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# Hungarian on-farm research program for varroa control in organic beekeeping

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## Abstract

*Varroatosis as the current bane of the beekeepers is causing the biggest economic damage in the apicultural sector. Consistent control of varroatosis should be provided without harmful effects such as the occurrence of toxic residues in the hive products. In the technology of organic beekeeping only natural materials are allowed to be used such as essential oils and organic acids. In 2013 within the beekeeping on-farm research program, ÖMKi was collaborating with beekeepers throughout Hungary in comparative trials for testing the efficacy of different types of varroa control treatments and management. The trials were set up in market operations. One essential task of the program was to monitor the infestation level systematically with different mite-counting techniques.*

## Introduction

Varroa mites have a vector role, distributing viruses and weakening bees that become more susceptible to other pathogens as well. Disorientation, robbing, and frame exchanging may transport mites from one colony to another (Oliver, 2011). There are no colonies without mites in Hungary. The infestation level increases over time in colonies that are untreated or not managed regularly. The continuous builtup of mite population causes slower build-up, less honey production, a viral epidemic, poor wintering, or at worst, colony collapse. The infestation level should be kept as low as possible for a sustainable production. Any intervention in the colony against mite may cause disturbance and expense where the relevance of the timing and the type of method should be considered. The degree of varroa infestation must be measured in a timely manner in order to determine what efforts are needed to be making to keep the mite population below a threshold level that would cause economic injury to the colony. Oxalic acid (OA) is one of the most common natural acaricides used against varroa throughout Europe. Its activity is well known since the middle 1980s at least, due to experiments performed mainly in Eastern-Europe and Asia on the spraying and sublimation administration techniques (Nanetti, 2003). Formic acid (FA) is a natural product found in honey (Liu 1991). Several field and laboratory tests (Hoppe et al. 1989, Bracey & Fischer 1989, Fries 1991, Ritter & Ruttner 1980, Feldlaufer et al. 1997) have shown formic acid to have acaricidal properties in varroa. In the on-farm research program throughout the season the different treatments and managements were chosen that were matching with colonies' biological state and environmental conditions such as brood period, temperature, etc. Most of the treatments affect only the foretic mites. Therefore during the season some operations - where it is possible - they generate capped brood less state for treatments. The major part of the mite control is good timing of the closing treatment in the end of the beekeeping season in the brood less period.

## Material and methods

Experimental setup

The Research Institute for Organic Agriculture (ÖMKi), 17 beekeepers where participating creating "participatory" research team in the on-farm program. True 'on-farm' research involves producers in experiment design, often in collaboration with scientists or extension educators. Farmers either conduct or help conduct the experiment, providing a real-life setting in which to test their theories. I this case a comparative study of commercial products for organic beekeepers in combination of bee management methods were set up. In the beginning of the beekeeping season each beekeeper selected 12 hives from their operation and made 3 groups of (3*4) or (2*2)+(2*4) colonies per apiary. The beekeepers were chosen from different location for better representative geographical data, see figure 1. The timing of treatment periods and the method of bee management

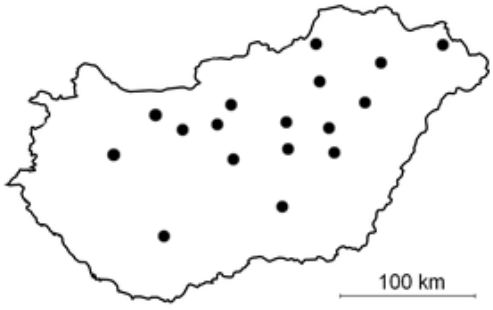


**Figure 1. The geographical locations of the participating operations.**

method were depending on the honey flow seasons and the type of beekeepers' equipment.

Monitoring mite levels

In practice instead of calculating the total colony infestation rate the recommended seasonal threshold levels were adapted to the local conditions which must be under the economic injury level (Amsler et al. 2009). The adapted threshold levels were at half measure as the colony density very high in Hungary compare to other European countries, which redounds rapid infestations from neighbouring colonies. The types of threshold levels where the natural 24-hr mite drop count and the rate of phoretic mites on sampled adult bees. For counting the natural drop of phoretic mites from the bees the sticky board under a screen method were used (Martin, 1998). The average natural 24-hr mite drop count was calculated from one week periods. For the rate of phoretic mites the bees were sampled from the nest, and in brood period the nursery bees where usually most of mite are present. The sample sizes were at least 300 bees. The samples where processed following the methods described by AIB* (2007).

Treatment

Because of the treatment timing setup, one monitoring period carried out right before a treatment was in some cases the backup of the previous treatment as well. The active ingredient materials of the treatments where organic acids, formic, and oxalic as "natural" treatments in the hive, as they are all naturally found in honey. All treatment where using commercial product and instruments. In each treatment period the actual active ingredient materials were the same but different brand or processed by different instrument. The backup monitoring was following a week after the treatments, to avoid counting mites fallen directly due to the treatments. The first summer treatment period was in June with one or two repetitions of dribbling OA products. 4-5 days were spaced between the repetitions. The second summer treatment period was in July with a three time sublimating oxalic acid. Until autumn groups of untreated colonies were kept as control samples for monitoring natural mite population development. In the first autumn treatment period in September two type of FA evaporating devices were compared: barred cages with evaporator plate standing and gel packs. From this time the groups of former untreated colonies were divided in two for the comparative trials. In the second autumn treatment period the OA dribbling products were applied in one or two repetitions. For the final treatment OA sublimation was applied only once in the winter in the broodless period.

