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Efficacy of Hydramethylnon, Indoxacarb, and Methoprene Baits Against the Little Fire Ant *Wasmannia auropunctata* (Roger) (Hymenoptera: Formicidae)

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Abstract

Bioassays of several ant baits using lab-reared little fire ant (LFA) colonies in a no-choice test were conducted. Four of the baits were presented in a soybean oil-impregnated corn grit matrix: Probait (0.73% hydramethylnon), Advion (0.22% indoxacarb), Extinguish Professional (0.5% S-methoprene), and Extinguish Plus (0.365% hydramethylnon and 0.25% S-methoprene). A fifth bait, 0.18% indoxacarb was presented in a peanut butter matrix (Indoxacarb PB); all were compared to peanut butter (control). To ensure uptake and transmission of the toxicants, colonies were exposed to three days of fasting and two days of bait only. During this observation period, 95-100% worker and queen ant mortality were attained in the Probait and Extinguish Plus colonies at 7 weeks after treatment (WAT). This trial demonstrated that hydramethylnon and a mixture of hydramethylnon and methoprene formulated with soybean oil on corn grit were more effective than indoxacarb or methoprene on corn grit, or indoxacarb in peanut butter.

Introduction

The little fire ant (LFA), *Wasmannia auropunctata* (Roger) (Hymenoptera: Formicidae) has become one of the most damaging invasive pests to agriculture, landscapes, and residences, negatively impacting human and animal health to such an extent that workers have refused to harvest or tend fields, landscapes or orchards (Conant and Hirayama 2000, Conant et al. pers. comm.). A native to South America, LFA has had an outdoor latitudinal range from 32°40'S to 32° 20'N. More recently, this pest has become established on several Pacific and Atlantic islands, as well as Africa, the mainland US (Florida), and temperate regions under greenhouse conditions (Kroshelnycky et al. 2005, Lubin 1984, Mikheyev et al. 2009, Vanderwoude 2007, Wetterer et al. 1999, Wetterer and Porter 2003). LFA is extremely difficult to control once established as it shares many traits of highly successful and destructive invasive ant species: 1) generalist feeding and nesting habits, 2) superficial nests in manmade and natural cavities, not limited to underground, 3) high colony mobility, 4) polygyny, 5) colony budding, 6) low intraspecific aggression, 7) high interspecific aggression, and 8) small physical size. Moreover, LFA is a quarantine pest, which hinders exportation of agricultural and floricultural products from Hawaii and other infested Pacific islands to other states and foreign countries.

The most economically feasible and environmentally least damaging treatment for LFA over large areas is the use of the bait toxicant system, similar to those currently used to control the red imported fire ant (RIFA), *Solenopsis invicta* Buren. This minimizes the use of pesticides and provides effective colony-level control (Williams 1992). Hydramethylnon is a toxicant that has proved successful in controlling RIFA (Williams and Whelan 1992). However, this toxicant loses efficacy after exposure to light and moisture (Vander Meer et al 1982, Mallipudi et al 1986,

Taniguchi et al 2003). Effective bait formulations for LFA under tropical conditions would include the ability of the bait to remain attractive to ants under wet humid conditions, as well as exhibit delayed toxicity, good efficacy after trophylaxis, non-repellency, and ease of formulation with carriers. Because LFA are able to construct supercolonies and arboreal nests, an additional important characteristic would be the ability to apply the bait toxicant to arboreal nests. This study evaluated the efficacy of hydramethylnon, methoprene, a hydramethylnon/methoprene mixture, and indoxacarb as granular and paste baits.

Materials and Methods

The trial was conducted at the University of Hawaii at Hilo, College of Agriculture, Forestry and Natural Resource Management (CAFNRM) instructional farm near Hilo, Hawaii. Baits tested were: Probait (0.73% hydramethylnon); Advion (0.22% indoxacarb); 0.18% indoxacarb in a peanut butter matrix (Indoxacarb PB, Vanderwoude et al 2011); Extinguish Professional (1.5% S-methoprene); Extinguish Plus (0.365% hydramethylnon and 0.250% S-methoprene); and an untreated peanut butter check. All treatments were replicated four times in a randomized design.

