

KEEPING YOUR BEES SAFE FROM THE VARROA MITE

MEGHAN MILBRATH, 2018

Right now, honey bees are in the midst of an epidemic. The mite known as *Varroa destructor* damages developing honey bees, transmits a variety of viruses, and is a leading cause of colony death. While the varroa mite has been present in the United States for a few decades, in recent years the prevalence of varroa and its associated viruses has reached epidemic proportions. Unfortunately, this deadly pest-pathogen combo has become so widespread in the United States that every colony is *at risk* of dying from varroa-associated viruses, because most beekeepers are trying to keep bees in a landscape where there really high pressure of this mite.

Those of us in beekeeping education and extension have seen a rather upsetting trend with beginner beekeepers: they start full of enthusiasm, but will lose all or most of their bees year after year, usually to unchecked varroa populations. After about 3-4 years of steady losses, one of two things happens: they quit beekeeping, or they take varroa management seriously. If you consistently lose more than 10% of your colonies, you need to critically evaluate your management strategy, and give varroa the respect that it deserves. The individuals who succeed in keeping their bees alive over winter during this epidemic are those beekeepers who take parasite control seriously, or even critically, and make varroa control a *regular part* of their season-long honey bee care.



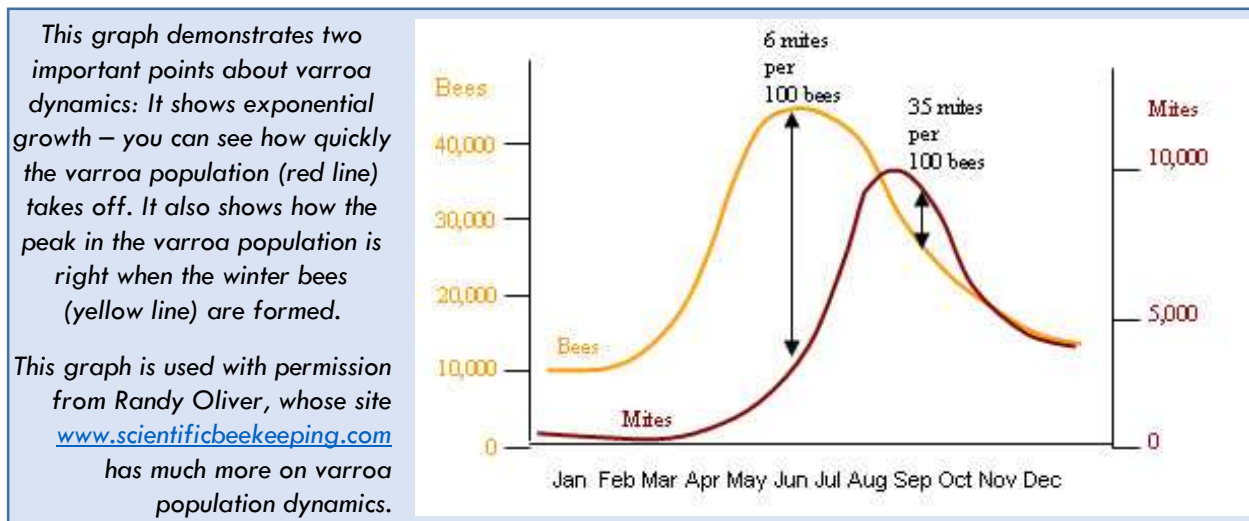
Honey bee with a varroa mite on her thorax and signs of deformed wing virus – one of the viruses transmitted by varroa destructor. Photo by Stefan de Konink BY CC 1.0, via Wikimedia commons



We can take actions to keep our bees safe from varroa mites, so there is no reason to lose all or most of your bees every year. While varroa mites WILL be in your hives this year, not every colony is doomed to die from the viruses that these mites transmit. If you keep the varroa population in check, your honey bees can remain healthy. If the varroa population gets out of control, the colony becomes profoundly sick from injury and disease, and is at a high risk of dying.

Colony with parasitic mite syndrome in a colony where mites were not controlled. Note the sick, melted looking larvae. There is a very low chance that this colony could survive the stress of winter, even if varroa was controlled at this point. Photo by Meghan Milbrath

Varroa mite populations can grow quickly, if unmanaged. Each female mite reproduces multiple times in her life, and each time she reproduces, she lays multiple daughters (and they all reproduce multiple times, and they all produce multiple daughters, and those daughters reproduce...). The timing of the varroa population explosion is what makes this pest a key cause of winter death; when left unchecked, varroa populations peak when the winter bees are formed. The winter bees are the ones produced right before the colony goes into winter. These bees, with their extra fat-bodies and different hormones, are the ones that will live through the heart of winter and will raise the first round of brood in the spring. They have to be in great health to go through this arduous time. Most of the colonies that we lose in fall and winter are because the winter bees are infested with varroa during development. Once the stress of winter hits, these bees cannot survive.



All of this reproduction is occurring under capped brood cells, which means that the more capped brood we have, the faster varroa can reproduce, and 2) we can't see the population of varroa as it grows out of control. **A heavily infested honey bee colony may look very healthy and large, and you may not see any mites when you inspect, while the mites have caused deadly levels of damage out of sight.**

When you keep animals, you want to make sure that you are doing right by them – you keep them healthy, and you don't let them get overtaken by parasites. With bees, the ethical implications of parasite management run even deeper. When you let a colony succumb to varroa infestation you can also be making the epidemic worse for those around you. A colony that is heavily infested with varroa can act as a reservoir. Bees will often drift or abscond from a varroa infested colony and neighboring bees will rob the weakened colony. When this happens, the mites very quickly get transmitted to other neighboring colonies. This means that your infested colony can affect the bees and beekeepers around you. It also means that that your otherwise healthy colony can become re-infested quite quickly from a neighboring colony.

