TOOLS FOR VARROA MANAGEMENT

A GUIDE TO EFFECTIVE VARROA SAMPLING & CONTROL

HEALTHY BEES · HEALTHY PEOPLE · HEALTHY PLANET™

HONEY BEE HEALTH COALITION™

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Every honey bee colony in the continental United States and Canada either has Varroa mites today or will have them within several months. Varroa mite infestation represents one of the greatest threats to honey bee health, honey production, and pollination services. When honey bee colonies are untreated or treated ineffectively colonies can fail and beekeepers can incur major economic losses, and, ultimately, agricultural food production may be impacted. In addition, colonies with Varroa are a source of mites that can spread to other colonies, even in other apiaries, through drifting, robbing, and absconding activity of bees.

All beekeepers should remain vigilant to detect high Varroa mite levels and be prepared to take timely action in order to reduce mite loads. Effective mite 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 mite 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.

PHOTO COURTESY OF THE BEE INFORMED PARTNERSHIP

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.

Integrated Pest Management and Varroa Mite Control

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 season and type of beekeeping operation.

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. ***Integrated Pest Management (IPM)*** is a set of proactive, non-chemical and chemical methods that offers 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 the number of mites early and to assess the effectiveness of controls.

» Use of cultural practices (i.e., breeding, screen bottom board, removal of drone brood, etc.) to deter mite population build-up.

» Rotation of chemical products that considers mite/bee population dynamics and minimizes potential development of mite resistance caused by repeated use of any one chemical control.

IPM techniques can help beekeepers maintain a colony's Varroa mite levels below 2 to 5 mites per 100 adult bees (i.e., a 2 to 5 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 also 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 about Varroa mites is not a practical option for most beekeepers. Honey bees 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 will most likely die and, in the process, spread mites and infections to other colonies in the same apiary and surrounding area.

ABOUT VARROA MITES

The Varroa mite, Varroa destructor, 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 Varroa may die within months. Varroa mites reduce overall colony vigor as well as transmit and enhance diseases, such as honey bee viruses. Varroa, which is present on all continents, except Australia and Antarctica, is the most damaging honey bee pest and a major factor responsible for colony losses worldwide.

Adult Varroa mites are phoretic – they move around the environment by attaching themselves to adult bees. 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, Varroa mites remain and mite populations can increase quickly and unexpectedly. As a rule of thumb, in colonies with brood, ***mite populations double about once a month*** -- and even quicker when the colony has large amounts of drone brood, or when Varroa are transmitted from neighboring colonies. Therefore, beekeepers should have an IPM plan in place to frequently and regularly monitor and manage Varroa mites in their colonies.

Honey Bee and Varroa Mite Seasonal Development

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

» Dormant

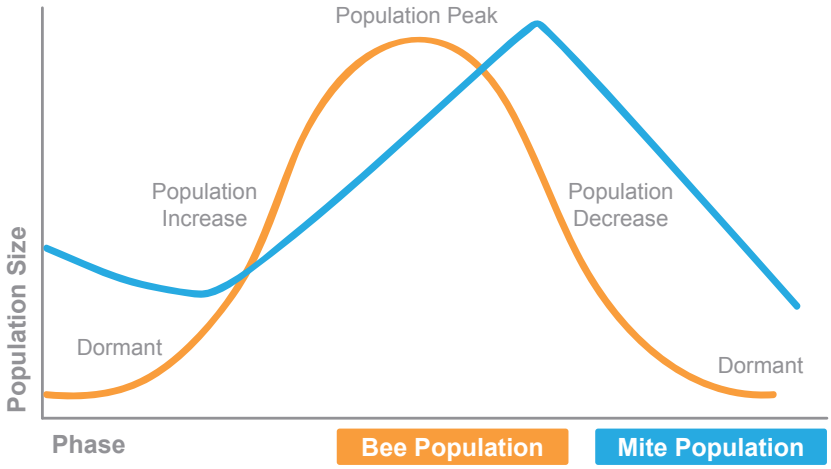
» Population Increase

» Population Peak

» Population Decrease

Varroa mite populations increase and decrease in synchrony with the seasonal pattern of honey bee development. Mite populations reach their highest levels soon after the brood and adult honey bee populations reach their peak, when there are more brood bees on which Varroa reproduce. When the bee population and the amount of bee brood decline, the phoretic mite numbers drastically increase on the adult bees as the amount of bee brood decreases. Eventually, Varroa numbers decrease, along with the adult bee population. The size of the mite population at the start of Population Decrease is critical because the colony needs to be healthy enough to rear sufficient numbers of bees to survive the dormant phase. During broodless periods, all mites are carried on adult bees, except in locations where reduced brood rearing may be continuous during this phase (see Figure 1).

