USE OF DIATOMACEOUS EARTH AND ENTOMOPATHOGEN COMBINATIONS AGAINST THE RED IMPORTED FIRE ANT (HYMENOPTERA: FORMICIDAE)

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Thelohania solenopsae Knell, Allen, & Hazard is a common intracellular pathogen of fire ants, *Solenopsis* spp., in South America and was recently discovered in the USA (Williams et al. 1998). Williams & Oi (1998) found that infected *S. invicta* Buren colonies produced smaller worker populations and decreased queen weights compared to uninfected colonies. This protozoan alone will not solve the *S. invicta* problem in the USA but could be used with other biological agents, natural products, or insecticides in a fire ant IPM program.

The LC_{50} for *Beauveria bassiana* (Balsamo) Vuillemin was 4.5× higher for workers from healthy colonies than for workers from *T. solenopsae*-infected colonies (Brinkman & Gardner 2000). Stimac et al. (1993) combined diatomaceous earth (DE) with *B. bassiana* in tests against *S. invicta*, but further studies are needed. The objective of the research reported herein was to determine the interaction of DE with either *T. solenopsae* or *B. bassiana* against fire ant workers.

Solenopsis invicta colonies infected with *T. solenopsae* were originally obtained from USDA ARS CMAVE, Gainesville, FL. Healthy colonies were collected from a pasture located 8 km northwest of Griffin, GA. These colonies were tested to confirm presence or absence of *T. solenopsae* by using procedures of Williams et al. (1998). Sixty-two percent of workers from the *T. solenopsae*-infected colonies possessed octet stage spores. *Thelohania solenopsae* was not detected in workers from local colonies. Test arenas were 35-ml clear plastic cups containing dental plaster (¼ volume of cup) and Fluon® (Northern Products Inc., Woonsocket, RI 02898) coated on the inside walls. The treatments tested on workers from healthy colonies were untreated controls, DE alone, *B. bassiana*, and *B. bassiana* + DE. Workers from *T. solenopsae*-infected colonies were treated with DE. Untreated workers were kept as controls. BotaniGard® ES (Mycotech Corp., Butte, MT 59701) was pipetted in cups on the surface of the dental plaster at a rate of 2.4×10^6 *B. bassiana* CFUs per cm^2. Cups that were treated with DE each received 0.1 g of Celite 545® (Fisher Scientific, Pittsburgh, PA 15275).

Ten ants were placed in each cup. Honey was provided as a food source, and cups were placed on wet foam. A hole in the bottom of each cup allowed the dental plaster to maintain moisture. Mortality was checked daily for 10 d. Treatments were replicated 10 times in a randomized complete block design with repeated measures. Analysis of data was with the PROC MIXED procedure (Littell et al. 1996); means were separated by LSD ($\alpha = 0.05$).

At 10 d after exposure, mortality of healthy workers exposed to DE alone was 29% (Fig. 1). Arthur (2000) reported that insect mortality is directly related to DE exposure interval and Stimac et al. (1993) observed almost twice this level of mortality of fire ants after 22-30 d of exposure to DE.

The mortality of ants from *T. solenopsae*-infected colonies that were exposed to DE was significantly ($F = 46.44$; df = 5,9; $P = 0.0001$) higher than observed with other treatments with 89% dead by 10 d after exposure. Although this mortality was subadditive (Cossentine & Lewis 1984), it was relatively high. According to Cossentine & Lewis (1984), mortality is subadditive

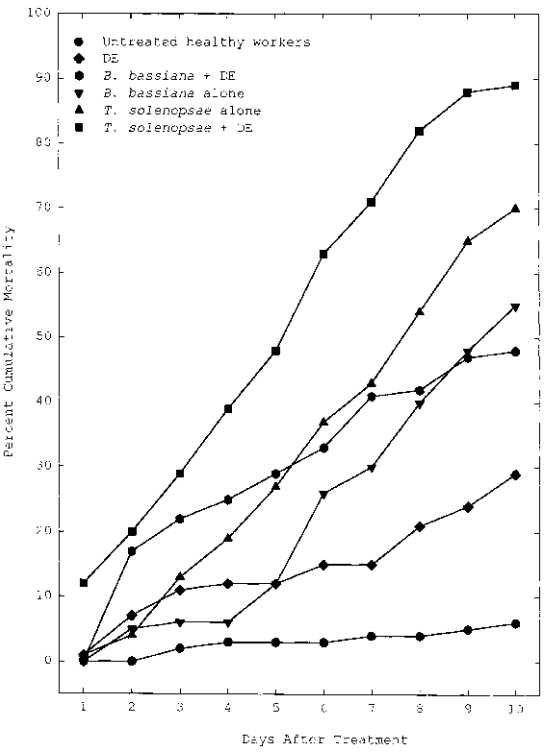

Fig. 1. Cumulative percentage mortality of *Solenopsis invicta* workers from healthy and *Thelohania solenopsae*-infected colonies exposed to diatomaceous earth (DE), *Beauveria bassiana*, or nothing.

when it is less than the sum of the effects of the two pathogens, but greater than the effect of either component alone. *Thelohania solenopsae* and DE affect fire ants in different modes; yet, DE exposure increases the level and rate of death of workers from infected colonies. This suggests that the two are compatible for use against fire ants.

Mortality of fire ants from healthy colonies treated with *B. bassiana* alone was lower than that caused by *B. bassiana* + DE for 8 d after exposure. After that time, mortality resulting from exposure to *B. bassiana* alone increased to 55% by 10 d after exposure (Fig. 1). Also, there was no significant difference in mortality between untreated ants from *T. solenopsae*-infected colonies and healthy ants following exposure to *B. bassiana* + DE. Results of this study indicate that combining DE with *B. bassiana* does not increase fire ant mortality above that caused by exposure to *B. bassiana* alone. The abrasive action of DE appears not to enhance the mode of action of the fungal conidia in breaching the fire ant exoskeleton.

Summary

Pathogen and diatomaceous earth (DE) combinations were tested on *Solenopsis invicta* in laboratory studies. Mortality for healthy fire ants treated with *Beauveria bassiana* was not greatly increased by exposure to DE. Mortality of fire ants infected with *Thelohania solenopsae* and exposed to DE was relatively high. Results suggest that *T. solenopsae* and DE are compatible for use against fire ants.

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