Varroa Management

This booklet provides basic information about the monitoring and control of the parasitic mite, Varroa destructor, in Hawaii.

The Varroa Mite

Varroa destructor is an external parasite of honeybees, that feeds on the blood (haemolymph) of adult and immature bees. The varroa mites originated in Asia, in close association with *A. cerana*, the Asian honeybee. In the 1970's, *V. destructor* was found parasitizing *A. mellifera* in Western Europe. By 1982, the mites had spread to the US. Presently, with the exception of some Hawaiian islands and Australia this destructive honeybee pest is found worldwide.

Frequently asked questions

What are the problems associated with Varroa?

The varroa mite is one of the most serious pests of honeybees. The mites weaken adult and developing bees by feeding on their haemolymph. In addition high mite levels are often associated with the spread of viral diseases in the hives.

An infested hive is less productive than a healthy hive, and high levels of varroa can kill a colony within a year of infection.

When did Varroa get to Hawaii?

The mites were first detected in Oahu on March 2007, and later found in Hilo, Hawaii, in August of 2008.

How do I know if my colonies have Varroa?

Monitoring for mites can be done in a variety of ways. Some methods are more sensitive than others in detecting the presence of the mite, especially when the mite levels are low.

Sampling adult bees and/or drone brood are the most effective ways to detect the mite. Within this pamphlet you will find a quick review of the most common sampling methods for Varroa.

Should I continue to monitor once I know my hives are infested?

Yes, you should keep track of the infestation levels and treat hives when the mite levels are high.

Mites spend a large portion of their life cycle inside capped cells and their presence might not be obvious at a quick glance. Continuous sampling will help track the levels of non-reproductive Varroa (phoretic mites) that are feeding on the adult bees.

Monitoring and thresholds

Survey methods can be used to detect the presence or absence of Varroa or to provide an estimate of the levels of infestation in the hive. High sensitivity in the test is needed for detection. In contrast, less intrusive and rapid methods are often preferred to monitor mite levels.

Detection

As the Varroa mite spreads, either via swarms, hive robbing, or more likely through transport of infested hives, the beekeepers in uninfected areas should remain vigilant. Survey methods vary in their sensitivity and their ability to detect the arrival of the mite to an area. There are two sampling methods that increase the chances of detection of the mite: drone brood sampling and adult bee sampling.

Sampling drone brood can be very effective due to the fact that Varroa mites prefer drones 8-10 times more than they prefer worker brood. So even at low infestation levels, drones are a magnet for the reproductive female mites. Sample a minimum of 50 capped drones cells per hive (preferably 100 cells) to increase the odds of detecting Varroa.

If drone numbers are low, sampling nurse bees is a good alternative. When female mites are in their reproductive phase, they are more likely to be found in the cells or on nurse bees, therefore sampling either of these stages increases the likelihood of detection.

Beekeepers with large bee yards (>100 colonies) are often unable to sample all their hives, and consequently mite detection can be more challenging, The probability of early detection, however, increases if: 1- the sampling occurs at regular intervals (every 1-2 months during the initial stages of Varroa dispersal), 2- the beekeeper makes an effort to sample approximately 10 % of the hives, and 3- the beekeeper includes some of the strongest colonies in the sample.

Infestation Levels and treatment thresholds

Mite levels have dramatic effects on hive health and survival. A heavily infested hive can suddenly display a number of symptoms, including an increase in viral diseases, such as deformed wing virus, a reduction in brood production, and a quick decline in overall strength possibly due to weakened adult bees. The rapid changes observed at high levels of mite infestation can catch the beekeepers off guard, and a hive can be lost within a few months to a year if the Varroa populations spike out of control.

Although it is obvious that high levels of Varroa can have very serious consequences for the colony and that beekeepers should apply control methods to keep the mite population at a low level, it is somewhat more difficult to determine what can be considered a tolerable level of infestation. Hives vary greatly in the level of infestation that can be tolerated before the colony declines and economic losses occur. Climatic and biological factors such as bee race, and the underlying level of disease that existed in the hive before the arrival of Varroa, may influence the hive’s response and tolerance to the mite invasion. It is also possible that the first year or two of Varroa presence may be the more difficult for the hives or that there is year- to- year variation in mite levels.

Beekeepers should monitor and record the cycles of the Varroa population in their own apiaries. The colony cycle table presented below shows an increase of Varroa levels starting in the fall and peaking in winter. During the winter months the mite levels increased 4- fold compared to the summer levels. A noticeable increase in mite levels during the fall suggests that mite populations will spike in the winter and treatment is needed.