Figure 1: Honey Bee & Varroa Mite Seasonal Phases



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

MONITORING VARROA MITE POPULATIONS

Bee colonies can tolerate a low number of mites, but will decline or die as mite numbers rise. Monitoring (sampling) for Varroa mites enables a beekeeper to detect a colony's mite population. Accurately assessing and understanding mite population is the basis of an IPM control strategy.

Waiting too long to confirm elevated mite population numbers is risky. A delay in treatment can reduce a colony's likelihood of survival over the winter 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 Population Decrease phase, mite levels should be re-checked to confirm that mite numbers are low going into the Dormant phase. During the Dormant phase, sampling should continue, if possible. However, if it is too cold to safely remove and sample bees from the cluster, wait until milder conditions permit sampling.

Also, ***repeat sampling after treatment*** to confirm the effectiveness of the treatment that was performed.

Aggressively treat colonies whenever sampling results warrant.

Recommended Sampling Methods

Two sampling methods provide the best estimates of mite populations. Both involve removing mites from the bodies of adult bees, then counting the mites to establish a standard percentage measure of mite numbers (i.e., number of mites per 100 adult bees). The recommended sampling methods are the ***powdered sugar shake and the alcohol or soap wash.***

This section also evaluates alternative sampling methods that are less reliable than those recommended, but are capable of providing, and 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.

PHOTO COURTESY OF THE BEE INFORMED PARTNERSHIP

Equipment Needed:

- 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
- Soap: automotive windshield washer fluid
- 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.

- 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, move her to another frame.
- Collect 300 adult bees directly into the collection jar from a brood frame by moving collection jar downward over adult bees so they fall backwards. Or shake bees directly from two or three brood frames into a larger collecting container (honey bucket, cardboard container, or lipped tray) and scoop up ½ cup of bees and quickly pour them into the quart jar.

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

The powdered sugar shake method is non-lethal, so the bees may 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.
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 the process increases the risk of undercounting the mites.)
4. Invert the jar and shake it like a saltshaker, capturing the 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 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 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.

For best results, sift the powdered sugar through a flour sifter to ensure a fine texture. ***Do not perform this test in high humidity or during strong nectar flow, because 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 hive.

1. Add enough alcohol (inexpensive rubbing alcohol works well) or soap (use a low-sudsing soap, such as automotive windshield washer fluid) to completely cover the bee sample in the jar.
2. Vigorously shake the jar for at least one minute to 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. After shaking, empty the liquid contents into a clear plate or white shallow pan through a mesh screen that traps the adult worker bodies.
4. Add more alcohol or soap 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 mites per 100 adult bees, expressed as the percentage of infestation.

Counting steps:

» Count the 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 percent to 5 percent of total colonies within multiple apiaries).

Interpreting Sample Findings

When using the recommended powdered sugar shake or alcohol or soap wash sampling methods we suggest ***using the following guidelines (Figure 2) to determine when a colony needs treatment and to evaluate treatment.***

Figure 2: Treatment Thresholds by Phase;(%=Number of mites/100 adult bees)

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%	<2-3%	>3%
Population Increase	<1%	<2-3%	>3%
Peak Population	<2%	<3-5%	>5%
Population Decrease	<2%	<2-3%	>3%

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

Caution: *Mite population is reaching levels that may soon cause damage; non-chemical control might be employed while chemical control may be needed within a month; continue to sample and be prepared to intervene.*

Danger: *Colony loss is likely unless the beekeeper controls* Varroa immediately.

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

When mite levels are between 3 percent and 5 percent, further control efforts may or may not be needed or the beekeeper may decide to wait a week or so before taking another sample. The variable rate of 3 to 5 percent is based on beekeeper risk tolerance – a 3 percent level represents a lower risk of mite damage or colony loss compared to 5 percent or higher levels.