Why can't our bees just take care of these parasites on their own? Unfortunately, most of our bees don't have strategies to keep mite populations down on their own (yet) - varroa mites are relatively new to our honey bees (they jumped over from a different bee species), and our bees haven't had enough time to evolve natural defenses. Even the strains that have some defenses (Russians, VSH, Mite Biters, Minnesota Hygenic, etc) don't have enough skills to handle the intense pressure that we see in most colonies during this epidemic. While breeders are working tirelessly to find bees that do have defensive strategies, as of 2018, most of the colonies in the United States don't have the ability to manage varroa populations by themselves in most of the places where we are keeping them. You may hear about people who are successfully treatment free. A lot of that has to do with where they live, and if they can keep their bees relatively isolated, with low disease pressure. In isolated areas, the bees and the mite/virus complex can reach a balance. If those bees are moved to a new location with high disease pressure, they generally

don't survive. While we all want to become treatment free, and to not add extra things into our hives, you likely are living in an area where the disease pressure is too high and your bees will get sick and die if varroa is left alone, and you will just make the epidemic worse for other bees and beekeepers in your area. We need to keep supporting breeders who are working on resistant bees, but we need to do our part to manage the epidemic to protect our colonies and those of beekeepers around us.

If you want to be part of the solution, the best thing that you can do is to monitor your colonies, and find the ones that succeed in your area with little intervention, and breed off of them. If the colonies can't keep mites low, then for the love of your bees, take care of the mites. Requeen that colony with a queen with better genetics, and keep trying. We need to get more bees out that can handle varroa, but we need to do it responsibly.

Controlling parasites to protect your colony and stop the epidemic

So what is a beekeeper to do? Below, I'll outline ways that we can keep our bees healthy in the face of high varroa pressure.

The information in this article is designed to explain the different tools that we have to manage varroa populations. Your goal as a beekeeper should be to develop a strategy at the beginning of each season that will use a variety of these tools, making sure that varroa mites never take over your colonies, and your bees stay healthy. This entire document is based on my personal experience and opinions. I'm still learning, and every year changes. Make sure you check the date and talk to other beekeepers who are successful in your area (meaning that they keep bees alive).



A frame of healthy brood. Because I monitored, and got no mites in my sample, I know that this colony is producing healthy winter bees. If I am not managing varroa, there could be all sorts of terror happening underneath the cappings of this colony. Photo by Andrew Potter www.andrewpotterphoto.com

Keeping your bees safe

We want to keep varroa from reaching dangerous levels. This means we have to do two things:

1. Monitor so you know the levels of varroa in your hives, and know if they are in danger
2. Use a mix of tools to keep the parasite load manageable for the bees
 - a. Tools that break varroa reproduction (prevent the mite population from taking off)
 - b. Tools to use if we have an infestation (bring a high population of mites down)

To keep our bees healthy, we want to make sure that varroa populations never reach dangerous levels. Throughout the season, we can use an integrated set of management strategies to help break the reproduction of varroa, preventing the population from taking off. If/when we find that our colony is overwhelmed and at risk of illness, we need to have a plan in place and the tools on hand.

UNDERSTAND THE SAFE THRESHOLD FOR VARROA POPULATIONS

Remember that your goal is to make sure that your bees are always healthy. This means we want to prevent varroa populations from reaching dangerous levels. Usually, the varroa population builds over the summer, peaking in late summer early fall. This means that there are times when we can find varroa in the hive, but it hasn't yet reached a level where the life of the colony is at risk.

As of 2018, the general consensus is that < 3% infestation is safe.

In a standard sugar roll test or alcohol wash where you count 300 bees (100 ml or just under 1/2 cup), you should see less than 9 mites. Over time this number has gotten lower as the epidemic has worsened, so you may see higher thresholds listed in older documents. A safe level of 3% is a guideline, set because we often see signs of disease around 5%.

Keep in mind that this is still a LOT of mites. Let's say you have 50,000 bees in your hive. A 3% infestation represents 1,500 mites on the adult bees. If even half of the mites are under the cappings, you would have 3,000 mites in your hive! (and that is considered safe!)

You can set your own threshold through experience - monitor your colonies (recording their levels and how they survive) and to talk to extension agents and local successful beekeepers in your area (who have <10% loss). If you consistently see that colonies with mite populations above a certain level do poorly, then that is your threshold. Be persistent, as thresholds can change over time as the mites or the viruses evolve. There are other factors to take into consideration: How far away are you from raising winter bees? Will you get a break in the brood cycle soon? How much season is left for varroa to grow? Northern beekeepers have to work hard to make sure varroa populations are low in the late summer/ early fall to protect winter bees, while beekeepers in warm climates might not be able to count on a break from population growth in the winter.



A newly emerged bee with deformed wing virus. While this virus is often found in the colony, it only causes disease when it is transmitted via the varroa mite. Usually we do not see signs of this disease until varroa populations are at 5% infestation. You can have thousands of mites in your hives without seeing signs of disease.

Photo by Sarah Scott

MONITOR SO YOU KNOW THE LEVEL OF VARROA IN YOUR HIVES

Looking for varroa is not the same as monitoring for varroa - you could have a lot of varroa in your colony, but not actually see any mites when you inspect. This is a really important point that catches a lot of beekeepers. By the time you see mites, it is usually too late. Our goal is to keep varroa populations from taking over our bees, keeping them from getting ill in the first place.

The best way to monitor varroa mite populations is to use a sugar roll or alcohol wash, because these methods allow you to get a percent infestation. In both methods you take a known number of worker bees, dislodge the mites from them, and count the mites, calculating the mites per 100 bees (percent infestation). Mite drops on inspection boards, checking drone brood, or just looking do not give you a rate of infestation, so it is hard to know what to do with the information you get. Learn how to do an alcohol wash or a sugar roll, so you have information that can help you make decisions.



made kit for sugar roll monitoring at many bee supply stores. Photo by Becky Masterman

* For more details and explicit instructions on how to perform a sugar roll visit <https://pollinators.msu.edu/resources/beekeepers/varroa-mite-monitoring1/>

* For instructions on making your own sugar roll kit visit the [Bee Informed Partnership website \(https://beeinformed.org/2013/03/19/how-to-make-a-sugar-roll-jar/\)](https://beeinformed.org/2013/03/19/how-to-make-a-sugar-roll-jar/).

