managed pollinators in the context of productive agricultural systems and thriving ecosystems.

A major tenet and founding principle of the Coalition is the recognition that the current decline in overall honey bee health is a multi-factorial problem, and all stakeholders have a role to play in managing bee health issues. The Coalition is focusing on accelerating improvement of honey bee health in four key areas: forage and nutrition, hive management, crop pest management, and outreach, education and communications. As part of the hive management focus area, the Coalition has developed this "Tools for Varroa Management" Guide that beekeepers can use to help focus on more effectively controlling the varroa mite in managed hives.

For more information on the Coalition and its key focus areas/products, please visit: *http://honeybeehealthcoalition.org/*

TABLE OF CONTENTS

Every honey bee colony in the continental United States and Canada is susceptible to infestations with Varroa destructor mites (varroa). Varroa infestation represents one of the greatest threats to honey bee health, honey production, and pollination services. Untreated or ineffectively treated colonies can fail, causing economic losses to beekeepers, and, ultimately, impacting agricultural food production through the loss of pollination services. In addition, colonies infested with varroa are a potential source of mites and diseases that can spread to other colonies and apiaries, through drifting, robbing, and absconding activity of bees. Management actions such as introducing brood frames, packaged bees or swarms to colonies or adding external splits, nucs or fullsize colonies to apiaries can further contribute to the spread of varroa.

All beekeepers should remain vigilant in monitoring for varroa levels and be prepared to take timely action to reduce mite loads. Effective varroa control will reduce colony losses and avoid potential spread of infectious disease among colonies.

This Guide will explain practical, effective methods that beekeepers can use to measure varroa infestations in their hives and select appropriate control methods. The Honey Bee Health Coalition offers this Guide free of charge and asks that you please reference the Coalition if distributing.

This Guide represents the current state of the science regarding varroa mites. It will be updated as new products or information become available. Check cover page to be sure you have the latest edition.

ABOUT VARROA MITES

Varroa destructor (varroa), is a parasite that lives on the outside of its host. The mite feeds on the brood and adults of western (European) honey bees, *Apis mellifera*. When left untreated, colonies with high levels of these mites may die within months. Varroa reduce overall colony vigor as well as transmit and worsen honey bee viral infections. Varroa, which is present on all continents, except Antarctica, is the most damaging honey bee pest and is a major factor responsible for colony losses worldwide.

Adult varroa can readily disperse within and among bee colonies. They readily spread among colonies and apiaries through natural drift of workers and drones, robbing of weak colonies by stronger ones, swarming, and absconding, or through human-aided exchange of bees and brood frames between colonies. Mites do not live longer than a few days without their host; so unoccupied bee equipment does not harbor live mites.

Even after a colony has been treated some varroa remain and mite populations can rebound quickly and unexpectedly. As a rule, in colonies with brood, uncontrolled ***mite populations can double monthly***. This increase can happen quicker if the colony has large amounts of drone brood, or if varroa are transmitted from neighboring colonies.

Therefore, beekeepers should have an IPM plan in place to frequently and regularly monitor and manage varroa in their colonies.

Honey Bee and Varroa Mite Seasonal Development

Honey bees and their parasitic varroa mite cycle through four temporal phases. In some locations, there is one cycle of these four phases per year and, in other locations, more than one cycle. The phases are:

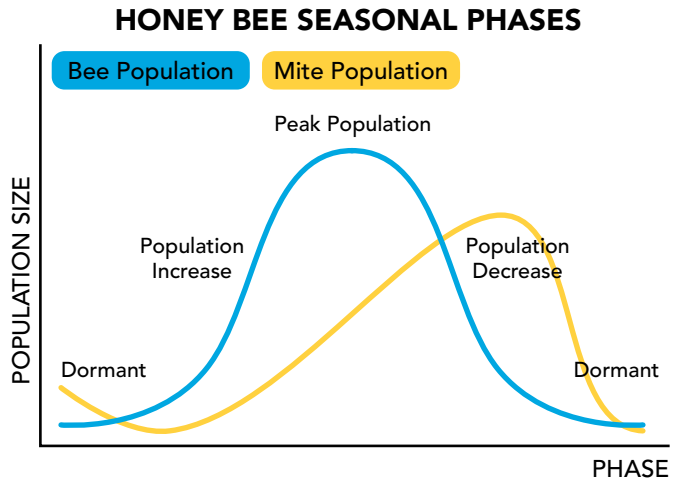
- Dormant
- Population Increase
- Population Peak
- Population Decrease

Varroa mite populations increase and decrease in synchrony 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 the adult bees. Eventually, varroa numbers decrease, along with the adult bee population.

The size of the mite population at the start of 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. and are referred to as phoretic (dispersal) mites. When there is reduced brood rearing, mite reproduction may be continuous during this phase (see Figure 1).

Figure 1: Varroa Mite Life Cycle

For details on the Varroa Life Cycle consult:
www.extension.org/pages/65450/varroa-mite-reproductive-biology



INTEGRATED PEST MANAGEMENT (IPM)

Integrated Pest Management (IPM) is a set of proactive, control methods that offer beekeepers the best "whole systems approach" to controlling varroa.

This Guide presents information about IPM techniques that integrate:

- Rigorous monitoring of mite populations to detect increases in their levels early and to assess the effectiveness of controls.
- Use of cultural practices (*i.e.*, breeding, screen bottom board, removal of drone brood, *etc.*) to slow mite population build-up.
- Rotation of treatment methods that considers mite/ bee population dynamics and minimizes potential development of mites
- Resistance caused by repeated use of only one treatment method.

IPM techniques can help beekeepers maintain varroa mite levels in colonies below 2 to 3 mites per 100 adult bees (*i.e.*, a 2 to 3 percent infestation level). Current data suggest that using these treatment thresholds may be a successful strategy for decreasing overall colony losses.

There is no "one-size-fits-all" solution for varroa management. This Guide reviews the efficacy, application, advantages, and disadvantages of a wide variety of control methods. This allows beekeepers to choose an approach suited to their individual circumstances and risk tolerance.

Doing nothing to control varroa levels is not a practical option for most beekeepers. The overwhelming majority of honey bee colonies are not capable of surviving or thriving unless the beekeeper prevents varroa from reaching damaging levels. If the beekeeper does not control varroa, a colony is likely to die and, in the process, spread mites and infections to other colonies.

Use our Varroa IPM Tracking and Control spreadsheet located on the back page of this Guide. Download here: *http://bit.ly/varroa-spreadsheet*


Photo Credit: Medhat Nasr

IPM and Varroa Mite Control

For more information, watch our video on IPM and varroa mite control: *http://bit.ly/varroaipm*

The information presented in this Guide will best help beekeepers who recognize that optimum management of varroa is based on understanding:

- The life cycles of both the honey bee colony and the mite.
- The number of mites present in the colony at any point in time.
- How tactics to control mites vary according to the seasonal phase of the bee colony and type of beekeeping operation.
- An IPM approach discourages reliance on a single, repeating treatment; it involves timely use of appropriate tools, including chemical control when necessary.

Successful varroa control solutions are proactive. They control varroa before the mites reach levels that threaten colony productivity and survival, rather than respond after the damage has occurred.

DESCRIBING VARROA MITE LEVELS

The most accurate way to describe varroa mite infestation is the **number of mites per 100 adult bees.** For brevity, this Guide expresses mite levels as a percentage.

For example: "3 mites per 100 adult bees" is written as "3 percent" in this Guide.

MONITORING VARROA MITE POPULATIONS

Bee colonies can tolerate a low number of mites but will collapse and eventually die as mite levels rise. Monitoring (via sampling) varroa levels in colonies enables a beekeeper to estimate mite infestation level. Accurately assessing the mite population to determine if treatment is necessary forms the basis of an IPM control strategy.

Waiting too long to confirm elevated mite population is risky. A delay in treatment can elevate mite levels past a threshold that may reduce a colony's likelihood of survival over the dormant phase and contribute to spreading mites to other colonies.

