CERES Trust Fund Organic Research Initiative Graduate Student Grant 2010-2011 Final Report

1. Project title: ***Improvement of Arthropod Biological Control Systems For Organic Greenhouse Production***

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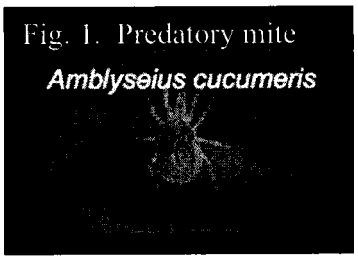
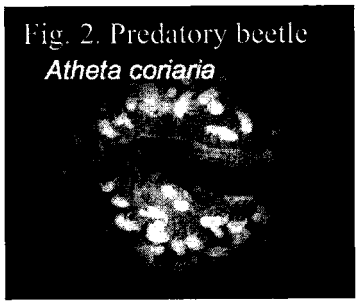
3. Major Professor: Dr. Matt Grieshop, Assistant Professor, Michigan State University, Dept of Entomology

4. Accomplishments and Projected Activities:

Objective 1. *Determine the preference of Atheta coriaria for breeder piles (with mites) vs. bran piles (without mites).*
Objective 2. *Determine whether the use of Amblyseius cucumeris hanging sachets will prevent A. coriaria from entering bran mixture.*





An experiment that addressed both objectives was conducted at Elzinga and Hoeksema Greenhouses (Portage, MI) in spring 2011to determine the compatibility of *A. cucumeris* mites (Fig. 1) and *A. coriaria* rove beetles (Fig. 2) for greenhouse biological control, and to explore an alternative application method of *A. cucumeris* to reduce potential negative interactions between the predators. Barley seed was planted into beds on five greenhouse benches (5.5x16ft) with each bench considered a separate experimental replicate. After two weeks of growth four treatments: 1) sawdust, 2) bran, 3) breeder piles, and 4) hanging sachets were equally spaced in a randomized complete block design on the benches. There were 50 1.5g piles of each sawdust, bran, and breeder piles, respectively, placed onto the soil surface of the barley beds, and 50 hanging sachets that were hung on cardstakes (Fig. 3). *A. coriaria* were released from two containers of 100-*Atheta*-System (BioBest, Ontario, Ca) (~200 adult beetles) onto greenhouse benches. At weekly intervals for 9 weeks 5 piles of sawdust, bran, and breeder piles, and 5 hanging sachets were randomly selected and destructively sampled using Berlese funnel heat extraction. The 10th week of samples were not collected due to low mite densities extracted in previous weeks. Data collection for this trial has been completed. A second trial using similar methods is currently underway.

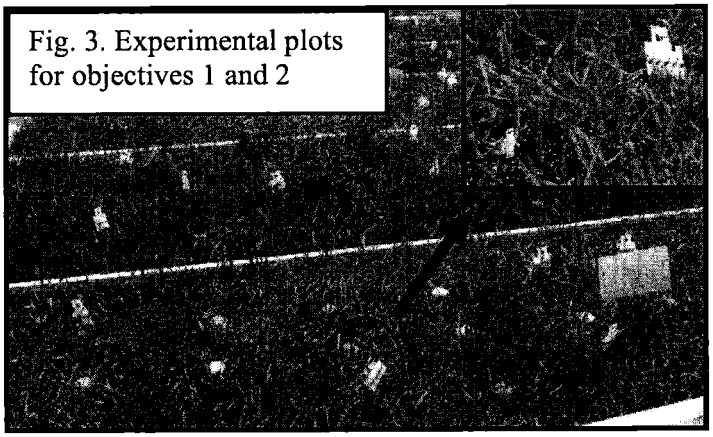


Fig. 3. Experimental plots for objectives 1 and 2

Objective 1 Conclusions: *Atheta coriaria* adults and larvae invaded breeder and bran piles within one week of exposure (Fig. 4) and were present in the piles for at least 5 weeks. *Atheta coriaria* were rarely present in the sawdust (Fig. 4) and *A. coriaria* adults invaded hanging sachets during weeks 3-5. The highest mean number of *A. coriaria* was extracted from bran piles (week 2), and *A. coriaria* may have shown a slight preference for bran over breeder piles. Other organisms extracted from bran and breeder piles included collembola, at least four different mite species, diptera larvae, other beetle larvae, indicating that bran and breeder piles provided a of supplemental food or habitat resource to many different fauna. Very few organisms were extracted from sawdust suggesting that organisms present in bran and breeder piles were likely using these

piles as a food source rather than for their structural characteristics.