How often should I monitor? Ideally, you should monitor mites at least once/month. Mite populations can change quickly, and you never want to be caught off guard. You could have low levels of varroa all summer long, and then suddenly suffer a huge infestation from neighboring colonies that goes downhill. Monitor more often in late summer/early fall when mite populations are at their highest, and your colonies are most at risk for re-infestation.

How early should I start monitoring? It is useful to monitor all season. First, you want to make sure that you are comfortable with the technique before you are in the high risk season (late summer/early fall). If you don't trust the results, it will be hard to make decisions. Second, it is useful to have information early in the season. If you see mites at the beginning of the year, you can anticipate a much earlier spike.

How many hives do I need to monitor? If you are trying to evaluate a colony's ability to deal with varroa (to see which ones to keep/ raise queens from), then you should evaluate every colony. If you just want to know if your bees are okay from varroa, it is recommended to measure from 8 in each yard. If you have fewer than 8, monitor all of them.

What is better – the alcohol wash or the sugar roll?

Both of these methods are fine – they both provide data in terms of mites/100 bees. They are both equally precise – if done well, you can get the same number with the sugar roll as the alcohol wash. The benefit of the alcohol wash is that it is easier – the sugar roll has more steps, and is easier to mess up. The benefit to the sugar roll is that the bees in the sample usually don't die, so some people are more likely to use it.



Varroa mites in an alcohol wash. Photo by Randy Oliver

IF YOU CAN'T MONITOR, AT LEAST MANAGE. KEEP YOUR BEES ALIVE.



While monitoring is an important way to understand varroa dynamics in your area, we can also use our past experience. If you have lost bees many years in a row, you know you are living somewhere with high varroa risk. If your past monitoring has shown that every year your mite levels are high in mid-August, you don't have to wait until your bees are sick to take action. Mites are different from other diseases which are rare—we don't recommend just putting antibiotics in your hive, because it is unlikely you will get AFB. It is highly likely that your colony will be overrun from mites, so it isn't bad to treat before mites reach dangerous levels. Photo by Andrew Potter

USE A MIX OF TOOLS TO KEEP MITE POPULATIONS AT A SAFE LEVEL

You want to create a management plan that keeps your bees safe all season long. The goal is to try to keep varroa mites from taking off, and to also know how to react quickly if you see a colony that is overrun. Practice management the whole season to keep mite populations low, and be prepared to intervene if you notice a problem.

- 1) Management – There are things we can use to prevent the mite population from taking off.
 - a. Non-chemical (physical),
 - b. Softer chemical treatments (can be used with minimal disruption)
- 2) Intervention – We need tools if we find that our colony is at risk of illness or death, because the mite population has gotten out of control.

The best approach is to go in to the season with a management strategy that includes a variety of tools designed to keep mite populations under control. Your specific plan will depend on how heavy the disease pressure is in your area, how much time you have, your experience, and the length of your season and timing of your honey flows. Unfortunately, there is no silver bullet or one-size-fits-all strategy.

Tools for season-long management (Keep varroa populations from taking off)

- Physical
 - Drone brood removal
 - Breaks in the brood cycle
- Soft acid treatments
 - Hop Guard II
 - ½ dose Formic Acid (Mite Away Quick Strips)
 - Oxalic Acid (not when honey is on)

End of season management (if varroa populations are likely to reach dangerous levels)

- Formic Acid full treatment (Mite Away Quick Strips)
- Thyme oils (Api Life Var, ApiGuard)
- Apivar

Broodless (Packages / winter)

- Oxalic Acid

The Tools – Management (non-chemical)

SCREENED BOTTOM BOARDS – The idea behind screened bottom boards is that when phoretic mites fall off of bees, by just falling or by getting groomed off, they will fall through the screen and onto the ground, where they will be too far away from the bees to re-enter the hive. The effectiveness of screened bottom boards is determined by the set-up. If the bottom is wide open, the mites will fall further (but the chance of a cold draft on your bees is much higher). If the screened bottom board has an inspection board employed, or is set on a solid surface, drafts will be much less of an issue, but screened bottom board will not be effective.

How to use a screened bottom board – Put it on the hive as a bottom board, and make sure the stand is designed so the mites can fall to the ground. Close the screen off in winter.



This hive stand is high off the ground so the varroa (and other debris) will fall a long way. The board can be left in during winter or to check for mite fall after a treatment. Photo used with permission from Sue Dompke

Pros

- No work for the beekeeper, and not disruptive to the bees

Cons

- Does not remove that many mites, so it has to be used conjunction with other tools. Having a screened bottom board is not enough.
- May make the colony cooler during cold periods, which can affect brood rearing.
- Does not work with some mite treatments that need the colony blocked off.

When screened bottom boards work best – Because their effects are so small, you will have to use other strategies as well, and those strategies may be sufficient even without a screened bottom board. Plenty of beekeepers use solid bottom boards and can manage varroa, so if you have solid boards and you are successfully managing varroa mites, it may not be worth it to switch. I have a mix of screened and solid bottom boards, and I don't feel that either design is much better.



I don't recommend using inspection boards for mite risk monitoring because it is too difficult to tell what the infestation rate is – we want a count in mites/bee, and we don't have a sense of the number of bees. However, inspection boards are great to see if a treatment worked. If you knew you had high mites, and applied a treatment, but didn't see any dead mites on the board, something may have gone wrong.

Photo by Maja Dumat (CC BY 2.0), <https://flic.kr/p/7CutKA>

DRONE COMB REMOVAL – We can use capped drone cells like a trap. A full frame of capped drone brood will have a lot of mites in it. We can pull the frame from the hive, removing the mites.

How to use drone brood removal – Purchase a green drone frame, or make a frame that will promote the larger drone sized cells (like using a medium frame in a deep box, or adding one frame without foundation). If your whole hive is foundationless, you should have plenty of drone comb. Put your drone frame on the edge of the broodnest (between the brood and the outside honey frame). Make sure that the colony has sufficient room for honey storage and growth, so they don't just fill it with honey. Record the date that you put the drone comb into the colony, and remove it in two to three weeks. It should take about a week for it to get drawn out, the queen to lay in it, and the eggs to hatch (though this is variable), and then another week for the larvae to be capped.