When mite levels are above 5 percent, apply mite control immediately, using a proven, effective, seasonally appropriate treatment method (See Figure 4: Control Options by Seasonal Phase). If post-treatment tests show that mite numbers remain above 5 percent after treatment, apply another control chemical or method without delay.

Recommendations on when to treat, and at what percent infestation rate to treat, have recently changed. Beekeepers should stay current with future changes based on new research findings. Older recommendations often suggested waiting until higher infestation levels are reached (10 percent to even 20 percent) before treating, whereas current recommendations emphasize treatment thresholds of 2 percent, 3 percent, or 5 percent.

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 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. The same level of mite infestation poses different risks during different phases of the bee/mite annual cycle.

Sample Often

Sampling several times throughout the year helps reduce sampling error and increase confidence in sampling results. Frequent sampling can detect mite increases at critical times of the season.

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 of thumb 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 mites 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 less efficient and less accurate. The Honey Bee Health Coalition does not recommend relying on the methods identified in the following (Figure 3) table.

Figure 3: Less Reliable Sampling Methods

Less Reliable Sampling Methods	
Method	**Concern**
Ether Roll	▪ Only detects 50 to 60 percent of mites. ▪ Material is highly flammable.
Drone Brood Assessment	▪ Difficult to interpret results of percent of brood infested. Drone brood is not always present when sampling is needed.
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	▪ 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.

SELECTING CONTROL METHODS

As stated in the Introduction to this Guide, there is no "one-size-fits-all" solution to Varroa mite management. Each beekeeper should select the control methods that are right for them. Success may require experimentation with several methods. It is important to seek to integrate methods and not simply rely on one chemical or non-chemical control. Relying on a single chemical or family of chemicals for treatment will hasten development of resistance in mite populations.

Newly established colonies, whether from splits or captured swarms, generally have low mite levels the first year and may not need treatment. Older colonies typically have higher mite populations and need highly proactive treatment.

Depending on a colony's level of Varroa infestation, beekeepers should begin to integrate Varroa control methods on colonies exhibiting high mite levels during the Population Increase phase (see Figure 1).

The most critical time to administer Varroa treatment(s) is after honey supers are removed (i.e., at or just after the Population Peak phase).

While mite densities may vary across colonies, all colonies in an apiary should be treated at the same time with the same chemical or non-chemical technique. If sampling results indicate high mite populations in one colony within an apiary, do not delay treatment. Delay increases the risk of harm to the colony and the spread of Varroa mites to other colonies.

Note:

» Beekeepers should assure that all control products are legal for use. Legal restrictions are changing and vary from state to state. ***Read the product label and follow all label instructions and precautions. Federal law prohibits the use of any registered pesticide in a manner not permitted by the labeling.***

» The efficacy of the various products and treatments identified in the tables and product descriptions below are based on published studies, Bee Informed Partnership Management Surveys (http://beeinformed.org/national-management/), and the collective professional judgment of the principal drafter and HBHC subgroup members. Information presented in the tables below should not be construed as an endorsement or recommendation of any product or treatment.

Summary of Controls Discussed in this Guide

Chemical Control Products

» Synthetic Chemicals
- Apivar® (amitraz) *see page 13*
- Apistan® (fluvalinate) *see page 14*
- CheckMite+® (coumaphos) *see page 14*

» Essential Oils
- Apiguard® or Thymovar® (Canada) (thymol) *see page 15*
- Api Life Var® (thymol + eucalyptol, menthol, and camphor) *see page 15*

» Acids
- Mite-Away Quick Strips® [MAQS®] (formic acid) *see page 16*
- Oxalic Acid (oxalic acid dihydrate) *see page 16*
- HopGuard® II (hops beta acids) *see page 17*

