Best Management Practices for *Varroa* Mite Control in Wisconsin

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Introduction

Beekeepers from hobbyist to commercial scale are challenged by controlling *Varroa* mite infestations in their colonies. There is a lot of confusion on *Varroa* control methods that work best in Wisconsin. The best methods to control *Varroa* mites in honey bee colonies vary widely across the United States. Seasonal temperatures and the brood cycles in honey bee colonies dictate what control methods work best at what times of the year in different areas of both the nation and the state. This document is intended to educate Wisconsin beekeepers on factors to be considered when choosing methods to control mites as well as give a brief biological sketch of the mite.

Specific instructions for applying chemicals (essential oils, organic acids and synthetic) will not be discussed because legally purchased mite treatments have the directions clearly spelled out on the label--which should be referred to before and during use. Not following label directions can result in minimal *Varroa* control, death and damage to the colony or queen, mite resistance, and/or contamination of honey.

A helpful reference document that outlines treatment options for honey bee pests and diseases is available from the Wisconsin Department of Agriculture Trade and Consumer Protection. It can be downloaded at:
https://datcp.wi.gov/Pages/Programs_Services/PestsDiseaseMgmtHoneyBees.aspx.
Additonal detailed *Varroa* management information can be found at:
https://honeybeehealthcoalition.org/varroa/ .
These detailed resources in combination with considerations for the Wisconsin beekeeping system offers the best choices for managing *Varroa* in honey bee colonies.

In Wisconsin, temperatures in March, April and May are usually too cool for some methods to work well. This also varies from southern Wisconsin to northern Wisconsin. For simplicity, the methods described in this document will assume a typical beekeeping management year in central Wisconsin. For southern Wisconsin, the season will start one or two weeks earlier and continue one to two weeks longer. For northern Wisconsin, the season will be shorter, most likely by one to two weeks on both ends of the season.

Varroa Lifecycle

Varroa mite infestations pose multipronged threats to honey bee colony health. *Varroa* mites can cause physical damage to individual honey bees in the form of detaching forewings and hindwings, making flight difficult to impossible for the bee. *Varroa* mites also pierce the bee cuticle and suck the hemolymph (or bee blood) from the bee, vectoring many viruses in the process—such as Deformed Wing Virus—which are proven fatal to a bee. The *Varroa* mite's life cycle is very well-matched to that of the honey bee. The mite mature alongside honey bee brood from the time the honey bee is a 5 day old larvae to adulthood (**Figure 1**, plates 2-9).