Sampling methods

Sampling adult bees

Sampling adult bees, especially nurse bees will give a snapshot of the level of infestation in your hive. This detection method is based on removing mites attached to adults to produce a count of mites/bee.

To conduct this test, brush about 200 bees from a frame into a clear glass container (mason jar). Cover the jar with a mesh lid. You can then choose to add one of these substances, rubbing alcohol, soapy water, or powdered sugar as a tool to dislodge the mites. Shake or roll (if using sugar) the jar, count the number of mites that fall off. The sugar method is less effective but the bees will not be killed during the sampling.

If you have more than 15 mites/100 bees during the fall, you have a relatively high infestation and should consider treatment immediately.

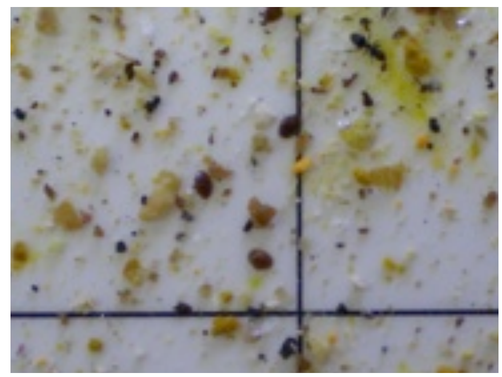
Sampling drone brood

Mite detection can be aided by sampling drone brood. Using a capping -scratcher fork check for mites on the developing drones.

This sampling method is made easier if the drones are clumped in an area of the frame which facilitates the use of the fork or if you can cut away a piece of the brood and examine it for mites. Since female mites are highly attracted to drone brood this method is a very effective early detection tool for Varroa.

Drone brood inspection can also help keep track of the infestation levels in the hive and the beekeeper may also choose to use drone brood removal as a Varroa management tool (see below for details).

Using sticky boards



Using screened bottom boards in combination with some kind of sticky surface to trap fallen mites is a recommended technique for management and sampling. Recording the number of mites that fall off the comb onto a sticky board (passive mite drop) is a relatively easy technique that provides a record of mite levels. This method is simple and non-disruptive. Unfortunately it is not very sensitive to low levels and may not be the best choice as an early detection method.

If you would like more detailed information about how to conduct these sampling techniques, please go to our website and download the handout on Varroa sampling and detection.

Treatment methods

What methods are available to control Varroa?

Control methods can be divided into:

- ***Chemical***

  Synthetic: varroacides.

  Natural: organic oils and acids.

- ***Biomechanical***

  Chemical free techniques that can be used during the honeyflow. Examples are drone comb removal and screen bottom boards.

- ***Cultural***

  The use of management techniques to disrupt the reproductive cycle of the colony and the mite.

- ***Genetics***

  Selection and breeding of traits than reduce Varroa's impact on the colony.

Please note that beekeepers may choose to use a mixture of controls methods as part of an Integrated Pest Management strategy, please see below for more details about this practice.

How does the climate of Hawaii influence the treatment methods I can use?

The Hawaiian climate allows the bees to produce brood year round, consequently treatments designed to work during the broodless periods, typical of temperate regions, are not suitable for the local conditions. Products such as lactic and oxalic acid are of little use for Hawaii beekeepers.

The prolonged flowering season of Hawaii results in extended honey flows and multiple honey harvests throughout the year. Varroacides however, should not be employed when there is a honeyflow and local beekeepers need to recognize when a suitable "window of opportunity" is present for treatment to avoid honey contamination.

Organic treatments such as thymol and formic acid can be employed in warmer climates, but the beekeepers should avoid excessively warm humid periods. Selecting the right environmental conditions is crucial for the efficacy of any control method.

Thymol gel (Apiguard)

Thymol is one of many essential oils that show promise in controlling Varroa infestations.. Thymol is sold under the trade name Apiguard and is applied as a gel formulation delivered in a tray to the top of the brood chamber. The product works by both contact and evaporation (sublimation) of the chemical. The honey supers should be removed during application, and for best results we recommend that treatment be applied when ambient temperatures are 59 F^0 to 85 F^0. The hive cover needs to provide enough air space for the chemical to sublimate and disperse homogeneously throughout the colony. We suggest a 2 inch space between the top of the brood frames and the cover.

Reports for thymol efficacy are generally high, ranging from 70 to 90% mite kill. Our experience with thymol indicates that best results are obtained if the treatment tray is introduced in the late afternoon, and the initial sublimation takes place in the evening when ambient temperatures are lower. We also noted, contrary to some recommendations, that the hive's entrance should not be closed and screen bottom boards can be used during treatment. Avoid rainy periods since adult bees may initially congregate on the outside of the hive when thymol is introduced.