Non-Chemical Controls

» Screen Bottom Board *see page 17*

» Sanitation (comb culling/biosecurity) *see page 18*

» Drone Brood Removal *see page 18*

» Brood Interruption *see page 19*

» Requeening with Resistant Stock *see page 19*

» Powdered Sugar *see page 20*

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

Control Options by Seasonal Phase

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

Figure 4: 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 (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: ▪ Oxalic acid (fumigation method) ▪ Winter or broodless period	Notes: ▪ Oxalic acid is best used when there is no brood. ▪ Varroa mortality over extended broodless period is high.
Moderately Effective Options: ▪ HopGuard® II ▪ In beekeeping regions with brood during this phase, Apiguard, or Api Life Var®, or formic acid (MAQS®) provided temperatures are within optimal ranges.	Notes: ▪ Little or no independent test results are available for HopGuard® II during the Dormant phase. The formulation has changed each of the last two years. ▪ The effectiveness of Apiguard®, Api Life Var® and formic acid (MAQS®) during the Dormant phase is unknown.
Least Effective Options: ▪ Anything that risks colony success through this phase ▪ Screen bottom board	Notes: ▪ Screen bottom board removes a small percentage of mites that fall from adult bodies. It is best used in combination with other techniques.

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® or Api Life Var® ▪ MAQS® (formic acid) ▪ Drone brood removal	Notes: ▪ Terminate Apivar® after 42 to 56 days of treatment, at least two weeks prior to adding supers. ▪ Terminate Apiguard® treatment before adding supers. ▪ Terminate Api Life Var® after two or three treatments (7-10 days each). Remove Api Life Var® tablets from the hive at least one month before harvesting honey or, if not using the colony for honey production, treat for full treatment period. ▪ It is legal to use MAQS® when storing honey. ▪ Strong, populous colonies tolerate drone brood removal two to three times.
Moderately Effective Options: ▪ HopGuard® II ▪ Colony division ▪ Requeening using hygienic stock ▪ Basic sanitation	Notes: ▪ The effectiveness of HopGuard® II has not been widely tested. ▪ Dividing the colony during the Population Increase phase will most likely negatively affect 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 managements	Notes: ▪ 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	
Period of nectar flow and rental of colonies for pollination services; bee population (both adult & brood) at peak; mite populations increasing, nearing peak; often honey supers on colonies.	
Highly Effective Options: ▪ MAQS® ▪ Apivar® or Apiguard® or Api Life Var® (Use is permitted only if no supers are present or colonies are not producing honey.)	Notes: ▪ MAQS®, Apiguard® and Api Life 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 resistance.
Moderately Effective Options: ▪ Requeening with hygienic stock ▪ Division of colonies ▪ HopGuard® II ▪ Oxalic acid drip	Notes: ▪ Requeening or dividing may negatively affect honey production (if colonies are strong enough to produce surplus). Hygienic or locally selected stock is not widely available. ▪ The effectiveness of HopGuard® II has not been widely tested. ▪ Oxalic acid is best used when there is little or no capped brood in the colony during the Dormant Phase or because of queen replacement that interrupts brood rearing.
Least Effective Options: ▪ Screen bottom board ▪ Drone brood removal	Notes: ▪ 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 mites on adult bees after colonies become broodless	
Highly Effective Options: ▪ Apivar® ▪ MAQS® ▪ Apiguard® or Api Life Var® ▪ HopGuard® II	Notes: ▪ Apivar® should not be used until surplus honey is removed. ▪ MAQS®, Apiguard® and Api Life Var® are not suitable for use in all temperatures. See the detailed descriptions of products below for temperature ranges for use of these products. ▪ HopGuard® II manufacturer's test data supports its effectiveness
Moderately Effective Options: ▪ Requeening with hygienic bees ▪ Dividing colonies ▪ Oxalic acid drip	Notes: ▪ Hygienic stock is not widely available. ▪ Requeening and dividing colonies may be difficult. ▪ 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	Notes: ▪ Mite resistance to Apistan® and CheckMite+® is well established. ▪ Colonies are unlikely to raise drones during this phase. ▪ Basic sanitation may help relieve stress.

Non-Reliable, Non-Tested Methods and Illegal Chemicals

Several treatments are ***ineffective*** for Varroa mite control, including:

» Low-dosage mineral oils

» Additional acids (such as lactic acid)

» Food stimulants and supplements

» Powdered sugar

» Small cell, "natural" comb for the rearing of smaller bees

Beekeepers should never use a non-registered chemical to control mites. Such use may violate both federal and state laws and is not a viable option for treating bee colonies.

Other methods that beekeepers may read or hear about should be adequately tested before adoption and should only be used with extreme caution. Always check for efficacy during and after use.

DESCRIPTIONS OF VARROA CONTROLS

More detailed descriptions of Varroa mite controls appear below.

