Project Title: The Use of 2-Heptanone to Control Varroa Mites in Honey Bee Colonies – Refining the Delivery System

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Project Leader: Gloria DeGrandi-Hoffman Location: USDA-ARS
Carl Hayden Bee
Research Center,
Tucson, AZ

Phone: 520-670-6380 (104), mobile: 520-730-0707

e-mail: gd-hoffman@tucson.ars.ag.gov

Cooperating Personnel: Drs. Syed Imam, Gregory Glenn, and William Orts Bioproducts Research Laboratory, Western Regional Research Center, USDA-ARS, Albany, CA and Dr. Diana Sammataro, Carl Hayden Bee Research Center, USDA-ARS, Tucson, AZ

Objectives

1. Test different delivery systems for the microencapsulated 2-heptanone and compare their effectiveness in reducing Varroa populations.

2. Determine the rate of spread of microcapsules containing 2-heptanone in a honey bee colony and their persistence on adult bees in the colony.

Objective 1: Various delivery systems containing 2-heptanone were tested in five frame nucleus colonies and then in full-sized 9-frame Langstroth colonies composed of two hive bodies. The presence of Varroa mites in the colonies was determined by placing sticky boards on the bottom boards of the hives and counting the Varroa that naturally dropped.

2-heptanone strips or disks were placed on the top bars of frames (Fig. 1) for 6-week periods. Apistan, the miticide currently registered for Varroa, was used as a positive control. A separate set of colonies received no treatment and were used as negative controls. A sticky board covered in hardware cloth was placed on the bottom of each colony to capture mites that dropped from adult bees. Like Apistan, 2-heptanone kills only adult Varroa in the phoretic stage on adult honey bees.

Figure 1. Prototypes of 2-hepatine delivery systems in honey bee colonies.

Each week colonies were inspected to determine if 2-heptanone was affecting colony behavior. The reaction of worker bees to the 2-heptanone disks or strips also was noted. Sticky boards were replaced and the dead mites collected over the previous week were counted. After the 6-week period, new Apistan strips were placed in each colony for one week and the mites that dropped onto sticky boards were counted (post-treatment counts). Weekly and overall mortality from each treatment was estimated using the equation: mite mortality (t) / (mite mortality (treatment interval) + mite mortality (post-treatment counts).

Powder delivery system: The efficacy of the powder delivery system and any possible effects on brood rearing were evaluated using the same procedures described above for the strips. The microencapsulated 2-heptanone powder was mixed in cornstarch and sprinkled on the top bars of frames in 5-frame nucleus colonies. The colony was checked after 24 hrs for dead mites on a sticky board placed on the bottom of the colonies. The number of dead bees on the screen covering the stick board also was counted to determine if the powder increased worker mortality rates.

Results

Objective 1: In our first trial, The KS (no wax) prototype provided the highest mite drop (81%) followed by APK (70%) (Fig. 2). Apistan generated an average mortality rate of 96% of the mite population. Unlike Apistan which had the highest weekly mortality during Week 1, KS (no wax) had its highest mortality in Week 2 and mortality decreased slightly in the subsequent weeks (Fig. 3). APK also caused the highest mortality in Week 2 and also in Week 5. Bees were attracted to all prototypes and chewed the outer wax and glucose covering, thereby releasing the 2-heptanone. The delivery systems did not increase bee mortality or disrupt colony behavior.

In the second trial, we tested a different set of prototypes. PT-4 generated the highest mortality of all prototypes (72%) (Fig. 4). The PT prototypes generated nearly equal mortality during each week of the test interval with only slight increases or decreases between the weeks (Fig. 5). As in the first set of prototypes, the PT did not increase bee mortality or disrupt colony behavior. The bees were attracted to the strips and readily chewed on them especially in the full sized colonies.

Objective 2: 2-heptanone in powdered form did not disturb honey bee behavior in the colony. The bees readily fed upon the 2-heptanone mixed with powdered sugar. The compound volatilized too quickly however, to kill mites effectively for the required 42-day period. We stopped testing powdered formulations and concentrated our efforts on the strip delivery system. We have successfully constructed a strip that can deliver microencapsulated 2-heptanone for 42-days.

