2004 Formic Acid Preliminary Report

Formic acid evaporation pads (MiteGone™) as a varroa mite control tool

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ABSTRACT

Our 2003 evaluation of the MiteGone™ formic acid delivery system determined that these evaporation pads (using a single, full-length pad as the treatment for 30 days) have potential to serve as an effective varroa mite control tool, whereby we achieved a mean efficacy of ca. 72%. In 2004, we evaluated differing numbers of these evaporation pads and found similar results, with mean efficacies ranging from a low of 43% for single, half-length pads to over 80% for three half-length pads per treated colony. Additional trials are planned for 2005, where full-length pads will be used at a more definitive rate of one pad for every five frames of bees.

INTRODUCTION

The parasitic mite, *Varroa destructor*, is the greatest cause of honey bee mortality in the US. Without intervention, honey bee colonies typically die within two years after initial varroa infestation. For over 15 years, effective varroa control strategies in the US have centered on the use of conventional pesticides. However, the consistent and exclusive use of these products to control varroa mites have led to additional problems for beekeepers; the most serious being the development of varroa populations that are resistant to fluvalinate (Apistan®) and coumaphos (Checkmite+®), and the potential contamination of hive products with pesticide residues.

Alternative strategies for varroa control are numerous and exhibit a wide range of efficacy and practicality. Physical and cultural controls such as screen bottom boards and drone brood trapping are typically not stand-alone strategies. However, they do represent options that can be incorporated into an IPM program that utilizes multiple strategies for suppressing varroa populations. Selective breeding and bee stock importation programs (e.g., Minnesota Hygienic bees, SMR bees, and the Russian bee importation and selection programs) show great potential; but more studies are needed on the effects of trait-carryover under open-mated queen rearing practices and the regional adaptation of mite-resistant bees to different areas of North America.

Other alternative approaches to varroa control are the use of biologically-derived compounds. These "biopesticides" may offer beekeepers practical, yet effective means of parasite control, and are therefore strong candidates for incorporation into varroa IPM and pesticide resistance management programs. A considerable amount of research on tracheal mite (*Acarapis woodi*) and varroa mite control with organic acids (formic, lactic, and oxalic acid) and essential oils (thymol, eucalyptol, etc.) has been conducted in Europe, the US, and elsewhere.

In 2003, we conducted a preliminary evaluation of the MiteGone™ (Kelowna, Canada) formic acid delivery system, and achieved 79% and 66% varroa control in single brood-chambered and double-brood-chambered beehives, respectively. In this current study, we evaluated the efficacy of differing numbers of MiteGone™ pads, where increasing pad number was expected to increase formic acid vapors in the colonies, and so provide greater varroa control than found in 2003. Mite mortalities obtained with formic acid were compared to those obtained with Apistan® (standard treatment) and untreated (control) colonies.

MATERIALS AND METHODS

Colonies. Two test apiaries ("Baum" and "Dyer") were established within a 1-mile of each other in Monmouth County, New Jersey, in the fall of 2003. Both apiaries contained 25 honey bee colonies of mixed commercial origin housed in "double-deep" hives (two-story, full-depth Langstroth hives); for a total of 50 colonies. Each colony consisted of a queen and worker bees covering 8-12 deep frames, and all colonies had similar levels of open and sealed brood (2-3 frames total). All colonies contained honey stores sufficient for overwintering, and were therefore not fed during the experiment. The placement of beehives was similar between apiaries with respect to sun exposure and windbreaks, and hives were positioned to reduce the drifting of foragers between colonies.

Treatments. All colonies were identified as being infested with varroa mites by using the alcohol wash technique, and treatments were assigned randomly to colonies within apiaries having comparable varroa mite infestation levels (% infestation = mites/bee x 100). In each apiary, the 25 colonies were divided into 5 treatment groups of 5 colonies each, where each group received treatment with one of three MiteGone™ pads treatments, Apistan®, or were left untreated (control). Treatments began on 2 September and ended on 30 September 2004.

Test colonies in the Apistan® treatment group received four (double-deep) 10% Apistan® strips. Strips were installed between frames such that adequate contact with bees was possible. Apistan® was used as the standard chemical control, as the colonies used in this study were not suspected of hosting fluvalinate-resistant varroa mites.

Test colonies in the formic acid treatment groups each received 1 ("FA-1"), 2 ("FA-2"), or 3 ("FA-3") half-length MiteGone™ pads soaked with ca. 125 ml of a 65% formic acid solution. The solution was added by cutting full-length MiteGone™ pads in half to expose 0.9 x 9 cm (3/8 x 3 ½ in.) of evaporating surface. Pads were attached vertically to an outermost frame in the brood chamber, with the opening oriented downwards to allow the formic acid to evaporate.

Mortality Data. Mite mortality was measured using laminated paper sticky boards (l x w = 38.1 x 30.5 cm) covered with hardware cloth (64 openings per in^2) to prevent bees from contacting the petroleum jelly used to capture falling mites. Sticky boards were placed on the bottom boards in each test colony at 7-day intervals for a period of 28 days (4 sticky board readings from each colony during treatment). On day 28, Apistan® strips were placed in all test colonies to quantify the varroa mite population remaining after the experimental treatments. Mite mortality from the evaluation Apistan® strips was determined for an additional 28-day period (30 September to 28 October 2004). Mite mortalities for each treatment group were combined across apiaries for analysis.

RESULTS

Apistan® is assumed to provide >97% varroa control in bee colonies not hosting varroa populations that are resistant to fluvalinate. We did not detect any signs of fluvalinate-resistance, and therefore believe the percent control for Apistan® was >97%. As such, we did not introduce another pesticide to determine the mite population after the full 56-day Apistan® treatment. Mite mortality data from Apistan® treatments were not included in the statistical analyses and are presented here for comparison purposes only. The formic acid treatments were compared to the untreated control group and among themselves.