Beekeepers can assess mite populations during any of the phases of bee/mite population cycles. ***Generally, a beekeeper should perform varroa monitoring assessments at least four times during the year, beginning with the Population Increase phase.***

During the bee Population Decrease phase, mite levels should be checked more frequently to confirm that infestation levels are low going into the Dormant phase. Sampling during the Dormant phase is less important because mite production is reduced plus it may be too cold to safely sample bees during this time. It is best to wait until milder conditions permit sampling.

Always repeat sampling after treatment to confirm the effectiveness of the treatment that was performed.

Immediately treat colonies when sampling results warrant.

Recommended Sampling Methods

For more information and a demonstration of both sampling methods, please watch our video: http://bit.ly/sampling-methods

Sampling methods involving the removal of mites from the bodies of adult bees, then counting the mites to establish a standard percentage measure of mite numbers provide the best estimates of mite infestation.

Two methods that sample mites in this manner are the ***powdered sugar shake and the alcohol/soap wash. Use of powdered sugar shake is less reliable (more variation in mite count) sampling method compared to alcohol/soap wash. Practice improves accuracy with both methods.***

This section also evaluates alternative sampling methods that are less reliable. They should only be used as a secondary confirmation of the varroa levels indicated by more accurate methods.

See the References and Additional Resources section for journal articles on sampling methods.

EQUIPMENT NEEDED:

Note: You can purchase sampling kits and follow the instructions provided or utilize the equipment list below to build your own.

- Wide mouth jar, such as quart Mason canning jar
- Solid lid replaced with modified # 8 screen mesh
- Powdered sugar, or
- Alcohol (any of the following): ethanol, ethyl alcohol, or isopropyl (rubbing) alcohol, or
- Non-sudsing soap or automotive windshield washer fluid with at least 40% alcohol)
- White plate, tray, or similar device. (Paper boards or sheets can be used for the powdered sugar shake method.)
- Water mister (to dissolve powdered sugar)

COLLECTING THE SAMPLE (BOTH METHODS)

Collect a sample of approximately 300 adult bees from one to three brood-nest combs (**avoiding the queen**). Three hundred bees are equivalent to about ½ cup of lightly packed bees. Using less than 300 bees will not give you an accurate sample.

- Mark a wide-mouthed, open neck glass or plastic collection jar with a line at ½ cup.
- Select a brood frame. Look for the queen. If she is present, set the frame aside or move her to another frame.
- Collect adult bees directly into the collection jar from a brood frame by moving collection jar downward over the adult bees on the frame, so they fall backwards.
- Alternately, shake bees directly from two or three brood frames into a larger collecting container (plastic pail or dishpan, or lipped tray.) Scoop up ½ cup of adult bees and quickly pour them into the sampling jar.

Experiment with your collection technique to consistently obtain a 300-bee sample.

Bees sampled by powdered sugar shake can be returned to the hive after testing. With the alcohol or soap wash method, the bees will be sacrificed.

POWDERED SUGAR SHAKE METHOD

1. Add approximately two tablespoons of powdered sugar to the jar. For best results, sift the powdered sugar through a flour sifter to ensure a fine texture.
2. Vigorously shake the jar for **at least one minute** to cover the bees in sugar and dislodge the mites from the bees. To improve the consistency of mite counts, shake the jar for a consistent length of time for every sample.
3. Set the jar down and wait three to five minutes. (Rushing this increases the risk of undercounting the mites.)
4. Shake again then invert the jar and shake it like a salt-shaker, capturing sugar with falling mites onto a clean plate or pan below. Shake the inverted jar until mites stop falling out.
5. Spray the powdered sugar deposit in the plate or pan with a water mist to dissolve the sugar.
6. Count the mites that remain.
7. Add an additional tablespoon of powdered sugar to the jar, shake and roll the bees again for 30+ seconds, and repeat steps 4, 5, and 6 to improve the accuracy of the count.
8. Count the number of mites in the plate or pan.
9. Calculate the total mite number per 100 adult bees. (See *Counting the Mites*)
10. Sampled bees can be released back into the top of their colony or at colony entrance.

Do not rush – allow temperature to build up in jar with powdered bees before shakeout.

If you perform this test in high humidity or during strong nectar flow (when bees may have nectar in their honey stomachs), dampness will cause the sugar and mites to adhere to the bees.

ALCOHOL OR SOAP WASH METHOD

Perform the alcohol or soap wash away from the smoker.

1. Add enough alcohol, low-sudsing soap, or winter automotive windshield washer fluid to completely cover the 300-bee sample in the jar. Note, you can add alcohol to the soap to decrease sudsing.
2. Vigorously swirl the jar for **at least one minute** to dislodge the mites from the bees. To improve the consistency of mite counts, shake/swirl the jar for a consistent length of time for every sample.
3. After swirling, empty the liquid contents into a clear plate or white shallow pan through a mesh screen that traps the adult worker bodies while allowing the mites to fall through.


Photo Credit: Bee Informed Partnership

4. Add more alcohol or soap solution to the jar and repeat steps 2 and 3. (This increases the accuracy of the count.)
5. Count the number of mites in the plate or pan.
6. Calculate the mite number per 100 bees. (See Counting the Mites.)

COUNTING THE MITES (BOTH METHODS)

The goal of mite assessment is to determine the number of varroa per 100 adult bees, expressed as the percentage of infestation.

Counting steps:

- Count the total number of mites collected in the plate or pan.
- Divide that number by the number of bees in the sample.
- Multiply by 100 to yield a percentage.

Example:

A beekeeper samples 300 adult bees and counts 12 mites in the pan.

12 mites ÷ 300 bees = .04 X 100 = 4% (4 mites per 100 adult bees)

To increase the accuracy of the assessment, count the actual number of bees in each sample. As you gain experience with sampling, your sample sizes will become more consistent.

How many colonies to sample for Varroa mites?

If an apiary has fewer than ten colonies, sample each colony. For larger apiaries, sample 300 adult bees collected from one brood frame in a minimum of eight randomly selected colonies in each apiary (or 3 to 5 percent of total colonies within multiple apiaries). If possible, include colonies from the center as well as the outer edges of the bee yard.

Interpreting Sample Findings

When using the recommended powdered sugar shake or alcohol or soap wash sampling methods we suggest ***using the following guidelines (Table 1) to determine when a colony needs treatment and to evaluate treatment efficacy. Mite thresholds are an evolving science and are often situation and regionally specific. Consult local apiary inspector or extension service for advice.***

Table 1: Treatment Thresholds by Colony Phase (%=Number of mites/100 adult bees)

Colony Phase	% Immediate control not needed	% Promptly control
Dormant*	<1%	>1%
Population Increase	<2%	>2-3%
Peak Population	<2%	>3%
Population Decrease	<2%	>2-3%

*Note, Sample just prior to clustering to determine whether bees are healthy going into dormancy.

When mite levels are below 1-2 percent, the infestation is considered to be reasonably low, so immediate control may not be needed. If sampling was done after treatment, this low level means that the treatment was successful in reducing the mites below damaging levels.

When mite levels are above 1-3 percent, apply mite control immediately, using a proven, effective, seasonally appropriate treatment method (See Table 3: Control Options by Seasonal Phase). If post-treatment tests show that mite numbers remain above 3 percent after treatment, apply another control chemical or method without delay.

Recommendations on when to treat, and at what percent infestation rate to treat, are subject to change. Beekeepers should stay current with recommendations based on new research findings.

COLONY LOSSES ASSOCIATED WITH VARROA MITE LEVELS

Various studies have found that winter colony losses increase with higher levels of varroa mite infestation. Losses can be expected even at a 3 percent infestation, and can increase rapidly with higher infestation levels. Some colony losses are inevitable, but treatment of varroa can be expected to keep losses at sustainable levels for most beekeepers.

