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An Advanced Catch-and-Release Trap for Controlling the Red Palm Weevil

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Abstract: The aim of the research was to develop a catch-and-release trap for monitoring and controlling RPW (*Rhynchophorus ferrugineus*, red palm weevil). The RPW insects were attracted through the use of an aggregation pheromone located into a dispenser inside the trap. The RPW adults entered through an entrance door into a sterilization room where they were sprayed with a solution containing the chemical sterilizer product “lufenuron”. The adults were then forced to move into a contamination room where it was present a wet media containing spores and hyphae of *Metarhizium anisopliae* and spores and crystalline insecticidal proteins of *Bacillus thuringensis*. The sterilized and infected RPW adults were counted and released into the environment where they reached new palms and join natural populations of RPW. Preliminary experiments showed that the catch-and-release trap was able to reduce the fertility of RPW adults and to increase their mortality after contamination with entomopathogens. Moreover, the infected RPW adults were able to infect untreated RPW larvae leading to a larvae mortality of 93% within 30 days. In conclusion, the advanced catch-and-release trap represents a safe and effective tool to monitor and control the population of RPW pest without environmental pollution and risks for human health.

Key words: RPW, trap, palm, biological control.

1. Introduction

RPW, *Rhynchophorus ferrugineus* (Olivier) (Coleoptera, *Curculionidae*) is a very serious pest for cultivated palms in many countries around the world (Southern Asia, North Africa, Europe, the Guff states, and the Middle East). The insect is a large beetle, native of southeast Asia, which has been introduced accidentally in the Mediterranean areas a few years ago (2004-2005). The adult female of RPW lives for about 100-150 days and produces a large quantity of eggs (300-350), of which 75% are fertile. The insect has a special behavior (aggregation pheromone produced by males), and it is precisely this behavior that determines the survival of the species to adverse environmental conditions. In fact, the greatest concentration of larvae in the jamb of the palm tree causes a rise of internal temperature up to peaks of 50 °C due to the fermentation. This allowed the concomitance of different development stages of the insect. It does not occur an inactivity period of the parasite.

RPW could invade many other areas and countries where the Date palms, the Coconut palms, the Sago palms, the Talipot palms, the Oil palms, the Royal palms, the Sugar palm, the Toddy palms, the Serdag palms, the Nibong palms, the Areca palms and some other ornamental palms are grown. This insect shows a clear preference for the *Phoenix canariensis* which is the widest distributed between ornamental palms in the Mediterranean basin, but can attack any other palm species, including dwarf palm (*Chamaerops humilis* L.) endemic in the Mediterranean [1].

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The lifespan of the RPW is quite long, in the Mediterranean areas it takes about 150 days from egg stage to the adult, and therefore the total life of the insect can be up to 300 days. The larva in eight growth stages can live about 84 days (depending on diet and climatic conditions). The oviposition regards a large number of eggs, varies from 300 to 700 (depending on climate). The female fertilization takes place several times during the life of the insect and lays her eggs in more than a palm tree. Spraying of insecticides has limits, in order to control the palm tree pests: washing out, low safety for users, environmental and operators, and costs. Endotherapy has proved his effectiveness to control RPW population [2]. It is based on injections of various products of biologically active substances which, entering into the circulation by special nozzles connected with pressure pumps; this method permits to limit the dispersal of pesticides. Blend of insecticides have been successfully tested by endotherapic method “Tree vital endopalm” developed by Nabawy [2]. Endotherapy have some limits, being a “point” approach and long term. The best strategy could be carried out by “point” approach of endotherapy in order to recover the attacked palm tree and “territorial” approach with the aim to arrest pest diffusion.

Among the solutions adopted in the integrated defense plans, the use of the male sterile (SIT, sterile insect technique) has been proven a suitable method to the control other phytophagous insect species. An environmentally friendly technique to sterilize the adults is to attract them into a catch-and-release trap and to spray them with a solution containing a chemical sterilizer product. Moreover, the caught RPW adults can be also contaminated with entomopathogens inside to the trap and when they are released in the environment they can spread the disease to other adults/larvae.

