Enhancing Natural Enemy Systems: Biocontrol Implementation for Peachtree Borers

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ABSTRACT

The ultimate goal is to develop a non-toxic formulation to protect beneficial insect-killing nematodes from ultraviolet radiation and/or desiccation to enhance efficacy in suppression of the lesser peachtree borer and other insects that attack crops aboveground. In this project we addressed the following objective: To determine whether different levels of a sprayable gel can protect beneficial nematodes from UV radiation and desiccation. Barricade® gel was previously shown to greatly enhance nematode efficacy suppressing lesser peachtree borer; however a major shortcoming was that the gel was applied at a high concentration separately from the nematodes, which makes the process less appealing to growers. Thus, we wanted to determine if Barricade could be effective in protecting the nematodes when applied at a lower concentration that can be sprayed with the nematodes. In experiments conducted outdoors, we measured viability and infectivity of the nematode *Steinernema carpocapsae* (All strain) when applied with different levels of the sprayable gel for varying amounts of time. *Steinernema carpocapsae* is the nematode that is most effective in suppressing the lesser peachtree borer (*Synanthedon pictipes*) and peachtree borer (*Synanthedon exitiosa*). The experiment included aqueous solution and three different Barricade concentrations (0.5%, 1%, 2%) as well as a control group at five different time intervals of 0, 15, and 30, 60 and 120 minutes. The addition of a sentinel insect, *Galleria mellonella* (as a model host) was exposed to the nematode applications for thirty minutes. The *G. mellonella* were checked after 24 and 48 hours to determine the survival of the nematodes. Results of the assay found Barricade can be used at a rate of 2% (and possibly lower) to protect entomopathogenic nematodes from harmful environmental conditions such as UV radiation and desiccation. The single spray approach of using Barricade should prove more appealing to farmers.

INTRODUCTION

Nematodes as a whole form a very diverse phylum (Nematoda). Most nematodes are free-living and benign, virtually being harmless to humans. However others are parasitic, which can be harmful to plants, humans or even livestock. In contrast, entomopathogenic nematodes in the genera *Steinernema* or *Heterorhabditis*, otherwise known as beneficial nematodes, are natural pesticides that are not harmful to humans or other non-target organisms. These nematodes kill their insect hosts with the aid of a symbiotic bacteria that is carried within the nematode gut. One major issue that prevents entomopathogenic nematodes from being used on a wider scale is their susceptibility to environmental factors such as UV radiation and desiccation. Because of this, many insect pests that are found in environments are adverse to nematode survival (e.g., insects that attack crops aboveground) making them difficult to be targeted by beneficial nematodes. For example, in a study aimed at suppressing the lesser peachtree borer, *Synanthedon pictipes*, which attacks the trunk and limbs of peach trees, nematode applications made in aqueous suspension failed due to exposure to UV radiation and desiccating conditions. If protected long enough, infective juvenile nematodes (IJs) will be able to attack targeted hosts aboveground and eventually suppress pest populations. Therefore, our overall goal is to develop a non-toxic formulation to protect the nematodes from UV radiation and/or desiccation and thereby enhance efficacy in suppression of above ground pests, in particular, *S. pictipes*. Specifically, in this project, our objective was to determine if a gel formulation (Barricade) could be combined with nematodes in a single effective spray. Barricade is developed from a gel that is best known for being used in residential and commercial structures in preventing the spread of fire. The gel works by creating a lubricated barrier between the structure and the fire, minimizing further fire damage. Barricade is shown to be non- toxic to nematodes and environmentally friendly. The Barricade gel (applied at 5%) had previously been shown to be effective when sprayed separately after the nematodes – but farmers may not want to make two consecutive sprays for a single pest. Therefore the single spray approach using a lower concentration may increase the likelihood of grower adoption.