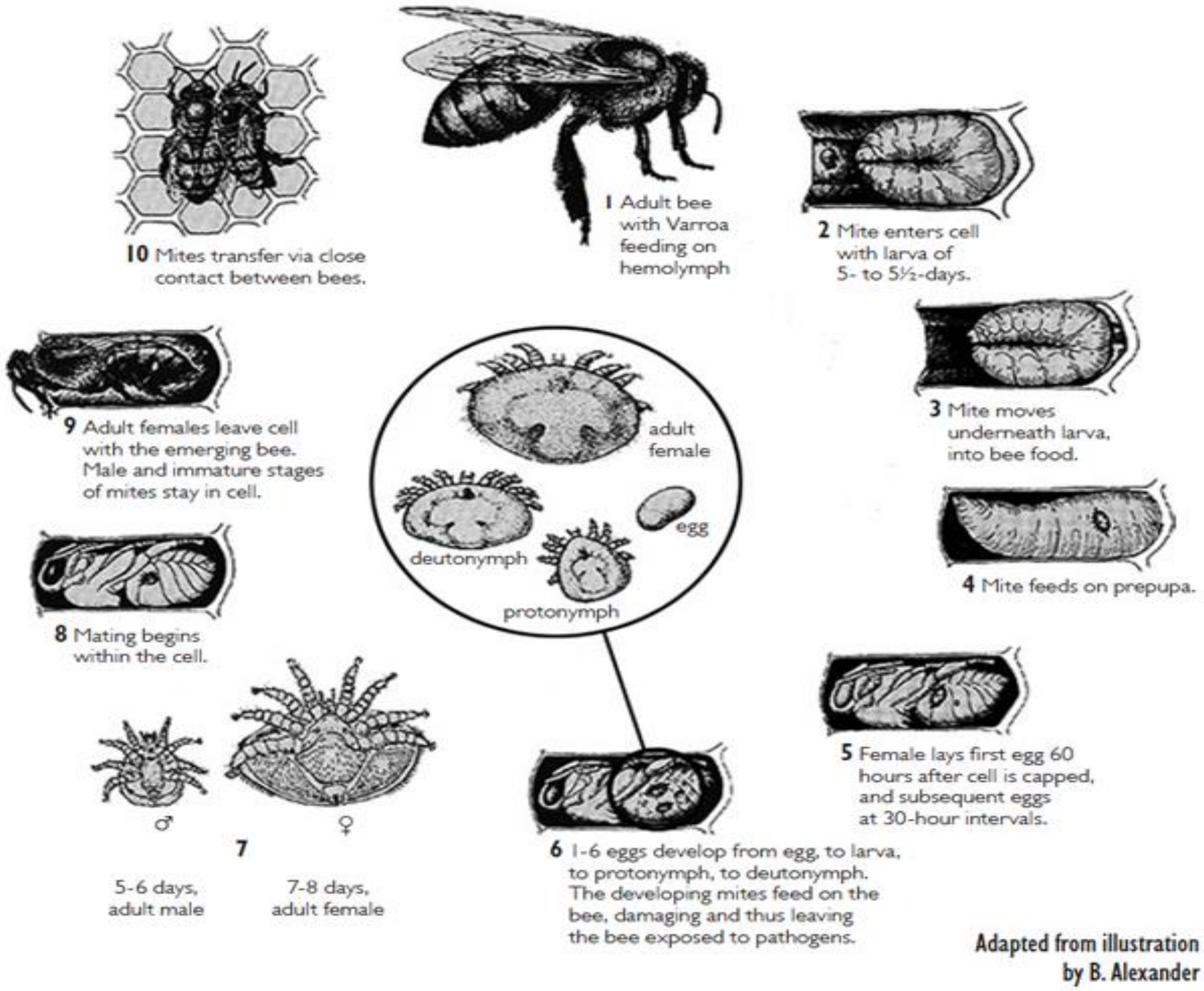

Figure 1. The *Varroa* mite, *Varroa destructor*, life cycle is closely paired with the honey bee life cycle, making it difficult to target with non-chemical IPM (integrated pest management) methods. The mite utilizes multiple stages of the honey bee life cycle for nutritional and reproductive needs. *Figure adapted from Henderson et al. 1986 and originally made by B. Alexander*.

During maturation, the *Varroa* mites feed on the immature honey bee larvae (**Figure 1**, plate 4) and are capped inside of the honey bee cell during pupation (**Figure 1**, plates 5-6). There is typically more than one adult mite in a single honey bee cell. While enclosed with a honey bee pupa inside of a cell, the mated female mites lay their eggs on the honey bee pupae. The young *Varroa* develop and mature inside of the capped cells alongside the honey bee pupae. The mites simultaneously emerge from the capped pupae cells when the young honey bee, or teneral bee, emerges. The male mite remains on the teneral bee while the mated female mite moves to a new adult honey bee worker and then to a honey bee larva, beginning the life cycle again.

High *Varroa* infestations, where more than 3% of honey bees in a colony have mites, cause honey bee colony populations to rapidly decrease and die out if left untreated. This means beekeepers need to take *Varroa* infestations very seriously and address *Varroa* levels before they reach high levels and cause irreversible problems.

Mite Control: Factors and Considerations in Wisconsin

Because of the relatively short growing season in Wisconsin, several factors can make mite control more challenging, but it is generally recommended to be practicing at least some of the lower-tier IPM pyramid control methods during the entirety of bee activity (**Figure 2**). The IPM pyramid is designed so that non-chemical pest control techniques are utilized before pesticides are utilized. The producer works up the pyramid from doing things like having genetically resistant stock, to drone trapping, to using natural, and lastly, synthetic pesticides. It is important to note that a beekeeper only knows if they need to continue moving up the pyramid if they are sampling their colonies for *Varroa* mites regularly—ideally monthly, from April through October.