Objective 2 Conclusions: Hanging sachets prevent *A. coriaria* from entering breeder pile mixture for up to 3 weeks. The delayed arrival of *A. coriaria* in hanging sachets provided sufficient time for mites to build populations within the sachets. *A. coriaria* found in the hanging sachets could have been newly emerged adults searching for food or mated females looking for oviposition sites. Sex determination of *A. coriaria* is needed for further evidence. Future experiments that observe mite population dynamics of hanging sachets in the absence vs. presence of *A. coriaria* should be performed to determine potential negative impacts of *A. coriaria*.

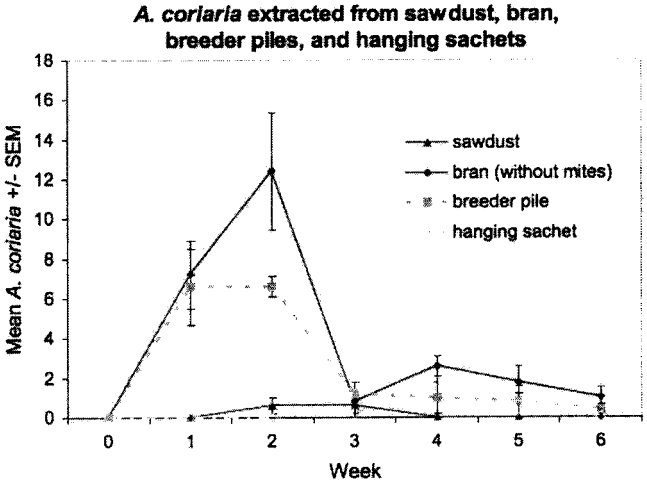
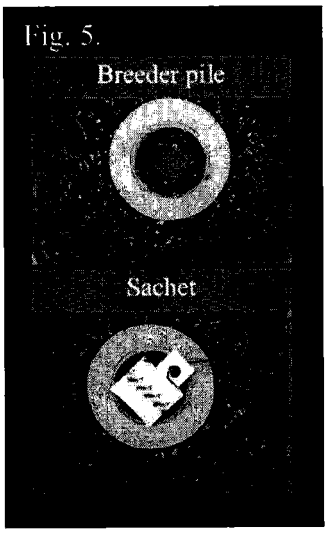


Fig. 4. Mean number of *A. coriaria* beetles extracted from sawdust, bran, breeder piles, and hanging sachets over 6 weeks.

Objective 3. *Compare temporal dynamics of mite populations between the two predator mite application methods: breeder piles vs. hanging sachets.*



The temporal population dynamics of *A. cucumeris* and prey mites in breeder piles and hanging sachets were explored in an experiment that quantified mite migration from breeder piles and hanging sachets. The proposed experimental design for mite migration was modified and conducted in a MSU greenhouse to observe migration in the absence of *A. coriaria*. Barley grown in 12x15in containers was used as habitat for the mites. Two treatments: sachets and breeder piles (1.5g) (7 of each) were placed onto Petri dishes that were fixed on circular yellow sticky cards (Fig. 5). These sticky cards were placed onto the soil of the barley habitat. , Five ml/day of water were applied to sachets and breeder piles to prevent desiccation of the mites. Sticky cards were collected and replaced at weekly intervals for 8 weeks. *A. cucumeris* mites and prey mites on the cards were counted using a dissecting microscope. A second trial for the experiment was also completed. In this trial, sachets were made in our lab because our supplier's machine was inoperative. We used extra empty sachets provided by BioBest (Ontario, Ca) and filled them with 1.5 g of *Amblyseius*-Breeding-System (the same material used to generate breeder piles). To simulate overhead watering, an adjustable hose nozzle was used on the 'mist' setting to water barley, hanging sachets, and breeder piles twice per day.

