# CALIFORNIA STATE SCIENCE FAIR
# 2014 PROJECT SUMMARY

**Name(s)**

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**Project Number**

34852

**Project Title**

## Synergetic CCD Effects of Ingestion of Bacillus thuringiensis d-Endotoxins on the Health of Honey Bees Apis mellifera L.

**Abstract**

**Objectives/Goals**

Pollination accounts for $15 billion in agricultural value and 1/3 of the U.S. food supply. Since 2006, Colony Collapse Disorder has been responsible for anomalous bee losses. GM Bt crops are viewed as potential culprits of CCD. Pollen of Bt plants contains d-endotoxins, encoded by B. thuringiensis cry-genes that are lethal to pests. Bt impact on pollinators remains unclear. The goal of the study was to quantify the synergetic effects of Bt d-endotoxins on bee health and investigate the connection between GM plants and CCD. I hypothesized that bees fed with Bt d-endotoxins will exhibit lower (1) food consumption, (2) survival, and deteriorated (3) olfactory associative learning.

**Methods/Materials**

In a 3-replicate study, 30 bees were selected from a hive and transferred into 2 groups of 15 insects. Cultured B. thuringiensis was allowed to produce d-endotoxins according to the methods of mass production. A Bt suspension was prepared in concentrations similar to those consumed by a nurse using hemocytometer spore counting. Control was fed with sucrose solution, while treatment groups received a Bt solution for 3 days. Mortality and amount of solution consumed per bee were measured. After the assay, conditioning of the proboscis extension reflex (PER) and extinction were performed.

**Results**

According to Pearson chi-squared test, mortality in Bt-treated groups (15.6%) was not significantly different from that of control (6.7%). Food consumption in treatment groups, verified by Student t-test, did not decrease. However, extinction %PER in control groups was significantly lower (2-proportion z-test, $Z = 3.2$, $P = 0.0012$) than that of Bt-treated groups. Bees treated with d-endotoxin exhibited a prolonged PER, demonstrating a lack of extinction process, which elucidated modifications in bee memory.

**Conclusions/Discussion**

Prolonged PER in Bt-groups indicated that d-endotoxin has an adverse effect on bee learning and adaptability. In the field, lack of behavioral flexibility might prompt a bee to return to depleted food sources, negatively impacting foraging behavior. My analysis is supported by previous studies and a discovery that reveals that the amount of Bt d-endotoxins ingested by bees might be underestimated due to accumulation of toxins in the hive. I conclude that pollen from GM plants adversely affects bee memory and suggest that Bt d-endotoxins have a link to CCD.

**Summary Statement**

I investigated the synergetic effects of Bt d-endotoxins on bee health and determined that pollen from GM crops has a negative impact on bee memory and a connection to Colony Collapse Disorder caused by modifications in foraging behavior.

**Help Received**

The study was conducted in a school laboratory under the supervision of Mrs. Fallon. Mrs. McCarty gave insights into statistical analysis; beekeepers Alan Henninger, Shane Harris, and Alysa Sakkas provided live bees; father encouraged and purchased materials.