You have about a two-week window while the cells are capped to remove the frame. Some people do this one time per year, other beekeepers will do this consistently through the summer. You can also just cut out/remove large pieces of drone brood while you are in the colony for inspection.



Green drone frames. These can be purchased at any bee supply store.



The bees will naturally put drone comb in spaces without foundation – here a medium frame was put in a deep brood box. The drone comb can be easily removed with a hive tool. Photo used with permission from Jamez Brisson.

Pros

- You can remove a lot of varroa mites from the colony

Cons

- It takes a lot of energy for a colony to raise a full frame of drones. This energy could be used to raise young, draw wax, or bring in honey.
- If you forget to remove the drone frame in time, you have just provided a lovely place for more mite reproduction.
- It can only be used when the colony is naturally drawing wax and raising drones (not in the fall, or not on small colonies).

When drone comb removal works best –

Drone brood removal only works with strong healthy colonies that would be raising drones anyway. Bees will not draw out wax if there is not sufficient nectar, so you can't put in a new drone frame in September as a last minute management strategy. If your colony is weak, already overloaded with mites, there is no nectar flow, or it is late in the season, drone brood removal wouldn't be the best strategy. You also have to make sure that you can visit each hive on the scheduled days – otherwise you can just raise a lot of mites.



You want to make sure you kill the drone pupae/mites. You can put a green frame in the freezer for 24 hours, or you can feed the drones to your chickens.

Photo by Meghan Milbrath, owner of the world's cutest miniature chickens.

BREAKS IN THE BROOD CYCLE – When varroa are in capped brood cells two things are happening: the varroa are reproducing, and they are safely hidden away from grooming bees. If you can create a colony with no capped brood, then the varroa cannot reproduce during that time, and the mites that are left in the hive are all vulnerable to falling to the ground or getting groomed by the bees. A lot of beekeepers use breaks in the brood cycle alone to control mites. This is a very effective tool.

How to perform a break in the brood cycle – There are many ways to break the brood cycle. Some beekeepers will simply remove all the capped and nearly capped brood – using them for other hives (and dealing with the mites appropriately). Others will temporarily cage or remove the queen and eggs, and later reintroduce her. One easy way is to make a nuc with the queen, and allow the original hive to make a new queen by itself. The nuc will grow slowly (not have so much brood to build up a big population of varroa), and the original colony will get a break from having capped brood as they create a queen.



The queen is caged for 12 days, allowing all of the brood to eclose (emerge from the cappings). Photo by Waugsberg - Own work, CC BY-SA 3.0, via Wikimedia commons.

Pros

- Very effective in stopping varroa reproduction

Cons

- Need to know enough about bee biology to time well and be comfortable finding/ handling queens.

When breaking the brood cycle works best – When you have a strong enough colony and/or enough time left in the season for the colony to handle the loss of workers/honey. You can combine the breaks in the brood cycle with other treatments – this is a really good time to do a dribble with oxalic acid (covered later in this document).

Photo by Sarah Scott.

Many beginner beekeepers use breaks in the brood cycle without knowing it. This frame shows backfilling – where a beekeeper (me) didn't put supers on fast enough, and the bees ran out of space. If this were to continue, the bees would swarm, and it might be a while before there is enough space for them to brood up again. Sometimes swarming (or superscedure) is the reason why you can have success without using other treatments. A break or two in the brood cycle may be sufficient to stop varroa populations from taking off – it doesn't remove any mites, but it can prevent them from reaching dangerous levels before the winter bees are made. I often use breaks in the brood cycle – I split in spring, and once again in July, or I make nucs for queen rearing. I have found that in my area, this is often enough to keep varroa from taking off, and I don't have to do any other mite control in those hives.



SPLITS – Splitting prevents a colony from having a high percentage of infested bees, using a principle similar to dilution. Varroa mites reproduce faster than bees, because each colony has only one reproductive bee (the queen), but many reproductive varroa. When you split a colony into multiple colonies with multiple queens, you allow for more bees to be raised. Remember that we measure mite load as percent infestation, or mites per 100 bees. When we split, we keep the same number of mites, but increase the number of bees, so the rate of infestation drops.

How to make a split – There are many ways to split colonies. The ‘best’ way will depend on the size of your colony, the time of year, and your needs. Many beekeepers make splits in the spring for swarm management, or in the late summer after the main honey flow. Various size splits can be made (including nucs), and can be queened by introducing a mated queen, virgin, or cell, or by allowing the colony to requeen. Splits and breaks in the brood cycle often go hand in hand, and many beekeepers split colonies, and create a break in the brood cycle by using queen cells.

Pros

- Many beekeepers already make splits to increase numbers or make up losses

Cons

- Colonies have to have enough bees to raise workers/ get enough honey to survive the season.
- Many beekeepers are limited by the number of colonies that they can manage.

When making splits works best – When you have enough time for the colonies to build up sufficiently to make it through the winter. This often goes hand in hand with breaking the brood cycle. Making splits after the honey flow, and requeening with queen cells, causes a nice break in brood production at a time when you won’t be needing so many workers.

A split can serve multiple purposes; these hives were split to create increases, to requeen, and to manage varroa. The splits were made in mid-July, near the end of the main honey flow in my area. The capped brood was put into the single boxes. They will get moved to a new location, and will get a queen cell the next day. The big hive in the original location kept the old queen, and will get the honey removed and an oxalic acid treatment. In 3 weeks, the splits will be checked for queens, and they will also get an oxalic acid treatment (before brood is capped). I’ll have a young queen in half my colonies, and I’ll have a backup in case I lose any over the winter. All of the colonies will experience a break in the brood cycle as well as oxalic acid



treatment before winter bees will be made.

