The Corinthian

Volume 16 Article 1

2015

Host-Plant Preference of Megacopta cribraria

Taylor Upole
Georgia College & State University

Follow this and additional works at: http://kb.gcsu.edu/thecorinthian
Part of the Biology Commons

Recommended Citation
Upole, Taylor (2015) "Host-Plant Preference of Megacopta cribraria," *The Corinthian*: Vol. 16, Article 1.
Available at: http://kb.gcsu.edu/thecorinthian/vol16/iss1/1

This Article is brought to you for free and open access by Knowledge Box. It has been accepted for inclusion in The Corinthian by an authorized administrator of Knowledge Box.

Host-Plant Preference of *Megacopta cribraria*

Taylor Upole

Dr. Caralyn Zehnder
Faculty Mentor

Introduction

Megacopta cribraria is an invasive insect species that was first reported in Georgia in 2009. This species has spread rapidly, and consequently within just four years has populated seven different states including Georgia, Virginia, Alabama, North Carolina, South Carolina, Mississippi, and Florida (Medal et al., 2013). *M. cribraria* is native to Southeast Asia. *M. cribraria,* commonly known as the kudzu bug, lablab bug, or globular stinkbug, has predominantly been found on and around homes that are adjacent to patches of kudzu (Ruberson et al., 2012). Kudzu, or *Pueraria lobata*, is also an invasive species from southern Asia that has rapidly made its way through the southeastern United States. Being from identical native regions, kudzu is the preferred host plant of the kudzu bug. There is a possibility that *M. cribraria* could be a biological control agent for kudzu, but studies are still being done to determine whether this will be an effective solution to kudzu's overgrowth (Eger et al., 2010).

Apparent competition (Holt 1977) is an indirect interaction between two species mediated by a common predator. When apparent competition occurs the predator becomes more proficient in consuming one prey species in the presence of another. This proficiency is a direct result of the insect-herbivore prospering from their native host-plant, growing in abundance, and then moving on to a similar plant species. The consequences of apparent competition can have an even greater negative impact on an introduced host-plant than on their native host-plant species (White et al., 2008). For example, *M. cribraria* feeds on both kudzu and soybeans (*Glycine max*). There is a high abundance of kudzu in the southeast leading to an increased growth of *M. cribraria* population. This growth in *M. cribraria* population density on kudzu then allows the insects to spillover to soybean and results in a higher consumption of soybean by *M. cribraria*. Studies have shown that *M. cribraria* herbivory can decrease soybean yields up to 50% (Eger et al., 2010). *M. cribraria* does not chew on the plant tissue; instead it uses its stylet to pierce the stem of the host plant and suck phloem. The results of this feeding can be stem and leaf damage along with plant death (Jenkins and Eaton, 2011).

Nitrogen is essential for the growth and survival of all organisms, and many insect herbivores are nitrogen limited (Mattson 1980). Insect herbivores have adapted to their inadequate amount of nitrogen by obtaining nitrogen from their host plants. The suitability of a host plant to the insect-herbivore depends on the quality of nutrients the plant has to offer (McClure 1983). The quality of nutrients depends on many variables including temperature, moisture, fertilization, irrigation, cultivation, and biotic and abiotic stresses (Mattson 1980). Many plants are treated with nitrogen fertilizers to increase plant growth and enhance the nutrient quality. This can lead to changes in plant quality, which influence the population growth rates of insect herbivores (Zehnder and Hunter, 2008).

Legumes and rhizobia have a mutualistic relationship that can influence the plant productivity (Thamer et al., 2010). The nitrogen-fixing soil bacteria contribute nitrogen to the legume, while fixed carbon produced by the plant is provided for the bacteria. Rhizobium inoculation can also increase plant stem length and root nodulation (El-Shaarawi et al., 2011). This symbiotic relationship can encourage nitrogen-containing defense compounds in the plant, which can protect plants against herbivores (Thamer et al., 2010). A distinctive factor in this mutualistic relationship is the specificity between the legume and rhizobium. The specificity can occur at different phases of the interaction from the initial bacterial infection as well as the actual nitrogen fixation (Wang et al., 2012).

Many organic soybean farmers are using bio-fertilization with nitrogen-fixing rhizobia instead of chemical fertilization, because studies have shown positive effects on soil fertility and soybean yields (El-Shaarawi et al., 2011). In a study using combinations of *Bradyrhizobium japonicum* inoculation and inorganic nitrogen on soybeans, it was determined that inoculation with the rhizobia could enhance soybean growth in addition to a very low amount of inorganic nitrogen (El-Shaarawi et al., 2011). Different sources of rhizobia, whether natural or commercially added, can determine the quantity of insect-herbivores the host-plant can attract. A study observing soybeans and soybean aphids, for example, found that plants occurring naturally in the study site did not host as many aphids as the plants that were treated with a commercial rhizobia blend (Dean et al., 2009).