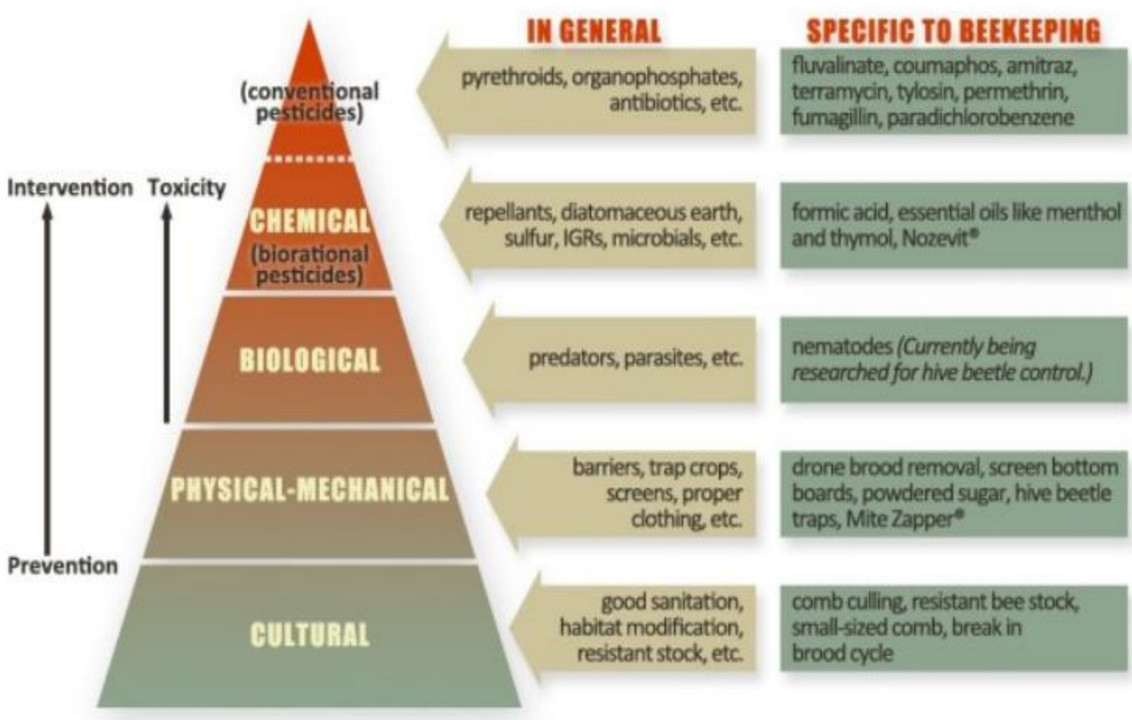

Figure 2: The Integrated Pest Management (IPM) pyramid focuses on working from the bottom to the top of the pyramid to control pest infestations. This approach first utilizes non-chemical control techniques and then pesticide-based techniques if the pest is still at high levels after sampling. *Figure from E. Niño, 2015*.

From May through August, the population of honey bees in a colony is usually increasing dramatically. This can mask the potential effects of an increasing mite population. A beekeeper checking the colony’s mite load in July may not get a true picture of the expanding mite population. It isn’t until the honey bee population of the colony dramatically decreases in late August that the true mite loads may become apparent. This said, high mite loads any time can give the beekeeper a “heads up” and be cause for extreme concern.

Many queens that are available have genetics that cause them to continue raising brood well into December. This is particularly true for Italian honey bees which are rather ubiquitous in Wisconsin, but less true for Carniolans or Russians, which are not found as commonly in Wisconsin operations. It is not uncommon for colonies to be raising brood in December in Wisconsin, but this is not always the best action for a colony’s health. Late season brood rearing decreases the beekeeper’s ability to use mite control methods that are most effective when a colony is in a broodless state, such as oxalic acid.