Significant differences in mite mortality were found for all formic acid treatments compared to the control group; and the formic acid treatments also differed significantly among themselves. Mean mite mortality for the control (untreated), F1 formic acid, F2 formic acid, and F3 formic acid treatments were 26.1%, 43.5%, 58.7%, and 82.3%, respectively. Mite mortality for each weekly period is presented in the graph below:

Figure 1. Proportion of varroa mites collected on sticky boards

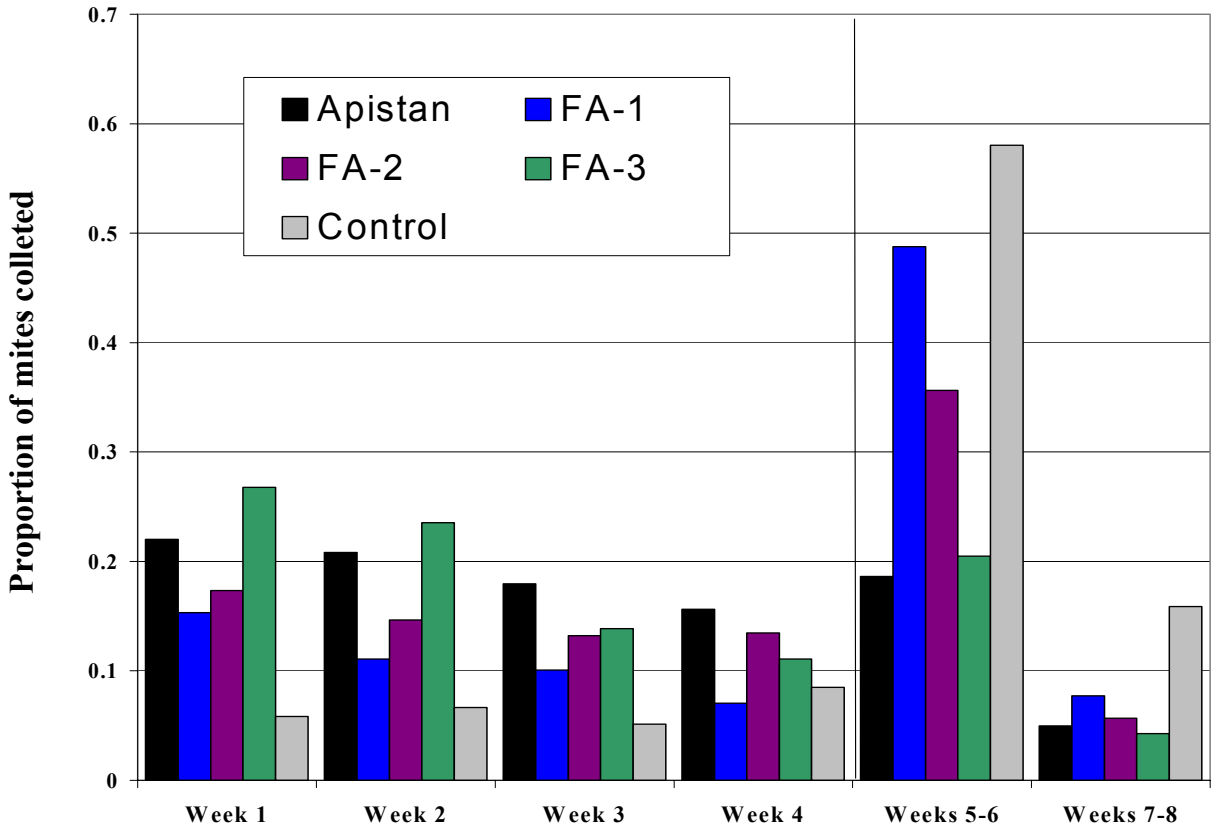

Table 1. Percent formic acid remaining in delivery pads at 14 and 28 days after pad installation.

Treatment	Day 14 after installation	Day 28 after installation	Ave. daily FA evaporation for 28 days of treatment
FA-1	25.4%	15.9%	3.8 g
FA-2	49.8%	17.4%	8.2 g
FA-3	68.9%	19.4%	12.5 g

DISCUSSSION

It is generally recognized that formic acid, regardless of delivery technique, has considerable utility as a viable alternative, alone or as part of an IPM approach, to conventional pesticides for controlling varroa mites, Alternating a conventional pesticide with a formic acid treatment would reduce conventional pesticide use by 50%, and could serve as a tool to combat fluvalinate- and coumaphos-resistance in varroa populations by decreasing the frequency of mite exposure to these pesticides.

The sticky boards + attached screen used here to capture falling mites during treatment, in effect, served the same function as screen bottom boards, as mites (if alive) trapped on the boards were prevented from reattaching to host bees. Therefore, mite mortality reported here should be considered the cumulative effect of chemical treatment and the culling of varroa from the brood nest through the physical barrier of a sticky board/screen bottom board.

As in 2003, the levels of varroa mite control found in 2004 using formic acid in the MiteGone™ delivery pad system were similar to those reported for the currently unavailable, gel-based formulation, Apicure® .

Increasing the level of varroa control using MiteGone pads would be possible by extending the treatment period beyond the 28-day period evaluated here, using more than one full-length delivery pad to increase the amount of formic acid that is released per day, or restricting the airflow at the hive entrance to allow for greater retention of formic acid vapors. Our 2005 formic acid trials will evaluate the potential of these treatment options.