Purdue University
Department of Entomology
Undergraduate Capstone
Project Summary
Fall 2013

Mentor: Dr. Ian Kaplan

Student: Emily Mroczkiewicz

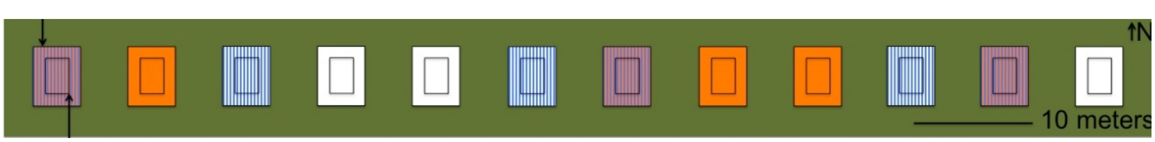
An Assessment of the Population Densities of the Goldenrod Gall Midge, *Rhopalomyia solidaginis,* and the Effects of Various Treatments on Gall Formation at Purdue Wildlife Area

Introduction

Plant-insect interactions in a natural ecosystem are under a lot of pressure from recent global changes that are occurring. These global changes can include alterations in climate, fluctuations in precipitation, and changes in atmospheric and soil compositions, among several others. Two of the most prevalent global change factors in this area, however, are changes in precipitation patterns and the addition of nitrogen to our ecosystems. These precipitation patterns are skewed recently because of the increasing intensity of climate change, and the addition of nitrogen is an important factor due to our agricultural systems and fertilizers. Certain insects and their environment can be good indicators of these changes. Gallmakers in particular are useful in determining some of the effects of these changes on an ecosystem, because their success in an area is visible and very clear due to the galls they induce on plants. The system at Purdue Wildlife Area utilizes a certain gallmaking species, *Rhopalomyia solidaginis*, and the rosette gall. The Goldenrod Gall Midge adult females deposit their eggs into the leaf bud of a developing Goldenrod plant, and this causes a gall to form, which serves as a shelter and nutrient sink for the developing larvae. In this experiment, I wanted to examine the ways in which global change factors such as nitrogen addition and extreme precipitation regimes can have an effect on plant communities and the insects that rely on the fitness of these plants.

Materials and Methods

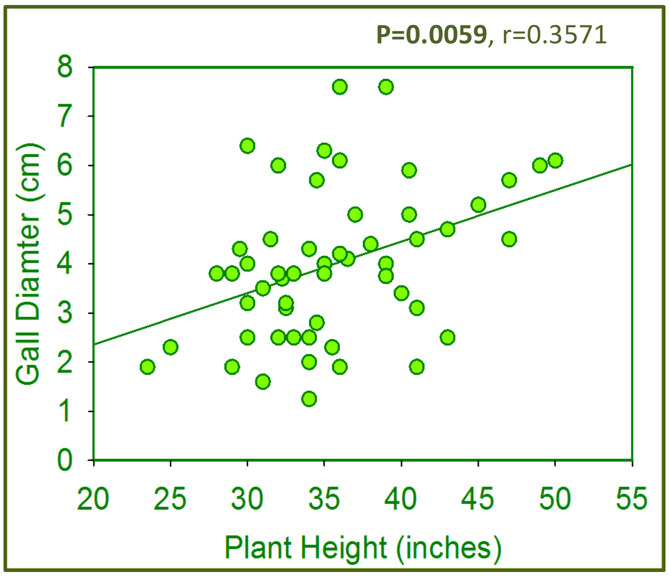
In order to carry out this experiment, I needed to create these changes in a controlled ecosystem. I was able to utilize an existing experiment at Purdue Wildlife Area, where the treatments had already been setup. Within Purdue Wildlife Area, PRICLE (Prairie Invasion and Climate Experiment) is working with these global changes in a mixed-grass prairie to assess the effects of climate change on invasive species. There are twelve plots, four treatments, and three reps of each treatment, which can be seen in the map below. The treatments include control plots (white), extreme nitrogen addition via a slow-release fertilizer (orange), extreme precipitation (blue), and fertility + precipitation (purple).