## Results

As the result are shown in table 1., the numbers for the degree of varroa infestation were the average numbers of all participating apiaries. All participating colonies were beginning with low infestation levels. The untreated control hives' infestation was starting to exceed our prescribed threshold levels in August and was rising eight times higher than the treated colonies until the first treatment in September. After starting to treat the former untreated colonies in September their infestation levels stopped rising but stayed higher than the threshold levels until the end of the year. The infestation level of the treated colonies stayed under the threshold level throughout the year.

Summer treatments with OA

In June the dribbling treated colonies were significantly less infested than the untreated control hives and no significant difference were perceived between product A and B. Until the next treatment period the infestation levels rise again. In practice sublimation technique of OA in August was carried out with less physical effort and disturbance compare to the dribbling treatments. The infestation levels dropped after the sublimation and stayed under the threshold levels.

Autumn treatment with FA

The infestation levels in both case of September AF evaporating treatments stayed under the threshold levels and in terms if infestation levels no significant difference were perceived between the two treatment types. However the bees showed difference in the tolerance for FA. The bees treated with the gel packs left the frame betweens right below the gel packs. The former untreated colonies showed dramatic decrease in varroa infestation into a quarter levels in two weeks treatment.

Autumn and winter treatment with OA

Glance the direct mite drops caused by the treatment were surprisingly high. No bees sampling were made from this point therefore no result were perceived of the rate of phoretic mites. October sublimation and November dribbling methods result an infestation level dropping to the quarter level of former levels. No

significant difference was perceived between the OA dribbling products. After the December sublimation no mite drops were perceived.

**Table 1: The timing and methods with the results**

| period | activity | methods for groups of (3*4) or (2*2)+(2*4) colonies/apiary and the degree of varroa infestation in average measurement | | | | threshold levels |
|---|---|---|---|---|---|---|
| 1st week of June | natural mite drop count | 1,6 | | | | 4 |
| 1st week of June | adult bee sampling | 0,2% | | | | 0,5% |
| 2nd-3rd week June | treatment | Untreated control | | dribbling oxalic acid product A | dribbling oxalic acid product B | |
| 1st week of July | natural mite drop count | 3,9 | | 3 | 3,1 | 5 |
| 1st week of July | adult bee sampling | 1,0% | | 0,6% | 0,7% | 1,0% |
| 2nd week of August | natural mite drop count | 6,1 | | 4 | 4 | 6 |
| 2nd week of August | adult bee sampling | 1,7% | | 1% | 1% | 1,3% |
| 3rd-4th week of August | treatment | Untreated control | | sublimating oxalic acid | | |
| 2nd week of September | natural mite drop count | 16 | | 2 | 2,1 | 4 |
| 2nd week of September | adult bee sampling | 3% | | 0,4% | 0,4% | 0,5% |
| 3rd week of September | treatment | evaporating formic acid product E | evaporating formic acid product D | evaporating formic acid product E | evaporating formic acid product D | |
| 1st week of October | natural mite drop count | 4 | 4,6 | 1,5 | 1,8 | 2 |
| 1st week of October | adult bee sampling | - | - | - | - | 0,3% |
| 2nd-3rd week of Oct. | treatment | sublimating oxalic acid | | | | |
| 1st week of November | natural mite drop count | 1 | 1,2 | 0,3 | 0,3 | 0,5 |
| November | treatment | dribbling oxalic acid product A | dribbling oxalic acid product B | dribbling oxalic acid product A | dribbling oxalic acid product B | |
| 1st week of December | natural mite drop count | 0,3 | 0,3 | 0,1 | 0,1 | 0,3 |
| December | treatment | sublimating oxalic acid | | | | |
| 1st week of January | natural mite drop count | 0 | 0 | 0 | 0 | 0,1 |

## Discussion

When there is brood in the hive 65% of the mite population (55% in worker and 10% in drone) are in the sealed brood at any time (Martin, 1998). Generally in Hungary once the conditions are appropriate for rearing brood in the end of the winter it will last until the beginning of the next winter. In 2013 after a short mild end of winter a very long cold spring period caused a break period in brood rearing in most of the

colonies. The general low infestation levels in the first monitoring result verify that in this interval a major proportion of the varroa population may have been perished as well with the brood that caught cold. Most of the treatment materials what were used are only affecting the phoretic mites and does not harm mites in the brood. It follows that these treatments work best on colonies that are broodless at the time of treatment. Therefore due to season, we were planning to shaking swarms, or making mating nucs for making broodless stages for the period of treatment during the brood season. However the environmental conditions were not optimal in 2013 weather. The timing of the untreated colonies exceeding the threshold levels in August indicated that at least at this time treatment was already too late to keep off economic injury. By the time the untreated colonies exceeded the threshold levels in principle at this time of the year the main honey flows are harvested already and in the rest of the season winterising is being done. The difference between the bees' tolerance for FA devices may have been caused of the evaporation intensity, what is confirmed by the feedback from the beekeepers that the gel pack had allot stronger scathing smell. However the losses of frame betweens were about the same because the barred cage devices were fixed in combles empty frames. The fall treatments period was overlapping the period of the natural brood shrinking when more bees are emerging than brood being capped. This probably caused a bigger ratio of phoretic mites of the total mite population in the colony, what was verified by the direct mite drops caused by the treatments. The end of 2013 December and 2014 January was so mild, that most colonies were having capped brood in January monitoring. This may let one suggest that the zero mite drops does not mean the disappearance of varroa population in the colony since the winter survivor were hiding brood already. Hungarian on-farm research program for varroa control in organic beekeeping is still continuing in 2014 where monitoring count will be made more frequent including direct mite drops. Other OA sublimating instruments and FA evaporating instruments will be tested.

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