An Update on Varroa Control Treatments.

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Introduction

This article is a response to the introduction of a new approved varroacide called Mite-Away-Quick Strips (MAQS) which has just come onto the market. This product is rather different from anything we have had before and, although it promises to be a very useful addition to the armoury, its use is not completely straightforward. As Randy Oliver says about its use on his web-site (scientificbeekeeping.com), 'the devil is in the detail'. The situation is made even more difficult by the fact that most of the 'detail' about how to use MAQS refers to its use in a very different climate regime to that in Britain (west coast North America) and in the context of somewhat different beekeeping practices (mostly double deep box Langstroth hives). Only time and experience will determine the role MAQS in Varroa control in Britain but one thing is sure, they are certainly not a re-incarnation of the pyrethroid strips that we all used in the early years of Varroa control. So the warning is, don't just wham them on the hives without giving it any further thought.

The safe and effective use of **all** varroacides (when and how) depends on a basic understanding of the Varroa mite itself; how it lives in a bee colony and particularly how it reproduces and the timing of this part of their life cycle. It also depends on understanding how the active ingredient of the varroacide is 'delivered' to the mite, so we will cover these two issues first.

Life Cycle of the Varroa Mite

All the mites you see in the hive are fertile females. They have already mated in the brood cell in which they were born and are up and ready to go (reproduce). When they are not in the brood cells they cling onto adult bees – usually tucked under a tergite (the chitinous plates that cover the abdomen of the bee). These are the so-called phoretic mites and are most commonly found on nurse bees where they are resting between breeding cycles (usually about 7 days but longer if the right age brood is not available) feeding off the haemolymph (blood) of their host.

When a mite is ready to reproduce it hops off its host bee and enters a cell that contains a near-mature larva. In the case of worker larvae this occurs within the last 24 hours prior to sealing but with drone larvae it can be as early as 48 hours. Initially the mite submerges itself (hides) in the brood food at the bottom of the cell and breathes through a sort of snorkel (the peristile). When the cell is sealed the mite emerges after about 4 hours and starts to feed on the haemolymph of the larva. Egg laying commences 60-70 hours later; the first egg produces a male and the remainder are female (4-5 of them). The male's sole function is to mate with his sisters whilst still in the cell after which he dies. The mother mite and her offspring leave the cell when the young bee emerges. Female mites go through 3-4 breeding cycles in their lifetime after which they die.

When choosing a cell in which to breed drone brood is preferred over worker brood in a ratio of about 10:1. The longer developmental period of the drone (14 days as opposed to 12 for a worker) – and possibly the more generous food source – means that reproduction is more successful in drone brood. On average the mother mite emerges from worker brood with 1.3 viable daughters but the success rate increases

to 2.6 when she reproduces in drone brood. As a result, over a given period the growth of the mite population is about 4 times faster when reproducing in drone brood than it is for worker brood. This is why drone culling is such a successful method of limiting the growth of the mite population.

When it comes to applying Varroa control treatments, the most important thing to understand is the relative amount of time that mites spend on a bee (phoretic mites) and in the brood (reproducing mites). Normally a mite spends 7 days on the bee compared with 13-16 days in the brood (including the pre-sealing period). If you include the new mites that will emerge with the brood, **at any one time during the main season 80-85% of the total mite population are in the brood and only 15-20% are phoretic**. Of all the varroicides that have been used to-date, only formic acid (the active ingredient of MAQS) is able to penetrate the cappings of sealed brood and kill breeding mites and their offspring within the cell. **All other treatments only kill phoretic mites, which is why they have to be resident in the hive and active for a period of 4-6 weeks – to kill mites as they emerge from the safety of the brood.**

Varroacide - Mode of Action

This refers to the means (the route) by which the varroacide reaches the mite. There are two main routes:-

1. Contact – either direct contact with the mite or indirect through its host (the bee), or

2. Vapour – the mite receives a fatal dose from exposure to the within-hive atmosphere.

There are currently no varroacides that are ingested directly by the mite or are systemic through feeding on the haemolymph of the bee. The **contact** route is inherently more reliable than **vapour** because the latter depends on temperature and the degree of ventilation to maintain a concentration that kills the mites but does not adversely affect the adult bees or brood.

During the early (golden?) days of Varroa control the pyrethroid strips ('Apistan' and 'Bayvarol') were mediated entirely by contact – the bees walked on the strips and this (presumably helped by grooming) was efficiently passed on to the phoretic mites. The strips continued to release their active ingredient for several weeks and a residency of 6 weeks ensured that 99%+ of the mites were killed – job done and they were almost completely idiot-proof. The dosage safety margin between killing mites and killing bees with the pyrethroids was something like 1000:1 but we now know the extremely stable and fat-soluble pyrethroids tend to accumulate in bees-wax which may result in adverse, long-term effects.

Oxalic acid is also entirely a contact varroacide but only remains active for a short period (probably just a few hours) and thus only kills mites that are currently on the bees. This is why oxalic acid should only be used on a colony that is entirely (or nearly) brood-free. It can have an adverse effect on adult bees but if used correctly damage is minimal. The fact that it can kill brood is irrelevant since there should be no brood to kill at the time it is applied.

