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

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Interpretive Summary:

2-Heptanone is a potent miticide that has the potential of controlling Varroa mites in honey bee colonies. The compound also repels adult wax moths and at high concentrations, can repel bees. Wax coated strips containing microencapsulated 2-heptanone resulted in about 70% Varroa mortality in colonies. We refined the microencapsulation method and found that films made from fruit or vegetable purées provided the best barriers to slow the release of the compound. We are testing the new delivery system in colonies against both Varroa and wax moth.

Objectives:

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

2) Provide strips to beekeepers in different regions of the country to determine efficacy in reducing Varroa populations.

Materials and Methods:

We tested a strip delivery system containing micro-encapsulated 2-heptanone in full-sized colonies infested with Varroa. Strips were placed in colonies for 6 weeks in late spring. For comparison purposes, we placed Check Mite (coumaphos; positive control)

or strips composed of microcapsules without 2-heptanone (negative control) into additional colonies (5 colonies per treatment). The brood area in the colony was measured prior to treatment. Mite mortality was estimated by the number of Varroa on sticky boards placed on the bottom board of each colony. Mites on the sticky boards were counted weekly. New sticky boards were used for each weekly count.

After 6 weeks, new Apistan strips were placed in all colonies for 1 week to kill any remaining mites on the bees. Efficacy of the treatments was estimated by the equation:

$$[A / (A+B)] \times 100\% = \% \text{ of Varroa killed}$$

Where: A = total mites counted on sticky boards for 6 weeks
B = Total mites killed in the 1 week exposure to Apistan following the 6-week treatment.

Objective 2:

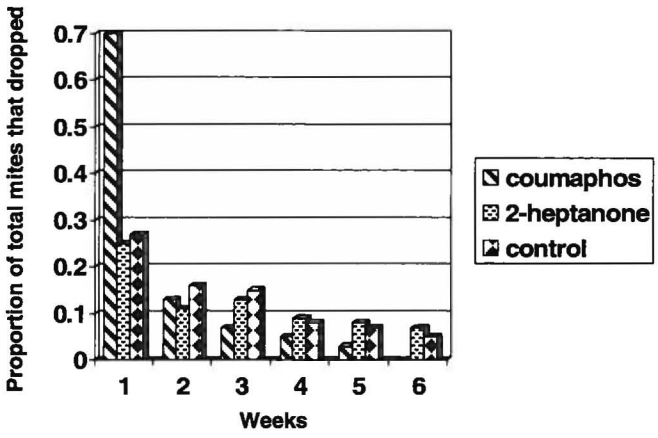
The microencapsulated 2-heptanone strips that provide the greatest mite mortality and least negative effects on colonies will be sent to beekeepers to test in their colonies. We will provide the beekeepers with: sticky boards to place on the bottom of their colonies, Apistan or Check Mite (for comparison of mite mortality) and mailing supplies to send the sticky boards back to us so that we can count the fallen mites. Ideally, we will send the strips to beekeepers in July so that they can be placed into colonies in August. Enacting mite control measures in August is when they are most effective in insuring colony survival (DeGrandi-Hoffman and Curry 2004). We will document both the mite mortality in the colonies from the mite drop on the sticky boards, and the survivorship of the colony the following spring.

Results and Discussion:

When placed in the hive, the strips did not disrupt normal bee activity (i.e., it is non-repellent). The bees walked over the strips and chewed the outer wax covering thus exposing the microencapsulated 2-heptanone. Brood areas increased and all colonies treated with 2-heptanone survived the treatment period without negative effects (i.e., queen loss, decline in adult worker populations or disruption in brood rearing).

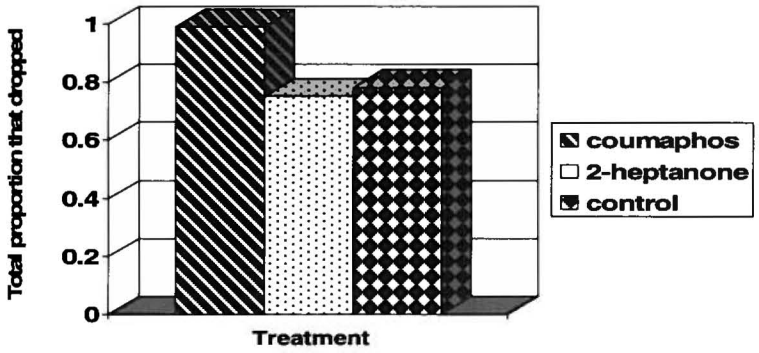
2-heptanone caused about 25% of the phoretic mites in the colony to drop within the first week of treatment compared with Coumaphos which caused about 70% of the susceptible phoretic mites in the colony to drop (Figure 1).

Figure 1. Proportion of Varroa mites dropping weekly in colonies treated with either coumaphos, 2-heptanone strips or untreated controls.



By 6 weeks, less than 1% of the susceptible Varroa in the colony treated with coumaphos dropped on to the sticky board while less than 10% of the mites were dropping in the 2-heptanone treated or untreated control colonies (Figure 2). Following the treatment with Apistan to kill the remaining mites in the colony, we found that less than 1% of the susceptible mites remained in colonies treated with coumaphos and about 25% of the mites remained in the hives treated with 2-heptanone or in the untreated controls.

Figure 2. Total proportion of Varroa mites dropping in 6 weeks in colonies treated with either Coumaphos, 2-heptanone or untreated controls.



The wax coated strips did not provide Varroa mortality that significantly differed from the negative control colonies. The strips sometimes lost their integrity in colonies after 2-3 weeks causing the 2-heptanone to be released too rapidly. We concentrated our efforts on improving the coatings on the strips. We tested various barriers that were biodegradable and durable enough so the bees could not chew through them too quickly. We found the best coatings to be those comprised of vegetable or fruit purees. We will test these strips in colonies later this summer. If they are effective in reducing Varroa populations, we will provide beekeepers with prototypes to test in their colonies.

Recent Publications:

Glenn, G.M., Klamczynski, A.P., Ludvik, C., Shey, J. Iman, S.H., Chiou, B., McHugh, T., DeGrandi-Hoffman, G., Orts, W., Wood, D., and Offeman, R. 2006. Permeability of starch gel matrices and select films to solvent vapors. J. Agric. Food Chem. 54: 3297-3304.