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RESEARCH ARTICLE

Field Evaluation to the attraction efficiency for the different sources of the red palm weevil aggregation pheromone

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Abstract:

Field experiments were conducted during the periods from June, 2014 to March, 2015, in three date palm orchards located in Al Ain city, Abu Dhabi, United Arab Emirates, in order to evaluate the attraction efficacy for five different sources from the red palm weevil (RPW), Rhynchophorous ferrugineus Oliver (Coleoptera: Curculionidae), aggregation pheromone by using the standard four window black bucket trap. The three orchards are characterized by having different levels of infestation incidence by red palm weevil. The Randomize Complete Block Design (RCBD) with five treatment and three replicates was used in each of the three orchards. The aggregation pheromone sources used in this experiment were: Rhyfer 700, Pherocon RDPW Lure, Ferrugitom 700, Weevil lure, and Ferrulure +. Collectively in the three farms as well as per each farm, Weevillure aggregation pheromone trap capture significantly lower average numbers of RPW adults than Rhyfer, Pherocon, Ferrulure, and Ferrugitom pheromone sources. Rhyfer pheromone is about 1.12, 1.18, 1.56 & 1.16 % more efficient than Pherocon, Ferrugitom, Weevillure & Ferrulure, respectively.

Keywords: Aggregation pheromone sources; Date palm; Black bucket trap; Rhynchophorous ferrugineus

Introduction

The red palm weevil (RPW), Rhynchophorous ferrugineus Oliver (Coleoptera: Curculionidae), is an economically important tissue-boring pest of date palm in many parts of the world. This weevil was first described in India as a serious pest of coconut palm (Lefroy 1906) and later on date palm (Buxton 1918). This weevil is considered the most important and major pest of date palm in the Arabian Gulf States (Abraham et al. 1998). In 1985, this weevil was accidentally introduced and established in the northern United Arab Emirates and has become widespread in the country (Ferry and Gomez 2002).

It is very difficult to detect RPW in the early stages of infestation. Generally, it is detected only after the palm has been severely damaged. The destructiveness of this weevil is abetted by several traditional farming practices, including the removal of leaves during harvesting or pruning of offshoots, which causes incidental injuries to trees. Injured trees release highly volatile compounds (kairomones) that attract male weevils (Gunawardena et al. 1998). Upon their arrival, males produce aggregation pheromones that attract both sexes, and the females begin laying eggs in soft or injured areas on the lower trunk of the tree. The newly hatched larvae feed on the soft plant tissue, digging deep into the plant trunk, compromising its structural integrity and disrupting nutrient transport to the upper part of the tree, which ultimately culminates in death of the plant if not managed (Murphy & Briscoe 1999).

Management of this weevil is by adopting an old Integrated Pest Management (IPM) strategy, which depends primarily on the use of aggregation pheromone traps for monitoring and mass trapping of the weevil adults (Abraham et al. 1998; Faleiro et al. 1998; Al-Saoud 2004; Abuagla and Al-Deeb 2012). Ferrugineol is the main aggregation pheromone of R. ferrugineus (Hallett et al.1993) and is complemented with 4-methyl-5-nonanone in mass trapping adopted in different countries (Abraham et al. 1998; Hallett et al. 1999; Vidyasagar et al. 2000).

To achieve the optimum trapping protocols it is fundamental to ensure the effectiveness of the chosen trap and aggregation pheromone to attract the weevil adults. The standard four window bucket trap is widely used, where the black colored one has been reported to be more efficient in capturing the weevil (Hallett et al. 1999; Abuagla and Al-Deeb 2012). The average recommended emission rate for the RPW aggregation pheromone is 3 mg / 24 hours (Hallett et al. 1999). While the pheromone efficiency depends on a number of factors, the most important are the composition, the concentration, the emission rate and the stability of emission, which is mainly based on the company technology in how to manufacture of the pheromone membrane that controls the rate of emission, which in turn affects the efficiency of the attractions (Kaakeh et al. 2001; Faleiro 2006). In the United Arab Emirates, the market have a number of different commercial sources of RPW weevil aggregation pheromone with variations in the membrane manufacturing technology, which is controls the pheromone emission rate, that will directly affect its efficiency in attracting the weevil. This study aims to evaluate the attracting efficiency for the five different sources from the commercial aggregation pheromone available in the local market under field conditions that represents different infestation levels by red palm weevil.