Despite the high potential of this technique for controlling RPW, no information is available on catch-and-release trap for controlling the RPW through sterilization and entomopathogen infections of adults. Starting from the above considerations, a research project was carried out by Green World S.r.l. to develop an advanced catch-and-release trap for controlling the RPW. The concept is to attract the RPW insects into a catch-and-release trap using an aggregation pheromone, and to sterilize and infect them with a chemical sterilizer product and entomopathogens respectively before release the RPW insects into the environment. The effectiveness of catch-and-release trap on controlling RPW was also evaluated.

2. Materials and Methods

The catch-and-release trap was made with a structure of metal material insulated with cork panels. The trap has one entrance and one exit in the opposite site as showed in Fig. 1.

The RPW insects are attracted through the use of an aggregation pheromone located into a dispenser sachet inside the first room of the trap (Fig. 2).

The RPW adults attracted by the natural pheromone enter through an entrance door into the trap; when the insect reached the central part of the first room, two LED lights switch on automatically for 1 min to push the insect to move forward in the next room. The second room is a sterilization room where the RPW are automatically sprayed with a solution containing the chemical sterilizer product “lufenuron” [(RS)-1-[2,5-dichloro-4-(1,1,2,3,3,3-hexafluoropropoxy)phenyl]-3-(2,6-difluorobenzoyl)urea]. In the contamination room, there is a plate containing a mixture of wet inert media and spores/hyphae of *Metarhizium anisopliae*, and spores and crystalline insecticidal proteins of *Bacillus thuringensis*. A water reservoir connected with the contamination room assures a high humidity environment which is fundamental for the survival of *Metarhizium anisopliae* and *Bacillus thuringensis*. Few minutes of staying in the contamination room are sufficient for

Fig. 1 Catch-and-release trap developed by Green World Consulting.

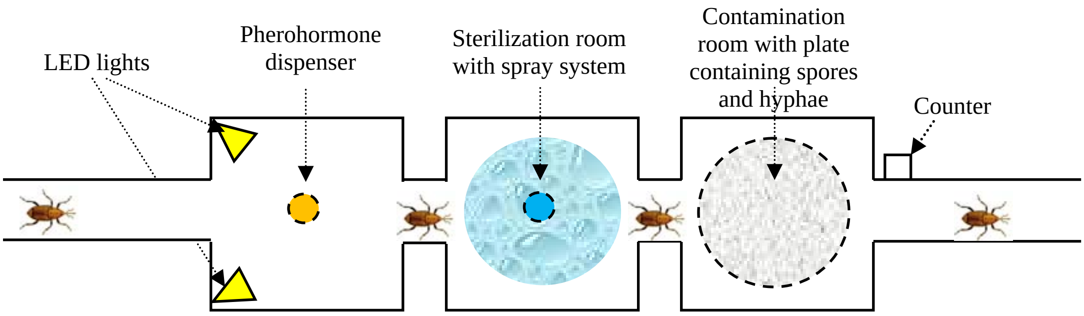

Fig. 2 Operating scheme of catch-and-release trap developed by Green World Consulting.

infecting the RPW adults. After the third room, the sterilized and infected RPW adults are automatically counted (infrared digital counter + datalogger located into the exit door) and released into the environment where they reach new palms and join natural populations of RPW adults.