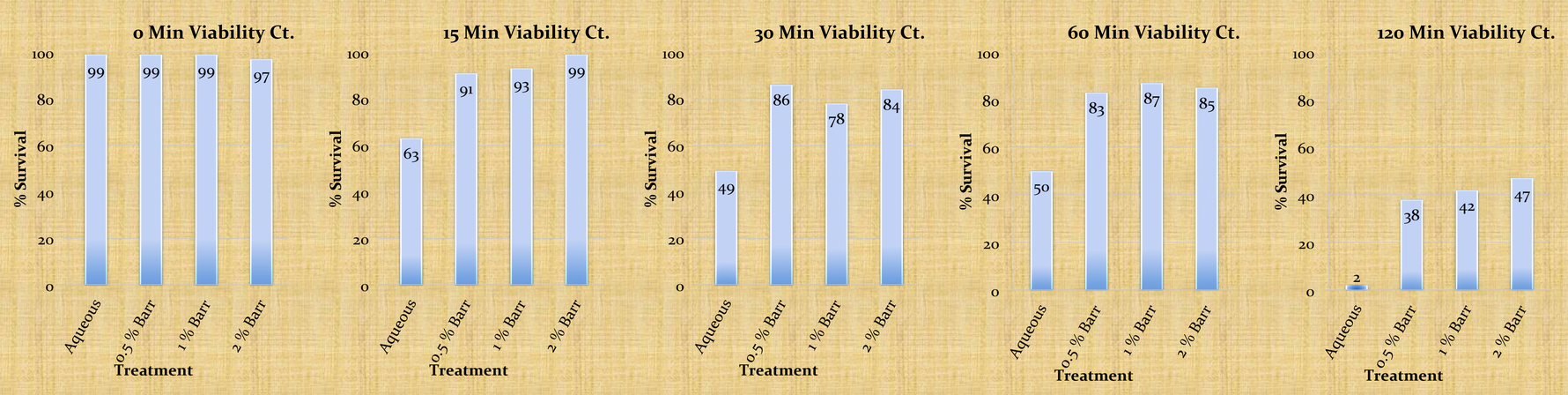

Fig 1.Viability count of Steinernema carpocapsae (All strain) nematodes after exposure to outdoor conditions at five time intervals. Survival percentages dropped significantly for the aqueous mixture starting just after 15 min. of being exposed to outdoor conditions. However, the percentages for the three Barricade (Barr) concentrations dropped significantly after two hours of exposure to outdoor conditions.

MATERIALS AND METHODS

Objective: To determine the ability of Barricade gel to be applied as a protective agent when combined with nematodes in a single spray, a baseline field test was conducted. Four formulation concentrations were used along with a water-only control; the four formulations included an aqueous solution consisting of nematodes and water, and three different concentrations of barricade plus nematodes (concentrations: 0.5%, 1% and 2%). To determine base-line survivability, of nematodes in the different formulations five time periods were used to measure nematode infection rate: infection immediately after nematode application (a zero time point), and infection 0.25, 0.50, 1 and 2 hours after nematode application. Applications were made outside under field conditions at approximately 30 °C. Two Petri dishes containing only the mixture of the four formulations, were examined under a dissecting microscope to determine the viability count of the nematodes after each time interval. Also a set of ten *Galleria mellonella* (greater wax moth larvae used as a model host) were added to the petri dishes for thirty minutes after each time period. After thirty minutes the *G. mellonella* were removed and placed on sterile 90 mm Petri dishes to be evaluated.; the insects were stored at 25 °C in the laboratory. Infection evaluations were taken 24 and 48 hours later by counting the number of live and dead *G. mellonella*. The number of live/dead insects was used to determine nematode survival and infectivity.

