BeeShield: An Innovative Varroa Mite Protection Tunnel Using Bee Behaviors at the Hive Entrance and Mite Response to Formic Acid

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The Varroa mite is the most dangerous honey bee parasite and imperils global beekeeping, causing yield reductions over 40% and estimated annual economic losses of billions of dollars. Currently, no effective preventative method exists against mite. Therefore, chemical treatment remains the primary solution. These traditional methods often involve fumigating or spraying hives with harmful chemicals, leading to toxic residues that adversely affect all the bees in the colony. Our project aims to develop an innovative Varroa mite protection tunnel by utilizing bee behavior at the hive entrance. Observations revealed that mite-infested bees exhibit distinct flight patterns, walking gaits, and hygienic behaviors compared to healthy bees. These patterns were used to develop a deep learning algorithm, which serves as a model to differentiate between healthy and infested bees. To identify a suitable organic substance for mite elimination at the hive entrance, we discovered that 75% formic acid effectively removes mites without altering bee grooming behavior or causing mortality. Subsequently, we developed 'BeeShield' an automated Varroa mite protection tunnel designed for the monitoring and treatment of mite-infested bees with optimized formic acid application. This novel system provides 100% protection against mite infestation, effectively preventing hive entry. Consequently, bee health significantly improved, resulting in a four-fold decrease in bee mortality. This, in turn, led to a three-fold increase in honey production compared to control. Crucially, honey quality remained unaffected, as the treatment is external. This innovation offers a solution to the challenges faced in beekeeping and promotes sustainable agriculture through enhanced food security.

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