USE CAUTION WHEN INTERPRETING ASSESSMENT RESULTS

Be very careful interpreting results from any single sampling technique. Inexperience with sampling procedures will affect results. Mite infestations vary from one colony to the next even in the same apiary. The same level of mite infestation poses different risks during different phases of the bee/mite annual cycles. Losses can be exasperated by other factors influencing colony health. Even a 2 percent infestation can increase rapidly to higher mite levels. Some colony losses are inevitable. However, treatment of varroa can be expected to keep losses at sustainable levels for most beekeepers.

SAMPLE OFTEN

Sampling several times throughout the year helps you better understand your colony, reduces sampling error and increases confidence in sampling results.

For example, mite populations can rapidly surge after honey harvest, or when colonies stop rearing brood and adult bee population decreases. This is a time when the colony must be healthy enough to successfully rear more bees to survive the Dormant phase. A single sample may not detect a rapid transition of mites from brood to adult bees during this period. A good rule is, "If in doubt, resample."

It is also important to sample after treatment to assess control effectiveness.

Alternate Sampling Methods for Varroa Assessment

While the two most accurate ways to determine numbers of varroa present during any seasonal phase of a honey bee colony are the powdered sugar shake method and the alcohol or soap wash method, some beekeepers continue to use methods that are not fully tested or are less efficient and less accurate. Alternate sampling methods may result in less consistent results. The Honey Bee Health Coalition does not recommend relying on the methods identified in the following (Table 2) table.

Table 2: Less Reliable Sampling Methods for Assessing the Number of Varroa Mites in Bee Colonies

Less Reliable Sampling Methods	
Method	**Concern**
Ether Roll	▪ Only detects 50 to 60 percent of mites. ▪ Material is highly flammable and can be dangerous to inhale.
Drone Brood Assessment	▪ Difficult to interpret results of percent of brood infested. ▪ Drone brood is not always present when sampling is needed. ▪ Immature mites are white/clear and are difficult to see.
Visual Inspection of Mites on Adults	▪ Unless mites are on thorax or top of abdomen, they are not easily seen. ▪ Finding mites on adults indicates that a high total mite population already exists.
Sticky (debris) Board	▪ May be useful to check mite population trends or as 'quick check' to confirm treatment effectiveness. Threshold suggested of <10 mites per day. ▪ Ants or other scavengers might remove mite bodies and interfere with estimates. ▪ Difficult to interpret number of mites per hour or per day to estimate total mite population.
CO_2 Sampling	▪ Use of CO_2 may be less accurate during honey flow. ▪ If used check accuracy by comparing with powdered sugar or alcohol/soap wash method

SELECTING CONTROL METHODS

As previously stated, there is no "one- size-fits-all" solution to varroa management. Hives should be monitored throughout the active season (see Figure 1) and if mites exceed threshold treatment should be administered.

Each beekeeper should select the control methods that are right for them. Success may require experimentation with several methods. It is important to alternate methods and not simply rely on one method of control. Relying on a single ***active ingredient*** or family of active ingredients for treatment will hasten development of miticide resistant populations and the number of options you will have to control mites.

Even newly established colonies (nucs, packaged bees, swarms) should be sampled and treated if mites exceed threshold levels noted in Table 1 above.

While mite densities may vary across colonies, all colonies in an apiary should be treated at the same time with the same control method. If sampling results indicate high mite levels in one colony within an apiary, do not delay treatment. Delay increases the risk of harm to the colony and the spread of varroa to other colonies.

Note:

- Beekeepers should ensure that all control products are legal (i.e., registered) for use to control varroa. Legal restrictions are changing and can vary from state to state. ***Read the product label and follow all label directions for use, storage and expiration date, advisory statements and precautions. Besides being potentially dangerous and ineffective, using any registered product in a manner inconsistent with its labelling is a violation of federal and state laws.***
- The efficacy of various treatments identified in the tables and product descriptions below are based on published studies, Bee Informed Partnership Management Surveys *(http://beeinformed.org/national-management/)*, the collective professional judgment of the principal drafter, and HBHC subgroup members. Science is ever-evolving and information presented in this Guide, including the tables below, is based on the best available science at the date of publication. It should not be construed as an endorsement or recommendation of any product or treatment.

Active ingredients are defined as those components of a product that affects the intended pest. Check the label to confirm which active ingredient you are using and whether there are recommended options for resistance management.

Try out the ***Honey Bee Health Coalition's Varroa Management Tool.*** This online decision tree tool helps beekeepers make informed varroa management and treatment decisions.

The tool will walk through a series of questions that will determine how best to manage varroa mites in an infected hive. *https://cantilever-instruction.com/varroatool/story_html5.html*

Summary of Controls Discussed in this Guide

CHEMICAL CONTROLS

Synthetic Chemicals	
Apivar®	See page 16
Apistan®	See page 17
CheckMite+®	See page 18
Essential Oils	
Apiguard® (U.S.) and Thymovar® (Canada)	See page 19
ApiLife Var®	See page 20
Acids	
Mite-Away Quick Strips® [MAQS®]	See page 21
Formic Pro©	See page 22
Formic Acid 65%	See page 23
Oxalic Acid/Api-Bioxal®	See page 24
HopGuard®3 (U.S.) and Hopguard II (Canada)	See page 25

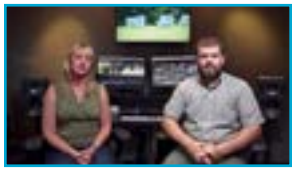
NON-CHEMICAL CONTROLS

Screen Bottom Board	See page 26
Sanitation (bee biosecurity/comb management)	See page 27
Drone Brood Removal	See page 28
Brood Interruption	See page 29
Requeening	See page 30

See details on each of these controls in the "Descriptions of Controls" section below.

Varroa Videos

Watch our series of videos that demonstrate step-by-step application of all controls covered in this guide.



Will Varroa kill my bes?

IPM

Sampling methods

Essential oils

Apivar®

Apistan® or Checkmite+ ®

Formic acid

HopGuard®

Oxalic Acid

Sanitation, screen bottoms

Drone brood removal

Requeening

Recommended Control Options by Seasonal Phase

Different control options are appropriate for each of the four population phases of the honey bee/varroa seasonal cycle. Below is a summary of options for each phase.

Table 3: Control Options by Seasonal Phase

Dormant Phase	
Bees are clustered; no brood in northern locations with reduced brood rearing in southern locations; all or most varroa mites are phoretic/dispersal (*i.e.*, on adult worker bodies, as there is little to no developing brood) and both populations are in decline because there is little or no reproduction occurring within the colony.	
Highly Effective Options: ▪ Api-Bioxal® bioxal Oxalic acid (fumigation method) (OAV) or dribble (OAD) ▪ Creating a broodless period ▪ HopGuard® 3 (US) Hopguard® II (Canada)	▪ OAV/OAD best utilized when little/no brood. ▪ Varroa mortality over extended broodless period is high. ▪ HopGuard® works best when little/no brood
Moderately Effective Options: ▪ In beekeeping regions with brood during this phase, Apiguard, Thymovar®, ApiLife Var®, 65% liquid formic acid, or Mite Away Quick Strips (MAQS®), Formic® Pro provided temperatures are within optimal ranges.	▪ The effectiveness of Apiguard®, Thymovar®, ApiLife Var®, formic acid, MAQS® and Formic® Pro during the dormant phase depends on the ambient temperature to ensure release of a sufficient dose to kill mites.
Least Effective Options: ▪ Any hive management practices that risks colony success through this phase (e.g., queen caging, opening the hive to apply a treatment) ▪ Open screened bottom boards (SBB)	▪ Open screened bottom boards only remove a small percentage of mites that fall from adult bees. Many prefer to close or reduce SBB during this phase rendering it ineffective.
Population Increase	
Seasonal colony buildup; colony brood population growing rapidly and adult worker population increasing; varroa mite population usually low but increasing; pre-honey flow supering of colonies.	
Highly Effective Options: ▪ Apivar® ▪ Apiguard®, Thymovar®, or ApiLife Var® ▪ MAQS® or Formic Pro® ▪ Drone brood removal	▪ Apivar® must be terminated after a 42- to 56-day treatment period, two weeks prior to adding supers ▪ Apiguard® treatment must be terminated prior to adding supers. ▪ ApiLife Var® must be terminated after 2 or 3 treatments (7-10 days each). Remove ApiLife Var® tablets from the hive at least one month before harvesting honey. (If colonies are not used in honey production, use OK.) ▪ In Canada liquid formic acid is registered for use. ▪ MAQS®/Formic Pro® use is legally permitted when colonies are supered. ▪ Drone brood removal may be used 2-3 times on strong, populous colonies.
Moderately Effective Options: ▪ HopGuard® II and HopGuard®3 ▪ Colony division (Swarming or making divides/splits) ▪ Requeening using hygienic stock ▪ Basic sanitation ▪ Movement to confinement (effectiveness undetermined)	▪ Hopguard® II/3 effective on smaller colonies during buildup or following almond pollination service. It may reduce mite levels during buildup. ▪ Dividing the colony during the Population Increase phase may reduce surplus honey production. ▪ Hygienic queens are not always available. ▪ Basic sanitation may help reduce other stressors.
Least Effective Options: ▪ Screen bottom board ▪ Powdered sugar ▪ Mineral oil ▪ Failure to perform timely hive managements	▪ A screen bottom board is marginally effective. ▪ There is little evidence that powdered sugar or mineral oil has any effect on mite populations.