Photo by Meghan Milbrath

Understanding the chemical options

If you can keep varroa mites levels down through physical methods, great. It means that you have the time and knowledge to take advantage of these techniques, AND that you live in an area where the disease pressure is not so high as to overwhelm your efforts. Many beekeepers aren't so lucky, and will have to use chemical tools to keep their bees safe. Before you freak out about putting chemicals in your hives, it is good to keep a few things in mind. First, and foremost, everything in the world is made up of chemicals (including you and honey, and bees). Your bees are constantly bringing in chemicals into the colonies. We know that not all chemicals are the same. Early varroa treatments for were quite harsh (neurotoxins), and many of them no longer work because the varroa mites have developed resistance. Furthermore, many beekeepers were averse to put these treatments into their hives, because of damage to their bees, concerns about the chemicals in the wax, or build-up in the honey. Some companies listened, and developed a series of anti-varroa tools that are naturally derived, organic, and safe to use while honey supers are on. Not all chemical tools have the same risk, and not all have the same effectiveness - you can't just throw a treatment on the hive, and think that you are safe because you treated. You need to choose the one that will reduce the varroa populations, and be appropriate to the context. Make sure that you are reading and following labels exactly, and are working with experts to make sure you are doing everything safely and effectively, before you head out to the bee yard.

A NOTE ON ESSENTIAL OILS. A lot of beekeepers have taken an interest in essential oils. I don't recommend going out and buying oils and mixing up treatments yourself. Here is why:

- 1) Oils build up in the wax. When you put oils in your hives, it may stay in there a long time.
- 2) They are not benign – it is still a chemical treatment, but you won't know what health effects to expect. Just because it is naturally derived, doesn't mean it is safe.
- 3) They are unregulated. You can't guarantee that the product on the label is what you will get. Even if you trust the brand, there is no one making sure that batches are consistent.
- 4) Bees use scent for everything in the hive. Their communication, their assessment of food stores, their queen evaluation. Essential oils are often persistent and strong smelling. It can have long term effects on the colony.



Kate Ware (CC BY-NC 2.0) <https://flic.kr/p/bvfeA8>

Use only things that are labeled for honey bees. If you want to use oils, use the registered thymol treatments. These products have been tested to show that they are effective against varroa, are formulated to control the release of the dose, and cause the minimum harm to bees. All of the products that I outline below, except Apivar, are naturally derived. There are plenty of tested and regulated options to choose from if I want to put natural chemicals in my hive.

ACIDS

We have three acid-based tools that can be used to manage varroa mites: Hop Guard II, formic acid (under the commercial names Formic Pro and Mite Away Quick Strips /MAQs), and oxalic acid. The benefit of acid-based products is that they do not build up in the wax, and some options have been labeled for use when honey supers are on (MAQs, Formic Pro, and HopGuard II). Another benefit of acid based treatments is that they appear to affect the mites by causing physical damage. This means that it is very unlikely that the mites will develop resistance to these products. It is easy for pests to develop resistance to neurotoxins or conventional pesticides, but it is difficult for them to change their bodies enough so they are resistant to acids, while still functioning like a mite. Which acid-based tool you use depends on the size of the colony, the temperature, and if honey supers are on.

HOPGUARD II – HopGuard II is the potassium salts of hop acids from the hop plant. While it uses the same plant that is used in beer, you can't just use beer in your hive - Hop Guard II strips are designed to have a sufficient concentration to affect mites, without being too damaging to the bees (though I have demonstrated scientifically that you can have a beer while applying the strips).

How to use HopGuard II – Apply per the label instructions-

https://www3.epa.gov/pesticides/chem_search/ppls/083623-00002-20150929.pdf



HopGuard II comes in little sticky strips that you drape over the frames in the brood nest. You use two strips for every 10 frames of bees, and want to make sure they are spread through the brood nest. The strips are designed to be left in for 14 days.

The labels indicate that you can use it up to three times per year, and most beekeepers who use it do these three applications right in a row.

Check for updates on the manufacturer's website:
<https://betatec.com/hopguard/>

Photo by Randy Oliver - www.scientificbeekeeping.com

Pros

- Does not have a strong effect on the hive – can be used on smaller colonies
- Can adjust the dose to the size of the colony
- **Can be used when honey supers are on**

Cons

- Expensive
- Does not get times under cappings, so has to be applied multiple times

Best use for HopGuard II: I think HopGuard II is a good tool for two situations: 1) if you know that you need to do something when honey supers are on, and the temperatures are outside of the safe range to use MAQS, and 2) if you are worried about nucs or other small colonies. Since it isn't a very strong treatment, it wouldn't be the best to use on a colony that has a really high mite load that you need to drop quickly. Don't use HopGuard II in a big hive in August if you haven't done any other mite control – it likely won't be enough. However, if you just got nucs to replace the colonies that you lost the last few years, this would be a good tool to use during the summer to keep varroa from taking off. Check your hive every two weeks, replacing the strips at each visit (for 3 treatments total).

FORMIC ACID – Formic acid is another naturally derived acid (it is found in ants, and already in small amounts in honey). In some countries you can use formic acid directly to treat hives. In the US, we have two available products: Mite Away Quick Strips (MAQS) and Formic Pro. Both products are made by the same company. They were both sold in 2018, but likely MAQS will be phased out for Formic Pro in the near future. Formic acid has a huge advantage in that it is designed to affect all the mites in a colony, including those reproducing in the capped cells, and it can be used with honey supers on.

How to use formic acid: Both products (MAQs and Formic Pro) are waxy strips that are applied to the brood nest. The manufacturer has a website with a lot of detailed info and cute videos for both products. They will also list any label changes or updates (<http://nodglobal.com>)

Make sure that you follow the labels:

https://www3.epa.gov/pesticides/chem_search/ppls/075710-00002-20170217.pdf

https://www3.epa.gov/pesticides/chem_search/ppls/075710-00003-20170302.pdf



Application of a single strip of MAQS. Photo by Randy Oliver - www.scientificbeekeeping.com

Full treatment (late summer or varroa are bad) – put two strips on at the same time (MAQS – Treatment is 7 days, Formic Pro – Treatment is 14 days).

Half treatment – during summer – put on one strip followed by a second strip (MAQS- 14 days apart, Formic Pro – 10 days apart).