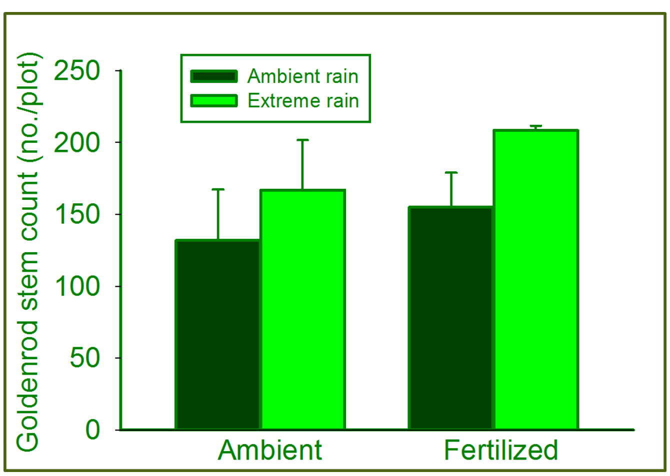
To collect the data necessary, I began by counting all of the Goldenrod stems in each of the twelve plots. This number could give me a general idea of the abundance of Goldenrod related to the various treatments. I then counted all of the Goldenrod stems in each plot that had a rosette gall somewhere on the stem. This number I could relate back to the treatments to get an idea of the proportion of galled plants per plot. I then randomly chose ten plants from each plot to measure plant height. Five of these plants were galled and five were ungalled. Of the five plants that were galled, I also recorded the diameter of the gall. This data I could then relate back to the treatments and see how the changes had an impact on plant fitness and subsequently how they affected gall size.

Results

The data was then analyzed using two-way ANOVA. The figures and data can be seen below.

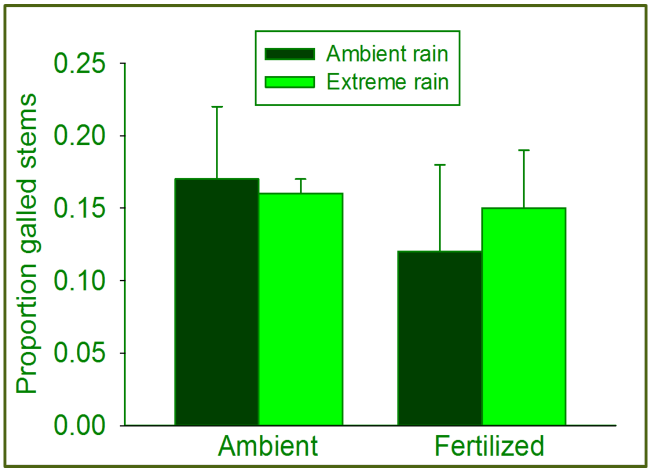


This figure shows a significant relationship between plant height and gall diameter within the twelve plots of different treatments. This distinct correlation suggests that smaller galls will form on smaller plants, and larger galls will form on larger plants. This could be due to the overall nutrient availability of the plants; better-fit plants have more resources to allocate to a larger gall, while smaller plants simply do not have the resources necessary to support a larger gall. Thus, larger galls are generally formed on larger plants.

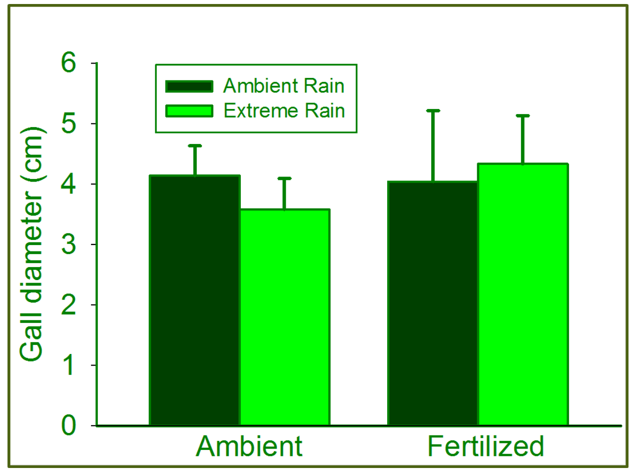


Precipitation: F=2.57, P=0.1474, Fertility: F=1.36, P= 0.2763, Precipitation x Fertility: F=0.11, P=0.7477

There is no significant relationship between the amount of Goldenrod per plot and the treatments. There is, however, a distinct trend in the data that suggests more Goldenrod plants in plots under the extreme precipitation treatments. The extreme rain was achieved by reducing the total amount of precipitation by half using plastic slates. This rain was collected and then applied back to the treatment plots at the end of thirty days. This simulates the extreme precipitation changes that can occur in some areas experiencing climate change.