Population Peak	
Bee population (both adult & brood) at peak; mite populations increasing, nearing peak; often honey supers on colonies.	
Highly Effective Options: ▪ MAQS® or Formic Pro© ▪ If no supers are re present or colonies are not producing honey Apivar®, or Apiguard®, or ApiLife Var® can be used	▪ MAQS®, Apiguard® and ApiLife Var® are not suitable for use in all temperatures. See the detailed descriptions of products below for temperature ranges for use of these products. ▪ Apivar® (amitraz) is highly effective. Be cautious about using it too often to avoid risk of developing mite resistance.
Moderately Effective Options: ▪ Requeening with hygienic stock ▪ Division of colonies ▪ HopGuard® II and HopGuard® 3 ▪ Api-bioxal Oxalic acid drip (OAD) or vaporization (OAV)	▪ Hygienic or locally selected stock is not widely available. ▪ If colonies are strong enough to produce surplus honey, requeening or dividing (splitting) colonies may negatively affect honey production. ▪ HopGuard® II and HopGuard® 3 can be used while colonies are supered for honey production; Oxalic acid is best used when there is little or no capped brood in the colony during the Dormant Phase or on broodless colonies during queen replacement
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 is restricted in this phase by the absence of sufficient drone brood and the difficulty of accessing the brood nest beneath honey supers.

Population Decrease	
Post-honey harvest; bee population decreasing; colonies rearing overwintering bees. Varroa mite populations growing, peaking, and then declining until eventually only phoretic/dispersal mites on adult bees after colonies become broodless.	
Highly Effective Options: ▪ Apivar® ▪ MAQS®, Formic Pro©, 65% liquid formic acid ▪ Apiguard®, Thymovar®, or ApiLife Var® ▪ HopGuard® II, HopGuard® 3	▪ Apivar® should not be used until surplus honey is removed. ▪ MAQS®, Formic Pro©, Apiguard®, Thymovar®, and ApiLife Var® are not suitable for use in all temperatures. See the detailed descriptions of products below for temperature ranges for use of these products.
Moderately Effective Options: ▪ Requeening with hygienic bees ▪ Division of colonies ▪ Api-bioxal© Oxalic acid dribble (OAD) or vaporization (OAV)	▪ Hygienic stock is not widely available. ▪ Requeening and dividing colonies may be difficult because colonies are shrinking as dormant season approaches. ▪ Oxalic acid is most effective if there is little to no capped brood present.
Least Effective Options: ▪ Apistan® or CheckMite+® ▪ Drone brood removal ▪ Screen bottom board ▪ Sanitation	▪ Mite resistance to Apistan® and CheckMite+® is well documented. ▪ Colonies are unlikely to raise drones during this phase. ▪ Basic sanitation may help relieve stress.

NON-RELIABLE, NON-TESTED METHODS AND UNREGISTERED (ILLEGAL) CHEMICALS

Several treatments are ***ineffective, lack independent verification, or are unregistered*** for varroa control, including:

- Mineral oils
- Unregistered organic acids (such as lactic or acetic acid)
- Food stimulants and supplements
- Powdered sugar
- Small cell, "natural" comb for the rearing of smaller bees
- Heat/cold treatments
- Unregistered essential oils

Beekeepers should never use an unregistered chemical or ***use a registered chemical inconsistent with label directions*** to control mites. Such use may violate both federal and state laws and may result in unintended consequences to the colony and beekeeper.

Treatments ***not*** described in this guide should be avoided until adequately evaluated and registered for varroa control.

DESCRIPTIONS OF VARROA CONTROL OPTIONS

To follow you will find tables that provide detailed information on varroa mite controls.

Flag icons indicate U.S. and/or Canadian registration.

Symbols (gloves, eyewear protection (goggles) and respirator) shown to left are included with varroa mite controls to help guide in choosing personal protective equipment.

Personal Protective Equipment

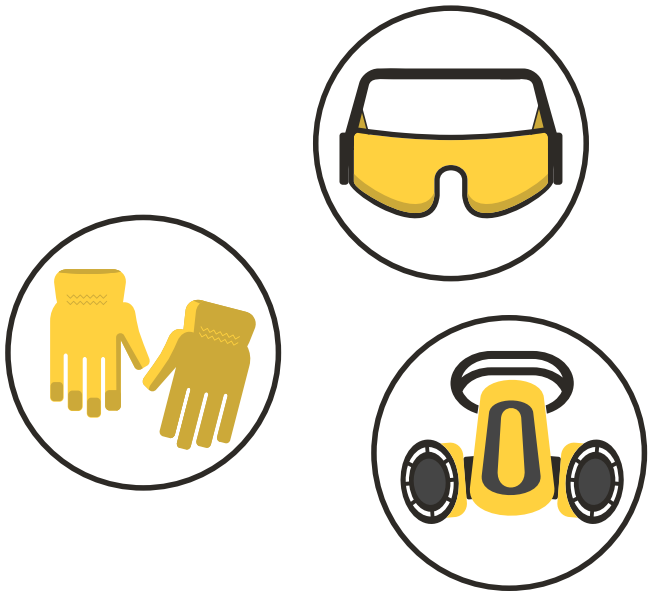
Check Label: Always check the label before use of chemicals and direct employees to do likewise, being certain they understand and follow the instructions on the label. Follow the label if specific protective clothing or equipment is included.

Clothing: Use shirts with long sleeves, pants and sturdy footwear when using chemicals.

Gloves: Use acid resistant gloves when handling hops *beta* acids and products containing formic acid and when mixing/ applying products containing oxalic acid. Protective gloves are recommended when using Apivar® or essential oils to avoid direct contact with skin surfaces.

Eye protection: Use of goggles is recommended when mixing oxalic acid into sugar water and for dribble or spray application to bees. Do not rub eyes or nose after use of any chemicals until after thorough washing of hands. As a general rule, eye protection should be used when working with any chemical.

Respirator: Please note that while there are many styles and models of respirator on the market, for the purposes described below, the Coalition recommends a full-face cartridge respirator with particulate filter. Use 3M™ Models 6002 or 6003 (but not the common painter's respirator Model 6001). Some bee equipment suppliers sell an oxalic acid appropriate respirator.



Managing Resistance

Varroa progress rapidly through their life cycle. When repeatedly challenged with a specific active ingredient, the mite is likely to develop resistance. Increasing dosage or use of more frequent applications may hasten the development of resistance and reduce the number of options for effective mite control. Using products having varying active ingredients (*i.e.*, practicing IPM) during the year or in different seasons, when available, will help slow development of mite resistance.

