Kearney Foundation Fellowship
Final Report Summary - Due October 31, 2009

Fellowship Recipient's Name: Michael Valainis

Project Title: The Ecology of Entomopathogenic Nematodes in Pistachio Orchards

Mentor Professor's Name: Edwin Lewis

Reporting Period: 2009-10 academic year

Research objectives:

Entomopathogenic nematodes of the species *Steinernema carpocapsae* are applied in pistachio orchards to control overwintering navel orangeworm larvae (*Amyelosis transitella*). The complex nature of soil food webs makes it likely, though, that the nematodes have more effects on the ecosystem than just killing their intended target. Entomopathogenic nematodes may infect alternate hosts or provide food for native predators. They may also indirectly affect local nutrient cycling and plant health as they die or emerge from hosts. By understanding the nematode's ecological effects, we can predict how to improve their efficacy and persistence.

1. To quantify entompathogenic nematodes' effects on soil arthropod diversity in pistachio orchards.
2. To quantify the spatial and temporal distribution of entomopathogenic nematodes in pistachio orchards.
3. To measure entomopathogenic nematode effects on local nitrogen levels and root growth in microcosm studies.

Approach/methods

For the field component of this research, nematodes were applied by micro-sprinkler to 35 random trees in a 60 X 60 tree orchard subplot in March 2008 and again in March 2009. Adjacent trees were designated as controls. We compared invertebrate diversity in soil samples and pitfall traps 1 week before as well as 1, 3, 5, and 10 weeks after application. Entomopathogenic nematode spatial distribution and soil moisture were also monitored at these times. We compared arthropod and nematode species abundance between treatment and control.

In greenhouse microcosms, we measured the effect of entomopathogenic nematode addition on nutrient cycling, soil respiration and pistachio root growth. Nitrate and ammonium levels were measured using plant root simulator probes and root growth was monitored using minirhizotron tubes and a camera.

Summary of Results

Objective 1:
My main contribution to this study was to quantify entomopathogenic nematode effects on soil

arthropod populations by sorting and doing counts of various groups of arthropods which were found in the pitfall traps. I have completed samples from week 1 (2008, 2009) and samples from week 3 (2008). Most arthropods abundances were not different between treatments, but several were. In, 2008 significantly more earwigs were trapped under control trees (ANOVA $p = 0.047$). This could be because earwigs are being infected, or repelled, by nematodes.

Predatory mites in the families Bdellidae, Gaolaelapidae, Anyhistidae, and Rhagiidae were expected to eat nematodes and so show population increases in nematode treated areas. Total predatory mite abundance varied significantly between years, but since there was no interaction between year and treatment, the years were pooled. The distribution was non-normal so non-parametric tests were used. Predatory mites were significantly more abundant under nematode treated trees in both years after 1 week ($p = 0.0285$, Wilcoxon rank sum test), and in week 3, 2008 ($P = 0.045$).

One small species of tenebrionid beetle, *Blapstinus discolor*, was found significantly more often under treated trees in 2008 (ANOVA $p = 0.02$). While more were found under treated trees after 3 weeks, the difference was not significant. These small beetles may be eating the nematodes also.

Objective 2:

I helped bait soil samples with *Galleria mellonella* larvae to assess presence of entomopathogenic nematodes. In 2008, nematodes were recovered from 71% of treated trees the same day after application. After 1 week nematodes were only recovered from 6%. In 2009, nematodes were recovered from 80% of trees the day of application, 37% after 1 week, 11% after 3 weeks and 3% after 10 weeks. Entomopathogenic nematodes may have persisted longer in the 2009 orchard due to sandier soils.

Objective 3:

I measured root area on jpeg images using the program "Rootfly". Entomopathogenic nematodes had no effect on local nitrogen levels and root growth in greenhouse microcosm studies for this experiment (n=12)

Many of the species we are dealing with in this project do not have well understood behaviors, so we went into this somewhat blind as to what was to expected from the data. For example, the detailed feeding behaviors of many of the arthropods we monitored are not really known. A more detailed knowledge of what goes on in the soil ecosystem would help to interpret the data gathered. This project is also an opportunity to somewhat extend our knowledge of interactions in soil ecosystems, but much more work is needed.