Beekeepers should keep an eye on treated hives, because thymol applications may temporarily disrupt the egg laying of the queen, and rarely the queen may disappear or die. If applied correctly the treatment is most often successful, and mite drops are very high.

Hives with 30,000 bees or more should be able to handle the full thymol dose of 50g per tray. Treating smaller hives or nucs may require adjusting the dose of the chemical. Hives with heavy infestations may require 2 consecutive treatments with thymol.

Drone comb removal

The drone comb treatment aims at trapping mites as they attack the brood. Drone cells are known to be significantly more attractive to female mites compared to worker brood cells. Selectively culling the capped drone brood provides both a way to estimate overall density of infestation but also serves as an effective control method by removing a large proportion of the mites found in the colony.

Plastic drone combs or drone foundation can be purchased commercially or beekeepers can modify a regular frame into a "half frame" with foundation only on the top part of the frame. Half frames allow the bees to draw drone cells in the open bottom section of the frame, and the drone portion can be simply cut away with a knife and removed.

The key to the success of drone comb trapping depends on: 1- the amount of drones produced by the hive and 2- the beekeeper's timing of the removal of the frame. Drone frames need to be removed after the majority of cells are capped, in order to trap mites within the cell, but before drone emergence, in order to prevent re-infestation by the mites and her newly formed daughters. If the drone comb is not removed promptly the hive will become a virtual "Varroa nursery". Deciding when to remove a drone frame takes practice, beekeepers can aim for 25-30 days after the frame is introduced to the hive. On Oahu, Varroa infestation levels in drone brood average 30 to 40 % in the summer months and removal of full drone frames (approximately 1400 drones) can have a large impact on the mite population.

Using varroacides and the development of resistance

The use of synthetic chemicals (fluvalinate and coumaphos) for Varroa control is a common practice in many parts of the world. The appeal of the varroacides is their initial high efficacy rate and the ease of application. There are, however, serious drawbacks to using pesticides in hives. Synthetic chemicals are known to leave residues in honey and wax, and beekeepers need to exercise extreme care when exposing their hives to any pesticide. It is also unclear what, if any, effect these chemicals have in the long term health of the developing bees. There is some evidence that miticides may interfere with sperm development in drones and consequently compromise the reproductive ability of the hive. Another concern with the widespread use of miticdes is that the initial efficacy of these chemicals does not remain constant as the mites develop resistance to these treatments over time.

Beekeepers that use varroacides should follow label directions carefully and avoid applications during the honey flow. To delay the development of resistance the beekeepers should treat only for the specified time and only when the mite levels require treatment. In addition, beekeepers should consider alternating their varroacide treatment with other chemicals, such as thymol or formic acid, or even including biomechanical control methods like drone brood removal in their management schedule.

The relationship between colony cycle and Varroa management

The life cycle of the Varroa mite is linked closely to the life cycle of the bees. The large- bodied, slow-developing drone bees provide excellent hosts for the female mites. Drone brood allows individual female mites to produce more offspring, and each drone can support more than one reproductive female mite.

Just as the life cycle of an individual mite matches that of its host, the growth of the mite population is linked to colony growth cycles. The availability of brood, and drone brood in particular, has a great impact on mite abundance. Although brood is always available in Hawaii's tropical climate, the reproductive cycle of the colony and certain management techniques can affect the availability of brood and consequently the population growth of Varroa. For example, during the swarming season, as the drone numbers increase, mite numbers also begin to rise. On Oahu, there can as much as a 10-fold increase in drone production during the summer months. In contrast, during re-queening events, when there is a decrease in egg laying and a temporary reduction in brood availability (worker and drone alike), mite numbers fall temporarily. Consequently, adjusting the treatment schedule to the cycles in brood production and anticipating variations in mite levels are important components of Varroa management.

Another important element affecting Varroa population growth is mite reproductive success, which is determined by the mother mite's ability to produce fertile daughters. Research has shown that mites from different parts of the world differ in their fertility, with some strains having lower reproductive success than others. We need to gain a deeper understanding of the dynamics of the mite population here in Hawaii so that we can better predict their increase and adjust our treatment levels. Research on this important issue is ongoing at UH Manoa.

Integrated Pest Management of Varroa in Hawaii

Integrated Pest Management (IPM) is a strategy commonly used in agriculture to ensure crop productivity while keeping pesticide use at a minimum. The goal of an IPM program is to intervene before the pest population increases and causes economic damages to the producer. Although IPM techniques aim to reduce the pest density, the treatments are not expected to eliminate the pest completely.