Bee Informed Partnership

The descriptions include "BIP results" from the Bee Informed Partnership (BIP). BIP is a national effort to provide beekeepers with real-world, practical management information. BIP is funded through a five-year grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA). The objective of BIP is to reduce honey bee colony losses by facilitating communication between beekeepers and researchers through anonymous information sharing.

BIP gathers information about current management practices using both participant surveys and data gathering efforts of Tech Transfer Teams (trained field agents who offer regular, on-site hive inspections and sampling for large commercial beekeepers and queen breeders). BIP correlates the survey results and other data with colony health.

The website www.beeinformed.org shares the resulting information about honey bee colony management practices with beekeepers in a user-friendly format and database. The information presented in the BIP results is an analysis of four years of beekeeper winter loss and management practices survey. The results compare colony loss rates between those using a given management practice in a given year and those that do not. BIP results show correlations that are not necessarily evidence of causation, so they should be interpreted with caution.

Chemical Controls

Synthetic Chemicals

Apivar® (amitraz)	
Name	Apivar® (Vetó-pharma)
Active Ingredient	Synthetic miticide (amitraz)
Form	Apivar®: slow-release impregnated rigid polymer strip
Mode of Action	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 6 weeks; **Population Decrease:** Immediately following peak population once honey harvested.
Effectiveness	40 to 95-99% (Mite knockdown not immediate, be patient)
BIP Results	35 to 47% fewer overwintering colony losses with use in three consecutive survey years.
Conditions for Use	Place strips in cluster, 2 strips per brood box.
Restrictions	Do not use more than 2x per year; rotate with other chemical controls; do not use when colonies are supered for honey; do not add supers for 2 week period following removal.
Advantages	Safe and highly effective unless there is mite resistance.
Disadvantages	May cause queen and brood loss; may affect drone sperm viability; low levels of break-down residue detected in beeswax & honey; potential for mites to develop resistance.
Considerations	The only legally permissible amitraz formulation is Apivar®; do not reuse strips; store unopened packages at room temperature; perform resistance test and/or monitor mite levels following use to confirm control effectiveness. (See Bibliography & Resources for information on resistance testing.)

Apistan® (fluvalinate)	
Name	Apistan® (Wellmark International)
Active Ingredient	Tau-fluvalinate (pyrethroid)
Form	Impregnated strip
Mode of Action	Contact
Treatment Time/ Use Frequency	42 days (6-8 weeks); Treat all hives in apiary at the same time.
Time of Year	**Population Increase:** Before flow if 2 weeks or more until supering; **Population Decrease:** Following honey harvest
Effectiveness	95 to 99% if no mite resistance
BIP Results	No difference in survivorship between treated & untreated colonies in 3 of 4 years; 31% fewer overwintering colony losses with use in one survey year.
Conditions for Use	Temperatures > 50°F (10°C); Do not use during nectar flow.
Restrictions	Best if daytime temperatures > 50°F; 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; long half-life; residues common in beeswax; continued use may affect brood development; negative synergistic interactions with other pesticides can occur and jeopardize colonies.
Considerations	Negatively impacts queen and drone reproductive health; wear latex 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.)

CheckMite+® (coumaphos)	
Name	CheckMite+® or Perizen (Europe)
Active Ingredient	Coumaphos (organophosphate)
Form	Impregnated plastic strip
Mode of Action	Contact
Treatment Time/ Use Frequency	Treatment time 6 weeks; Use 2x/year
Time of Year	**Population Increase:** Only if colonies will NOT be supered within 6 weeks **Population Decrease:** After honey harvest
Effectiveness	85 to 99% (if no mite resistance).
BIP Results	No difference in colony survivorship between treated & untreated colonies in 3 of 4 years; 24% fewer overwintering colony losses in 1 survey year.
Conditions for Use	N/A
Restrictions	Do Not use in queen rearing colonies; Do Not use when colonies are supered for honey.
Advantages	Effective and easy to use when mite populations are susceptible (note: extensive mite resistant pops in United States); can be used to control small hive beetle adults (utilized in different manner).
Disadvantages	Mite resistance; organophosphate; contamination of hive components; long half-life; negative activity with other products; negatively affects reproductive health of queens (rearing) & drones (sperm production).
Considerations	May negatively impact queen health; wear latex gloves; perform resistance test and/or monitor mite levels following use to confirm control effectiveness. (See Bibliography & Resources for information on resistance testing.)