The purpose of this study was to examine the host plant preferences of *M. cribraria*. We first hypothesized that *M. cribraria* prefers its native host plant when given the choice between kudzu and soybeans. If *M. cribraria* prefers kudzu over soybeans, it may indicate that *M. cribraria* could be an effective biological control agent for kudzu. We also wanted to determine if *M. cribraria* prefers soybean plants inoculated with nitrogen fixing rhizobia over non-inoculated soybean plants. Our hypothesis is that *M. cribraria* will prefer the inoculated soybeans to the non-inoculated soybeans due to the increased nitrogen.

Methods

Kudzu vs. Soybean

40 non-inoculated soybean seedlings were grown in individual pots in a greenhouse with equal access to sunlight. Kudzu and kudzu bugs were collected in excess at The Oconee River Greenway in Milledgeville, Georgia. Twenty bug dorms were prepared each containing one regular soybean plant, an equivalent amount of kudzu, and 7-12 kudzu bugs. Each dorm was monitored twice a day for two days, once at approximately 8:00 A.M. and again at approximately 4:00 P.M. Temperature, number of insects per plant, and insect activity were logged and used for data interpretation.

Inoculated Soybeans vs. Non-Inoculated Soybeans

40 soybean seedlings were grown in individual pots in a greenhouse with equal access to sunlight. Prior to planting, 20 of the soybean seeds were randomly chosen to be inoculated with *Bradyrhizobium japonicum* (N-DURE A Premium Inoculant for Soybeans, Lot # K165).

When the plants were 17 days old, a pair of equivalently sized plants, one inoculated and one non-inoculated, were placed in a bug dorm. 7-12 kudzu bugs were put into each of the 20 bug dorms, and each dorm was monitored twice a day for two days, once at approximately 8:00 A.M. and another at approximately 4:00 P.M. Temperature, number of insects per plant, and insect activity were recorded and used for data analysis.

Statistical Analysis

A two-tailed t-test was used to analyze the data for both trials. Equal variance was assumed, and a p-value of 0.05 was used to determine statistical significance.

Results

In both laboratory preference tests, *M. cribraria* did not feed during the 8 A.M. monitoring period, so there was not a significant difference in the number of bugs on any given plant during those times (Table 1). These observations took place at approximately 8:00 A.M. and when it was approximately 25°C in the greenhouse. Therefore, we decided to focus on the afternoon monitoring times when the bugs were more active and feeding. These observations took place at approximately 3:30 P.M. and the temperature in the greenhouse was on average around 33 degrees Celsius.

Table 1. Statistics for both preference tests during morning monitoring hours.

	Soybean Plant A.M.	*Kudzu A.M.*
Mean # of insects per plant	2.43	3.15
Standard Deviation	1.65	1.94
	Non-Inoculated Soybean Plant A.M.	*Inoculated Soybean Plant A.M.*
Mean # of insects per plant	1.68	1.63
Standard Deviation	1.80	2.03

In the afternoons, *M. cribraria* were found more often on kudzu than on soybeans (Figure 1: t73= -2.69; p= 0.01). *M. cribraria* did not show a statistically significant difference in preference between non-inoculated and inoculated soybeans. (Figure 2: t75= -1.36; p= 0.18).

