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EVALUATION OF THREE TRAPPING STRATEGIES FOR RED PALM WEEVIL, *RHYNCHOPHORUS FERRUGINEUS* (COLEOPTERA: CURCULIONIDAE) IN THE PHILIPPINES

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ABSTRACT

A six day trial evaluating three different trapping methods for red palm weevil (RPW), *Rhynchophorus ferrugineus*, was conducted in a commercial coconut plantation in the Philippines. Results clearly demonstrated that the treatment composed of freshly cut coconut palm stumps with stacks of sectioned trunks and palm hearts combined with the RPW aggregation pheromone (Ferrolure), the synergist ethyl acetate (weevil magnet), and food additives (either fermented dates of sections of palm hearts) was most effective at attracting and retaining adult RPW (n = 23 adults captured in six days). Two other treatments, bottle traps with aggregation pheromone and synergists, or freshly cut coconut palm stumps and stacks of cut palm trunks, failed to capture to adult RPW over the course of this experiment.

Keywords: Coconut, Ferrolure, Philippines, *Rhynchophorus vulneratus*

INTRODUCTION

The red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier), (Coleoptera: Curculionidae) is considered to be the world's most serious invasive pest of palms. Larvae feed internally causing extensive damage which can result in palm mortality. Native to South Asia and Melanesia where coconuts (*Cocosnucifera* L.) are a highly preferred host, RPW has been moved globally through the international trade in palms (Murphy and Briscoe, 1995). It is an economic pest of date palms (*Phoenix dactylifera* L.) in the Middle East with ~50% of these nations having RPW infestations (El-Mergawy and Al-Ajlan, 2011; Faleiro, 2006) and the FAO has identified RPW as a category-1 pest of date palms in this region. Ornamental plantings of Canary Islands palms (*P. canariensis* Chabaud) in urban areas in the Mediterranean (e.g., France, Italy, and Spain) have been severely affected by this pest (Faleiro 2006). The red stripe form of RPW (i.e., adults are black with a dorsal red stripe that runs from the anterior margin of the pronotum to the posterior margin of the metanotum), formerly known as *R. vulneratus* (Panzer) and *R. schach* Olivier, before being synomized by Hallett *et. al*., (2004) with *R. ferrugineus*, is a potential new palm pest in Southern California (USA) following its discovery in Orange County in 2010 (Hoddle, 2011a,b,c).

With the identification and synthesis of the male produced aggregation pheromone, a two component blend of "ferrugineol" (4-methyl-5-nonanol) and "ferrugineone" (4-methyl-5-nonane) (Hallett *et al*., 1993), pheromone technology has been widely used to manage RPW in commercial date plantations (e.g., Saudi Arabia) and for monitoring populations in urban areas (e.g., California). Area-wide control and monitoring programs for RPW depend heavily on trapping active adult weevils using bucket traps baited with the aggregation pheromone, synergists (e.g., ethyl acetate), and food additives (e.g., fermented dates, sugar cane, or pieces of freshly cut palm). Despite the commercial availability of this pheromone and recommendations for its use as part of an IPM program in date plantations, little information is available on the utility of trapping RPW, especially the red stripe "*vulneratus*" morph, in the native area of this pest. Sivapragasam *et al*. (2010) demonstrated that the "*vulneratus*" morph is attracted to the RPW aggregation pheromone in coconut plantations in Malaysia, which encompasses part of the native range of this color morph (Wattanapongsiri, 1966). Here we present results from trapping trials conducted to assess the attractiveness of the RPW aggregation pheromone together with the ethyl acetate synergist and food additives to the "*vulneratus*" morph in a commercial coconut plantation in the Philippines, an area that constitutes part of the native range of this color form (Wattanapongsiri, 1966).

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MATERIALS AND METHODS

To assess the attractiveness of the commercial RPW pheromone to the "*vulneratus*" morph, a small trial was executed in a 60 ha commercial coconut plantation in Quezon on Luzon Island in the Philippines over the period 20 October 2011 to 26 October 2011. This area has been reported previously to have the "*vulneratus*" morph infesting coconuts (Wattanapongsiri, 1966). Three treatments were set up and checked twice per day at 6:00am and 5:00pm for captures of RPW.

Treatment 1

This treatment consisted of traps with RPW aggregation pheromone (Ferrolure) + ethyl acetate (weevil magnet) + fermented dates. The aggregation pheromone, Ferrolure (a packet containing 700 mg mixture of 4-methyl-5-nonanol and 4-methyl-5-nonanone), and weevil magnet (a 40 ml packet of ethyl acetate) used in this study were sourced from ChemTica International (Santo Domingo, Heredia, Costa Rica). No water or pesticides were present in traps to kill adult RPW. Medjool dates (5-6 per bottle trap) were fermented with one teaspoon of baker's yeast and water for 1 day before being added to traps. Dates were used for three days and then replaced with cut pieces of palm hearts because no RPW had been captured after this first three day interval and the decision was made that dates were not an attractive food additive in the Philippines. Traps were hung in immature coconuts (a highly preferred host stage for RPW to attack) (Fig. 1) or on dead coconut trunks at ~1.0 m and ~ 1.75 m above the ground, respectively. Trap placement at these heights has no significant effect on captures of the "*vulneratus*" (Sivapragasam *et al*., 2010) or *R. ferrugineus* morphs (Faleiro, 2006). This treatment was replicated three times and the distance between traps was > 500 m.