Objective 3 Conclusions: Results from our first trial showed that hanging sachets have higher mean number of *A. cucumeris* than breeder piles over 6 weeks (Fig. 6). Mean number of *A. cucumeris* in breeder piles drastically decline within one week, at which point *A. coriaria* was also observed in the breeder piles. The decline of *A. cucumeris* was likely due to intraguild

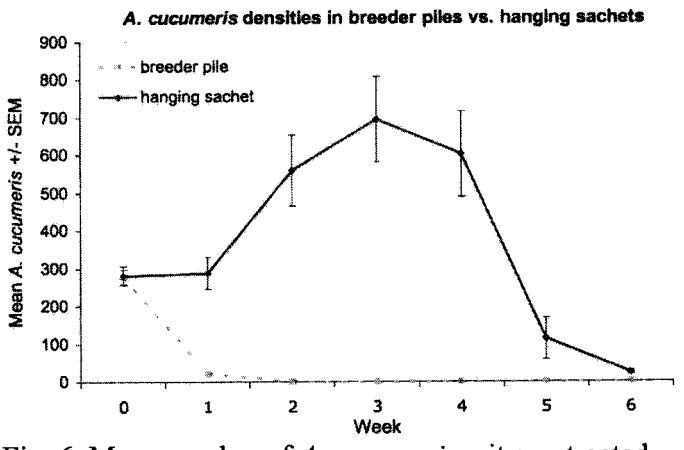


Fig. 6. Mean number of *A. cucumeris* mites extracted from breeder piles and hanging sachets over 6 weeks.

predation on the mites by *A. coriaria*. Data for weeks 6, 7, and 8 of the mites migrating experiment are not shown in Figure 5 due to low mite densities. *A. cucumeris* leaving sachets was greater than those leaving breeder piles at weeks 1 and 2 (Fig. 7a). The initial mean density of mites in sachets was more than three times greater than those in breeder piles (Fig. 7a). This explains why more mites migrated from sachets in the early weeks of the trial. By week 3 there was no difference between treatments.

Our second trial controlled for mite density among treatments (we constructed the sachets) and we observed a similar trend for breeder piles but trends in sachets were somewhat different. Mean number of *A. cucumeris* migrating from breeder piles was greater than those migrating from sachets at weeks 1 and 2 (Fig. 7b), but continually declines through 5 weeks (Fig. 7b). In contrast, mean number of *A. cucumeris* migrating from sachets increases through week 3, declines at week 4, and increases again at week 5. Over 5 weeks, mean number of *A. cucumeris* migrating from sachets was greater than from breeder piles.

Our results suggest that breeder piles and sachets provide different rates of *A. cucumeris* release that may be more or less suitable for a desired pest management strategy. Breeder piles release more mites in the first week, continually release fewer over time, and cease at week 5. Sachets release few mites after one week and continue to release a somewhat consistent mean number of mites through 5 weeks. Therefore, breeder piles could be used in a management situation where these mites are desired in higher densities in less time, where as sachets could be used preventatively to provide a more sustained release of *A. cucumeris* overtime.

