Is oxalic acid vaporization and/or brood interruption effective at controlling varroa?

Perhaps it's the wrong time of year to be writing about oxalic acid (OA). Most beekeepers apply this treatment in late fall or winter when brood is absent from colonies. But brood gaps can occur in mid-summer, especially if you're creating those brood gaps as part of an Integrated Pest Management (IPM) varroa control strategy. Alternatively, some beekeepers ignore the brood gap recommendation and apply OA when brood is present in their colonies. And some beekeepers might be interested in brood interruption without OA. If you fall into any of those categories, read on. Or, if you're only interested in applying OA later when your queens have stopped laying, just tuck this article away until the first wisp of crisp autumn air descends on your apiary.

Lead author Cameron Jack (now Lecturer and Distance Education Coordinator at the University of Florida Honey Bee Research Lab) gets suited up to apply oxalic acid vaporization treatments with helper Branden Stanford.

Oxalic acid has been around as a varroa control strategy for several decades. This treatment is potentially very promising since there are no reports of mite resistance to date. But despite its promise and relatively lengthy history, OA was only registered for use against varroa in the United States in 2015. Thus, it's a relatively new treatment option for most U.S. beekeepers, and because of this, there's still a lot of debate about OA. Is OA vaporization effective against varroa when brood is or isn't present? Is it most effective when used once or multiple times over a few weeks? Is caging your queen and creating a brood gap just as effective as OA vaporization for controlling varroa? And what about the bees — how stressful on your colonies is OA vaporization and/or caging your queens? These are the topics for our thirtieth "Notes from the Lab," where we highlight **"Evaluating the efficacy of oxalic acid vaporization and brood interruption in controlling the honey bee pest *Varroa destructor* (Acari: Varroidae),"** written by Cameron Jack and colleagues and published in the ***Journal of Economic Entomology*** **[113:582-588 (2020)].**

For their study, Jack and colleagues assigned 10 colonies to each of seven treatments, creating an impressive array of experimental groups among 70 colonies. All colonies were managed such that they were similar in strength, composition, and mite loads at the beginning of the experiment. The treatments were: 1) OA vaporization applied once, 2) OA vaporization applied three times over three weeks, 3) brood interruption for 24 days, 4) OA applied once + brood interruption, 5) OA applied three times + brood interruption, 6) no OA or brood interruption as a negative control, and 7) treatment with amitraz (Apivar) as a positive control.

Each application of OA was comprised of 1 g OA powder (label rate) vaporized through the hive entrance on the bottom board. Brood interruption was conducted by isolating a colony's queen in a queen cage within the hive for 24 days. Brood interruption occurred between day 0 and 24 for all treatments that included brood interruption, the 3x OA treatments occurred on days 8, 16, and 24, and the single OA application occurred on day 24. Finally, amitraz treatment was conducted by placing Apivar strips in the colonies for the first 35 days of the experiment. The authors conducted the experiment during September and October in Florida, meaning brood was present in the colonies throughout the experiment (except for the brood interruption treatments, of course).

The authors monitored three main outcomes during and after the experi-

Lead author Cameron Jack in the bee yard

ment. First, varroa levels were determined by placing sticky boards in the bottom of each hive for 72 hours. Varroa levels were assessed before the experiment started (day -4), when treatments were applied (day 0), midway through the experiment (days 8, 16, 24, 31, and 35), and at the end of the experiment (day 62). Second, colony strength was assessed by measuring the quantity of bees, brood, honey, and pollen in each colony before treatments were applied (day -4), midway through the experiment (day 31), and at the end of the experiment (day 62). Finally, colony mortality was noted at the end of the experiment.

Placing 1 g oxalic powder per brood chamber (label rate) into the vaporizer

So, what did they find? Did OA vaporization reduce varroa levels? Compared to untreated control colonies, there was no difference in mite fall on sticky boards when OA was applied on its own, either once or three times. Although other mite assessment methods such as alcohol washes can provide more reliable estimates of varroa numbers in colonies, sticky boards are an efficient and non-invasive means of assessing varroa when many colonies will be continually assessed (e.g., the 8 samplings from each of 70 colonies that occurred over the 2 months of this experiment). The authors' sticky board data indicate that OA vaporization at the current label rate was ineffective at controlling varroa under the conditions of this study.

