Varroa Resistance to Amitraz

What we know today

The resistance of varroa mites to acaricides, especially amitraz, is a critical issue in beekeeping, as amitraz has long been a cornerstone in the battle against these mites. This document provides an overview to help readers better understand the current situation and dispel some common misconceptions.

What is varroa resistance to acaricides?

Resistance means the varroa mite's ability to survive doses of acaricides that would typically be fatal.[1] In other words, what used to be effective no longer works as well.

Varroa mites can be exposed to a molecule through repeated treatments or from residues that build up in the wax.[2] Research has shown that these molecules, whether from varroa treatments or agricultural treatments, can be passed to larvae and stored in the fat bodies of adult bees, which are a food source for varroa.[3-4] Therefore, regularly renewing the wax is an essential way to reduce the development of resistance.

Not every surviving mite is resistant

In general, acaricide treatments have an average effectiveness of about 95% for synthetic molecules and 90% for organic molecules. A successful treatment may leave up to 10% of varroa mites in the hive. These residual mites will continue to reproduce, especially when brood production extends late into the season.

That is why it is essential to follow a treatment strategy that keeps infestation levels low. The mild and long seasons we have been experiencing in recent years make it harder to interrupt the varroa reproduction cycle, calling for a readjustment of management beyond just the end-of-season treatment.

After treatment, colonies may also be re-infested from nearby apiaries, making it necessary to monitor infestation rates regularly, particularly before and after the final treatment of the season.

Understanding amitraz resistance requires knowing amitraz's properties

Low accumulation in wax:

Amitraz has a unique property: it degrades rapidly in acidic environments. When used at the recommended dosages and frequencies, it accumulates very little in wax.[5-6] If residues do persist after treatment, studies have shown they can degrade by as much as 300 times within six months.[7] Additionally, no amitraz residues have been detected following honey bee colony treatment with Apivar when used as recommended per label.[8]

This is not the case with tau-fluvalinate, which accumulates more due to its properties and frequent use in agricultural pesticides. A study found tau-fluvalinate concentrations in wax up to 570 times above detectable levels.[9] Overall, varroa mites are exposed to amitraz for a shorter timeframe compared to other synthetic molecules. Therefore, the risk of resistance development against amitraz is comparatively low.

Amitraz targets the octopamine receptor in varroa mites:

Amitraz targets the octopamine receptor in Varroa mites, and several mutations have been identified in different countries: In France, the N87S mutation was observed[10], while in Spain, a new F290L mutation has been recently discovered[11]. In the USA, the Y215H mutation has been associated with treatment failures.[10]

However, studies have shown that these mutations alone may not be sufficient to cause resistance. For instance, in France, the N87S mutation was found at similar rates in both susceptible and resistant mites.[11] This suggests that resistance may result from a combination of mutations or other factors.

The complex nature of octopamine receptor defined as a G-linked protein receptor, along with the low accumulation of amitraz, could explain the **slow progression of resistance** despite decades of intensive use.

What about amitraz resistance in other species?

In livestock operations, amitraz has long been used against ticks. Research on cattle ticks shows that resistant tick populations become sensitive to amitraz again every spring, after a break of several months in treatment during the winter period.[12] This illustrates ticks' limited ability to maintain stable resistance to amitraz and demonstrates a relatively short reversal period.

What is the reversal period?

The reversal period is the time needed for varroa mites to regain sensitivity to a molecule. It can vary depending on the molecule's properties and the complexity of the resistance mechanism.

For tau-fluvalinate, for example, Italian researchers estimated the reversal period to be between 4 and 6 years.[13]

For amitraz, there is no comprehensive published study yet, but some evidence suggests that reversal could be quick, around one to two years at most.[10] This is likely due to amitraz's low persistence in the hive, supporting a quicker reversion compared to other molecules.

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So what's happening in the apiaries?

Resistance to a molecule varies according to its characteristics and usage. Current data suggests that resistance to amitraz is less persistent than for other acaricides:

- The increase in amitraz's CL50, even after decades of use, is far less than that of other molecules.[14-15]
- The decrease in effectiveness of amitraz-based treatments over time is less pronounced than for other molecules.[16-17]

While effectiveness is not as consistent as it was in the early 2000s, amitraz remains effective, even after decades of use in France, the United States, and many other countries. In the field, resistance is observed to develop slowly and in isolated cases, with a rapid reversion.[18]

Researcher Frank Rinkevich (2020) describes "*islands of resistance*" where only a few hives show high resistance, unlike resistance to pyrethroids, which usually affects the entire apiary.[18]

According to this study, "*The fact that nearly half of the commercial beekeeping operations that have relied on amitraz for Varroa control for at least 3 years did not yield enough Varroa to test for amitraz resistance is evidence of the ongoing effectiveness of this treatment.*"[18]

Key takeaways

- **Amitraz remains largely effective** after decades of use.
- **Amitraz residues in the hive are less frequent** than those of other molecules, limiting resistance development.
- **Varroa resistance to amitraz appears to be manageable and probably easier to reverse** through rotation than that to other acaricides.

Best practices for sustainable varroa mite management

- **Renew your wax!** Replace at least 30% of the brood combs each year to limit residue buildup and promote colony health.
- **Use multiple molecules during the season:** Studies show that colonies with the best winter survival rates are treated with 2 to 3 different molecules each year, targeting varroa mites in multiple ways.[19]
- **Monitor and manage infestation:** Perform regular mite counts to prevent infestation levels from spiraling. As infestation increases, so does viral load. Even after treatment, viruses continue to harm colonies with potentially serious effects.
- **Use biotechnical methods to disrupt the varroa cycle:** Use drone brood removal, or splits to break the parasite's cycle and slow its spread.
- **Only use approved treatments for beehives and follow instructions carefully:** Do not modify the dose (by doubling or halving) and do not leave strips in the hive all winter. Avoid repeated, unapproved applications of the same active ingredient within the same year. Along with protecting consumers of hive products, these recommendations are in place to safeguard the health of your bees and minimize the risk of resistance.
- **Amitraz acts through direct contact,** so achieving even distribution throughout the hive is essential for maximum effectiveness. Higher doses are not the key to better results; instead, proper distribution enhances treatment efficacy.[20]
- **Be mindful of seasonal changes in your hive:** a large brood population in autumn can contribute to a higher mite load. An end-of-season treatment alone, even if it works at over 95% efficacy, may not suffice or may present a slower kinetic of action; additional measures may be necessary to effectively reduce mite infestation.

Let's work together to keep our treatments effective!

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