Essential Oils

Apiguard® (thymol)	
Name	Apiguard® or Thymovar® (Canada)
Active Ingredient	Thymol (essential oil)
Form	Gel (individual hive dosage or bulk tub)
Mode of Action	Fumigant
Treatment Time/ Use Frequency	Twice at 2 week intervals (remove or spread remaining gel over frame top bars at end of 4th week)
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 temps are elevated **Population Decrease:** Post-honey harvest or approaching dormancy
Effectiveness	74 to 95% (more effective with warmer temperatures)
BIP Results	26 to 31% fewer overwintering colony losses with use in 4 consecutive survey years
Conditions for Use	Temperatures >59°F and <105°F (15 to 40°C)
Restrictions	Do Not use when colonies are supered for honey.
Advantages	Naturally derived; easy to use with container or tub.
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	Effectiveness reduced for light mite infestations; requires closed screen bottom board; do not feed sugar syrup during treatment; consider using spacer rim above brood nest for individual gel trays.

Api Life Var® (thymol + eucalyptol, menthol, and camphor.)	
Name	Api Life Var®
Active Ingredient	Thymol + camphor, menthol and eucalyptol oil (essential oils)
Form	Tablet: divide into ¼ strips, place on top of brood box at corners
Mode of Action	Fumigant
Treatment Time/ Use Frequency	2 or 3X for 7-10 days each (leave 3rd treatment in for 12 days); Repeat or combine with another treatment if heavy mite numbers.
Time of Year	**Population Increase:** Less effective but better during early season buildup or low mite numbers; **Population Peak:** If honey supers are not present **Population Decrease:** After nectar flow, with temperature considerations
Effectiveness	70 to 90%
BIP Results	24.5 to 40% fewer overwintering colony losses with use in 4 consecutive survey years
Conditions for Use	Use between 65 to 85°F (18-30°C); ineffective below 45°F (8°C).
Restrictions	Do not use more than 2x/year; do not use when colonies are supered for honey; wait one month before harvesting honey following removal of strips
Advantages	Naturally derived.
Disadvantages	Temperature considerations: may run bees out of hive if temperature is 80°F or above; increase in bee adult irritability; honey taste tainting.
Considerations	Wear gloves; high temps may cause bees to exit hives and/or adult/brood deaths; may melt plastic hive parts; not available in CA or HI.

Acids

Mite-Away Quick Strips® (MAQS®) (formic acid)	
Name	Mite-Away Quick Strips® (MAQS®)
Active Ingredient	Formic acid (organic acid)
Form	MAQS®: legal formulation-impregnated biodegradable strip
Mode of Action	Fumigant
Treatment Time/ Use Frequency	Treatment time 7 days, not necessary to remove strips.
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
Effectiveness	61 to 98% under temperature limitations; if too warm (>95°F) less effective
BIP Results	16 to 31% fewer overwintering colony losses with use in four consecutive survey years.
Conditions for Use	Two strips placed on top bars of brood chamber
Restrictions	Use between 50 to 85°F (10 to 30°C) remove if temperature >90°F.
Advantages	Natural product; OK to use while bees storing honey (taste tainting possible); able to kill mites under cappings.
Disadvantages	Potential for bee brood mortality and queen losses.
Considerations	Use acid-resistant gloves, protective eyewear and clothing, including respirator; post "72-hour restricted" re-entry signs in apiary; leave screen bottom board (if used) open and add empty hive body or spacer frame above brood chamber; may see bee bearding first couple of days; use permitted during nectar flow.

Oxalic Acid (oxalic acid dihydrate)	
Name	Oxalic Acid
Active Ingredient	Oxalic acid dihydrate (organic acid)
Form	Sugar syrup drip with syringe or applicator, also fumigation. NOTE: mist application approved for caged (package) bee use.
Mode of Action	Contact
Treatment Time/ Use Frequency	Treatment at application; Use no more than 2x/year.
Time of Year	**Population Decrease:** Late when brood rearing reduced **Dormant Phase:** When brood not present
Effectiveness	82 to 99% when brood not present
BIP Results	37 to 41% fewer overwintering colony losses with use in 2 consecutive survey years.
Conditions for Use	5mL between each frame; max. 50mL per colony; 1.0 g per brood chamber of Oxalic acid; fumigation per label directions.
Restrictions	Recently approved for legal status in US; Permitted in Canada.
Advantages	Cleanses bee adults of mites during broodless periods.
Disadvantages	Corrosive; Liquid application may chill adult cluster.
Considerations	Legalized in U.S. in spring 2015 http://www3.epa.gov/pesticides/chem_search/ppls/091266-00001-20150310.pdf

