



The Effects of Spider Communities on Soybean Herbivory

Ryan D. Bell, Michael V. Cole, Matthew H. Persons, PhD. & Alissa A. Packer, PhD.

Biology Dept., Susquehanna University, Selinsgrove, PA 17870



Abstract

Wolf spiders are generalist predators that exist in many agricultural systems. Communities of wolf spiders are comprised of a variety of species and may occur in patches of varying density and composition. We conducted a field study using three commonly occurring wolf spiders, *Pardosa milvina*, *Trochosa ruricola*, and *Rabidosa* spp. with soybeans as our model agricultural plant. Nine treatments were created by planting the soybeans during the summer growing season within enclosures with different wolf spider communities. The treatments were: 1) *Rabidosa* only, 2) *Pardosa* only, 3) *Trochosa* only, 4) *Pardosa* and *Rabidosa*, 5) *Pardosa* and *Trochosa*, 6) *Trochosa* and *Rabidosa*, 7) no enclosure, 8) no spiders, and 9) *Pardosa*, *Rabidosa*, and *Trochosa* (N= 17/treatment). Enclosures were checked on a weekly basis, and stem and leaf measurements taken. The presence of spiders was recorded, and any non-treatment species were removed. Plants were harvested at the end of the summer and leaves, pods, and root nodules were counted and plant biomass was weighed. Spider treatments were not shown to have a significant impact on the final plant biomass, or number of leaves, but **there may have been an interaction between the number of pods produced by soybeans among treatments.**

Introduction

Herbivory can be costly to plants because it removes valuable photosynthetic material that would otherwise be used to support growth and reproduction. This is especially important within the agricultural industry, which loses millions of dollars every year to herbivory. Pesticides are often used to reduce herbivory in agroecosystems, but growing concern for environmental safety has led to an increased interest in more natural remedies for pest reduction. One promising alternative is the use of biological control agents (Gouge 2004).

Members of the cursorial non-web building wolf spider family Lycosidae are often the dominant predatory arthropods in agricultural ecosystems (Samu et al. 2003), and thus are a good candidate for biological control measures. They are generalist predators that impact populations of many insect species within arthropod communities. Wolf spiders have the potential to indirectly impact crop production through reduction of insect herbivory. The presence of natural enemies, such as wolf spiders, suppresses pest species through predation and chemical cues left in the environment.

We conducted a field study using three commonly occurring wolf spiders, *Pardosa milvina*, *Trochosa ruricola*, and *Rabidosa* spp. with soybeans as our model agricultural plant. Nine treatments were created by planting the soybeans during the summer growing season within enclosures with different wolf spider communities. The treatments were: 1) *Rabidosa* only, 2) *Pardosa* only, 3) *Trochosa* only, 4) *Pardosa* and *Rabidosa*, 5) *Pardosa* and *Trochosa*, 6) *Trochosa* and *Rabidosa*, 7) no enclosure, 8) no spiders, and 9) *Pardosa*, *Rabidosa*, and *Trochosa*.

• Hypothesis 1: Presence of spiders will decrease leaf damage and increase seed set via both direct (consumptive) and indirect (chemical cues associated with predator presence) effects on plant herbivores.

Wolf spiders leave silk draglines as they move around the environment, which serve as chemical cues detectable by insect herbivores as well as other wolf spiders (Barnes et al. 2002, Hlivko & Rysprtra 2003). These cues also impact the behavior of insect herbivores, indirectly limiting their herbivory in agricultural systems (Hlivko & Rysprtra 2003). This is in addition to the direct impact that wolf spiders have on herbivores through predation.

• Hypothesis 2: Multiple predators will be more effective at controlling herbivore damage because they will show greater exploitation of available niches.

It has been suggested that a more diverse assemblage of spider species may lead to less herbivore damage (Greenstone 1999). The impacts of spider communities on the ecosystem may be dependent on the species composition due to differences in size, preferred habitats and periods of activity (Marshall et al. 2001). Alternatively, the presence of multiple predatory species could result in increased intraguild predation and cannibalism, and therefore decrease effectiveness of spiders as biocontrol agents.

• Hypothesis 3: Within the treatments containing more than one spider species, intraguild predation should lead to reduced numbers of the smaller spider species.