Colonies overwintered in Wisconsin will have mites in the Spring, commonly in high levels. Usually in March, there is a day or two when temperatures reach into the 40°s. When that occurs, beekeepers should be checking colony mite loads and food stores. The simplest sampling method is a powdered sugar roll, although there are other methods such as ethanol or ether rolls and daily sticky boards. The University of Minnesota’s Bee Lab has online instructions for sugar rolls and most beekeepers in Wisconsin use this method to test mite infestion levels. Instructions can be found at z.umn.edu/freebee. Typically, a **3 percent** mite load, (where 3 out of 100 adult honey bees are carrying one or more mites), is the level at which to consider controlling with miticides or taking drastic non-chemical IPM approaches to quickly knock down mite populations. In March, a beekeeper should consider controlling the mites at even the one or two percent infestation level, as infestations typically grow in the spring, stay static or decrease in the summer, and drastically increase again in the fall. A two percent mite load in March, if left untreated, can have devastating effects by the end of summer or early fall. A two percent load in September may indicate that the mite level is under control.

In March and April, the temperature is usually too cool for chemicals like Apiguard (thymol gel) and Mite Away Quick Strips - “MAQS” (formic acid) to be effective. Hives will typically have brood by this time of the year so oxalic acid (dribble or vaporization) will not be as effective. Subsequent applications of oxalic acid can be very hard on honey bees and can cause queens to have a break or cease in egg laying activities, sometimes prompting a colony into premature supersedure of the queen.

There are two management options that may be most effective for varroa control in the early spring: Apivar (amitraz) or drone trapping. Apivar must be placed in the colony for 42 days and removed two weeks before honey supers are placed on the colony. If the honey supers are to be added June 1st then Apivar must be administered by the end of March.

Drone trapping is the practice of placing a frame of drone comb in the hive. The drone comb is placed on the edge of the brood oval, the bees to draw it out, and the queen subsequently lays eggs in it. *Varroa* mites prefer laying eggs in the drone brood because of the longer pupal stage of the drone. This allows the female *Varroa* mite to raise one additional female *Varroa* mite before the drone emerges from its cell. Drone comb is placed in the hive and then removed prior to the drones emerging.The combs of capped drone brood are then placed in the freezer to kill the drones and mites under the cappings. If the beekeeper decides to place drone comb in the hive, it is essential that the comb is removed and froze **prior** to drone emergence. If the drones are allowed to emerge, the colony will experience a dramatic increase in mites, as the beekeeper has essentially set up a varroa-rearing frame. If the beekeeper is not good at using records or is not able to regularly conduct hive inspections to check for brood development, then this option is not recommended. Bee supply companies sell plastic frames with 100% drone size cells for this use. The plastic frames are green to make identification and removal easier. The most common brand sold is Pierco drone comb, but the beekeeper can also buy drone cell wax foundation and apply cross wire.

When springtime temperatures warm, MAQS (formic acid), an organic chemical, may be used. MAQS can be used all summer, even with honey supers on the colonies, until temperatures drop in the fall. Daytime temperatures should be over 50º F but under 92º F for MAQS to be used, as stated on the manufacturer's instructions.

HopGuard II (hop compounds) is another organic treatment that can be used when daytime temperatures rise above 50º F. Like MAQS, HopGuard can be used with honey supers on the colony.

Community treatments or encouraging beekeepers in an area to apply mite treatments at the same time reduces the risk of colonies being reinfested with mites from neighboring colonies. This type of reinfestation has recently been coined as the "mite bomb" from researchers at the University of Maryland. If some beekeepers treat their bees in August and September and the mite levels in neighboring colonies are allowed to increase resulting in a "crash" of the colony, mites from the crashing colonies can infest neighboring colonies that had previously been treated and had mites under control, thus resulting in a mite infestation spread to colonies throughout an area. Community treatments reduce this risk of reinfestation by ensuring area beekeepers have a mite treatment plan and synchronize mite control efforts to lower the chance of a mite bomb.

As colonies build up, a cultural, non-chemical *Varroa* management practice can create a break in the brood cycle of the colony. When a brood break occurs, all mites become phoretic and are exposed in the colony as the brood on which they were reproducing emerge, as briefly described in the *Varroa* life cycle section. A break in the honey bee brood cycle not only temporarily stops the mite reproductive cycle, it allows the bees to groom some of the *Varroa* mites off of other adults. A brood break may be accomplished in four ways: swarming; "walk away" splitting; queen removal; or caging the queen.

