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Improving soil quality by conserving insect pathogens

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Abstract
This study found that organic fields had a greater abundance of naturally occurring entomopathogenic fungi (EPF) than conventional fields in 2011, but that no differences were present in 2012. Conventional producers who used organic fertilizers on their fields had greater abundance of one type of EPF, Metarhizium, in their farm soils than other conventional producers. This suggests that organic practices in corn and soybean fields, and the application of organic fertilizers in conventional fields, could bolster the abundance of naturally occurring EPF.

Keywords
Entomology, Economic and environmental impacts, Farming systems, Organic production practices and comparisons, Soils and agronomy

Disciplines
Agronomy and Crop Sciences | Entomology | Soil Science

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Improving soil quality by conserving insect pathogens

Abstract: Field and laboratory experiments were conducted to determine how best to encourage the presence of entomopathogenic fungi (EPF) that can act as naturally occurring controllers of crop pest infestations.

Principal Investigator:

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Co-investigators:
Erin Hodgson
Eric Clifton
Entomology
Iowa State University

Budget:
$26,007 for year one
$27,453 for year two

Q Is organic field soil a more suitable environment for pathogens of insects when compared to that in conventional fields?

ECOLOGY

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Background

Little research has been conducted on the conservation of soil-borne entomopathogens. An improved understanding of these organisms could enhance their use as natural enemies of pests and decrease the need for conventional insecticides that may have detrimental, non-target effects on organisms and their ecosystems.

The project goal was to determine if conventional versus organic farming practices affected the abundance of naturally occurring fungal pathogens of insects, also known as entomopathogenic fungi (EPF). These organisms provide ecosystem services by killing pests and suppressing pest outbreaks. Species of EPF include *Beauveria bassiana Metarhizium spp.* and are important sources of mortality for several species of insects.

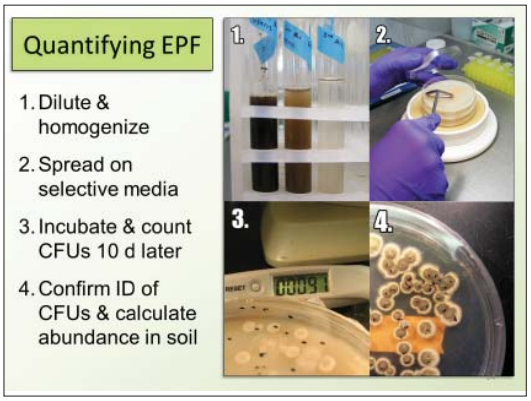
However, knowledge concerning the effects of agricultural practices on EPF is lacking. A better understanding of these organisms is an essential step in developing strategies to conserve EPF in agricultural systems

The researchers hypothesized that

1. organically farmed soil is more suitable to EPF than conventional soil,
2. certain soil properties and farming practices would be correlated with the abundance of EPF, and
3. herbicides and fungicides could have negative impacts on EPF.

Project objectives were to:

- Survey abundance of entomopathogenic fungi in conventional and organic soils
  a. Determine the occurrence of EPF in soil samples by measuring mortality of insects from EPF
  b. Determine abundance of soil-borne EPF with selective media
  c. Test correlations of EPF abundance with soil properties and field history



EPF quantification of CFUs

- Measure the effects of common pesticides on EPF

Approach and methods

In 2011 and 2012, soil was collected from organic and conventional fields of corn and soybean and the surrounding field margins. Entomopathogenic fungi from the soil samples were quantified by measuring mortality of larval greater wax moth, Galleria mellonella, and by counting colony-forming units of EPF on selective growth media. Field history and soil properties were analyzed by using multiple regression techniques to determine factors that were correlated with the abundance of EPF.