Smaller individuals are more likely to be preyed upon by larger spiders, both conspecific and heterospecific. Additionally, following the hatching of spiderlings, there will be another trophic level added to the spider assemblage, in which smaller spider species may be able to prey upon spiderlings of larger species.

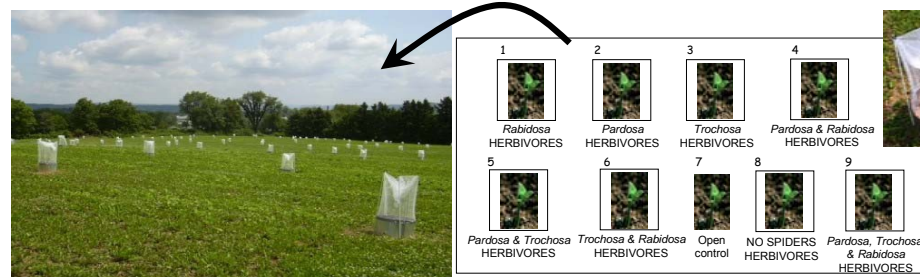


Figure 1 – A subset of the 142 enclosures in which soybean were planted and various spider communities were added.

• Hypothesis 4: The threat of intraguild predation and cannibalism can cause spiders to exhibit antipredator behavior, compromising feeding efficiency of spiders and resulting in lower body condition. The density of spider populations in a limited area may also negatively impact body condition.

In addition to the effects that wolf spiders may have on insect herbivores, they also have many potential intraguild predator-prey interactions between members of Lycosidae. The presence of additional spider species may interfere with insect prey capture directly through competition or indirectly through increases in antipredator behavior that result in decreased feeding. Space within the enclosures is limited, in a field setting the wolf spiders would have much more space to move though. As populations within the enclosures rise due to reproduction and the hatching of spiderlings, intraguild and conspecific competition may increase, resulting in lowered body condition.

Methods

This experiment was initiated June 2004 at the Susquehanna University Ecology Resource Center (SU-ERC) in Selinsgrove, PA. One hundred forty-two sites were selected and randomly assigned a treatment group (Figure 1). Spiders communities varying in species composition were constructed within enclosures (1/4 m²) (Figure 2). Enclosures were constructed using aluminum flashing (14" in height, buried 4" at the base) and tulle fabric sewn to create a mesh sleeve that was taped to the top of the flashing and supported on three fiberglass fence posts. Invertebrate-free corn stubble and litter were added to each enclosure to simulate the conditions of a no-till field. *Glycine max*- RoundUp® Ready Soybean seedlings were transplanted into the enclosures. Spiders were hand-collected and added in specific densities to the enclosures to approximate natural densities. *Pardosa* enclosures had four females and one male introduced to their treatment. Enclosures containing *Trochosa* had two females and one male. *Rabidosa* enclosures contained one female and one male. The densities of each species was maintained regardless of spider community composition.

Data were collected on a weekly basis during the months of June, July and August, and a final data were collected in September 2004 when the surviving plants were harvested. Data collected included:

Weekly:	Final:
Leaf number	Leaf number & weight
% leaf damage	Pod number & weight
Damage type = S, M, H or R	Stem weight
Flower number	Nodule #/unit root wt
Pod number	Nodule wt/unit root wt
Plant height/width	Spider Number
Spider number	Spider Sex & Maturity
Spider location	Spider Weight
	Spider Width & Length



Prior to weighing, all plant material was dried for a minimum of 48 hours in order to ensure the absence of moisture. All data was entered into an Excel document and analyzed using SPSS.

Results

Plant biomass was not significantly impacted by the spider treatment or presence within the enclosure. Treatments were maintained throughout the experiment. The spider species collected at the end of the harvest period matched those that were added at the beginning of the summer. *Pardosa milvina* final populations showed a strong interaction between the treatment and the final spider populations (Figure 2).

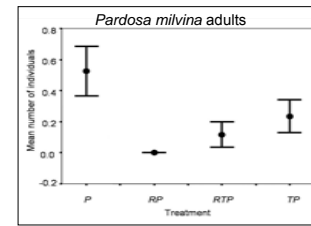


Figure 2- The effect of treatment on final number of *Pardosa milvina* individuals was found to be significant for the model ($p = 0.005$).