Initial indications of mite resistance may be a "treatment failure" and/or need for more treatments. A treatment failure could be due to improper application, use of outdated (expired) control material, improper storage of miticides or other factors. For the synthetic miticides (*i.e.*, Apistan®, Bayvarol, Apivar® and Checkmite®) your State, Tribal, or Provincial apiculturists may help identify if a treatment failure or less effective mite kill could be due to increased mite resistance against the applied active ingredient.

Chemical Controls

SYNTHETIC CHEMICALS

Apivar®	
Name	Apivar® (Véto-pharma)
Active Ingredient	Amitraz (formamidine acaracide/insecticide)
Formulation	Formulated as slow-release blended and extruded polymer strip
Route of Exposure	Contact
Treatment Time/ Use Frequency	42 to 56 days, then remove strips; Treat all hives in apiary at same time.
Time of Year	**Population Increase:** Only if colonies will NOT be supered within 8 weeks; **Population Decrease:** Immediately following peak population once honey harvested.
Registrant-reported Effectiveness	Up to 95% effective. Please note that this depends on mite resistance and on the extent of prior use. See label for mite resistance management.
Conditions for Use	Place 1 Apivar strip per 5 frames of bees. Place strips near the bee cluster or – in case brood is present – in the center of the brood nest. Only use Apivar in brood boxes where honey for human consumption is NOT being produced. NOTE: Chemical is controlled release so immediate mite knock down may not occur.
Restrictions	It is not recommended to use more than 2 times per year; rotate with other products including different active ingredients; DO NOT USE WHEN COLONIES ARE SUPERED FOR HONEY; WAIT TWO WEEKS BEFORE SUPERING FOLLOWING USE.
Advantages	Safe and highly effective unless there is mite resistance or the cluster moves away from contact with strips.
Disadvantages	Residues may be detected in beeswax & honey; some indications of mites developing resistance where Amitraz has been used for several seasons (including prior to registration of Apivar). Apivar is a long-term treatment that does not provide immediate mite knockdown, but works throughout the treatment period of 42 to 56 days.
Considerations	The only legally permissible (i.e., registered for use in bee colonies) amitraz is Apivar®; do not reuse strips; store unopened packages at room temperature; opened packages should be used up immediately; perform resistance test and/or monitor mite levels following use to confirm control effectiveness. (See Bibliography & Resources for information on resistance testing.)
Video	Watch our Apivar video: *http://bit.ly/controls-apivar*

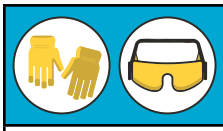
Apistan®

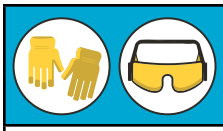
Name	Apistan® (Wellmark International)
Active Ingredient	*Tau*-fluvalinate (pyrethroid ester acaracide/insecticide)
Formulation	Formulated as slow-release impregnated flexible polymer strip.
Route of Exposure	Contact
Treatment Time/ Use Frequency	42 days (7 weeks); Do not leave strips in hive for more than 56 days (8 weeks); Treat all hives in apiary at the same time.
Time of Year	**Population Increase:** Before flow if 7 weeks or more until supering; **Population Decrease:** Following honey harvest
Registrant-reported Effectiveness	95 to 99% but ONLY if no mite resistance; resistance widely documented
Conditions for Use	Temperatures > 50°F (10°C); Do not use during nectar flow.
Restrictions	Best if daytime temperatures > 50°F (10°C); do not use when colonies are supered for honey.
Advantages	Highly effective with susceptible mite populations (Note: mite resistance has been well documented).
Disadvantages	Widespread mite resistance; contamination of hive components (*e.g.*, elevated fluvalinate residues in wax and comb pollen); persistent continued use may affect brood development; interaction with other pesticides can occur and jeopardize colony health.
Considerations	May adversely affect queen and drone reproductive health; wear chemically resistant gloves; perform resistance test before use and/or monitor mite levels following use to confirm control effectiveness. (See Bibliography & Resources for information on resistance testing.)
Video	Watch our Apistan video: http://bit.ly/controls-apistan

CheckMite+®

Name	CheckMite+® (Elanco Healthcare)
Active Ingredient	Coumaphos (organothiophosphate acaricide/insecticide)
Formulation	Formulated as slow-release impregnated rigid polymer strip.
Route of Exposure	Contact
Treatment Time/ Use Frequency	Treatment time 6 weeks; Do leave the strips in hive for more than 45 days; Use 2x/year
Time of Year	**Population Increase:** Only if colonies will NOT be supered within 6 weeks **Population Decrease:** After honey harvest
Registrant-reported Effectiveness	85 to 99% (if no mite resistance). Effective against the small hive beetle (but application method is different compared to when used for mite control.)
Conditions for Use	Wait two weeks after use before supering.
Restrictions	Do not use in queen rearing colonies; Do not use when colonies are supered for honey; Wait two weeks after use before supering.
Advantages	Effective and easy to use when mite populations are susceptible (note: extensive mite resistant populations in United States and Canada); can be used to control the small hive beetle adults (applied in different manner).
Disadvantages	Mite resistance; organophosphate; contamination of hive components; (*e.g.*, elevated coumaphos residues in wax and comb pollen) long half-life; negative activity with other products; negatively affects reproductive health of queens queen rearing & drones (sperm production).
Considerations	Wear chemically resistant gloves; perform resistance test and/or monitor mite levels following use to confirm control effectiveness. (See Bibliography & Resources for information on resistance testing.)
Video	Watch our CheckMite video: *http://bit.ly/controls-checkmite*

ESSENTIAL OILS

 Apiguard® /Thymovar® 	
Name	Apiguard® (USA Vita Beehealth) and Thymovar® (Andermatt-Canada)
Active Ingredient	Apiguard 12.5g, Thymovar 15g. Conditions for Use: Apiguard Temperature restrictions >59°F and <105°F (15 to 40°C), Thymovar Temperature restrictions >59°F and <85°F (15 to 30°C), Apiguard can be stored up to 85°F (30°C) and Thymovar up to 77°F (25 °C).
Formulation	Apiguard gel - individual hive dose or bulk tub; Thymovar - individual dose as wafer
Route of Exposure	Apiguard: contact and Fumigant Before fumigant
Treatment Time/ Use Frequency	Apiguard®: Twice at 2-week intervals, apply individual dosage tray or 50 gm per for double box hive (remove or spread remaining gel over frame top bars at end of 4th week).. At temperatures above 77°F, a lower dosage of 25-26 ml (approximately 0.88 oz/25g) Apiguard gel can be used effectively. Repeat dose applications may be applied at intervals of 1-2 weeks, as needed for up to 4 applications of 25-26 ml (approximately 0.88 oz/25g) where mite infestations persist. Small and wintering bee colonies and nuclei require only one dose of 12-13 ml (approximately 0.44 oz/12.5g) to 25-26 ml (approximately 0.88 oz/25g). Apiguard gel (depending on the colony or nucleus size) left in place until the product disappears from the tray. Thymovar®: Twice at 3-4 week intervals, 1 wafer for single brood chamber and 2 for double box hive, remove excess materials at end of 2nd application.
Time of Year	**Population Increase:** Only if colonies will not be supered within 6 weeks **Population Peak:** Only if bees are not storing honey & not during pollination rental if temperatures are elevated **Population Decrease:** Post-honey harvest or approaching dormancy
Registrant-reported Effectiveness	74 to 95% (more effective with warmer temperatures)
Conditions for Use	Temperature range restrictions: Apiguard >59°F and <105°F (15 to 40°C) Thymovar >59°F and <85°F (15 to 30°C),
Restrictions	Do Not use when colonies are supered for honey.
Advantages	Naturally derived; no known varroa resistance to Thymol; easy to use.
Disadvantages	May reduce queen egg-laying activity; may increase adult and young larvae mortality; works best under warmer temps; may cause bees to beard in hot weather; human skin irritant.
Considerations	Use gloves; effectiveness reduced for light mite infestations; requires closed screen bottom board; consider using spacer rim above brood nest .
Video	Watch our Apiguard video: *http://bit.ly/controls-apiguard*

