# Comparing biopesticide alternatives for effectiveness against *P. brassicae* and non-toxicity to *A. mellifera*

Ben Simmons, Emry Greene, and Emma Rosenau
Rubenstein School of Environment and Natural Resources, University of Vermont

**Background and Motivation:**

- Conventional agriculture makes of many synthetic insecticides, which are harmful to biodiversity (Kim et al., 2020). See Figure 1.
- Natural insecticides are an effective alternative to their synthetic counterparts and have fewer negative environmental impacts (Karkanis and Athanassiou, 2020). However, much development remains before natural insecticides are a practical large-scale environmental solution, and before that continued research to ensure that the natural insecticides chosen do not have inadvertent harmful ecological effects (Karkanis and Athanassiou, 2020).
- The plant-derived compound ricinine has proved effective against the cabbage butterfly caterpillar *Pieris brassicae* (Karkanis and Athanassiou, 2020). However, ricinine used as an insecticide has proved to be harmful to an important pollinator, the European honeybee *Apis mellifera* (Rother et al., 2009). da Silva et al. (2020) have shown that mint oil has little negative effect on *A. mellifera*.
- We propose to compare both the insecticidal effectiveness and honeybee non-toxicity of ricinine, mint oil, and a synthetic pesticide to determine the useful insecticide with the least ecological impact.

Figure1: This image shows common application practices for synthetic fertilizers. Because of this method, these fertilizers are easily spread into the surrounding environment through runoff and absorption into the soil, creating a potential threat to surrounding insect species. Additionally, there are other ecological and physiological risks associated with pesticide contamination. This photo was retrieved from Best Food Facts.

**Literature cited:** Ali, S., Ullah, M. I., Arshad, M., Iftikhar, Y., Saqib, M., & Afzal, M. (2017). Effect of botanicals and synthetic insecticides on Pieris brassicae (L., 1758) (Lepidoptera: Pieridae). *Turkish Journal of Entomology, 41*(3).doi:https://pdfs.semanticscholar.org/d528/fbb454b2f4730578166dc80e9263e9629b31.pdf da Silva, I.M., Zanuncio, J.C., Brügger, B.P. *et al*. Selectivity of the botanical compounds to the pollinators *Apis mellifera* and *Trigona hyalinata* (Hymenoptera: Apidae). *Sci Rep* 10, 4820 (2020).https://doi.org/10.1038/s41598-020-61469-2 Karkanis, A.C., Athanassiou, C.G. Natural insecticides from native plants of the Mediterranean basin and their activity for the control of major insect pests in vegetable crops: shifting from the past to the future. *J Pest Sci* (2020). https://doi.org/10.1007/s10340-020-01275-x Kim, H., Sun, Y., Kim, T., & Moon, M. (2020). Biodiversity monitoring for selection of insect and spider bioindicators at local organic agricultural habitats in South Korea. *Entomological Research, 50*(10). Rother DC, Souza TF, Malaspina O, Bueno OC, da Silva MGF, Vieira PC, Fernandes JB (2009) Susceptibility of workers and larvae of social bees in relation to ricinine. Iheringia Ser Zool 99:61–65

**Hypothesis:** We hypothesize that there is a relationship between type of pesticide and *Pieris brassicae* and honeybee activity

**Predictions**: We hypothesize that plants treated with R. Communis or synthetic pesticides will cause a substantial decrease in both *Pieris brassicae* presence and bee activity, and plants that are not treated with pesticides will display normal bee activity and *Pieris brassicae* presence (Figures 2 & 3). Plants treated with spearmint oil will decrease *Pieris brassicae* presence without decreasing bee activity on the plant (Figures 2 & 3).