Results and discussion

In 2011, soils from conventional fields had significantly lower occurrences of EPF and the average number of colony-forming units for *Metarhizium* also was lowest in conventional fields. The 2012 data showed no significant difference in the abundance of EPF between conventional and organic fields. Multiple regression analysis for the 2011 data revealed that abundance of *Metarhizium* was positively associated with applications of organic fertilizers and silt content, and negatively associated with nitrogen content, tillage, conventional field margins, conventional fields and herbicide applications. For the 2012 data, no parameters were significantly correlated with abundance of EPF. The difference in results between 2011 and 2012 may have been due to the drought conditions that were present in the state during 2012. Past research has found that both temperature and precipitation affect the abundance of EPF, and the extremely hot and dry conditions in Iowa during 2012 may have overwhelmed any effects of farming practices on EPF

A laboratory study also was conducted by applying herbicides and fungicides to soil containing different strains of *Metarhizium*. Then the samples were measured for abundance of *Metarhizium* by quantifying colony-forming units on selective media and mortality of larval G. mellonella. None of the pesticides used in the study had negative impacts on the abundance of *Metarhizium* in bulk soil after a single foliar application.

Conclusions

1. Occurrence of EPF was significantly lower in conventional fields compared to organic fields in 2011 (but not 2012).
2. Abundance of EPF in the genus *Metarhizium* was lowest in conventionally farmed soils in comparison to the other soil types in 2011 (but not 2012).
3. Abundance of *Metarhizium* was explained by both soil properties and some cropping practices for the 2011 data (but not 2012).
4. Herbicides and fungicides used in a laboratory experiment did not reduce the abundance and virulence of *Metarhizium* in bulk soil.

Impact of results

All proposed experiments were completed. The results of the research were communicated to the agricultural community in Iowa through outreach presentations and to the scientific community through presentations at scientific meetings. The

EPF collecting from soil.

results will affect agriculture in Iowa because they cast light on methods farmers may use to promote the abundance of entomopathogenic fungi in soils, such as the use of organic fertilizers. They also illustrate that a limited use of pesticides in conventional farming practices, such as a singular foliar application of herbicides and fungicides, is not directly harmful to entomopathogenic fungi in all cases. Iowans may use these results to achieve and maintain soils with an abundance of entomopathogenic fungi, which in turn may aid in suppressing agricultural pest insects.

Education and outreach

- Eric Clifton, Erin Hodgson and Aaron Gassmann communicated information from their experiments at Practical Farmers of Iowa field days held on August 27 and September 13, 2011.
- Clifton and Gassmann co-authored a publication testing interactions between a crop pest and entomopathogens: Petzold-Maxwell, J. L., Jaronski, S. T., Clifton, E. H., Dunbar, M. W., Jackson, M. A., & Gassmann, A. J. (2013). Interactions among Bt Maize, Entomopathogens, and Rootworm Species (Coleoptera: Chrysomelidae) in the Field: Effects on Survival, Yield, and Root Injury. Journal of Economic Entomology, 106(2), 622-632.
- Clifton completed a thesis for an M.S. in Entomology, which will be submitted for publication to *Journal of Applied Ecology.* Impacts of conventional and organic agriculture on soil-borne entomopathogenic fungi. 2013.
- Eric Clifton presented his research at four scientific conferences, and received three awards for outstanding presentations.
- Clifton, E. H., Jaronski, S. T., Hodgson, E. W., and Gassmann, A. J. 2013. Effect of conventional and organic agriculture on soil-borne entomopathogenic fungi. North Central Branch Meeting, Entomological Society of America. Rapids City, South Dakota
- Clifton, E. H., Hodgson, E. W., Jaronski, S. T. and Gassmann, A. J. 2012. Impacts of conventional versus organic agriculture on entomopathogenic fungi. Entomological Society of America. Knoxville, Tennessee
- *Placed 2nd in the President's Prize Competition, PIE-Section 4*
- Clifton, E. H., Hodgson, E. W., Jaronski, S. and Gassmann, A. J. 2012. Effects of cropping systems on entomopathogenic fungi. North Central Branch Meeting, Entomological Society of America. Lincoln, Nebraska
- *Placed 2nd in the President's Prize Competition, B.S./M.S. Section*
- Clifton, E. H., Hodgson, E. W., Jaronski, S. and Gassmann, A. J. 2011. Effects of organic and conventional agriculture on entomopathogenic fungi. Entomological Society of America, Reno, Nevada (poster)

Placed 1st place in the President's Prize Competition, PIE-Section 3

Leveraged funds

No additional funding was leveraged from this project.

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