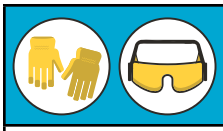


ApiLife Var®

Name	ApiLife Var® (Véto-pharma)
Active Ingredient	Thymol (74.09%) (8g), Oil of eucalyptus (16%), Menthol (3.73%) + camphor (essential oils)
Formulation	Tablet (wafer)
Route of Exposure	Fumigant
Treatment Time/ Use Frequency	3 tablets for 7-10 days each (leave 3rd tablet in hive for 12 days); Repeat or combine with another product, if heavy mite numbers.
Time of Year	**Population Increase:** Less effective but better during early season buildup or with low mite numbers **Population Peak:** If honey supers are not present **Population Decrease:** After nectar flow, with temperature considerations
Registrant-reported Effectiveness	70 to 90%
Conditions for Use	Divide tablet (wafer) into 4 pieces and place each piece in a corner of the hive on the top bars. Use between 65 to 95°F (18-35°C); ineffective below 45°F (8°C).
Restrictions	Remove at least 1 month (30 days) prior to adding honey supers and do not use during honey flows. Do not harvest honey from brood chambers or colony feed supers. Do not use Api Life Var at temperatures above 95°F degrees.
Advantages	Naturally derived, no known resistance to essential oils mix.
Disadvantages	Temperature considerations: may run bees out of hive at higher temperatures; increase in bee adult irritability; taints honey taste.
Considerations	Wear gloves; high temperatures may cause bees to exit hives and/or adult/brood deaths; may melt plastic hive parts; not available in all states (CA or HI).
Video	Watch our ApiLife Var video: *http://bit.ly/controls-apilifevar*

ACIDS

 Mite-Away Quick Strips® 	
Name	Mite-Away Quick Strips® (MAQS®), NOD Apiary Products
Active Ingredient	Formic acid (organic acid)
Formulation	MAQS®: saccharide gel strip in a laminated paper wrap formulation of 46.7% formic acid.
Route of Exposure	Fumigant
Treatment Time/ Use Frequency	There are 2 treatment options. For a full dose, use 2 strips for 7 days. For a half dose, use only 1 strip. Replace with fresh strip after 14 days for total 21 days. Do not feed colony when using MAQS®
Time of Year	**Population Increase/Population Peak:** Unique chemical that can be used while honey supers present **Population Decrease:** Following harvest if not too warm but bees flying regularly
Registrant-reported Effectiveness	61 to 98% under temperature limitations; if too warm (>92°F-33°C) colony damage may occur
Conditions for Use	Full dose (2 strips for 7 days) or single strip (7-day interval then single new strip for additional seven days) per a single or double brood-chamber of standard Langstroth equipment or equivalent hive with a colony cluster covering a minimum of 6 frames. There should be a strip touching each top bar containing brood. Use when outside day temperature 50-85° F (10-29.5°C). Do not inspect/disturb colony during treatment (except to add 2nd single strip).
Restrictions	Apply when outside daytime temperatures are between 50-85°F (10-29.5°C); can cause brood and queen mortality and perhaps colony absconding. Consider increasing hive ventilation under higher temperatures.
Advantages	Natural product; OK to use while bees storing honey; able to kill mites under cappings. Not necessary to remove strips following treatment as bees will chew and discard. (If removed dispose of properly).
Disadvantages	Potential for bee brood mortality and queen losses. May see bee bearding, especially first 3 days of treatment period. Recommended to not disturb colony during treatment period (except for addition of single strip). Check to be certain colony queenright one month after application.
Considerations	Can only be obtained through special order through the manufacturer. Applicators and other handlers must wear coveralls over a long-sleeved shirt, long pants, socks and shoes, acid resistant gloves (neoprene or nitrile) and protective eyewear. Although not required a respirator is recommended when handling this material. Follow the manufacturer's instructions for cleaning and maintaining Personal Protective Equipment (PPE). Leave screen bottom board (if used) open and add empty hive body or spacer frame above brood chamber for additional ventilation. May see bee bearding first couple of days; use permitted when honey supers on colonies but do use strips in supers.
Video	Watch our Mite-Away Quick Strips video: http://bit.ly/controls-MAQS



Formic Pro©

Name	Formic Pro© (NOD Apiary Products)
Active Ingredient	Formic acid (organic acid)
Formulation	Saccharide gel strip in a laminated paper wrap formulation of 42.25% formic acid.
Route of Exposure	Fumigant
Treatment Time/ Use Frequency	There are two treatment options available: Option One: 2 strips for 14 days. Option Two: 1st strip for 10 days, then remove and replace with 2nd strip for an additional 10 days. Do not feed colony when using Formic Pro.
Time of Year	**Population Increase/Population Peak:** Unique chemical that can be used while honey supers present **Population Decrease:** Following harvest if not too warm and when bees are still flying regularly
Registrant-reported Effectiveness	83-97% effective within temperature range of 55-92°F (15-33°C). Temperatures above or below the recommended range can lead to colony damage and impacts efficacy.
Conditions for Use	Both treatment options can be applied to single or double brood-chamber of standard Langstroth equipment or equivalent hive with a colony cluster covering a minimum of 6 frames. There should be a strip touching each top bar containing brood. Use when outside day temperature 50-85° F (10-29.5°C).
Restrictions	Temperatures above 92°F (33°C) can cause brood and queen mortality and perhaps colony absconding. Consider increasing hive ventilation under higher temperatures. Do not inspect/ disturb colony during treatment (except when adding 2nd single strip)
Advantages	Natural product; OK to use while bees storing honey; able to kill mites under cappings. Not necessary (but OK) to remove strips following treatment as bees will chew and discard.
Disadvantages	Potential for bee brood mortality and queen losses. May see bee bearding, especially first 3 days of treatment period. Recommended to not disturb colony during treatment period (except for addition of single strip). Check to be certain colony queenright one month after application.
Considerations	Applicators and other handlers must wear coveralls over a long-sleeved shirt, long pants, socks and shoes, acid resistant gloves (neoprene or nitrile) and protective eyewear. Although not required, a respirator is recommended when handling this material. Follow the manufacturer's instructions for cleaning and maintaining PPE. Close screen bottom board (if used), bottom hive entrance open and add empty hive body or spacer frame above brood chamber for additional ventilation. Do not remove paper packaging. May see bee bearding first couple of days; use permitted when honey supers on colonies but do use strips in supers.

Formic Acid 65%

Name	65% formic acid (NOD Apiary Products & Vita Bee Health)
Active Ingredient	Formic acid 65%
Formulation	In Canada 65% Formic acid liquid is permitted to be applied in soaked absorbing pads, slow-release pads or Mitegone pads
Route of Exposure	Fumigant
Treatment Time/ Use Frequency	21-30 days; Absorbing pad (30-40 ml per 2 story hive) up to 6 applications: one every 1-10 days; slow-release pad (250 ml) once, Mitegone (120-125 g formic acid 65% per pad), one pad per 5 frames of bees; 2x per year
Time of Year	**Population Increase:** Application must be removed 6 weeks prior to adding supers for honey collection. **Population Decrease:** Post-honey harvest
Registrant-reported Effectiveness	60 to 93% effective within temperature range of 55-92°F (15-33°C). Temperatures above or below the recommended range can lead to colony damage and impacts efficacy.
Conditions for Use	Use when outside temperatures are between 50-86 °F (10°C-30°C) and leave hive entrances fully open.
Restrictions	Do not use more than 2x/year; do not use when colonies are supered for honey; Stop treatment or remove pads if temperature above 86 °F (30 °C)
Advantages	Naturally derived, no known resistance to formic acid.
Disadvantages	Potential for bee brood mortality and queen losses under higher temperature
Considerations	Formic acid fumes can be dangerous. Applicators and other handlers must wear protective clothing, acid resistant gloves (neoprene or nitrile) and protective eyewear. Although not required a respirator is recommended when handling this material. Clean or replace. Follow the manufacturer's instructions for cleaning and maintaining Personal Protective Equipment (PPE).