Important note – the formic acids have important considerations for temperature and hive configuration. If you don't follow their instructions carefully, you will increase the chance of brood damage and queen loss. I have lost a few queens and brood after applications of formic, but the colony has always rebounded strongly after its use.

Pros

- Can knock down high levels of mites
- Short treatment (7 days)
- Gets mites under cappings
- Can be used when honey supers are on
- Can do a half-treatment for mid-summer
- Labeled for organic use

Cons

- Can cause queen replacement or brood damage
- Can only be applied during certain temperatures

Best use for formic acid (Mite Away Quick Strips): MAQs are my go-to treatment in 2 situations: First, as a way to keep varroa at bay when honey supers are on. A ½ dose (one strip) can be applied twice over the summer to prevent populations from getting dangerous. Second, this is the best treatment if you have high levels in the fall, if you live in an area where the weather cooperates. Because it works so quickly, it is easy to get the mites cleared before the winter bees are made. It doesn't store well, but I like to have it on hand in case I have a colony that tests high for varroa.

OXALIC ACID – Oxalic acid (OA) is a naturally found acid (it is what gives you that dry feeling in your mouth when you eat spinach). It works by affecting the mites that are loose in the hive. We don't know the exact mechanism, but it seems that the mites have to come into direct contact with the crystals.

How to use oxalic acid: Oxalic acid can be applied in a sugar water solution, or as a vapor. Make sure you read the label, because there is chance of injury during application -

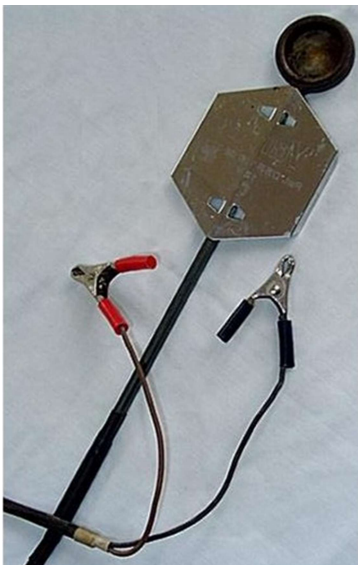
https://www3.epa.gov/pesticides/chem_search/ppls/091266-00001-20151013.pdf

With OA, the goal is to actually coat the bees. This means that you want to apply it when the bees are in the hive, in a loose cluster. On a warm day, you'll miss all the foragers. If it is too cold, you'll miss all the bees inside the cluster. Shoot for a cool morning (60°F).

By solution (dribble method): You can use this method for new packages or for established colonies. Mix up a weak solution in 1:1 sugar water. You can use the table at <http://scientificbeekeeping.com/oxalic-acid-treatment-table/> to learn how to make a solution. Use a syringe to apply 5ml of solution to each 'seam' of bees (the space between the frames, where the bees are). If you are treating a package, you can use a spray bottle to drench the cluster. The solution will not remain effective if stored, so use it soon after you mix it.



Dribble application of oxalic acid. 5 mL of a 2-3% solution is applied to each 'seam' of bees – between each frame. Since you want to coat as many bees as possible, this is best done on a cool day, when all the bees are in the hive (but not so cold they are damaged by the liquid). Photo by Meghan Milbrath



A typical vaporizer sold to be used with OA crystals. Photo by Randy Oliver

By vaporization/ sublimation: If you use this method, be careful, and follow the personal protective equipment (PPE) instructions on the label. You really can hurt yourself if you breathe in OA vapors. You need to completely close up the hive, and follow the dose and time instructions with your vaporizer.

Both methods (dribble and vapor) kill phoretic mites equally well. The dribbling method is a bit quicker, but can't be used when it is cold out or they could get chilled. The vaporizer can be used all year, but requires extra equipment and extra safety precautions, and is slower to use.

Pros

- Very cheap

Cons

- Not approved for use with honey supers on
- Only effective on phoretic mites – will not kill mites under the cappings.
- Health risks to queens, workers, and brood unknown.

When oxalic acid works best – I think oxalic acid is a really good tool in a few situations: during the late fall, to clean up a hive that has been well managed, for new packages, and in combination with a break in the brood cycle. Oxalic acid has become really popular among beekeepers this last year, and I heard from many beekeepers who relied exclusively on it. My experience (which has been echoed by other state inspectors and extension educators) is that many people who used OA alone still were overwhelmed by varroa mites, even when they used it multiple times in a row. Since oxalic acid does not kill mites that are under the cappings, its best usage is when the colony doesn't have any capped brood. We also have a very poor understanding of the effect of OA on bees and on the queen, which is why I don't usually hear it recommended to just do many repeated uses.

You can buy kits from some of the beekeeping supply stores, which will ensure that you are using the labeled version of OA. There is a third method of application that has been tried by many beekeepers even though it is not been approved by the EPA, and therefore is not legal: oxalic acid absorbed in shop towels or another cellulose matrix. In 2017, we performed a field test at MSU to try this method. In our trials, this method did not do much to manage mites, and I don't recommend its use.

Watch the trade journals to see if new application methods become approved, or if it becomes labeled for use with honey supers on.

Powdered sugar as a treatment?

Many people want to use powdered sugar a treatment or preventative tool for mites because they view it as more natural than the alternatives. But is it really safer? Powdered sugar is a chemical, it is not naturally found in the hive, and it is damaging to larvae. Just because we can eat it, doesn't mean that it is safe for bees. The reason that we use powdered sugar in the sugar roll, is that it prevents mites from grabbing on to bees. It would cause some mites to fall off from increased grooming as well. It may cause increased



Photo by Photo by Liralen Li (CC BY-NC-ND 2.0) <https://flic.kr/p/nHFEGK>

grooming, and can cause mites to fall off. However, the effect is very small, and it won't get to the mites that are in the cappings. To make any difference on mite counts, powdered sugar must be applied frequently – so frequently that the increased disturbance to the colony may outweigh the benefits of mite drops. If you want to use this chemical as a mite treatment, I would save it only for a newly installed package, before there is open brood.