In the present situation with Varroa, the IPM program will attempt to control the mite population using a variety of treatments applied during different times of the year. Successful pest management will reduce the losses to honey producers and will help maintain the strength of hives for crop pollination. Varroa IPM strategies are likely to vary from locality to locality due to weather, colony cycles, and honeyflow seasonality. It is important that each beekeeper becomes familiar with the rhythms of their hives and is able to identify the reproductive cycle and the corresponding rise in the mite population. The charts presented in this brochure are based on data from the southeastern portion of Oahu.

Although we are not endorsing specific products, we are emphasizing the use of screened bottom boards, drone comb and thymol, treatments that have produced good results during our first year of Varroa monitoring and control. We will continue to update our information and the recommendations as more data becomes available for the different regions of Oahu and the Big Island of Hawaii.

Colony dynamics

Colony dynamics will vary slightly across the islands and each beekeeper should consider his/her unique situation. The key issue is to recognize when mite levels are increasing and treat accordingly. To able to identify and respond to changes in mite density the beekeeper needs to sample at least 4 times during the year.

Colony Dynamics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Worker Brood	Low	Low	Low	Medium	High	High	High	High	High	High	Medium	Medium
Drone Brood	Low	Low	Low	High	High	High	High	High	Medium	Medium	Medium	Low
Honey Flow	Low	Low	High	Medium	High	High	High	High	High	Medium	Medium	Low
Swarming Season	Low	Low	Low	Medium	High	High	High	High	Medium	Medium	Low	Low
Re-queen/Spliting	Low	Low	Low	Low	Low	High	High	High	Low	Low	Low	Low
Mite Levels Passive Drop	High	High	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	High	High

High
Medium
Low

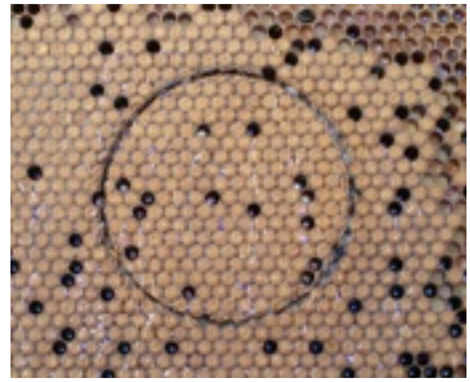
Treatment and sampling schedule

Control Method	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Screan-bottom-board	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment
Drone Brood Removal	No Treatment	No Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	Treatment	No Treatment	No Treatment
Thymol Treatment	Treatment	Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	Treatment
Formic Acid Treatment	Treatment	Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	No Treatment	Treatment
Varroa Mite Sampling	Treatment	Treatment	No Treatment	Treatment	No Treatment	No Treatment	Treatment	No Treatment	No Treatment	Treatment	Treatment	Treatment

Treatment
No Treatment

Hygienic Behavior: How genetics can play a part in the control of Varroa

Traits that are important in the breeding and selection of managed honeybee colonies include productivity, tameness, and behavioral mechanisms that increase colony resistance to disease. Hygienic behavior is the genetically based tendency for the worker bees to detect and remove larvae that are infected with diseases and parasites, including Varroa. Hives are considered hygienic if the workers remove 95% of dead or infected pupa within 24-48 hours. To test for hygienic behavior a patch of capped brood of about 200 cells is killed by freezing. The bees' response to the dead larvae and pupae is then recorded and scored.



Patch of brood frozen with liquid nitrogen (above), and the same patch 48 hours after re-introduction to the hive (below).

According to the literature, the frequency of hygienic behavior in the wild is relatively low, approximately only 10-12 % of hives exhibit this trait. On Oahu, the percent of hives that exhibit hygienic behavior is very variable, but some hives appear to be consistently good throughout the year. Identifying hives with strong cleaning behavior, especially among those that have already been exposed to Varroa, is highly recommended. These hives can be used as a source of new queens and drones and to produce splits. In addition to the natural resistance found in some hives, beekeepers may want to consider locally produced queens fertilized with semen from hygienic drones. These queens should produce consistently good cleaning worker bees and thus provide some added protection against the impact of the Varroa mite.

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Written by: ETHEL M. VILLALOBOS, July 2009. Thanks to M. G. Wright, J. Hayes, T. E. Shelly, L. Medina, J. Wright and S. Nikaido for comments and suggestions in the development of this brochure. Photos by: S. Nikaido, J. Wright , and E. Villalobos. Funding provided by Hawaii Department of Agriculture.