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Effects of Beauveria bassiana on the Mortality and Thorax Width of Bombus impatiens Colonies

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BACKGROUND

Pesticides are widely used to protect against unwanted insects, but risk assessments of the effects on pollinators have traditionally only been applied on an individual level, not a population level.[1] This has allowed many pesticides to be approved without the knowledge of sub-lethal effects, such as life history characteristics and population structure to name a few. The biopesticide BotaniGard, containing the entomopathogenic fungus *Beauveria bassiana*, has previously been thought to be safe for non-targeted insects, but recent studies have found it to have significant negative effects on pollinators. Such negative effects can include decrease in longevity and odorant responsiveness with an increase in sucrose sensitivity and mortality rates.[2,3,4]

Most of the current literature of the effects of BotaniGard on pollinators is limited to honeybees. However, it is important to explore this question in other native pollinators as well, such as the bumblebee *Bombus impatiens*. This species is an important pollinator because it is essential for both greenhouse pollination and agricultural pollination.[5,6] An important factor in bumblebee survivability is body size as its variability allows them to be less susceptible to environmental changes, with smaller bees tending to be less impacted by starvation.[7,8]

Figure 1: Image of one of the colonies used in the Dunlap lab led by graduate student Emily Beahm.

OBJECTIVES

- Explore the effects of BotaniGard on bumblebees
- Examine if field realistic dose levels of BotaniGard influence the death rate of bumblebees
- Examine if field realistic doses of BotaniGard influence the size of the deceased bees

PREDICTIONS

- Treatment colony will have higher death rate after dosing compared to control colony.[3,4]
- The death toll for bees with wider thoraxes will be higher than that of bees with smaller thoraxes.

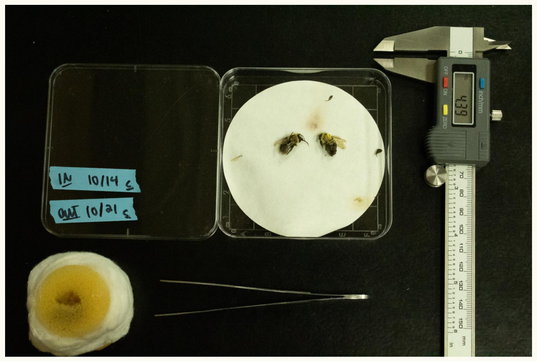

Figure 2: Image of the supplies and setup for measuring the thorax width of the bees. This included (from left to right) a foam holder to steady the bees, a petri dish that stored the bees, pliers, and digital calipers.

METHODS

- Colonies were housed in wooden boxes located in separate rooms and given pollen and sucrose ad libitum.
- Dosing weeks occurred once every 2 to 3 weeks to allow for FMPER testing between doses. During the dosing week, a subset of bees from each colony would be randomly selected and dosed once with either water for control bees or BotaniGard for treatment bees.
- Dead bees were removed from the colonies between every 1 to 3 days, depending on death total and availability, and were incubated in petri dishes separated by colony and day.
- Data used for analysis was the dead bees present in each colony after the second dosing round was administered.
- Analysis used to compare average of three thorax widths for each bee included a t-test, which assumed unequal variances.

RESULTS

- The differences in total number of deaths in the control colony (Dose 1 n = 67; Dose 2 n = 119) compared to the treatment colony (Dose 1 n = 76; Dose 2 n = 75) over a period of 21 days each after both the first and second dose were not statistically significant.
- The differences in average thorax width of bees were not statistically significant between the control and treatment colonies (P= 0.13 with control = 4.45 cm, treatment = 4.35 for Dose 1; P = 0.63 with control = 4.48 cm, treatment = 4.44 cm for Dose 2).

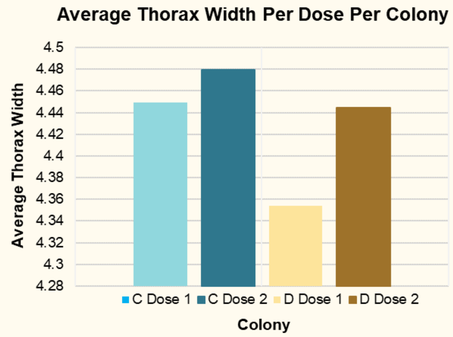

Figure 3: Graph showing the average thorax width (in centimeters) per colony from both Dose 1 and Dose 2.

DISCUSSION

- Contrary to initial predictions, the mortality of the control colony was much higher than that of the treatment colony in Dose 2. The fewer deaths in the treatment colony could have been due to a colony effect unrelated to the BotaniGard treatment, such as being due to the control colony being visibly much more numerous. However, it is also possible that the initial dose of BotaniGard may stunted the growth of the treatment colony, causing them to have a smaller colony and less deaths as a result.
- Though the t-test analysis found this data set of thorax sizes to be statistically insignificant, more replicates would have to be performed to determine if the effect of BotaniGard on thorax width is truly not significant or if it will be significant with a larger sample size. Based on my experience with the colonies and a larger data set than used here, I predict that Figure 3 would represent a trend of the treatment colonies producing smaller bees that will be statistically significant given a larger sample size. It is possible that field realistic doses have a biologically significant effect on bee size that is currently statistically unsignificant.
- It should be noted that the treatment colony did seem to produce smaller bees, had a smaller number of bees, and occasionally had failed larval cells (which was not present in the control colony).

POTENTIAL EXPLANATIONS

- Potential explanation for differential mortality rates:
  - Varied colony sizes
  - Differential response to bee mites found sometime after dose 2 was administered
  - Isolated events in the lab unrelated to the colonies or to treatment
  - Suboptimal moisture due to the structure of the housing containers

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