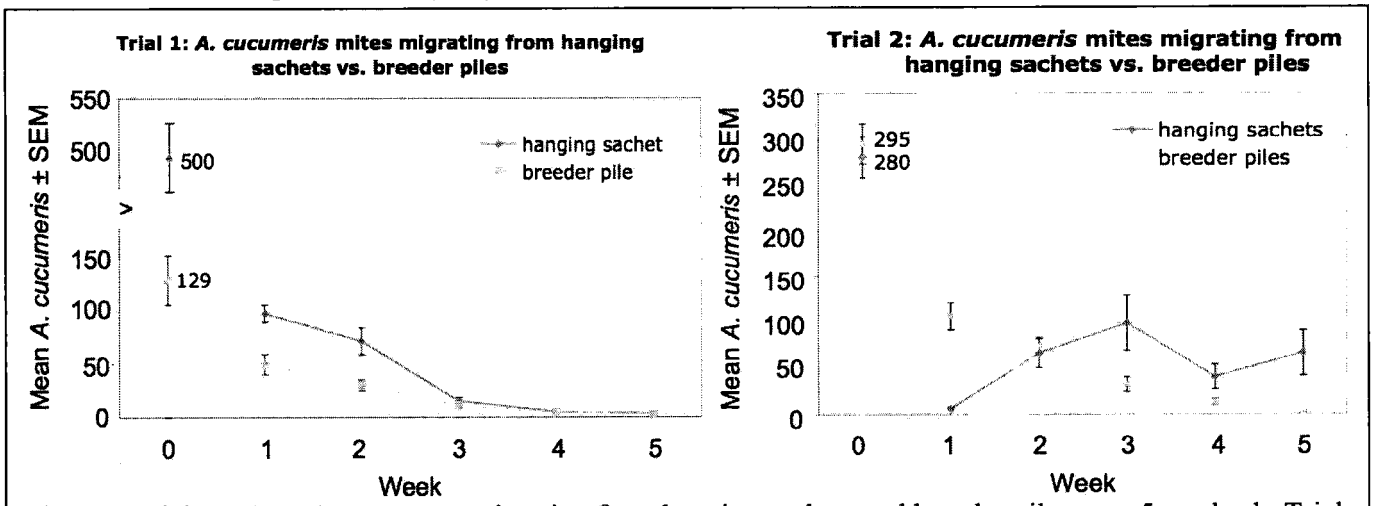


Fig. 7 a. Trial 1: Mean *A. cucumeris* migrating from hanging sachets and breeder piles over 5 weeks. b. Trial 2: Mean *A. cucumeris* migrating from hanging sachets and breeder piles over 5 weeks.

Objective 4. *Develop and deliver extension and educational programming using traditional and electronic extension outlets.*

Preliminary results were presented to growers at Elzinga & Hoeksema Greenhouses (Portage, MI). Final results will be presented in an oral presentation titled, "Can habitat partitioning of thrips natural enemies reduce intraguild predation in greenhouses?" in November 2011 at the Entomological Society of America annual meeting in Reno, NV. Results will also be presented at the Great Lakes Fruit, Vegetable, and Farm Expo in December 2011. An extension bulletin/fact sheet is under production and will be completed and placed on the Organic Pest Management Lab (www.opm.msu.edu) website once ongoing related experiments (part of a separate project) are completed.

5. Impacts: At present, there is very little science-based information available to growers on how to best establish arthropod regenerative biological control systems. Our work has provided growers with valuable insights on natural enemy compatibility and ways to reduce negative interactions among predators, empowering

them to make better decisions on the implementation of biological control in their greenhouses. For example, in place of the breeder pile approach, our grower collaborators are using the sachets approach on greenhouse plugs to preventatively introduce *A. cucumeris* mites and reduce potential negative interactions among predators. These experiments have opened doors to grant proposals for potential research projects that explore such topics as open rearing methods for *A. coriaria* and optimal predator combinations for thrips and fungus gnat management in greenhouses. Furthermore, our research has brought our attention to the vast biodiversity in organic greenhouses that should be examined further to better understand these systems.

6. Acknowledgements: We would like to thank Mark Elzinga, Roger Rosenthal, and staff at Elzinga & Hoeksema Greenhouses and Chris Daye, Dianne Konrad, and staff from BioBest Biological Systems (Ontario, CA) for their continued support in and contributions to our research. We would also like to thank Jeanne Himmelein from MSU Extension, and Suzanne Towner, Michael Kelleher, Krista Buehrer, Phil Kavouriaris, and Joseph Riddle of the Organic Pest Management Lab for their hard work and contributions to our research projects. Finally, a BIG thank you to the CERES Trust for funding our research and providing us the opportunity for continued research in sustainable and organic agricultural systems.