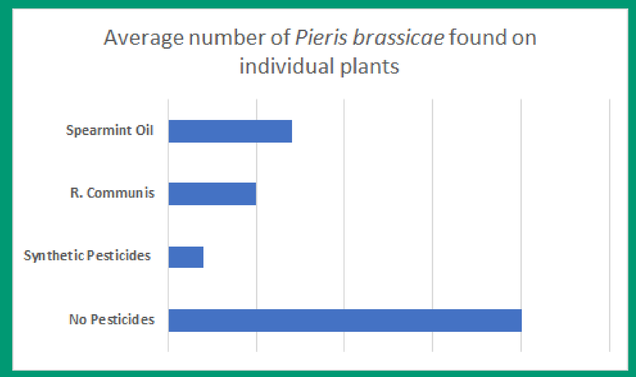


Figure 2: Our predictions about how different types of pesticides will affect the number of Pieris brassicae on crop plants. Presence of Pieris brassicae will be measured by averaging the number of individuals on the different grouped plants.

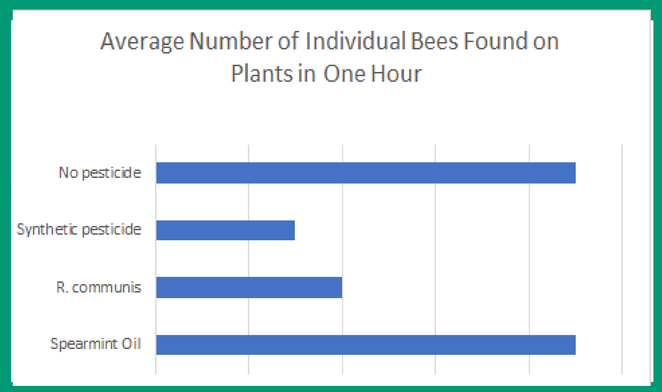


Figure 3: Our predictions about how different types of pesticides will affect the level of bee activity on food crops. Bee activity will be measured by averaging the number of individual bees that appear in each group's plants during a duration of one hour.

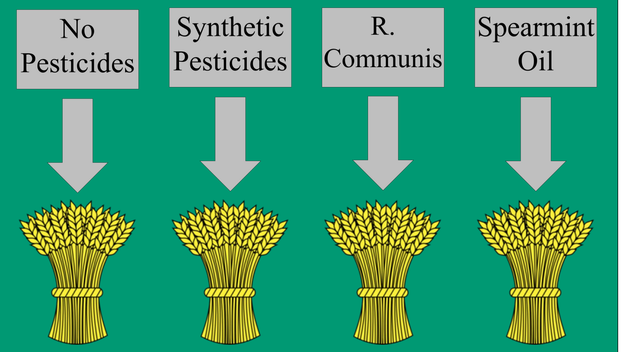


Figure 4: An illustration of the four separate study groups. Uniform cabbage monocultures will be the crop studied across all test groups.

**Intended Analysis:**
Two separate ANOVA tests will be performed on the data collected from the visual surveys. Each test will use the same four independent variables (a synthetic pesticide, R. communis extract, spearmint oil, and none) as categorical data and the dependent variables (bee visits and amount of *P. brassicae*) will represent our continuous data.

The intended goal of the resulting data is to determine whether spearmint oil can promote pollination, determined by the presence of bees, while simultaneously repelling pests at a similar or greater rate than other common pesticides. This application is only being studied on one crop on a small scale, but the pending results could indicate potential for studying spearmint oil application on a larger scale to determine if large scale production is effective.

**Study Design:**
This study will be conducted on the University of Vermont's horticultural farm because it is within the range of all involved species. It will include four uniform patches, each a monocrop of cabbage utilizing the same growing practices except for the type of pesticide that is applied (a synthetic pesticide, R. communis extract, spearmint oil, or none) to reduce confounding variables (Figure 4). Each day of the cabbage growing season, at a uniform time, the number of *A. mellifera* visits to each plot will be recorded over the course of an hour as well as the number of *P. brassicae* in each plot using a visual survey.

**Expected Results:**
Over 75% of the world's food crops depend on bee populations for pollination (da Silva et al, 2020). Bees have increasingly been imperiled by factors such as the use of synthetic pesticides in tandem with parasites like varroa mites (Kim et al, 2020). If our study shows spearmint oil can be effective in reducing pest activity such as *Pieris brassicae* while not harming the honeybee, it could help to push for more widespread use of biopesticides. Using spearmint oil as a pesticide alternative has the potential to benefit bee populations and would decrease the negative externalities associated with traditional synthetic fertilizer use such as runoff contamination.