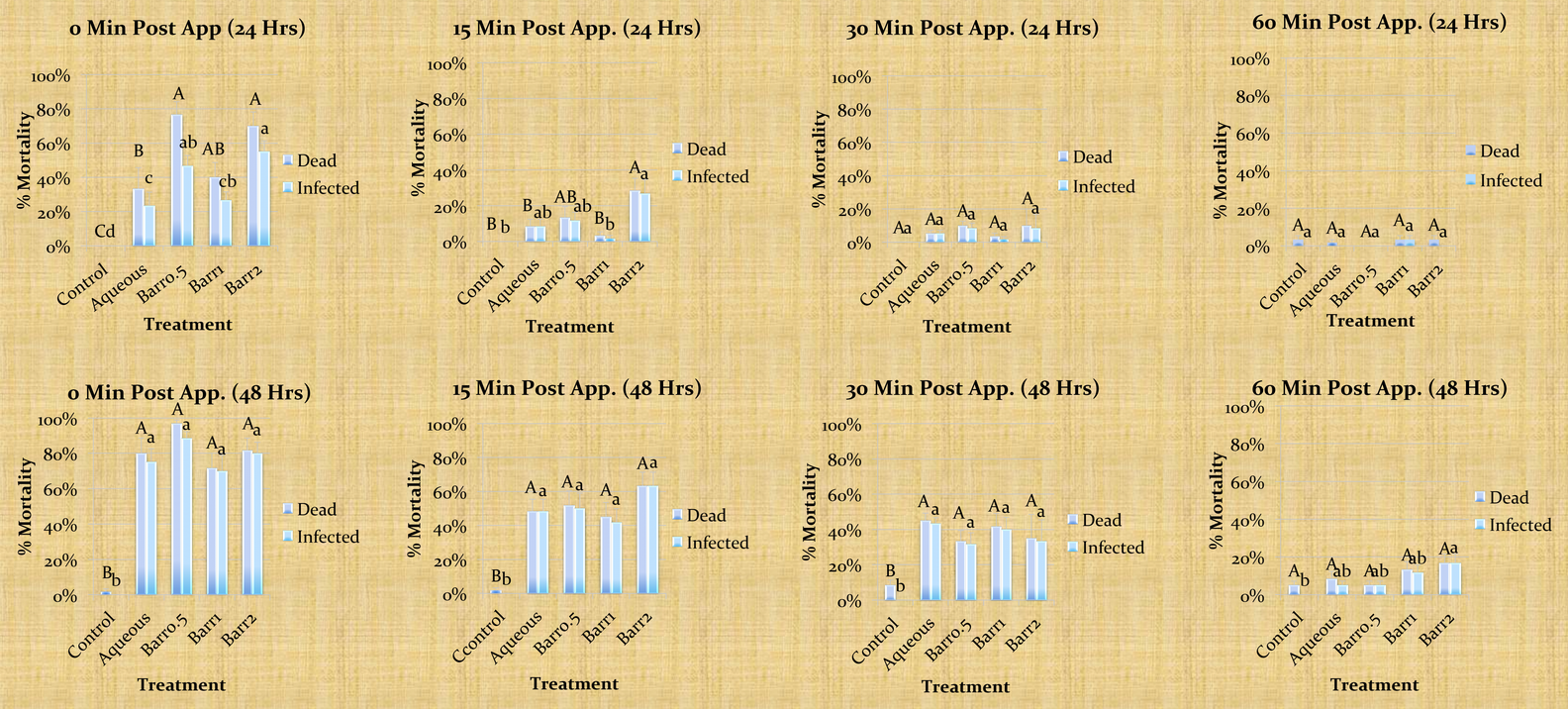

Fig.2 Survival of Galleria mellonella after exposure to Barricade (Barro) concentrations combined with nematodes at four different time intervals. A control that was water only and a aqueous solution without Barricade were also included in the assay.

RESULTS and DISCUSSION

1. Some differences were observed among treatments even at 0 h of exposure to sunlight and 24 h incubation; even the very short exposure to sun may have affected the aqueous nematode treatment without Barricade.
2. After 15 min of exposure to sunlight and 24 h incubation the nematode treatments with Barricade (e.g., 2%) showed superior virulence compared with the control whereas the nematodes without Barricade failed.
3. After 60 min exposure to sunlight and allowing 48 h incubation, Barricade at 2% still showed superior infection relative to the control whereas other treatments were not separated from the control.
4. These results indicate that Barricade can be used at a rate of 2% (and possibly lower) to protect entomopathogenic nematodes from harmful environmental conditions such as UV radiation and desiccation. These results will facilitate the use of environmentally friendly biocontrol agents in orchard pest management.

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