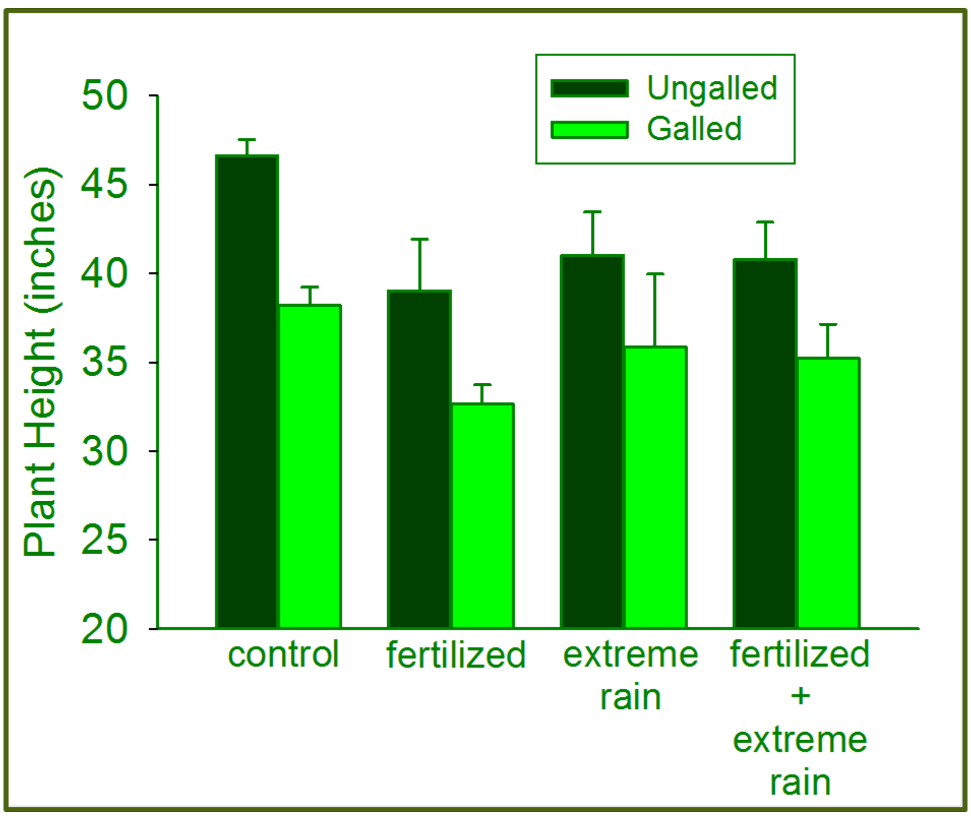


Precipitation: F=0.12, P=0.7409, Fertility: F=0.43, P=0.5297, Precipitation x Fertility: F=0.16, P=0.7007



Precipitation: F=0.03, P=0.8719, Fertility: F=0.16, P=0.6957, Precipitation x Fertility: F=0.28, P=0.6104

As shown by the figure above, there is no significant relationship between the proportion of galled plants per plot and the four treatments. The data does not suggest any trends or distinct correlations. There is also not a significant relationship between the diameter of the galls and the various treatments. This data does not show a distinct trend in this relationship.



Fertility: F=5.35, *P*=0.0321, Precipitation: F=0.35, P=0.5592,
Galling: F=17.76, P=0.0005, Precipitation x fertility: F=4.09, P=0.0575

The figure above represents the relationship between all of the treatments and plant height for the twelve plots. The data show a significant relationship between the addition of nitrogen fertilizer and plant height, and a significant relationship between plant height and fertilizer when combined with the extreme precipitation treatment. Extreme precipitation alone, however, did not have a significant effect on plant height. Another factor that had a significant impact on plant fitness was galling. Plants with galls were generally shorter than those plants that did not have galls. This could be due to the fact that the occurrence of galls on plants generally drains the plant of available nutrients when these resources are distributed to the gallmakers instead of contributing to plant fitness.

Discussion

Using the data shown and the figures above, we can draw the following conclusions: taller plants result in larger galls; Goldenrod height is compromised in the presence of a gall, by the addition of a nitrogen fertilizer, and by the addition of this fertilizer when combined with an extreme precipitation treatment. This data suggests that the previously discussed global changes (the addition of nitrogen to our atmosphere and soils, and climate change resulting in extreme rainfall events) can have a significant impact on plant fitness. These factors subsequently have a big impact on the insects that rely on these plants for survival. Gallmakers depend on healthy plants for a site for egg insertion and a source of nutrients and shelter for their developing young. Goldenrod plants are also a site for insect mating and provide a habitat for certain insects to thrive. Climate change can alter these systems to a great extent, and these changes impact the entire ecosystem.

References

Crutsinger, G., et. al. (Feb. 2008). Galling by *Rhopalomyia solidaginis* alters *Solidago altissima* architecture and litter nutrient dynamics in an old-field ecosystem. *Spring Link, 303*(1-2). Retrieved from http://link.springer.com/article/10.1007%2Fs11104-007-9490-3

Hilton, B. (2005). *Hilton Pond Center for Piedmont Natural History.* Retrieved from http://www.hiltonpond.org/ThisWeek051001.html

Smith, N., Schuster, M., & Dukes, J. (2013). PRICLE. Retrieved from http://web.ics.purdue.edu/~ngsmith/PRICLE.html