Two weeks before exposure to baits, LFA workers were transferred to 5.7 L plastic boxes with fluon coated internal walls; an insect trapping adhesive was applied just inside the container rim to form a 0.5 cm wide barrier. Queens were transferred one week later. Colonies consisted of approximately 350 workers and one queen. A polystyrene petri dish (60 ID mm x 15 H mm) containing a water moistened cotton ball, used to maintain humidity, was placed at one end of each colony's box to serve as a nest; the lid was darkened with black spray paint. Ants in all treatments were fed a diet of peanut butter, soybean oil, and sugar water (10% w/v); the feeding station was situated on the opposite end of the box from the nest. The colonies were maintained in a roofed, screen-house with natural sunlight. During the trial, the average temperature was 72.1°F (22.3°C) (range 65.6°F (18.7°C) to 82.2°F (27.9°C)); average relative humidity was 75% (range 40.8 to 100%).

All food was removed three days prior to bait exposure; water was provided throughout this fasting period. Each bait treatment (1.2 ml) was measured onto a plastic vial lid (30 mm ID x 5 mm H) and placed at the feeding station end of each colony's box. Food was returned to the feeding station 48 hours after bait introduction and changed weekly; original baits remained unchanged in the feeding station throughout the observation period.

Observations of ant mortality were recorded 2 and 3 h after treatment (HAT), at 1, 2, 3, 4, 7, 9, and 11 d after treatment (DAT), then at weekly intervals from 2 to 7 weeks after treatment (WAT). Digital photographs of each colony documented live and dead ant counts which were completed in the lab. Ant mortality for each bait treatment was corrected using Abbot's formula, then arcsine transformed prior to statistical analysis (ANOVA and Tukey's Test).

Results and Discussion

Probait (hydramethylnon) maintained a higher ($P<0.05$) level of LFA worker and queen mortality as compared to the other baits throughout the trial period (Fig. 1). Worker ant mortality of >50% was achieved at 2 weeks after treatment (WAT) for Probait, at 3 WAT for Extinguish Plus (hydramethylnon and methoprene), at 4 WAT for Extinguish Professional (methoprene), and at 6 WAT for Advion (indoxacarb). By 7 WAT, only Probait and Extinguish Plus achieved or exceeded 95% worker and queen ant mortality. Early mortality within colonies exposed to Extinguish Plus can be attributed to the efficacy of hydramethylnon within the bait rather than

the methoprene which would affect queen reproduction. The highest worker ant mortality achieved with Extinguish Professional was only 65.4% during the 7 wk trial period. This may be due in part to the repellency of the higher level of methoprene (0.5%) in Extinguish Professional to LFA workers as compared with Extinguish Plus (0.25% methoprene, 0.365% hydramyethylnon), which was demonstrated in field attractancy LFA trials (Cabral et al., unpublished data). Reproductive pupae, as opposed to worker pupae, were observed within 7 wk, which may be indicative of colony stresses on the queens due to methoprene's growth regulator effect on reducing worker replacements in this no-choice bait trial. Extending trial observations to 8 to 12 WAT may have provided more insight into the effects of Extinguish Professional on LFA colonies. Worker ant mortality rates among Advion (indoxacarb in corn grit) and Indoxacarb PB-treated LFA colonies were 61.4% and 40.1% at 7 WAT, respectively. Advion did not provide faster control of LFA as compared to hydramethylnon, contrary to results observed with imported fire ants (IFA) (*Solenopsis invicta* Buren) (Hu and Song 2007). Moreover, colonies exposed to Indoxacarb PB continued to produce eggs and pupae during the trial (at 6 WAT), indicating the colonies were reduced but not eliminated with a single treatment. In addition, LFA possibly preferred the baits with hydramethylnon (Probait, Extinguish Plus) over either indoxacarb formulations; this preference was observed in field attractancy LFA trials (Cabral et al., unpublished data).