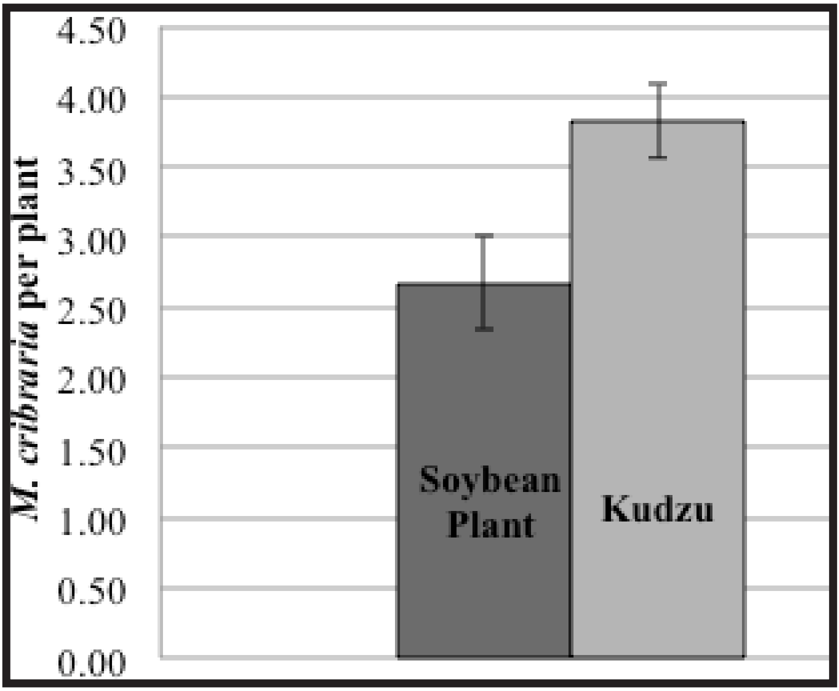

Figure 1. Average density (+ one standard error) of *M. cribraria* on kudzu, *Pueraria lobata*, or soybean, *Glycine max*, during the afternoon monitoring hours.

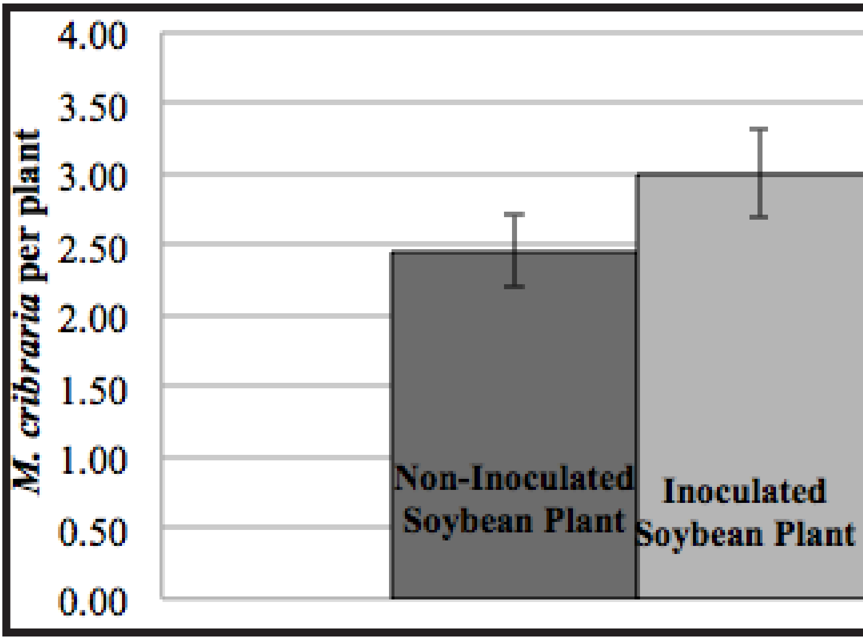

Figure 2. Average density (+ one standard error) of *M. cribraria* found on non-inoculated soybean plants, *Glycine max*, and inoculated soybean plants during the afternoon monitoring hours.

Discussion

Considering only afternoon monitoring times, this study determined that *Megacopta cribraria* readily chooses kudzu over soybean plants when given the choice in a laboratory setting. These results coincide with the majority of the research on *M. cribraria*, which has shown that it readily prefers kudzu over other plants. A previous study found higher *M. cribraria* density on kudzu than on wisteria and soybeans in the field (Ruberson et al., 2012). Medal (2013) discusses a field experiment conducted near Athens, Georgia that resulted in a 33% loss of kudzu plant biomass by *M. cribraria* herbivory when not sprayed with insecticides. One of the key factors of kudzu being a preferred host plant to *M. cribraria* is that is the only known perennial host that can support large quantities of the insect (Ruberson et al., 2012). The outcome of these studies increases the hope of *M. cribraria* being an effective biological control agent for the troublesome kudzu vine.

When given the choice between inoculated and non-inoculated soybean plants, *M. cribraria* did not show a significant difference in preference. This result was unexpected, and will require further research to determine its cause. In most cases, additional nitrogen supplied by rhizobia improves food quality of the plant and consequently increases herbivore performance (Kempel et al., 2009). A factor that could be considered to cause this variance is the amount of rhizobia used to inoculate the soybeans. It has been found that smaller amounts of nitrogen-fixing rhizobia actually had greater beneficial effects on the soybean than larger amounts (El-Shaarawi et al., 2011). This expresses that *M. cribraria* may not have performed in an effective way under lab conditions. It would be interesting to conduct further research to determine how *M. cribraria* detects nitrogen in its host plant. Additionally, it is possible that inoculation did not change nitrogen levels in the phloem that *M. cribraria* was feeding on.