Three experiments were conducted during summer 2012 at the Experimental Station of Green World S.r.l. in Lanuvio (Rome) Central Italy (lat. 41.67° N, long. 12.7° E, altitude 324 m above the sea level) to validate the efficacy of catch-and-release trap. In the first experiment, a trap activated only with chemical sterilizer lufenuron was used. Teen couples of RPW (which were obtained by cocoons previously harvested in infested palms keeping separate the adult males from the adult females that hatched from the cocoons to prevent fertilisation) were putted into the first room of the trap one by one. The RPW were collected from the exit door after they were sprayed with the chemical sterilizer. A control treatment was also established in which teen couples of RPW were not treated with chemical sterilizer. The RPW pests were then putted into two 50 L-boxes (one for those treated with chemical sterilizer and one for the untreated ones) with a layer of 20 cm of vermiculate and five apples on the top of the vermiculite layer. The apples were continuously added as needed. The larvae were harvested from each box after 50 days and counted. In the second experiment, a trap activated only with *Metarhizium anisopliae* and *Bacillus thuringensis* was used. Teen couples of RPW (which were obtained by cocoons previously harvested in infested palms) were putted into the first room of the trap one by one. The RPW were collected from the exit door after they pass through the contamination room. A control treatment was also established in which teen couples of RPW were not treated with entomopathogens. The RPW pests were then putted into 50 mL-jars (one treated adult for each jar). In each jar, an untreated middle stage larva was added to verify the spread of the entomopathogens from the treated adult and the untreated larva. In each jar pieces of apples were putted to feed the insects. The number of dead adults and larvae was counted every day from the moment when the adult treated with entomopathogens was placed in the same jar with untreated larva. In the third experiment, the ability of the trap to attract RPW adults was tested. Two 50 m^2 greenhouse compartments were used. Each compartment contained one catch-and-release trap. In each compartment, 15 couples of RPW adults were released. In one compartment, the trap was activated adding the aggregation pherohormone (Rhyfer 220, Intrachem, Italy) the chemical sterilizer solution and the entomopatogens. In both compartments, five palm trees (1 m tall) were planted in pots of diameter 80 cm using a substrate containing peat and pumice (2:1 w/w) and organic fertilizer Guanito (Italpollina S.p.A.) at the rate of 4 g/L. Plants were grown under natural light conditions with air temperature ranging from 20 °C to 32 °C. In each compartment, the number of caught RPW adults by the trap was recorded with a datalogger.

All data were statistically analyzed by ANOVA using the SPSS software package (SPSS 10 for Windows, 2001). Duncan's multiple range test was performed at p = 0.05 on each of the significant variables measured.

3. Results and Discussion

The first experiments showed that the spray application of lufenuron on RPW adults strongly reduced the fertility of the RPW. In fact, the number of larvae recorded into the box containing treated RPW adults was lower than that recorded in box containing untreated adults (4 vs. 110 larvae). The above findings are in line with the results obtained in other pests. For example, a significant reduction in fecundity and fertility, as well as survival of individuals of the first generation, was recorded when adults of *Anastrepha suspensa* Loew were fed a diet containing 0.1% diflubenzuron. Similarly, a marked decline in egg production and fertility in *A. ludens* Loew was observed in the laboratory following treatment with cyromazine. Finally, fertility of four *Anastrepha* species was significantly reduced when the adults were fed with the insect growth regulator lufenuron [3]. In the second experiment, the entomopathogens showed a high activity against RPW adults with a mortality of 91% within 17 days from the infection with entomopathogens. Moreover, the entomopathogens present in the body of adults were able to infect the untreated larvae contained in the same jars. In fact, the larvae showed a mortality of 93% within 30 days. In the control treatment, the mortality of adults and larvae was very low (7% and 10% for adults and larvae, respectively). Similar results were reported by Gindin et al. [4] who showed a cumulative RPW adult mortality of 100% in 2-3 weeks treating the adults with a dry rice-based formulation and in 4-5 weeks treating the adults with a spore suspension. In the third experiment, it was observed that the aggregation pherohormone was able to attract 48 RPW adults to enter into the trap during 20 days while in second greenhouse compartment, the number of adults that during the same period entered into the trap without aggregation pheroromone was zero. Moreover, visual observations showed that caught RPW insects had a low tendency to re-enter into the trap in a short time due probably to a "memory" of the negative experience of the pest into the trap. The data confirmed the effectiveness of the new catch-and-release trap on monitoring and controlling RPW population in controlled environment. In fact, the trap was very effective in catching RPW adults and reducing their fertility through treatment with lufenuron solution. Moreover, both entomopathoges were extremely active to cause the death of RPW adults and larvae. However, additional tests are needed in palm fields to evaluate the effectiveness of the advanced catch-and-release trap in natural conditions. Moreover, the advanced catch-and-release trap can be used in an integrated pest management strategy together with the endotherapic method "Tree vital endopalm" [2] to control the RPW population in a safe and environmentally friendly way. The advanced catch-and-release trap could also be useful for monitoring and early detection of red palm weevil pests in palm crops. Based on the research activities of Al-Saoud et al. [5], it would be interesting to evaluate other trap colors (e.g. red) to improve the effectiveness of the trap in catching the RPW.

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