Enhancing Targeted Crop Pollination by Training Apis mellifera Using Synthetic Mimic Odors and AI-based Analysis

Lo, Matthew (School: The Haverford School)

This research proposed methods to enhance targeted crop pollination by training honeybees using synthetic floral mimic scents. Honeybees were individually trained through the Proboscis Extension Response (PER) paradigm using four different mimic scents composed of sunflower volatile organic compounds. Honeybees were also conditioned through an in-hive feeding of a sucrose solution containing the mimic scent to induce increased attraction towards the natural sunflower scent. The sunflower mimic with the highest final PER rates (92%) was composed of Bornyl Acetate, Vanillin, and Beta-Pinene, but all mimic scents showed significant increases in PER rates to the natural sunflower scent after training compared to the control group (13%), peaking at around 90%. Additionally, significant changes were observed for the first time in eight antennal movement behaviors after training, specifically in tip position, angle, symmetry, movement frequency, extension, distance between the tips, scape position, and scape angle. Using the identified antennal behavioral features, two machine learning models (random forest and neural network) were trained and successfully performed prediction of trained and untrained honeybees with around 90% accuracy, further validating the effect of training with sunflower mimic scents. Finally, testing in a sunflower field (Southern Hill Farms, Florida) confirmed a significant increase (approximately 260% across three days) in the number of pollen granules collected by the hive trained with the optimized mimic. These results clearly show the application of synthetic mimic odors for enhancing targeted crop pollination and demonstrate significant potential for addressing global food shortages and improving agricultural practices.

Awards Won: