



Efficacy of bait free pheromone trap (Electrap™) for management of red palm weevil, *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae)

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ABSTRACT: The Red Palm Weevil (RPW) *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) is a key pest of palms that has significantly expanded its geographical range in diverse agro-ecosystems during the last three decades. Food baited pheromone (ferrugineol) traps have been widely used in both RPW surveillance and also in mass trapping programmes for over two decades. Currently RPW pheromone traps have to be serviced (change of food bait and water) at bi-weekly intervals to sustain the trapping efficiency. In area-wide RPW- Integrated Pest Management (IPM) programmes, trap servicing is unsustainable and also not possible due to the enhanced cost associated with this practice. In this study the comparative efficiency of the service-less dry pheromone trap (Electrap™) against the traditional food baited traps, revealed that weevil captures in both the Electrap™ and the food baited traps (PicusanTrap™ and the bucket trap) were statistically similar. The Electrap™ offers a sustainable service-less trapping option for RPW management, especially in areas where the trap density has to be increased due to high weevil activity.

Keywords: Dry trap, Electrap™, pheromone traps, *Rhynchophorus ferrugineus*

INTRODUCTION

The Red Palm Weevil (RPW) *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) also known as the Asian Palm Weevil is one of the world's most invasive pest species currently reported to infest 40 palm species (<http://www.savealgarvepalms.com/en/weevil-facts/host-palm-trees>). The RPW has its home in South and South East Asia where it is a major pest of coconut (Lefroy, 1906). After it was reported on date palm in the Middle East during the mid 1980s (Zaid *et al.*, 2002), the pest rapidly expanded its geographical range (Giblin-Davis *et al.*, 2013) and is currently reported from nearly 50 countries in diverse agro-ecosystems worldwide including the Mediterranean basin countries where it is a key pest of the Canary Island palm. Weak quarantine measures at the local, regional and international level have resulted in the rapid spread of RPW both internally and also across international borders making it a trans-boundary pest. Difficulties in detecting infested palms in the early stage of attack makes it extremely difficult in controlling the pest. Infested palms exhibit

tissue damage internally and extrusion of chewed up palm tissue with a typical fermented odour. Severely infested palms may harbor overlapping generations of the pest and often topple due to extensive tissue damage (Abraham *et al.*, 1998; Dembilio and Jacas, 2012). The annual loss due to removal of severely infested palms in the GCC countries, at 1 and 5% infestation has been estimated to range from \$5.18 to \$25.92 million, respectively (El-Sabea *et al.*, 2009).

The RPW is currently managed employing an Integrated Pest Management (IPM) strategy where the use of food baited pheromone (ferrugineol) traps (FBPTs) forms an important component of the strategy (Abraham *et al.*, 1998). With the synthesis of the male produced aggregation pheromone by Hallett *et al.*, (1993), FBPTs have been widely used in both RPW surveillance and also in mass trapping programs for over two decades where captures are female dominant usually in a ratio of 1:2 (male : female). Additionally, the trapped weevils are known to be young, gravid and fertile indicating significant impact of trapping on the population reduction

of the weevil in a given locality (Faleiro *et al.*, 2003). However, recent olfactometer based assays reveal that only a part of the adult RPW population is attracted to the pheromone (El-Shafie and Faleiro, 2017). In order to attain high weevil captures in RPW pheromone traps it is essential to adopt the best trapping protocols (Hallett *et al.*, 1999; Faleiro, 2006; Vacas *et al.*, 2016; Oehlschlager, 2016) with respect to the trap design, trap components (lure, bait and water), trap servicing, trap density etc. Black coloured RPW traps have been found to capture more weevils (Al-Saoud, 2013), while dome shaped traps are known to be superior as compared to the bucket traps (Vacas *et al.*, 2013). The aggregation pheromone is more attractive to RPW when combined with Kairomones or volatiles emitted from the host (Hallett *et al.*, 1999). RPW pheromone traps with dates mixed in water exhibit the best bait-lure synergy, consequently attracting a higher number of weevils as compared to other food baits (Faleiro and Satarkar, 2005). The food bait laced with insecticide is known to prevent escape of weevils for the traps that occurs in FBPTs without insecticide. Vacas *et al.*, (2013) reported that the addition of water to traps baited with palm tissues is essential, as this increased captures more than three fold compared with dry traps without water. Co-attractants based on fermenting compounds, ethyl acetate and ethanol, could improve the attractant level of ferrugineol and potentially replace non-standardised natural kairomones in RPW trapping systems (Oehlschlager, 2016; Vacas *et al.*, 2016).