Oxalic Acid/Api-Bioxal®

Name	Oxalic Acid® U.S. and Canada; Api-Bioxal® (Vétobioxal (Véto-pharma) U.S.
Active Ingredient	Oxalic acid dihydrate (organic acid)
Formulation	Sugar syrup drip with syringe or drenching applicator, also Sublimation (fumigation). NOTE: A mist application approved for caged (package) bee use; Spray with sugar syrup to engorge bees before applying.
Route of Exposure	Contact
Treatment Time/Use Frequency	Treatment most effective on brood less bees; Use no more than once on dormant (winter) bees but repeated uses during season considered less harmful to adult bees.
Time of Year	Early **Population Increase** and late **Population Decrease** when brood rearing is reduced. May be used when honey supers are on colony provided specified on label. **Dormant Phase:** Best used when brood not present.
Registrant-reported Effectiveness	82 to 99% when brood not present.
Conditions of Use	Mix 35 grams (approximately 2.3 Tablespoons) of oxalic acid into 1 liter of 1:1 sugar syrup. With syringe trickle 5 ml of this solution directly onto the bees in each occupied bee space in each brood box; maximum 50 ml per colony of oxalic acid in sugar syrup; fumigation of 2 g per hive in Canada and 1 g per hive box in the U.S; and follow label and vaporizer directions.
Restrictions	Api Bioxal is the only formulation approved for use when honey supers are in place with proper label.
Advantages	Cleanses adult bees of mites during broodless periods.
Disadvantages	Corrosive; Liquid dribble application may chill adult cluster. Not effective in colonies with much brood. Fumigation application is extremely dangerous to applicator health - follow label precautionary directions for handling. When applying, need to use proper clothing (long pants, long sleeves), acid resistant gloves, protective eyewear (goggles or face shield) and respirator. Proper respirator is a half-face acid/particulate model with cartridge & particulate filter. Check that it fits properly. Orientation upwind is recommended. The vapors quickly recrystallize.
Considerations	Wear long-sleeved shirt, long pants, socks and shoes. Wear chemical-resistant gloves. A respirator is required.
Video	Watch our Oxalic Acid video: *http://bit.ly/controls-oxalicacid*

HopGuard® 3

Name	HopGuard® 3 (BetaTec) Hopguard II in Canada
Active Ingredient	Potassium salt (16%) of hops *beta* acids (organic acid)
Formulation	Folded cardboard strips
Route of Exposure	Contact
Treatment Time/ Use Frequency	For Hopguard® 3 2-week treatment; Max use 4 times per year. Hopguard® 3 remains moist and extends effective treatment to 2 weeks. To increase efficacy apply consecutive treatments according to the label. Treatment effective only when strips wetted (about 1 week depending on humidity)
Time of Year	**Population Peak:** OK to use when honey supers on hive but need to check effectiveness after use. **Population Decrease:** Especially when brood reduced. **Dormant Phase:** Suggested use when brood not present or brood reduced. Temperature >50°F (10°C)
Registrant-reported Effectiveness	HopGuard® 3 optimally effective when little or no sealed brood present. May also be used when honey supers are in place, and at the onset of winter brood development. Effectiveness range 75-95 %. More effective with little to no brood. Quick knockdown of phoretic mites.
Conditions for Use	Corrosive – use appropriate clothing and eye protection. May stain clothing, gloves.
Restrictions	Strips only effective when moist (about 5 days); strips should not be remoistened, discard any leftover excess liquid material in the pouch.
Advantages	Natural compound; No known resistance to Hopguard; can be used during honey flow. Water based acid so no potential residue in beeswax.
Disadvantages	Strips are "messy" to use; use disposable gloves; check effectiveness of mite control following treatment.
Considerations	Limited efficacy data reported with product use; Strips must be wet to be effective.
Video	Watch our HopGuard video which is valid for all HopGuard formulations: https://youtu.be/rOlafuIBBf0

Non-Chemical/Cultural Controls

Screen Bottom Board	
Name	Screen Bottom Board
Technique	Replace solid bottom board with #8-mesh (1/8") screen surface. Falling mites drop out of colony through screen.
Route of Exposure	N/A
Treatment Time/ Use Frequency	Continuous, year-round
Time of Year	Year-round, unless in cold climate regions, it should be removed or closed.
Registrant-reported Effectiveness	Perhaps up to 5-10% effective (in northern climates states only)
Conditions for Use	Replace hive bottom; leave space below for trash ('garbage pit').
Restrictions	May attract scavengers beneath hive; may reduce brood rearing in lowest box during **Population Increase** (early spring) and bees may be hesitant to go downward into lowest brood box to rear brood.
Advantages	Low-tech and inexpensive; may be used with hive debris sticky board; can be used with sticky board as monitoring method for Varroa infestation.
Disadvantages	Minimal to little control; may need to close hive bottom when fumigant control chemicals are used; may inhibit brood rearing in lower frames in spring with cool temperatures.
Considerations	Minimally to not effective; must be used with other controls; not reliable as single control technique; works best with good hive location (sunny site, good air drainage and hive ventilation with winter protection in northern locations).
Video	Watch our Screen Bottom Board video: *http://bit.ly/controls-bottomboard*

Sanitation	
Name	Sanitation (bee biosecurity) comb management
Technique	Brood Comb Culling (replacement) + culling brood comb with high number of drone cells; basic hive sanitation; locating hives in sunny sites with good air drainage; Reducing bee adult drifting. Remove and replace brood frames every 3 to 5 years; remove brood frames with more than 1/3 of cells with drone-sized cells/brood
Route of Exposure	Culling older brood frames and removing drone brood cells to reduce accumulated residues in hives; remove dead-outs; store equipment inside or in covered stacks for security; place hives in sunny areas with good air drainage; space out colonies in apiary by adding distinguishing color, markings, or apiary landmarks to reduce drifting of adult bees; clean hive inspection tools between hives.
Treatment Time/ Use Frequency	Continuous examination and taking actions as needed every time hives inspected. Move undesired frames to edge of box during active season, remove when broodless.
Time of Year	**Population Increase** and **Population Decrease**
Registrant-reported Effectiveness	Unknown; considered to improve overall colony health and bee environment in the hives.
Conditions for Use	Possible negative effect on bee population if 5 or more combs removed at one time.
Restrictions	May reduce potential honey harvest; brood comb culling best performed under ideal comb drawing conditions (or replace with empty drawn honey combs from honey supers).
Advantages	May assist with improving overall bee colony health and performance and reduce accumulated residues of chemicals used for varroa control.
Disadvantages	Culling costs in colony resources.
Considerations	Minimally to not effective if used without other controls; avoid movement of frames or bees between colonies except as specific management activity.
Video	Watch our Sanitation video: *http://bit.ly/controls-sanitation*