Most fire ant baits are formulated as a granular form on corn grit, suitable for ground nesting ants, but cannot be applied during or soon after rainfall (Vander Meer et al. 1982). Previous efforts to control LFA in Hawaii under various conditions clearly demonstrate that this tramp ant species is difficult to control with commercially available ant bait products. Three factors contribute to this. First, the major agricultural area in the state receives an average annual rainfall of 300 cm (East Hawaii Island), making treatment with dry granules problematic (Souza et al. 2008). Second, LFA form nests in both the arboreal and ground strata, and ground-applied baits do not appear to be effective toward the arboreal component (Souza et al. 2008). Finally, even after repeated weekly or bi-weekly treatments with granular baits, ant activity quickly returns to pre-treatment levels after treatments cease (Souza et al. 2008, Taniguchi 2013). A paste or gel formulation may prove more effective for arboreal ants like LFA. Additional trials are needed to evaluate alternate methods of arboreal applications and to determine if a repeated bait application can achieve 100% mortality of LFA colonies with single and multiple queens.

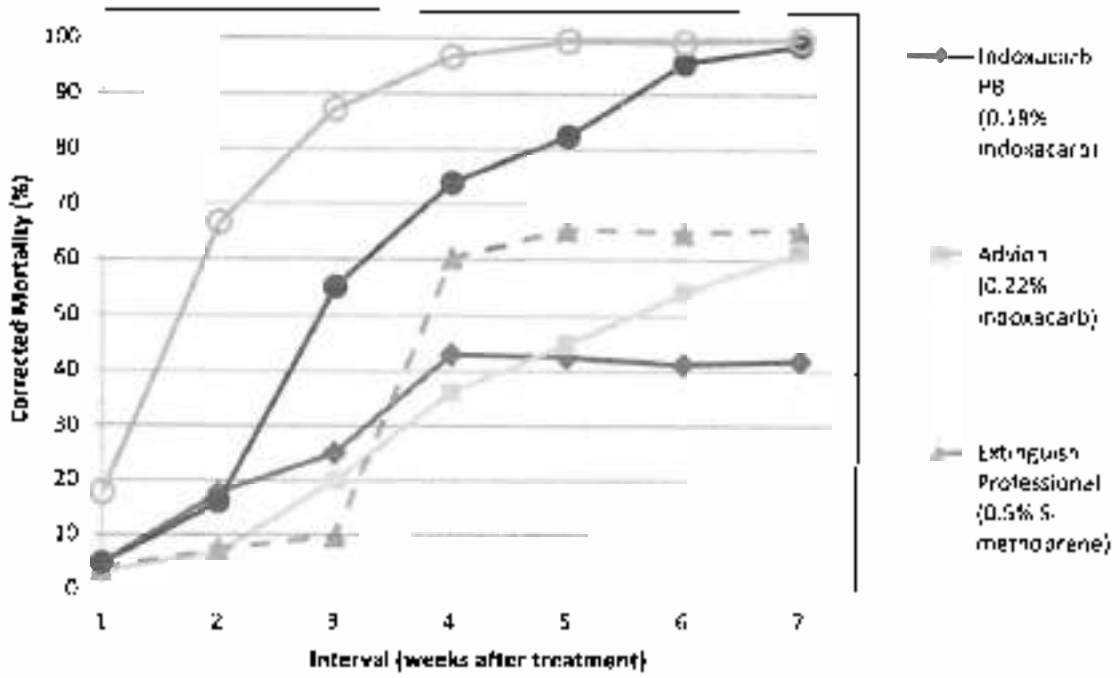

Figure 1: Efficacy of Ant Baits on LFA Colonies

*Treatment means with different letters were different ($p<0.05$) within week after treatment. Control mortality (%) was less than 10% for the duration of the trial.

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