HopGuard® II (potassium salt of hops beta acids)	
Name	HopGuard® II
Active Ingredient	Potassium salt (16%) of hops beta acids
Form	Folded cardboard strips
Mode of Action	Contact
Treatment Time/ Use Frequency	1 strip per 5 frames of bees, 4 week treatment; Max use 3x per year (6 strips)
Time of Year	**Dormant Phase:** Suggested use when brood not present or brood reduced. Decrease during Pollination phase.
Effectiveness	Not clear, little beekeeper experience to date. Registrant suggests that it is most effective when used during the pre-pollination period (before sealed brood), mid-summer, and at the onset of winter brood development.
BIP Results	10% fewer overwintering colony losses with use in one survey year.
Conditions for Use	Perhaps during little capped brood phase.
Restrictions	Not legal in all states; Section 18 registration. Check with your state Department of Agriculture to see if it is approved in your state.
Advantages	Natural compound; can be used during honey storage.
Disadvantages	Strips are "messy" to use; Use disposable gloves; check effectiveness of mite control following treatment. As an emergency exemption use, any adverse effects should be promptly reported to your State Department of Agriculture.
Considerations	New material only available 2 years and formulation changed in second year; little data or experience reported with product use.

Non-Chemical Controls

Screen Bottom Board	
Name	Screen Bottom Board
Technique	Bottom board with #8-mesh (1/8") screen surface
Form	Passive
Mode of Action	Falling mites drop out of colony through screen.
Treatment Time/ Use Frequency	Continuous, year-round
Time of Year	Year-round
Effectiveness	Perhaps up to 10% effective (in northern areas only)
BIP Results	Nationally no advantage in 4 consecutive survey years; however, in northern states a 12.4% reduction of loss was recorded in one survey year.
Conditions for Use	Replace hive bottom; leave space below for trash.
Restrictions	May attract scavengers beneath hive; may reduce brood rearing in lowest box during population increase (early spring).
Advantages	Low-tech and inexpensive; may be used with hive debris sticky board.
Disadvantages	Minimum to little control; may need to close hive bottom when fumigant Varroa 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).

Sanitation (Comb Culling/ Biosecurity)	
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.
Form	Remove & replace brood frames every 3 to 5 years; remove brood frames with more than ⅓ of cells with drone-sized cells/brood
Mode of Action	Culling older brood frames & removing drone brood cells; remove dead-outs; store equipment inside or close stacks of equipment with drawn comb; 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 equipment between hives.
Treatment Time/ Use Frequency	Continuous use beginning at apiary establishment. Move undesired frames to edge of box during active season, remove when broodless.
Time of Year	Population Increase and Population Decrease
Effectiveness	Unknown; considered to improve overall colony health
BIP Results	Beekeepers who replaced more than 50% of their comb in a given year lost more colonies than those beekeepers who did not replace any comb in all 4 survey years.
Conditions for Use	Negative effect 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 honey storage frames).
Advantages	May assist with improving overall colony health and performance.
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.

Drone Brood Removal	
Name	Drone Brood Removal (Drone Trapping)
Technique	Remove and destroy drone brood once capped.
Form	Use drone frames in brood chamber.
Mode of Action	Mites preferentially 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)
Effectiveness	Not as effective as stand-alone treatment; effectiveness compounded by repeating 2 to 3x.
BIP Results	Nationally 11% fewer overwintering colony losses detected in 1 of 4 years; however, northern states saw 10 - 33% reductions in loss recorded by operations using this technique in 3 of 4 years.
Conditions for Use	Only applicable in Population Increase and Peak Population (when colonies actively rear drones).
Restrictions	Need to remove capped brood in timely manner.
Advantages	Inexpensive and effective.
Disadvantages	Time consuming management; may be minimally effective.
Considerations	Use colored drone comb or shallow frame in standard box (stimulating bees to build drone comb from bottom bar); cull drone cells built between brood boxes; to improve effectiveness, reduce drone brood on other brood combs to consolidate for easier removal.