THYMOL BASED TREATMENTS – There are two treatments that use the oil derived from the thyme plant: ApiLife VAR and ApiGuard. Thymol oil seems to be very effective in controlling mites when used in sufficient concentrations (Unfortunately, while planting thyme near your hives will look nice, it will not control varroa). The thymol based treatments also work through fumes (like formic acid), so the temperature during application will be very important. If it is too hot, the fumes can be damaging, and if it is too cold, they won't be effective. Around 70° is ideal, but make sure you read the label for current recommended temperature ranges.

How to use:

Label for ApiLife Var

- https://www3.epa.gov/pesticides/chem_search/ppls/073291-00001-20061109.pdf

Label for ApiGuard

https://www3.epa.gov/pesticides/chem_search/ppls/079671-00001-20141007.pdf

ApiLife VAR comes in a wafer form, and has other essential oils mixed in (menthol, camphor, and eucalyptus). A full dose requires that you apply the wafers three times every 7-10 days, but they are easy and not disruptive to apply.

ApiGuard is a crystal gel. If you only have a few hives, you can buy single foil trays that are put at the top of the hive. The gel can also be purchased in a tub, and a syringe is used to apply it to note cards that are placed across the frames. Each application lasts for two weeks. After two weeks, you put another tray on for a following two weeks.



Api life Var application. Photo by Randy Oliver – Scientificbeekeeping.com



ApiGuard application. The gel is contained in a single use foil pack. Photo by Anita Deeley – www.BeverlyBees.com

Pros

- Can knock down high levels of mites
- Is formulated to be in the colony long enough to kill mites as they emerge from under cappings.

Cons

- Takes weeks to work
- Cannot be used with honey supers

Best use for thymol: Most beekeepers use thymol in the late summer right after the honey supers come off (end of July). This is an excellent option for those who monitor and find a high level in late summer, or as a go-to treatment for beginners to use in late summer, as they are learning about integrated pest management. The biggest thing to worry about with thymol-based treatments is the oil affecting the flavor of the honey. Do not use thymol when you have honey supers on. They also aren't effective against the mites unless it is warm enough, so these can't be used very early in the season.

SYNTHETIC PESTICIDES

The products listed in this document thus far are all naturally derived, and I haven't covered any synthetic pesticides. There have been a few synthetic pesticides developed for varroa. Right now, only one of them is still effective. Its long-term viability is not certain, however, because it is used multiple times a year in the vast majority of commercial colonies in the United States.

APIVAR – Apivar is the only synthetic varroacide that is still working to control varroa. It is applied by placing strips (2 strips per deep box) in the brood nest. It is designed to be a slow release product, and remains in the hive for 42 days. You need to wait 2 weeks after removing the strips to add honey supers, so this treatment is really only useful in the fall, or in early spring in some parts of the country.

Label for Apivar: https://www3.epa.gov/pesticides/chem_search/ppls/087243-00001-20130521.pdf

Pros

- Can knock down high levels of mites
- Is formulated to be in the colony long enough to kill mites as they emerge from under cappings.

Cons

- Takes weeks to work
- Cannot be used with honey supers



Apivar application. Photo by Randy Oliver – Scientificbeekeeping.com

JUST BECAUSE A BEE SUPPLY COMPANY SELLS IT DOESN'T MEAN IT WORKS.

Lots of resistance has been identified in the old 'First Gen' products containing fluvalinate and coumaphos. These products are still sold (Mavric, Checkmite), even though they likely don't work. I don't recommend using these products to control varroa.

Active ingredient	Commercial Name	Organic	Application Method	Honey Supers on?	Length of treatment	Temperature
Oxalic Acid	None	No	Home mix vapor or dribble	No	Broodless (package, winter, split)	When bees are in a loose cluster
Hop Beta Acids	Hop Guard	No	Strip	Yes	10 -14 days, up to 3x	None listed
Apistan	Apivar	No	Strips	No	42 days	None listed
Thymol	Api Life VAR	No	Wafers	No	3 x 7-10 days apart	65-85
Thymol	Api Guard	Yes	Gel	No	2 x 2 weeks apart	Above 60
Formic Acid	Mite Away Quick Strips	Yes	Wax pad	Yes	One 7-day treatment	55 - 85

Formulations (and opinions/recommendations) can change every year. Make sure that you read labels, and talk to other beekeepers and extension agents to see what they are using with success. For more information on varroa management tools, see the Honey Bee Health Coalition's 'Tools for Varroa Management' document, and Randy Oliver's website www.scientificbeekeeping.com.

Remember that your goal is to have your parasite population under control **before** your winter bees are made. This means that you may have to start treatments weeks earlier than you expected. Many beginner beekeepers mistakenly think of treatments as a fall activity, or winter prep, and only take action against the mites **after** the winter bees are already made (and injured and infected). Some of the products take 3-4 weeks to work. Give these interventions time to work, and make sure you pay attention to when you need honey supers on and when your winter bees will be raised.

GENERAL PRINCIPLES

- 1) Remember that **successful management is about the mite population levels and the health of your bees, not the number of treatments that you applied**. Applying a bunch of treatments does not mean your bees are healthy. Likewise, allowing bees to succumb to varroa to remain treatment-free, is also not success. We are being successful beekeepers when we keep our bees healthy and free from pests.
- 2) **Monitor to make sure that your management and interventions are working and are sufficient**. Your mite populations may be kept in check with just using drone brood removal, and you can save time and money and stress to the bees because you don't have to perform further interventions. Or, maybe you applied thymol gel, but by the time you got it in the hive, your varroa population was so out of control and just the one series was insufficient to bring the population down to safe levels. If a product wasn't applied properly, or too late, or too low of a dose, then your bees are still at risk. The only way to know if your actions are sufficient is to monitor.
- 3) **Be prepared to change/ modify your strategy**. Strategies have to change from year to year, because the varroa population will grow at different rates depending on what happens in your colony, and the threat from neighboring bees will change over time. In a really long season when the bees can keep raising brood, the mites can reach enormous populations. The next season, if all your colonies swarmed early then shut down during a drought, mite populations may hardly grow at all.
- 4) **What works for someone else may not work for you**. Many people who are successful with little intervention do so because they are in remote areas, and don't have a lot of pest pressure. If you live in a city with many beekeepers, then there may be constant infestation pressure, and you will have to be more watchful. Some bees can handle varroa better than others as well. Your neighbor's bees may do just fine with just a split, but the bees in your colony may need extra help. Give the bees the help they need, then plan to get queens from your neighbor next year.
- 5) **Think way ahead and be proactive**. If your winter bees will be developing in the end of August, and you are planning on using a product that takes four weeks to work, then figure out the date that it needs to be in the hive, and act accordingly. While a colony can sometimes recover if it is treated during an infestation, your bees will still be damaged, and that damage can have long lasting effects on the colony. It is much better to stay ahead of varroa populations so that they never take off in the first place. One of the biggest mistakes that beekeepers make is dealing with varroa once it is already at really high levels and the brood are already heavily damaged.

