Evaluating the Efficacy of Novel Carbon Dioxide Spray and Pesticides Using a Convolutional Neural Network for Varroa Mite Treatment in Honey Bee Colonies

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Honeybees are indispensable pollinators, contributing 80% of crop pollination and $183 billion to the global economy annually. Unfortunately, in the US, beekeepers lose 40-50% of commercial beehives annually. According to the USDA, the largest cause of this decline are Varroa Mites. These ectoparasitic mites feed on bees' fat bodies and transmit lethal viruses, contributing to global colony collapse. Current pesticide treatments for Varroa control, such as Apivar and Comaphous, are effective but pose risks of in-hive contamination, environmental toxicity, mite resistance, temperature sensitivity, and even bee harm. Last year, this research evaluated 30% CO2 as a non-toxic, inexpensive, and effective alternative for Varroa Mite treatment in the lab. This year, an extensive field trial was run to compare the efficacy of CO2, Apivar, and Comaphous treatments using 45 hives (15 per treatment group) under the same field conditions. Mite populations were monitored using sugar-shake tests. Each hive was sugar-shaken 3 times, and Varroa populations were recorded before treatment, 3 days, 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks, and 6 weeks post-treatment. A convolutional neural network was developed to predict future in-hive mite populations for beekeepers. Data was statistically analyzed through ANOVA, Kruskal-Wallis, and post-hoc tests. The data showed that CO2 had a 96.2% Varroa Mites elimination, followed by Apivar with 95.7%, and Comaphous with 87.3%. Overall, these findings suggest that CO2 can be used as a highly effective treatment for Varroa. This novel treatment holds potential for commercial application and reversal of honeybee decline across the globe.

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