Fig. 1
Traps hung in immature coconuts (a highly preferred host stage for RPW to attack).

Treatment 2

This treatment consisted of freshly felled coconut palms. The plantation owner was asked to fell five palms that were suspected to be infested with RPW. All five palms exhibited extensive internal damage, but no RPW life stages were found and it was difficult to determine if feeding damage had been caused by RPW or another serious coconut pest, *Oryctes* rhinoceros beetles. Three of these five felled palms were used for Treatment 2, the remaining two palms were used for Treatment 3. For Treatment 2, palm trunks were cut into sections ~ 40-50 cm in length and stacked around the stump. Cut pieces of trunk were notched with a chainsaw blade to make crevices in which adult RPW could hide should they reach this resource. Cut palm hearts were placed on top of the wood pile to boost the attractiveness of the stack of cut sections (Fig. 2). At each inspection interval the wood stack was pulled apart and logs were inspected for RPW attracted to this resource. This treatment was replicated three times and palm stumps with associated log stacks were separated by > 200 m.

Fig. 2
Treatment 2 (palm trunks were cut into sections ~ 40-50 cm in length and stacked around the stump).

Treatment 3

This treatment consisted of Treatment 1 (i.e., bottle trap with RPW pheromone + ethyl acetate + fermented dates or palm hearts) and Treatment 2 (i.e., palm stumps and stacks of sectioned and notched palm trunk) combined and was replicated three times at different sites in the plantation (Fig. 3). Two cut palm stumps and sections of cut palm trunk and pieces of palm heart were used for two replicates, and one replicate did not have a cut stump and was comprised of a stack of cut palm trunks and palm heart material. This treatment was replicated three times and two replicates were separated by ~ 100 m and both were > 800 m from the third replicate. At each inspection interval the bottle trap was inspected for RPW and the wood stack was pulled apart and logs were examined for RPW.

Fig. 3
Treatment 1 (i.e., bottle trap with RPW pheromone + ethyl acetate + fermented dates or palm hearts) and Treatment 2 (i.e., palm stumps and stacks of sectioned and notched palm trunk).

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RESULTS AND DISCUSSION

The results of these trials were clear cut and consistent. However, there are caveats; due to the low rate of treatment replication (n = 3 for each of three treatments), short experimental duration (six days), and the fact that treatments were not blocked to account for location effects in the plantation, results presented here should be interpreted conservatively. Treatment 1 and 2 did not result in the capture of any RPW over the six day monitoring period. Treatment three, the pheromone bottle traps placed on freshly cut coconut palm stumps with stacks of cut sections of palm trunk and palm hearts resulted in the capture of 23 RPW over the course of the trial. The sex ratio of captured RPW was highly female biased (n = 18 females [78%]; n = 5 males [22%]). This result is consistent with pheromone trapping results observed previously for the "*vulneratus*" morph in Malaysia (Sivapragasam *et al*., 2010). Unidentified phoretic mites were found on 60% and 67% of males and females, respectively (Fig. 4). Phoretic mites have been recorded previously on RPW adults but their potential role as control agents of RPW is uncertain as known species probably exploit rotting palm tissues as food (Porcelli *et al*., 2009).

Fig. 4
Red palm weevil attacked by unidentified phoretic mites.

All three replicates of Treatment three resulted in the capture of RPW and the first captures were made ~ 24hr after the palms were felled and stacked with the pheromone bottle trap. Captures ranged from one to five RPW at a site. RPW were found either inside bottle traps, or more often underneath wood stacked on top of palm stumps, or in chainsaw blade width notches in cut sections of palm trunk. The notches were attractive resting sites because adult RPW are exceptionally thigmotactic and can push themselves deeply into very tight crevices to hide. The majority, 78% (n = 18) of RPW were captured when treatments were examined at 6:00am, the remaining 22% (n = 5) were captured at 5:00pm.The color morphs of RPW that were captured in Treatment three included *R. ferrugineus*, "*R. vulneratus*", and a color and pattern spectrum between these two distinct forms (Fig. 5).

Fig. 5
The color morphs of red palm weevil.

The results of this trial present a potential RPW control strategy in coconut plantations in the Philippines using freshly felled coconut palm stumps, stacks of sectioned palm trunk, and the RPW aggregation pheromone, ethyl acetate synergist, and food additives. Palm stumps and stacks of sectioned palm trunks could be sprayed with a non-repellant contact insecticide (e.g., deltamethrin, carbaryl, or chlorpyrifos [Faleiro, 2006]) to kill weevils attracted to cut palm material and pheromone traps. Pheromone trap deployment of one to two per ha have been demonstrated to be an effective density for mass trapping RPW in date plantations leading to reduced pest pressure (Faleiro, 2006). Similar densities of cut palm stumps and stacks of cut palm trunks combined with pheromone traps may be effective at reducing RPW densities in commercial coconut plantations in the Philippines. For this study, felled palms were those selected to be in advanced stages of succumbing to RPW infestation and palms were felled and cut into sections quickly, ~20-30 mins per palm. Similar selection criteria could be used for setting up these insecticide treated palm trunk stacks if this approach can be demonstrated experimentally to be effective and economical when compared to alternative management strategies. Felling RPW infested coconut palms for this control strategy would have the added benefit of removing or "rogueing" inoculum sources within plantations.

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