

Economic injury levels of Varroa destructor and pathogens associated with honey bee (*Apis mellifera*) colony losses in Western Canada

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Varroa destructor, a parasitic mite of honey bees (*Apis mellifera*), is thought to be the primary cause of winter colony mortality. To manage this mite, beekeepers must use Integrated Pest Management (IPM) strategies. An effective IPM relies on prompt monitoring of mite levels to treat colonies when they reach an economic threshold and before they develop to economic injury levels. Concerns have been raised about the possible interaction between varroa mites and other stressors that may lead to high colony mortality. Varroa mite levels were recorded in colonies from five regions of British Columbia, Canada: Lower Mainland, Kootenay, Okanagan, Cariboo, and Peace. Varroa mite levels were analyzed for associations with colony strength and mortality, as well as with other pathogens that were identified using total RNA sequencing. The Kootenay and Lower Mainland regions had the highest mite levels in the fall, followed by the Okanagan, Cariboo, and Peace regions. The Peace region had the lowest mite growth and lowest colony mortality. Varroa mite levels in the fall significantly predicted odds of colony mortality in the spring. Colonies with $\geq 1\%$ mite infestation in the fall had a significantly higher mortality rate ($p=0.005$) compared to colonies with $<1\%$ mite levels. Therefore, treatment is recommended above that threshold. Also, deformed wing virus-B levels were 8.4 times higher than those of deformed wing virus-A variant in all the regions and were highest in the Kootenay region, which also had the highest rate of colony losses. Lastly, *Malpighamoeba mellificae* and *Vairimorpha apis* transcripts were identified along with other pathogens that deserve further investigation, including *Apis mellifera* filamentous virus, Lake Sinai virus, and *Apis mellifera* solinivirus 1. The dynamic nature of host-pathogen interactions requires frequent pathogen surveillance to determine the prevalence and levels of parasitic mites and associated infectious diseases and their impact on honey bee health, not only in the regions of this study but globally. More studies are needed to determine the nature of the interaction between the identified pathogens and *V. destructor*.