What about brood interruption? Did that control varroa? Fewer mites fell on the sticky boards of colonies experiencing brood interruption, indicating that brood interruption was also ineffective at reducing varroa levels, at least over the two-month duration of the experiment.

And what about brood interruption *and* OA vaporization? Did that combination control varroa? The combination of brood interruption and OA vaporization led to greater mite drop on the sticky boards compared to brood interruption on its own, but not compared to OA on its own or the untreated colonies. And this was true for both the single OA treatment and the 3x OA treatment. In other words, while the combination of brood interruption and OA vaporization was better than brood interruption on its own, the effect still wasn't beneficial compared to leaving colonies alone. Overall, this means that OA vaporization with 1 g per brood chamber was not effective at reducing varroa levels in colonies that did or did not have brood.

Well this doesn't sound very promising. What about colony strength and survival? Were there benefits of OA vaporization and/or brood interruption for those outcomes, which really are the bottom line? Unfortunately, no. As might be expected, there was less brood and there were fewer bees in colonies that experienced brood interruption, which resulted in less honey in those colonies at the end of the experiment. And there were no differences in colony strength between any of the other treatments and untreated control colonies.

Importantly, there were big differences in survival. Only 10% of the colonies experiencing brood interruption survived, compared to 70% survival for untreated colonies and 100% survival for colonies treated with amitraz (Apivar). Survival was slightly better for the colonies experiencing OA vaporization (60% overall) or brood interruption plus OA vaporization (50% overall), but still less than untreated colonies or those treated with Apivar. These results indicate no benefits (and, importantly, some *detriments*!) of brood interruption and/or OA vaporization on colony strength and survival. The low survival of brood interruption colonies was especially dramatic, and readers may want to note this treatment occurred in the early fall (i.e., September in Florida).

Overall, Jack and colleagues' study is a very nice addition to the growing literature on OA vaporization and/or brood interruption as tools in a beekeeper's arsenal to combat varroa. Some studies find that OA vaporization can control varroa, especially when brood is absent from colonies. But just like the authors' results from this study, OA vaporization is not always found to be effective, either when used in combination with brood interruption or not. This means we have more to learn about how to maximize the effectiveness of brood interruption and OA vaporization while minimizing stress on bees.

One particularly important follow-up topic that needs further study is

Vaporizing oxalic acid in one of the experimental colonies. Note the entrance is sealed with a towel to keep the oxalic vapor inside the hive for the duration of treatment.

the dose of OA. For example, some work in Europe has found that 1 g OA per brood chamber applied via vaporization is effective at controlling varroa in small colonies, but 2.00-2.25 g OA per brood chamber is necessary for larger colonies in larger hives. This larger quantity of OA is over twice the label rate in the United States and could pose greater risk to bees. Thus, controlled field studies that simultaneously vary the dose of OA and the size of colonies need to be conducted while assessing mite levels and colony survival. In speaking with the authors, you'll be happy to know that such studies are currently in the works by Jack and colleagues. … So, stay tuned for their next results.

Finally, it is our opinion that further quality control and/or regulations should be put in place to ensure that commercially available vaporizing devices reach an appropriate temperature. Oxalic acid must reach a temperature of 157 C to sublimate, but if 189.5 C is reached, OA decomposes to formic acid, carbon dioxide, carbon monoxide, and water. It is our experience that some vaporizers will get too hot too quickly and possibly decompose rather than sublimate OA. This could obviously have major implications for the effectiveness of OA vaporization. Thus, more care should be taken by companies, beekeepers, and potentially regulators to ensure the proper temperature of OA vaporization equipment is reached but not exceeded.

Until next time, bee well and do good work,

Scott McArt

References:

1. **Jack, C. J., E. van Santen and J. D. Ellis. 2020.** Evaluating the efficacy of oxalic acid vaporization and brood interruption in controlling the honey bee pest *Varroa destructor* (Acari: Varroidae). *Journal of Economic Entomology* 113:582-588. **https://doi.org/10.1093/jee/toz358**

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