The thymol based varroacides ('Apiguard', 'Apivarlife' and 'Thymovar') all work by a mixture of vapour mediation and contact and it is impossible to apportion the two routes. When using 'Apiguard' it is a good sign if most or all of the thymol gel has been removed from the tray at the end of each 2 week treatment period. The bees carry the small chunks of gel through the hive rubbing against many other bees in the process and this is how the contact element is achieved. With all two dose treatments it is

important that they are done consecutively so that all the emerging mites are exposed to a lethal dose. Contrary to popular perception the dosage safety margin for thymol is quite low (under 10:1) so it is possible to overdose with these products – so you must adhere to the manufacture's instructions.

Now we come to formic acid and this is an entirely vapour mediated treatment. Its big advantage over all the other treatments discussed so far is that, being a small molecule, it is capable of penetrating the cappings of sealed brood cells and killing the mites within. Its disadvantage is that there is a fairly narrow range of vapour concentration over which it works. If the concentration is too low it does not kill the mites in the cell and, because it has short residency, an insufficient number of phoretic mites will be exposed. At the other extreme, if the concentration of vapour is too high it can kill a lot of brood, some adult bees and the queen herself seems to be particularly vulnerable. Loss of brood is not too serious but losing the queen late in the season – with little hope of natural re-queening – would be something of a disaster.

Mite-Away-Quick Strips

Formic acid has been use in some countries for many years but has always been subject to the problems (too much or too little) as outlined above. MAQS is a new formulation in which formic acid can be used in a more controlled manner. The strips contain 95%w/w formic acid but its evaporation is modified by a starch substrate and the material (membrane) in which it is wrapped. So how should it be applied and, in particular, what hive configuration and what level of ventilation should be used?

The instructions and guidance currently available with the product and on the web refer to North American conditions; hives, climatic conditions and bees (colony size).

1. In terms of hive configuration, most instructions assume the use of a two box brood system (double Langstoth deep boxes) and suggest that it is also an advantage (a safety factor?) to also have a super in place during treatment. The standard treatment of 2 MAQS strips is placed on the top-bars between the two brood boxes. With a single brood box the strips are placed on top of that and the addition of 1 or 2 supers would seem to be essential.

2. Adequate ventilation is clearly vital and the instructions are to ensure a full-width entrance (no entrance block). There are apparently two floor (bottom boards they call them) heights in common use in America; $^{3}/_{8}$" and ¾", the latter being equivalent to our old solid floors. The suggestion is that the deeper floor (with more ventilation) is safer but the formal trials only gave weak support to this idea. It is also suggested that with a 2 box configuration it is a good idea to initially set the upper box forward so as to give a second full-width entrance which should be closed again after the first 3 days of treatment. Not very much is said about open-mesh floors (screened floors as they call them) but the implication is that these should be used with the tray out. One trial showed that there was about a 5% loss of efficiency using an open-mesh floor with the tray out compared with a solid floor. This may seem insignificant but the difference between 90% and 95% kill means that there is double the number of surviving mites to found the ensuing population build-up.

During the first few days after the treatment is applied one must apparently expect 'bearding' on the front of the hive (bees that have come out to seek respite from the formic acid fumes) The addition of a super helps reduce bearding. Measurement of the concentration of formic acid in the hive atmosphere shows that it peaks during the first 48-72 hours and then declines quite rapidly. It is thought that most of the mites in the brood are killed during this comparatively short period.

It is recommended not to open the hive just before treatment - a 3 days gap is suggested to let the bees settle down and 'get their house in order' before the ordeal. It is also recommended leaving the hives well alone for a few days after treatment and not to attempt to feed whilst the strips are in the hive. The membrane that held the gel will be shredded and removed by the bees and requires no action from the beekeeper.

I find myself slightly puzzled by the recommendation for high levels of ventilation when using two MAQS per hive. Why does one strip with slightly less ventilation not work just as well? If it is simply the concentration of formic acid vapour that matters it ought to work. There may be some factor I have not taken into account so please do not act on this idea.

Other Advantages of MAQS

Perhaps the biggest advantage is that the whole treatment lasts only 7 days and then, if it has been done right, the hive returns to normal. Any loss of brood will quickly be made up by the queen being stimulated to lay hard. One of the potential snags with thymol based varroacides is that is that they remain on the hive for much longer (4 weeks) and this does suppress brood production in some colonies and this can result in a shortage of 'winter bees'. Because formic acid is so volatile (and is a natural constituent of honey anyway) MAQS can be used when there are super on the hive. However, I would see this as a measure to be used only in an emergency and not a regular practice.

Safety, Storage and Shelf-life

MAQS should only be handled wearing chemical resistant gloves and these should be removed and disposed of or washed to avoid getting formic acid on your skin and particularly your eyes. The product comes in a plastic box containing 20 strips (treatment for 10 hives). This must be kept in a cool, dark place and must be kept sealed at all times. Once the outer wrapping of a strip has been removed it must be used immediately. At the present time the shelf-life of the strips is only 12 months (so less by the time you get your hands on them) so they must all be used in the current year – you can't use half this year and half next. Research is being undertaken to increase shelf-life in the future but that is the current situation.

In Conclusion

As it only became legally available this summer I have obviously not yet tried MAQS on my own hives. If you want to try MAQS this year, before there is any additional advice on its use under British conditions, I suggest you do it thoughtfully and without putting all your eggs in one basket. It may turn out that its use is easier and more reliable than the current information suggests - only time will show. Also be aware that next year another new varroacide ('Hopguard' – marketed by Vita (Europe)) will (hopefully) have received approval and be available to us. This product is thought to be extremely benign as far as the bees are concerned and has the additional attraction that it clearly has something to do with beer.