The best strategy for dealing with varroa is to be prepared, and to incorporate season-long mite management that can interrupt varroa population growth.

EXAMPLES OF SUCCESSFUL MANAGEMENT STRATEGIES FOR THE VARROA MITE.

Situation 1: A completely new beekeeper buying packages, who is not confident about what to do.

- Perform an oxalic acid dribble on the package after the queen has been accepted and released.
- Apply ApiGuard in late summer.

Situation 2: A new beekeeper buying nucs, who lives in a high disease pressure area.

- Apply hopguard II once the nucs have become established and have expanded past their initial frames.
- Monitor using a sugar roll, and use formic pro if the colony varroa populations are above 3%
- Oxalic acid dribble after colony is broodless.

Situation 3: A fairly new beekeeper with overwintered hives.

- Split the hives in spring
- Apply ½ formic treatment in summer when honey supers are on
- Apply a thymol treatment after honey supers are removed.

Situation 4: Any beekeeper with just a few hives

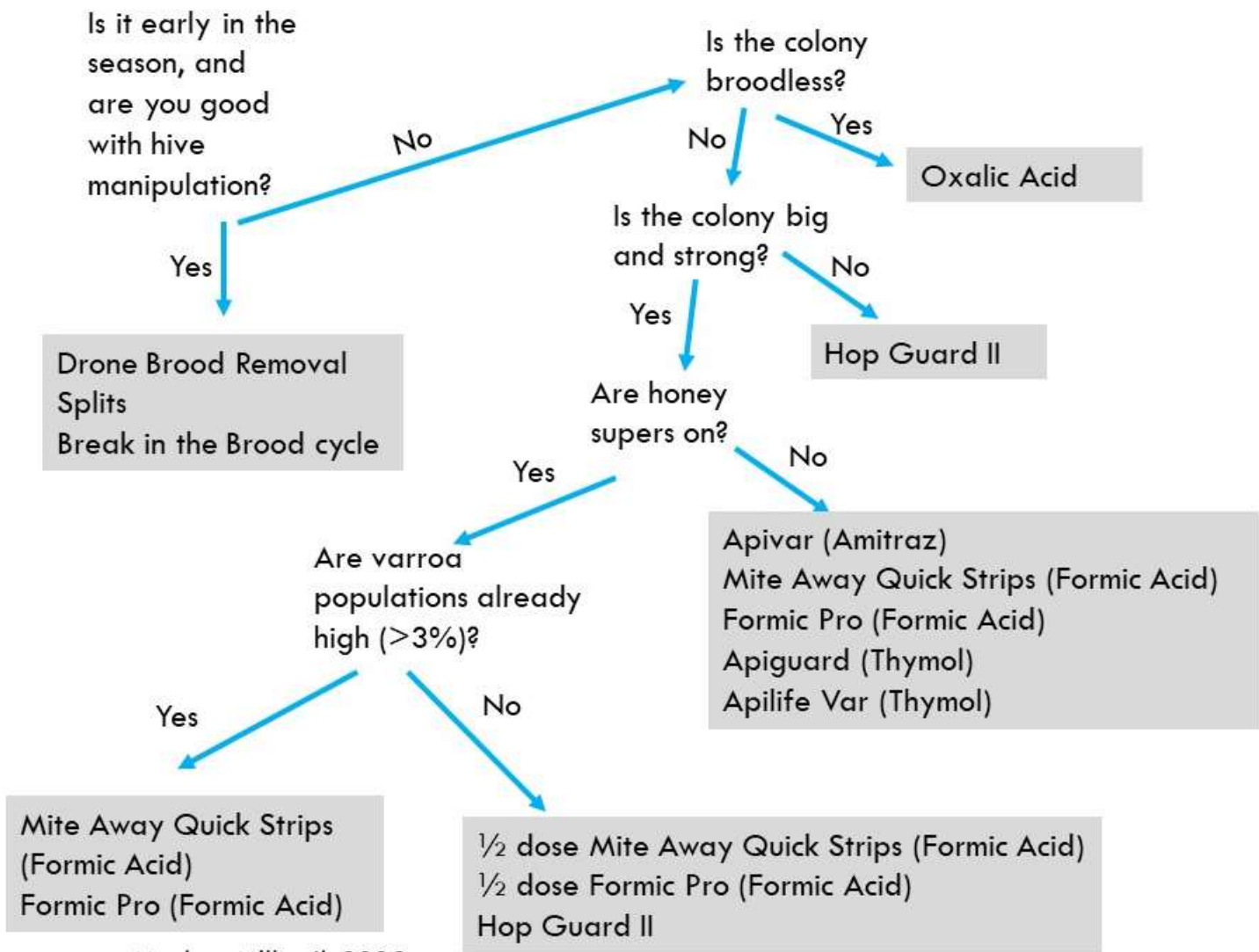
- Drone brood removal through spring
- Monitor closely and use formic acid if above threshold.

Situation 5: Experienced beekeeper

- Make splits in the spring.
- Make splits in the late summer after the honey flow, using queen cells.
- Use Oxalic Acid once splits have requeened, but before they have capped brood.

**Your bees deserve to be healthy and free of pests.
Make this the year that you keep the varroa mite under control!**

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Meghan Milbrath 2018