M. cribraria were consistently inactive during morning observing times. This could be due to the cooler temperatures and the limited amount of light coming into the greenhouse. A similar study indicated that *M. cribraria* performed poorly in caged areas with less light and limited space to maneuver (Zhang et al., 2012). During the afternoon monitoring times, *M. cribraria* were active, and the small area of the bug dorm did not seem to be a limiting factor. This suggests that *M. cribraria* may be sensitive to particular surroundings. In the future, the amount of light and the temperature of the study area should be kept constant for a more controlled result.

Conclusion

Although *Megacopta cribraria* is a new invasive species to the United States, a significant amount of research is being done to improve our understanding of this insect-herbivore. This research has found that *M. cribraria* prefers kudzu over soybeans. Along with previous and ongoing studies, our research has given new hope to the idea of containing the ever-increasing kudzu concern across the Southeastern United States, but new concerns may arise as the *M. cribraria* population rapidly grows in this region.

References

Dean JM, Mescher MC, De Moraes CM. "Plant–rhizobia Mutualism Influences Aphid Abundance on Soybean." *Plant Soil* (2009): 187-96.

Eger J. E., Jr., Ames LM, Suiter DR, Jenkins TM, Rider DA, Halbert SE. "Occurrence of the Old World Bug Megacopta Cribraria (Fabricius) (Heteroptera: Plataspidae) in Georgia: A Serious Home Invader and Potential Legume Pest." *Insecta Mundi* (2010): 1-11.

El-Shaarawi AI, Sabh AZ, Abou-Taleb SM, Ghoniem AE. "Effect of Inorganic Nitrogen and Bradyrhizobium Japonicum Inoculation on Growth and Yield of Soybean." *Australian Journal of Basic and Applied Sciences* (2011): 436-47.

Holt RD. "Predation, Apparent Competition, and the Structure of Prey Communities." *Theoretical Population Biology* 12.2 (1977): 197-229.

Hosokawa T, Kikuchi Y, Shimada M, Fukatsu T. "Symbiont Acquisition Alters Behaviour of Stinkbug Nymphs." *Biology Letters* 4.1 (2008): 45-48.

Jenkins TM, Eaton TD. "Population Genetic Baseline of the First Plataspid Stink Bug Symbiosis (Hemiptera: Heteroptera: Plataspidae) Reported in North America." *Insects* (2011): 264-72.

Kempel A, Brandl R, Schädler M. "Symbiotic Soil Microorganisms as Players in Aboveground Plant-herbivore Interactions - the Role of Rhizobia." *Oikos* 118.4 (2009): 634-40.

Mattson WJJ. "Herbivory in Relation to Plant Nitrogen Content." *Annual Review of Ecology & Systematics* (1980): 119-61.

McClure MS. *Variable Plants and Herbivores in Natural and Managed Systems*. New York: Academic, 1983.

Medal J, Halbert S, Smith T, Santa Cruz A. "Suitability of Selected Plants to the Bean Plataspid, Megacopta Cribriaria (Hemiptera: Plataspidae) in No-Choice Tests." *Florida Entomologist* (2013): 631-33.

Ruberson JR, Takasu K, Buntin GD, Eger, Jr. JE, Gardner WA, Greene JK, Jenkins TM, Jones WA, Olson DA, Roberts PM, Suiter DR, Toews MD. "From Asian Curiosity to Eruptive American Pest: Megacopta Cribraria (Hemiptera: Plataspidae) and Prospects for Its Biological Control." *Applied Entomology and Zoology* (2012).

Thamer S, Schädler M, Bonte D, Ballhorn DJ. "Dual Benefit from a Belowground Symbiosis: Nitrogen Fixing Rhizobia Promote Growth and Defense against a Specialist Herbivore in a Cyanogenic Plant." *Plant and Soil* 341.1-2 (2010): 209-19.

Wang D, Yang S, Tang F, Zhu H. "Symbiosis Specificity in the Legume - Rhizobial Mutualism." *Cellular Microbiology* 14.3 (2012): 334-42.

White EM, Sims NM, Clarke AR. "Test of the Enemy Release Hypothesis: The Native Magpie Moth Prefers a Native Fireweed (Senecio Pinnatifolius) to Its Introduced Congener (S. Madagascariensis)." *Austral Ecology* (2008): 110-16.

Zehnder CB, Hunter MD. "Effects of Nitrogen Deposition on the Interaction between an Aphid and Its Host Plant." *Ecological Entomology* 33.1 (2008): 24-30.

Zhang Y, Hanula JL, Horn S. "The Biology and Preliminary Host Range of Megacopta Cribraria (Heteroptera: Plataspidae) and Its Impact on Kudzu Growth."

Environmental Entomology (2012): 40-50.