Discussion

The most effective prototypes had an average of 70-81% mite drop compared with 85-96% mortality with Apistan. The prototypes did not disrupt colony behavior or increase bee mortality. A mathematical model (VARROAPOP) that simulates honey bee colony and Varroa population dynamics predicts that 70-80% control is sufficient to reduce Varroa populations to levels where they do not threaten colony survival (DeGrandi-Hoffman and Curry 2005).

In 2006, we will test slightly modified versions of the KS (no wax) and APK delivery systems to determine whether mortality rates are consistent and repeatable in spring and fall. We then will provide samples to commercial beekeepers to determine the effectiveness of the delivery system in reducing mites in colonies of various sizes.

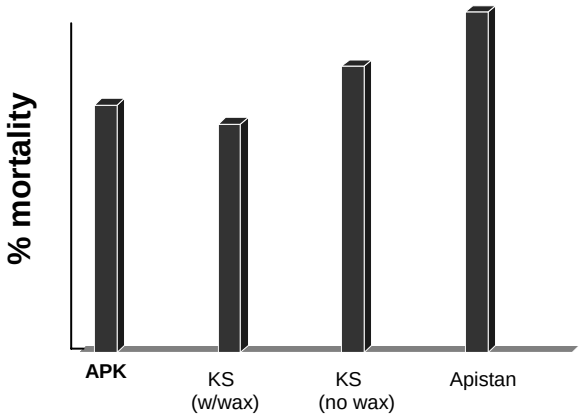
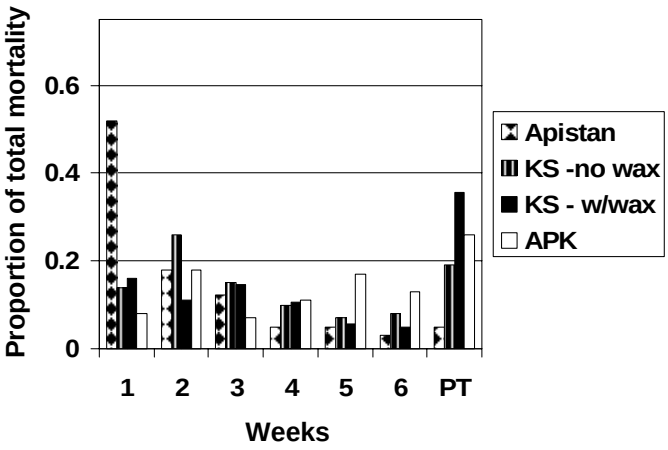


Figure 2. Mortality from 2-heptanone prototypes compared with Apistan (trial-1)

Figure 3. Weekly Varroa mite mortality in colonies containing prototypes of 2-heptanone delivery systems.



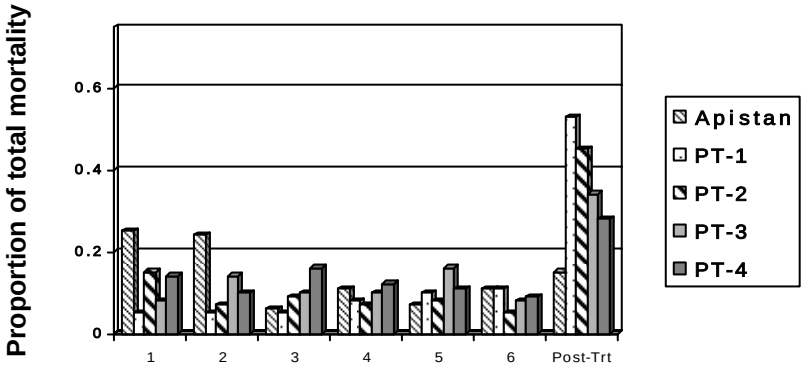


Figure 4. Weekly mortality of Varroa mites in honey bees colonies containing different 2-heptanone delivery systems.

Figure 5. Mortality of Varroa mites after 6-week exposure to either Apistan or four different prototypes of 2-heptanone delivery systems