Efficacy of Three Miticides (Oxalic acid, Formic acid, Apilife Var) on *Varroa destructor* and *Acarapis woodi* in Honey Bee Colonies in Canada

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Oxalic acid, Formic Acid MiteAway™ single application pad and Apilife VAR™ were evaluated and compared with Apistan® against varroa mites and tracheal mites in honey bees in Ontario, Canada. Honey bee colonies were treated with Formic Acid MiteAway pads (250 ml of 65% formic acid/pad/hive), Apilife VAR and Apistan® as recommended. Two concentrations of Oxalic acid (dihydrate), 28g/l and 35g/l in 50:50 (sugar:water)sugar syrup were tested. Applied amount of Oxalic acid in sugar syrup to each bee colony was determined based on the colony strength. Colonies with 4-6 frames covered with bees received 40 ml and colonies with 7-9 covered with bees received 50 ml. Oxalic acid in sugar syrup was trickled on honey bees in between the top frame bars in the brood chamber. Treatments were applied on the 20th of October when temperature ranged between 5-11 ºC. The number of fallen mites was determined using sticky traps during the treatment period of three weeks. After treatment period all colonies were treated with Apistan® for another three weeks to determine varroa mites left in treated colonies.

Apistan® was the most effective treatment. The percent of varroa mortality averaged 95.21±1.01% (means ± SE, n = 8). Treatment with Formic acid Mite-Away pads resulted in an average mite mortality 92.84±2.28% (n=7). Percentages of varroa mite mortality were 89.42±2.39% and 55.52±6.48% in colonies treated with Oxalic acid concentration 3.5 g/l (n=7) and 2.8% (n=8), respectively. Apilife VAR (n=8) killed an average of 63.0±7.16%. No significant difference ($p < 0.05$) was found in the efficacies of Apistan®, Formic Acid Mite-Away pads, and 3.5% Oxalic Acid. The ratios of coefficient of variations of percentages of varroa mortality in Formic Acid Mite Away and 3.5% Oxalic acid treatments to Apistan® showed tested treatments provided consistent results as Apistan®. Efficacies of Apilife VAR and 2.8% Oxalic Acid were significantly lower than the efficacy of Apistan®, Formic Acid Mite-Away, and 3.5% Oxalic Acid. The number of brood chambers affected the efficacy of Oxalic acid. The efficacy for 3.5% Oxalic Acid was 89.87±2.93% in single brood chamber colonies, 87.21±7.07 in 1.5 and 73.67±18.83% in double brood chamber colonies.

Formic acid showed a significant effect on tracheal mites. Apistan®, Oxalic acid and Apilife Var had no to low effects on tracheal mites. Colonies treated with Formic Acid Mite-Away had 85.7% of colonies survived winter. This was followed by 3.5% Oxalic acid with 71.4% bee colony survival, Apistan with 62.5% survival, Apilife VAR with 50.0% survival and 2.8% Oxalic acid with only 25% of colonies surviving the winter. These results suggested that formic acid was highly effective in killing both tracheal mites and varroa mites. This may explain the high survivorship of bee colonies treated with formic acid. Bee colonies treated with Apistan®, Apilife VAR and 2.8% and 3.5% Oxalic acid continued to have high level of tracheal mites. These results suggest that Formic Acid MiteAway and 3.5% Oxalic acid are effective alternatives to Apistan® as a late fall treatment for varroa mites and formic acid is the most effective treatment for tracheal mites.