Brood Interruption	
Name	Brood Interruption
Technique	Interruption of colony brood cycle
Form	Divide colony (can combine with requeening with hygienic stock); or cage queen for 1-2 weeks to disrupt egg-laying, thus interrupting brood rearing.
Mode of Action	Interrupt growth 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
Effectiveness	Little data; not a stand-alone treatment.
BIP Results	No information
Conditions for Use	Need a queen or queen cell for each division created.
Restrictions	Splitting and requeening splits difficult when there are few forage resources.
Advantages	Non-chemical and potentially effective It utilized with adult mite cleaning chemical control & 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.
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 & use treatment that is effective when there is no brood (oxalic acid or HopGuard® II); potential lower honey harvest or population growth due to delay in brood production.

Requeening	
Name	Requeening (ideal with resistant stock)
Technique	Utilize bee stock with demonstrated hygienic or other mite reducing behaviors, if possible.
Form	Requeen using selected stock.
Mode of Action	Selected stock demonstrates slower mite growth.
Treatment Time/ Use Frequency	Treatment during Population Increase or Peak Population or post-honey harvest. Use annually.
Time of Year	**Population Increase:** As necessary **Peak Population:** Post honey harvest **Population Decrease:** Making of nucs
Effectiveness	Long-term solution to reduce need for chemical controls
BIP Results	Low survey responses. Use of locally selected bee stock resulted in 18 to 41% fewer overwintering losses in 3 consecutive survey years; Caucasian hybrid stock: 42% fewer losses; Buckfast hybrid stock: 92% fewer losses; Buckfast bees: 84% fewer losses; no statistically significant results for Varroa Sensitive Hygiene (VSH) or Minnesota (MN) Hygienic from 3 consecutive survey years.
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.
Advantages	Stocks selected for mite resistance or tolerance may reduce chemical dependency.
Disadvantages	Cost of buying or rearing queens; requeening not always successful.
Considerations	Known stocks of some potential mite population reductions: Varroa Sensitive Hygiene (VSH), Russian bees, Carniolan bees (in northern locations), Minnesota Hygienic, improved Carniolan stock, Buckfast.

Powdered Sugar	
Name	Powdered Sugar
Technique	Icing sugar
Form	Dusting over and between frames of brood
Mode of Action	Contact
Treatment Time/ Use Frequency	Treat 1 to 2x per week. Use frequency is unknown, suggested use may eliminate emergence of new mites from brood cells.
Time of Year	**Population Increase:** Before extensive brood **Population Decrease:** Shortly before dormancy (when majority of mites are phoretic on adult bees)
Effectiveness	Minimal < 10%; Do Not rely upon. Check post treatment to determine effectiveness.
BIP Results	No reduction in overwintering loses from 4 consecutive survey years.
Conditions for Use	Need to use with open bottom or screen bottom board.
Restrictions	May harm open brood.
Advantages	None apparent, as method is minimally or not effective.
Disadvantages	NOT a stand-alone treatment; labor intensive.
Considerations	Generally not effective; do not rely upon. Check effectiveness post-treatment.

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 beekeepers, growers, researchers, government agencies, agribusinesses, conservation groups, manufacturers and brands, and other key partners dedicated to improve the health of honey bees and other pollinators. The Coalition's mission is to collaboratively implement solutions that will help to achieve a healthy population of honey bees while also supporting healthy populations 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 their hives.

For more information please visit at *http://honeybeehealthcoalition.org/*

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ADDITIONAL RESOURCES

General information

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Sampling for varroa tutorials

www.extension.umn.edu/honeybees

https://agdev.anr.udel.edu/maarec/educational-resources/powerpoints

Other Resources

www.scientificbeekeeping.com

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

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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*

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Ellis, A, Hayes, Gerry W., and Ellis, James D. 2009 The efficacy of dusting honey bee colonies with powdered sugar to reduce varroa mite populations Jour Apic Res. Vol. 48 (1): 72 - 76.

Other resources

See *www.scientificbeekeeping.com/mite-management-update-2013/* – many other articles, pick latest articles

Also see *www.beeinformed.org/*

Older material

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