Swarming

Swarming is an effective way for a colony's brood cycle to be broken. The mother queen typically leaves the origin colony shortly before a new queen emerges from her queen cell, a process which may mean a colony is completely queenless for hours to 3 days before a virgin queen emerges from a capped queen cell. After this, the virgin will take orientation flights around days 3-5 after emergence, and then take 1-3 mating flights over the next several days. New eggs can be expected around day 10 of the queen's reign, if day 1 is her emergence from her queen cell. This ultimately results in diminished brood rather than a true break in brood, as the queen will start laying around day 10, but there are still at least some brood from the original queen throughout most of this process. The colony is ultimately queenless for a short period of time, so long as the virgin successfully mates, but this is not a technique of brood breaking that is as successful in knocking down *Varroa* populations as is a true period of broodlessness.

Beekeepers commonly try to avoid swarming and they do this by increasing the broodnest size and by otherwise letting the colony run out of open cells. To instead encourage swarming, beekeepers can easily do the opposite by letting their colonies get congested with bees or otherwise run out of space. It's important to note that beekeepers tend to avoid swarming because they don't want to lose bees. If swarming is instead induced, then it would be practical to ensure that the beekeeper has swarm traps out and that there are not structures nearby where a newly established bee colony would cause problems.

Splitting

When making a split and allowing the split to raise its own new queen ("walk away" split), a beekeeper is breaking the brood cycle in the future. The healthy, laying queen that is in the original colony has laid several frames of open brood and capped brood that need to be included for a split to successfully rear its own queen. The brood break in this split process is the broodless period. When the new queen (which the bees reared from young open brood laid by the original queen before the beekeeper made the split) emerges, there is very little or no brood in the split that was laid by the original queen still in the split. The new queen will take her orientation flights around days 3-5 after emergence, and then take 1-3 mating flights over the next several days. New eggs can be expected around day 10 of the queen's reign, if day 1 is emergence from her queen cell. This means that there is a 10 day break in the brood cycle, perhaps even longer depending on how much brood from the original colony was in the split to begin with. This is a good non-chemical method for *Varroa* control in Wisconsin, as the beekeeper can monitor their splits to ensure successful requeening, no bees are lost due to swarming, and there is a brood break.

Queen Removal

If the beekeeper wants to requeen a colony, remove the old queen, wait 5 days, then remove all queen cells that the bees have made during that time. Then the beekeeper introduces a new caged queen. This creates a brood break (where the colony is completely broodless). This is a very risky procedure, as the caged queen will need approximately 3 days to be introduced (bringing the period of time with no new brood to approximately 8 days). There is a high risk that the bees will not accept the new queen. By creating this brood break for the bees, the beekeeper has also created a brood break in the *Varroa* mite life cycle.

Caging the queen

Caging the queen is another fairly risky way to induce a diminished brood period in a colony, but there is no true brood break. In this procedure, the queen is found and placed in a cage for several days so that she cannot lay new eggs. It's important to realize that an eggless period of time is one of the signs to a colony that their queen is failing, so performing this method with the best queen in the apiary is not a good idea, as it sometimes causes queen supersedure. Ultimately, a queen shouldn't be caged for more than eight days or so, which is not enough time to have a significant drop in *Varroa* population levels.

Conclusion

Throughout the spring and summer, the beekeeper should be checking mite loads on their colonies. In the summer, strong colonies may be increasing in population very quickly. This may skew a beekeeper's assessment of how well mites are being controlled. In late August, the population of honey bees in the colony will drop as the colony prepares for winter. This is a critical time for mite control. Honey should be harvested as soon as possible in the late summer, as an early honey harvest will allow for the colony population to stabilize to fall levels and allow the beekeeper to check the mite load and begin fall treatments.

As in the spring, fall daytime temperatures must be above 50º F for some miticides to work. Effective fall treatments are Apivar, Apiguard and MAQS. Apiguard is more effective if colonies are not being fed during application.

An effective late fall/early winter treatment (when brood rearing has almost stopped) is oxalic acid. It can be applied either by the dribble or the vaporization method. Oxalic acid should only be applied once a season, as multiple applications can cause more harm than help to colonies.

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