Entomopathogenic nematodes applied as infected *Galleria mellonella* cadavers against wireworms (Coleoptera: Elateridae)

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Wireworms (Coleoptera: Elateridae), are important pests of cereal crops in Montana, USA. Because of lack of effective control measures, alternative control methods such as biological control with entomopathogenic nematodes (EPNs) are needed. EPNs are normally applied in aqueous suspensions but can also be applied as EPN-infected host cadavers. Imidacloprid, a prophylactic seed treatment insecticide causes short term suppression of wireworms. This study was focused on evalauting efficacy of EPNs applied via *Galleria mellonella* L. (Lepidoptera: Pyralidae) infected cadavers in conjunction with imidacloprid seed treatment against sugarbeet wireworm, *Limonius californicus* (Mannerheim) in field and greenhouse. *Galleria mellonella* cadavers were prepared by inoculating live larvae with 200 freshly produced EPN infective juveniles. None of the EPN strains tested were found effective in terms of reducing wireworms and protecting crop yield in field. When applied with imidacloprid treated wheat seeds in greenhouse, one *G. mellonella* cadaver infected with *Steinernema carpocapsae* (All and Cxrd strains) or S. riobrave 355 killed 50-68% of *L. californicus*. The mortality range was 40-56% for *S. carpocapsae* (All and Cxrd strains) and S. riobrave 355, when seeds were planted without imidacloprid, not differing significantly from imidacloprid treatment (but higher than control). However, plant damage was significantly lower in imidacloprid treated plants (8-24%) as compared to non-imidacloprid plants (57-75%) at 35 days after treatment (DAT). *Limonius californicus* larvae reduced 57% and 92% of non-imidacloprid plants at 14 and 35 DAT, respectively. Overall, EPN alone treatment was not found as effective as the combination of imidacloprid and EPN treatments in greenhouse.

Keywords: Wireworms, *Limonius californicus*, Entomopathogenic nematodes, Montana, imidacloprid, *Galleria*

Biocontrol with Benefits: Control of Peachtree Borer with Entomopathogenic Nematodes

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The peachtree borer, *Synanthedon exitiosa*, is a major pest of peaches and other stone fruits. Entomopathogenic nematodes, particularly *Steinernema carpocapsae*, provide high levels of biocontrol efficacy against peachtree borer. Control levels following applications of *S. carpocapsae* are equal or superior to standard chemical insecticides such as chlorpyrifos. For growers that lack irrigation, a gel formulation "Barricade" can be used to facilitate nematode survival and biocontrol efficacy. In this project, we explored 1) optimization of rates and formulation, 2) whether S. carpocapsae application targeting peachtree borer provides other benefits to the grower, specifically control of root-feeding weevils. Experiments were conducted over two years in a commercial peach orchard in Georgia, USA and on the USDA-ARS research station in Byron, GA; *S. carpocapsae* was used in all experiments. Results indicated that a lower rate of 0.5 million infective juveniles per tree provided similar results to a higher rate (1.5 million per tree). Additionally, nematodes combined with a lower rate of Barricade (2%) provided similar control levels compared with the full Barricade rate (about 5%). Applications of *S. carpocapsae* were more effective than chlorpyrifos in controlling peachtree borer in the Year 1 and provided statistically similar results to chlorpyrifos in Year 2. The nematode applications targeting peachtree borer also reduced populations of root-feeding weevils such as *Oedophrys hilleri*. Our findings indicate that lower rates of nematodes and gel formulation can be used for effective biocontrol of peachtree borer, and that additional benefits can be gained when targeting peachtree borer with *S. carpocapsae*.

ADVANCES IN FORMULATION, APPLICATION AND CONTROL OF PESTS
POSTERS

Screening of adjuvants to enhance the entomopathogenic nematode survival and adherence after aerial application on grapevine leaves

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Expanding the available biological control agents to fight against aerial grapevine pests can provide new strategies in both IPM and organic viticulture. Current application technology supports the implementation of entomopathogenic nematodes (EPNs) against aerial pests. We hypostatized that by selecting the best combination of EPN-adjuvant, we can enhance EPN viability and persistence on grapevine leaves, and herewith apply EPN against aerial grapevine pests. The aim of this study was to screen for the best adjuvant-EPN mix to ensure high survival, viability, and adherence on leaves. The compatibility of five commercial adjuvants approved for grapevine application (Multi-US, MaxiMix, Dash HC, Nu-film-17 and Adrex) and four EPN populations (*Heterorhabditis bacteriophora* VM-21, *Steinernema carpocapsae* ALL, *S. feltiae* RM-107 and *S. feltiae Koppert*) were tested by exploring the maximum adjuvant recommended field dosage concentration. In laboratory experiments, we investigated the survival of infective juveniles (IJs) after 4 and 24 h exposure to each adjuvant. Thereafter, we tested their infectivity against the model insect *Galleria mellonella* (Lepidoptera: Pyralidae). Adherence to leaves and survival was determined by spraying the IJs-adjuvant combination on grapevine leaves and establishing the leave coverage and their survival after 1 h. Overall, all the EPN populations were compatible with all the adjuvants, except for *H. bacteriophora*-Adrex combination. Also, most of the adjuvants provided similar to control leave coverages, maintaining IJs survival ~80% after 1 h. Additional studies are needed to increase the grapevine leave coverage by EPN. These promising results bring new opportunities to apply EPN against aerial grapevine pests.

Potential of entomopathogenic nematode isolates from Germany and Israel to control the tomato leaf miner(Tuta absoluta, Meyrick)(Lepidoptera:Gelechiidae) in Georgia

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The most important, damage cause of pests in Georgia today is Tomato leaf miner(*Tuta absoluta, Meyrick*),(*Lepidoptera:Gelechiidae*). Tuta absoluta lives of tomato on and in the leaves, and also in the fruit of tomatoes, and as it can cause up to 100% yield loss.

Species of the entomopathogenic nematodes, Steinernema carpocapsae isolate "Zi" (Germany) and strain *Steinernema carpocapsae* (Israel) were studied against Tomato leaf miner, Tuta absoluta (Meyrick). Under laboratory conditions, by using different nematode strains 500 juveniles IJ/ml of *S. carpocapsae* isolate "Zi"(Germany) and strain *S. carpocapsae* (Israel) were used separately and in combination against Tomato leaf miner, 4th instar larvae and pupae Tuta absoluta. In both strains were used water for control. In the results of investigation to shown, that high effect of all treatments of pests such as, 4th instar larvae of Tomato leaf miner,*Tuta absoluta* was recorded on the 7th day, after treatments with *S.carpocapsae* izolate Zi(Germany) and *S.carpocapsae* (Israel) in combination. Separately the percentages of 4th instar larvae mortality were 65 % for S.carpocapsae izolate Zi, 78 % for *S.carpocapsae* (Israel). In combination of both strains *S.carpocapsae* izolate Zi,(Germany) and *S.carpocapsae* (Israel) were 94%.

Separately the percentages for pupae mortality for *S.carpocapsae* izolate Zi,(Germany) was 47 %, for *S.carpocapsae* (Israel). 62%, in combination of both strains were 71% and no larvae mortality on control treatments.

In conclusion, It was determined that, 4th instar larvae *T.absoluta*(Tomato leaf miner) can be controlled by *S.carpocapsae* izolate Zi (Germany) and *S.carpocapsae* (Israel) in the combination and further studies should be conducted at field and greenhouse conditions.