Bi-weekly replacement of the food bait is essential to sustain the trapping efficiency and is the main constraint in increasing the trap density in an area wide program where a higher trap density often needs to be adopted due to enhanced weevil activity (Faleiro, 2006; Vacas *et al.*, 2016). Mass trapping programs are usually initiated at 1 trap/ha as recommended by Oehlschlager, 1994 but has often to be increased (4-10 traps/ha) depending on the weevil activity in the field (Faleiro *et al.*, 2011), which is unsustainable and also not possible due to the enhanced cost associated with trap servicing. In this context, it has become imperative to search for service-less trapping options. The use of attract and kill technology using trap and bait free systems have been found promising (El-Shafie *et al.*, 2011; Faleiro *et al.*, 2016). Another alternative is the use of a dry trap without the food bait, water and insecticide. Communication in insects has for long been attributed to factors other than scent and hearing (Riley, 1894) and the Electrap™

functions on the principle that insects communicate by radiations emitted from oscillating molecules and is the first of its kind developed and patented for attracting and trapping RPW. In this study we tested the comparative efficiency of the black coloured dome shaped dry pheromone trap (Electrap™) against the traditional food baited bucket trap in a RPW infested date plantations in the Al-Ahsa date palm oasis of Saudi Arabia.

The general overview of the Electrap™ is presented below (Figure 1). In this trap insects are captured and disabled using pulsed emission from MASER (Microwave Amplification by Stimulated Emission of Radiation). Inside the core Electrap™ device is placed the pheromone lure (Ferrolure) and the solid formulation of the kairomone (ethyl acetate). The invention has been granted a patent by the United Arab Emirates as well as the Gulf Cooperation Council.

Since long the possibility that insects communicate by radiations emitted from oscillating molecules has been proposed (Riley, 1894; Callahan, 1965; Shimron *et al.*, 1985). The Electrap™ functions on the principle of MASER, where a fully inside mirrored 'Resonance Chamber' (core electrap device), loaded by natural light, incessantly reflects the light, starts a resonance process till the saturation of the light reflection inside the chamber, thereby emitting the infrared electromagnetic radio waves loaded by the lures molecules and attracting the insects. This mechanism of electromagnetic communication and olfaction in insects has been previously reported by several workers (Laithwaite, 1960; Callahan, 1965; Turin, 1966; Wright, 1977; Porcella, 2013). In The Electrap™ the said Resonance

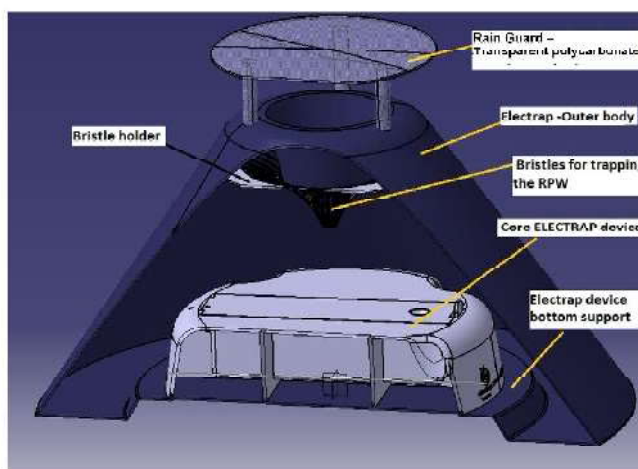


Fig. 1. General Cross section of the Electrap™ with the major components

Chamber is mounted horizontally in the trap and the semiochemicals (Pheromone and Kairomone) are placed inside which can last for 4 to 6 months without renewal.

MATERIALS AND METHODS

Two field trials were conducted between 31 January and 3 April, 2016. In trial-I (Three weeks: 31 January to 20 February, 2016), three treatments comprising T1: ELECTRAP™ (without the food bait); T2: Picusan Trap™ with pheromone (Ferrolure+) + Food bait (200g dates in 1L water) and T3: Traditional four window bucket (5L) trap with pheromone (Ferrolure+) + Food bait (200g dates in 1L water) were tested. Each treatment was replicated 10 times. Treatments were set 10 m apart within each replication while a distance 20m was maintained between two the replications. Trial-II was carried out in the same field (Six weeks: 22 February and 3 April, 2016). The same experimental protocols were followed as indicated above in trial-I. However the treatment involving the Picusan Trap™ in trial-I was eliminated and in trial-II, the Electrap™ (T₁) was tested against traditional four window bucket (5L) trap (T₂).

RPW population is known to be highly aggregated (Faleiro, 2006) that could result in experimental error with traps close to an infested palm capturing more weevils as compared to traps away from an emerging brood of weevils. To eliminate bias of treatments due to the aggregated / clumped distribution pattern of RPW, the treatments (traps) were moved sequentially from one spot to another every week in each block to eliminate spot bias if any. Observations on weevil captures were recorded at fortnightly intervals in all the traps, when also the food bait and water in the Picusan Trap™ and the traditional food baited bucket traps (T₂ and T₃ in trial-I and T₂ in trial-II) was renewed.