Materials and Methods

Three private date palm orchards located in Al Ain city, Abu Dhabi Emirate, United Arab Emirates, that is having a history of infestation by the red palm weevil, were chosen to conduct this study. The first orchard located in Khatam Al Shakla with low incidence of infested date palm trees, the second orchard located in Zakher with high incidence infested date palm trees, and the third orchard located in Markhaniya with medium incidence infested date palm trees.

In each orchard five different sources from the commercial aggregation pheromone available in the local market were evaluated for its effectiveness in attraction the red palm weevil. The experimental design used in these orchards was the Randomize Complete Block (RCBD) with five treatments and three replicates. The Treatments were:

1. Rhyfer 700: 4-Methyl-5-Nonanol (9 Parts) + 4-Methyl-5-Nonanone (1 Part), Both Components 95% pure+ synergist
2. Pherocon RDPW Lure: (4-Methyl-5-Nonanol (31.5%) + 4-Methyl-5-Nonanone (3.5%)
3. Ferrugitom 700 : 4-Methyl-5-Nonanol 90%+ 4-Methyl-5-Nonanone 10%
4. Weevil lure: 4-Methyl-5-Nonanol (9 Parts) + 4-Methyl-5-Nonanone (1 Part)
5. Ferrulure +: 4-Methyl-5-Nonanol (9 parts) +4-Methyl-5-Nonanone (1 part) Plus Synergist, Pheromone is 95% Pure and synergist chemical

The trap used in the evaluation for this different sources of the aggregation pheromone is the one adopted and used by Abu Dhabi Food Control Authority (ADFCA), which is the standard four window black bucket trap, of the size 10 liters. It has four small slots on the sides and four small slots on the cover. The outer surface of the trap is coarse type that allows RPW to climb and to enter into the trap. The pheromone were installed by a metal wire in the middle of the bottom surface of the trap cover. The five pheromones sources were replaced by new ones monthly. One hundred grams from the dry unmarketable and very low quality date palm fruits were added to each trap every two weeks. In addition, five liters of water were added weekly. Total number of RPW caught by each trap was determined weekly during the period from June, 2014 to March, 2015.

Analysis of variance (ANOVA) was conducted for the data collected from 15 traps in each orchard and the means were separated by the least significant difference LSD procedure of the SAS statistical software (SAS 2001).

Results

Results of this study confirm the existence of significant difference in the average number of red palm weevils caught in the three orchards. This result is compatible with the objective of the study for the evaluation of the efficiency to this different sources of the pheromone under field's conditions that represents different levels of infestation by red palm weevil (Figure 1). The average number of red palm weevils in the second orchard has reached about 279.1 weevils per

trap during the study period from June 2014 until March 2015, compared with 80.2 and 43.5 weevils per trap in the third and first orchard, respectively. This indicate high differences in the total number of RPW adults collected from all the 15 traps in each orchard during the study period, that reached about 4187 weevils for the second highly infested orchard, compared to 652 weevils in first orchard that represent the low infestation level, and 1203 weevils in third orchard that represent the medium level of infestation.