Drone Brood Removal	
Name	Drone Brood Removal (Drone Trapping Varroa)
Technique	Be sure to remove and destroy drone brood once capped. Use drone frames/foundations in brood chamber or comb with elevated drone brood cells.
Route of Exposure	Mites preferentially attracted and reproduce in drone brood; removal of capped drone cell selectively removes mites without harming adult bee population.
Treatment Time/ Use Frequency	Treatment at **Population Increase** and **Peak Population**. Remove drone brood at 28-day interval (before adult bees emerge).
Time of Year	Only when colonies rear drones (**Population Increase** and **Peak Population**)
Registrant-reported Effectiveness	Not as effective as stand-alone treatment; effectiveness compounded by repeating 2 to 3x during **Population Increase**.
Conditions for Use	Only applicable during **Population Increase** and **Peak Population** when colonies actively rearing drones.
Restrictions	Need to remove capped brood in timely manner before adult drones emerge.
Advantages	Inexpensive and effective. Less impactful to the hive than successive comb removal.
Disadvantages	Time consuming management; may be minimally effective. If drone brood is not removed before emergence it will rapidly increase mite reproduction. Using this method excessively can negatively impact honey production.
Considerations	Use colored drone comb or shallow frame in standard box (stimulating bees to build drone comb from bottom bar) or foundationless frames; cull drone cells built between brood boxes; to improve effectiveness, reduce drone brood on other brood combs to consolidate for easier removal.
Video	Watch our Drone Brood Removal video: *http://bit.ly/controls-dronebrood*

Brood Interruption	
Name	Brood Interruption
Technique	Divide colony (can combine this method with requeening, naturally-derived miticides (e.g. oxalic acid) and/or use of Varroa-resistant stock); or cage queen for 1-2 weeks to disrupt egg-laying, thus interrupting brood rearing.
Route of Exposure	Interrupt reproductive cycle of mite population.
Treatment Time/ Use Frequency	Treatment during **Population Increase** or **Post-population Peak** (during nectar flow or post-harvest). Use once annually; may reduce harvest yield.
Time of Year	**Population Increase**, **Peak Population** or **Post-harvest**
Registrant-reported Effectiveness	Not a stand-alone treatment.
Conditions for Use	Need a queen or queen cell for each split/division created.
Restrictions	Splitting and requeening splits difficult when there are few forage resources.
Advantages	Non-chemical and potentially effective if utilized with chemical control and subsequent introduction of hygienic/resistant stock.
Disadvantages	Requeening and/or holding original queen in cage not always successful; highly time consuming; need to purchase or raise queens to place queen in split. In short season climates it may affect honey production. Research indicates that caging queens during **Population Decrease** can negatively impact hive survival.
Considerations	Effective but requires good beekeeping skills for season-long management (commercial beekeepers who split their colonies tend to retain the newer colonies better than non-split ones); may use brood interruption to create time with no capped brood cells and use chemical control that is effective when there is no brood (e.g., oxalic acid or HopGuard® II/3); potential lower honey harvest or population growth due to delay in brood production.
Video	Watch our Brood Interruption video: *http://bit.ly/controls-broodinterruption*

Requeening	
Name	Requeening (ideally with varroa resistant stock)
Technique	Utilize bee stock with demonstrated hygienic or other mite-reducing mechanisms, if possible
Route of Exposure	Selected stock demonstrates slower mite population growth.
Treatment Time/ Use Frequency	Treatment during **Population Increase** or **Peak Population** or post-honey harvest. Use annually when queens available.
Time of Year	**Population Increase:** As necessary **Peak Population:** Post honey harvest **Population Decrease:** Making of nucs
Registrant-reported Effectiveness	Long-term solution to reduce need for chemical controls. Works well when combined with other methods.
Conditions for Use	Works best with proper queen introduction methods
Restrictions	Not always easy to introduce new queen into colony, especially when resources are not abundant. Late season queen replacement is often unsuccessful.
Advantages	Stocks selected for mite resistance or tolerance may reduce chemical dependency.
Disadvantages	Cost of buying or rearing queens; requeening not always successful. Overly hygienic stock can negatively impact colony growth.
Considerations	Known stocks with some potential mite population reductions: Varroa Sensitive Hygiene (VSH), Russian bees, Hilo Bees, Purdue Mite-biters, Carniolan bees (in northern locations), Minnesota Hygienic, improved Carniolan stock, Buckfast bees.
Video	Watch our Requeening video: *http://bit.ly/controls-requeening*

Disclaimer

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Precaution and legal responsibility.

Any product mentioned in this document must be used in accordance with the directions on the label. The user assumes the risk to persons or property that arises from any use of the product in a way that is inconsistent with the label.

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The views and opinions expressed in this document are those of the authors and do not necessarily reflect those of the U.S. EPA, USDA, the U.S. Government, or other affiliations.

ADDITIONAL RESOURCES

Please visit and provide varroa monitoring data to www.mitecheck.com

General information

HBHC Hive Health BMPS.
https://honeybeehealthcoalition.org/resources/hive-health-best-management-practices/

Canadian BMPs for Honey Bee Health
https://honeycouncil.ca/wp-content/uploads/2016/12/BMP-manual-for-honey-bee-health-Feb-2017-English.pdf

Dieterman, *et al.* 2013. *Varroa destructor*: research avenues towards sustainable control. Journal of Apicultural Research 51(1): 125-132 summary information on taxonomy, collection, species identification (morphological and molecular), and experimental collection, rearing and preservation of mites.
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Webster, Thomas, & Delaplane, Keith. 2001. Mites of the Honey Bee. Dadant and Sons, Hamilton, IL. ISBN 978-0915698110. 280 pp. Paperback. Older information but good general biology chapter by S. Martin Biology and Life History of Varroa Mites and chapter by M.T. Sanford. Introduction, Spread and Economic Impact of Varroa Mites in North America.

Sampling

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SAMPLING FOR VARROA TUTORIALS

www.extension.umn.edu/honeybees

https://extension.oregonstate.edu/video/sampling-varroa-mites

https://bee-health.extension.org/methods-for-varroa-sampling/

http://capabees.org/content/uploads/2013/02/varroathreshold.pdf

www.scientificbeekeeping.com

www.beeinformed.org/2011/09/test-for-varroa/

USE of MAQS from NOD

http://nodglobal.com/application-usa/ In English for US Beekeepers (also w/ Spanish subtitles)

http://nodglobal.com/application-can/ In English w/ French subtitles for Canadian beekeepers

https://www.youtube.com/watch?v=UAZvkjHaA1g&feature=youtu.be

https://www.youtube.com/watch?v=Y6s6mqUvab0&feature=youtu.be

VARROA INFORMATION

Good general information on varroa mites http://nodglobal.com/the-varroa-mite/

From Vita infographic on varroa www.vita-europe.com/gallery

Integrated Pest Management

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CHEMICAL CONTROL

Berry, J.A., W.M. Hood, S. Pietravalle, and K.S. Delaplane. 2013. Field-level sublethal effects of approved bee hive chemicals on honey bees (*Apis mellifera* L). PLoS ONE DOI: 10.1371/journal.pone.0076536 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0076536

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Oliver, R. 2014. Amitraz: red flags or red herrings. American Bee Journal. 154(10): 1119-1112

MITICIDE RESISTANCE

Beltsville (Pettis) Test to Detect Varroa Mite Resistance to Apistan and Coumaphos: http://www.agf.gov.bc.ca/apiculture/factsheets/223_pettistest.htm

OTHER

Berry, J.A., Owens, W.B., & Delaplane, K.S. 2010. Small-cell comb foundation does not impede Varroa mite population growth in honey bee colonies. Apidologie 41: 41-44 doi 10.1051/apido/2009049. https://www.apidologie.org/articles/apido/full_html/2010/01/m08138/m08138.html

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Other Resources

www.scientificbeekeeping.com

www.beeinformed.org/2011/09/test-for-varroa/

Bee Health App i Tunes:
https://itunes.apple.com/ca/app/bee-health/id1005231410?mt=8

Bee Health App google Play:
https://play.google.com/store/apps/details?id=ca.ab.gov.beehealth&hl=en

Varroa Integrated Pest Management – Sampling & Control Tracking Worksheet

Inspection Date	Apiary	Colony #	# of Sampled colonies	Initial Sampling Results	Action/treatment taken	Treatment date applied	Treatment date completed	Follow-up Sampling Date	# of Sampled Colonies After Treatment Completed	Sampling Results After Treatment (was treatment effective?)	Notes (i.e. observations, batch number if chemical used, follow-up treatment if any, etc.)