Data on weevil captures were compiled at the end of each experiment and subjected to statistical analysis (ANOVA p: 0.05) for trial-I, while for trial-II, weevil capture data were subjected to 't test'.

RESULTS AND DISCUSSION

Results presented in Figure 2 and 3 reveal that the mean weevil captures in the traps evaluated in both the trials were statistically similar. In trial-I, statistically similar weevil captures of 2.1, 1.9 and 1.1 weevils/trap were recorded in the PicusanTrap™, Electrap™ and the traditional bucket trap, respectively. Further, in trial-II trap captures of 2.0 and 1.9 were recorded in the bucket trap and Electrap™, respectively. Black-colored

pyramidal (Picusan™) traps are known to significantly increase captures in food-baited pheromone traps (Vacas *et al.*, 2013). However, both the Picusan™ and the traditional food baited bucket trap have to be serviced to sustaining the trapping efficiency. It is relevant to point out that the Electrap™ does not need any servicing and its trapping efficiency is similar to the Picusan Trap™ and the traditional food baited bucket trap where the food bait and water has to be renewed at least once every two weeks. The Electrap™ invention emphasizes the role of electro-magnetic radiation in attracting RPW adults similar to the assembling of moths proposed by Laithwaite, 1960. Further, Callahan, 1965 showed evidence for a far infrared (FIR) electromagnetic theory of communication and sensing in moths.

Once RPW adults enter into the Electrap™, escape of the trapped weevils is prevented due to the presence of the one-way bristles crown at the entrance. Subsequently the trapped weevils die due to quick dehydration. The dismantable bottom support allows an easy periodical removal of the dead weevils. It is pertinent to mention that the Electrap™ besides being bait and water free is also without any insecticide as often used in the FBPTs to kill the trapped weevils.

El-Shafie and Faleiro, 2017 propose that RPW semiochemical mediated technologies which could be used in area-wide RPW-IPM programs need to focus on the development of pheromone traps that eliminate the need to periodic servicing (renewing water, food bait and insecticide). The Electrap™ is an advancement in this direction and offers a sustainable service-less trapping option for RPW especially in areas where the trap density has to be increased due to high weevil activity. This

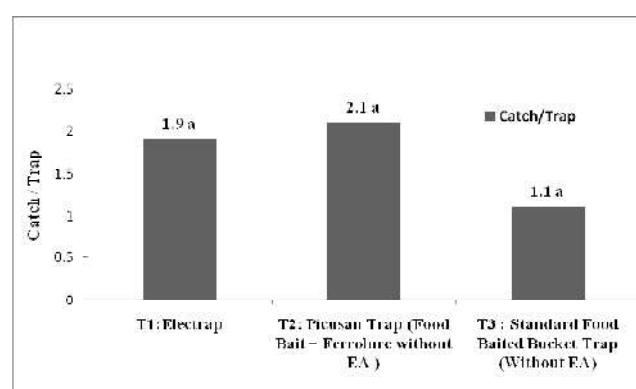


Fig. 2. Mean *R. ferrugineus* captures in different traps tested in Al-Ahsa, Saudi Arabia (31 January to 20 February, 2016)

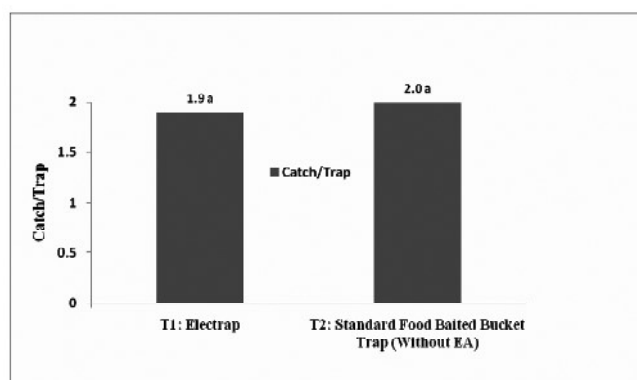


Fig. 3. Mean *R. ferrugineus* captures in different traps tested in Al-Ahsa, Saudi Arabia (22 February and 3 April, 2016)

invention based on patented electromagnetic diffusion system of semiochemical signals has also been recently conferred with a United Nations Industrial Development Organization (UNIDO) <http://www.unido.it/award2017/electrap/>. The Electrap™ is the first efficient service-less dry pheromone trap that can be incorporated into the RPW-IPM programme to reduce the cost of the trapping programme especially in an area-wide operation. Further improvement to this service-less trapping option, would be the development of smart trapping device for automatic data collection and transmission on the weevils captured for efficient decision making.

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