Figure 3 shows a significant interaction between the total spider density in the enclosures and the body condition of *Pardosa milvina*. As the density of spiders increases, the body condition is reduced.

Pardosa milvina body condition was also significantly impacted by treatment, with the worst body conditions in those treatments containing *Rabidosa*. Body condition was found to be significantly better in the *PT* treatment compared to the treatment containing only *Pardosa* ($p = 0.0311$).

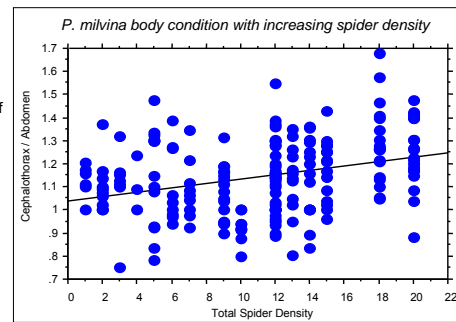


Figure 3 – *Pardosa milvina* body condition, as measured by the cephalothorax to abdomen ratio ($p < 0.0001$). Body condition gets worse with increasing total spider density. Cephalothorax width depends on maturity status and size, while abdomen width is dependent on satiation level. The lower the C/A value, the larger the abdomen is in proportion to the cephalothorax.

Discussion

• Hypothesis 1: Presence of spiders will decrease leaf damage and increase seed set via both direct (consumptive) and indirect (chemical cues associated with predator presence) effects on plant herbivores.

There were no observed differences between the control enclosure that contained no spiders and the other enclosures that contained spiders. This may be due in part to the stage at which the soybean were transplanted to the enclosures. Soybeans were added approximately two weeks after germination. Spiders may have offered greater protection from herbivory if present at germination. No spiders were observed on the soybean vegetation (diurnal observations only) through the course of the growing season, perhaps due to the lack of surrounding low level vegetation to serve as a means to access the upper canopy of the soybean. The enclosure design may have also limited the impact that the spider populations had on herbivores, as the enclosures preferentially allowed flying insects access to the plants. Mammal herbivory, presumably by *Marmota monax*, also made plant damage and herbivory due to insects hard to analyze.

• Hypothesis 2: Multiple predator species will be more effective at controlling herbivore damage because they will show greater exploitation of available niches.

Although there was some observational evidence of niche utilization in that *Trochosa* was much more commonly burrowed into the substrate, differences between treatments did not reflect a significant reduction in herbivory. Those treatments containing a more diverse assemblage of wolf spider species showed no decrease in herbivory.

• Hypothesis 3: Within the treatments containing more than one spider species, intraguild predation should lead to reduced numbers of the smaller spider species.

The *Pardosa milvina* treatments were strongly affected by the presence of *Rabidosa*, showing significantly fewer adults when in treatments with *Rabidosa* (Figure 2). The number of adult *Pardosa* in the treatment also containing *Rabidosa* (zero) was significantly different from the number of adult *Pardosa* in the *Pardosa* only treatment ($p = 0.004$). In treatments where all three species were together, adult *Pardosa* numbers were also significantly reduced relative to the *Pardosa* only treatment ($p = 0.04$). *Pardosa* juveniles did not show the same level of affect, perhaps because their size is below that which larger predators such as *Rabidosa* can comfortably take. *Rabidosa* numbers did not seem to be affected by either the presence or absence of the other species. Adult *Trochosa* numbers were significantly reduced when in treatments with *Rabidosa*.

• Hypothesis 4: The threat of intraguild predation and cannibalism can cause spiders to exhibit antipredator behavior, compromising feeding efficiency of spiders and resulting in lower body condition. The density of spider populations in a limited area may also negatively impact body condition.

Pardosa milvina body condition was much reduced in treatments containing *Rabidosa* individuals, indicating a strong intraguild effect reducing their overall body condition. Total spider density also served to reduce the body condition of *Pardosa milvina*, resulting in better body condition (cephalothorax/abdomen) in treatments with lower spider numbers. Although initial spider levels in the treatment were added in numbers to approximate wild populations, the hatching of spiderlings may have increased the population to such a point that there were negative impacts based on the density and number of individuals.

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