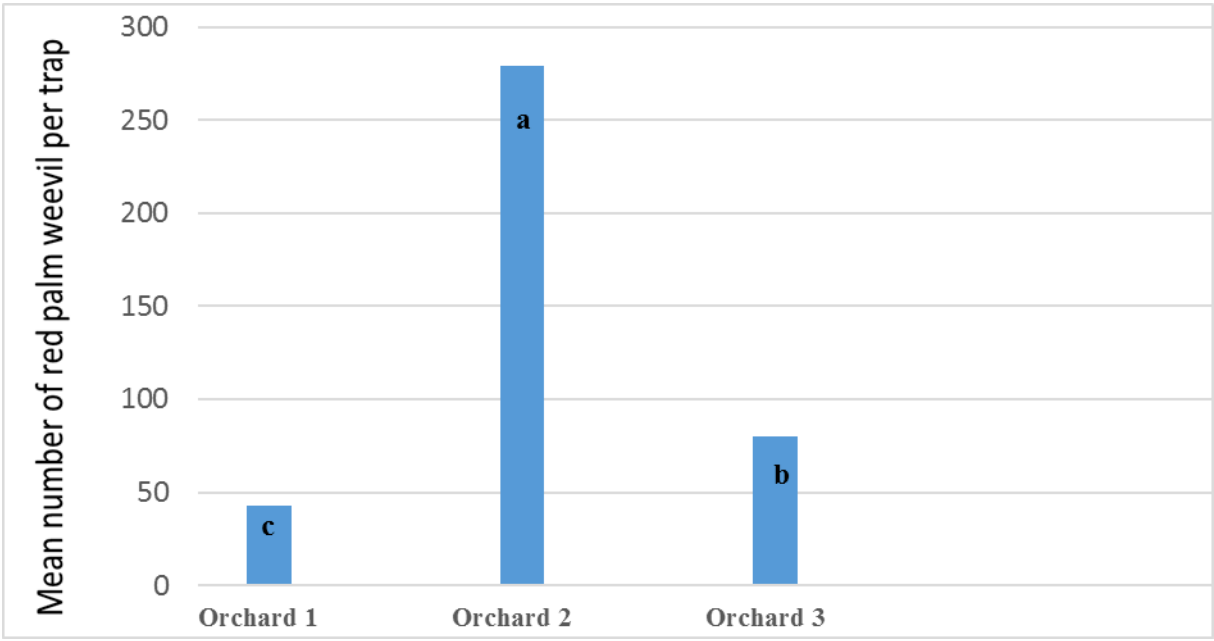

Fig.1: Mean number of red palm weevil adults caught by trap in each orchard from the period June, 2014 to March, 2015. Bars labeled with different letters are significantly different ($p < 0.05$), LSD 14.50

The efficiency comparison between the different sources from the aggregation pheromone revealed significant differences in the mean number of RPW captured in each of the three orchards (Fig.2). In the first orchard having low infestation levels by red palm weevil, the mean number of RPW reached (33.33) weevils per trap by using the Weevillure pheromone source, which is significantly lower than that of the mean number (54.33) weevils per trap in the Ferrugitom pheromone. While no significant differences were found between these two sources and the other three sources, where the mean number of RPW catches reached 39.67, 39.33, and 51.0 weevils per trap for Rhyfer, Pherocon, and Ferrulure, pheromone sources, respectively. In the second orchard which is represents the high infestation incidence, the efficiency for the different sources of the pheromone seems to be compatible with the results from the first orchard. Mean number of RPW captured by the Weevillure pheromone (214.33) weevils per trap was significantly lower than that of the mean number of weevils caught by other sources. No significant differences were found between the pheromones Rhyfer and Pherocon, where the number of captured weevils reached 343 & 284 weevils per trap, as well as no significant differences were found between the number of weevils captured by using the pheromones Pherocon, Ferrugitom, and Ferrulure sources that reached (284, 275.67 & 278.67) weevils per trap, respectively (Fig.2).

The efficacy results for the different sources of the aggregation pheromone in the third orchard which is characterize by middle infestation level were also compatible with the results from the first and the second orchard. (Fig. 2). Weevillure pheromone trap captured significantly lower mean number (57.33) of RPW than Rhyfer, Pherocon and Ferrulure pheromone sources (91.33, 98.67 & 82.0) weevils per trap, respectively. However, the numbers of RPW captured by using the pheromone Ferrugitom (71.67) weevils per trap were not significant different from the mean number captured by Weevillure pheromone trap as well as not significant different from the mean number captured by Rhyfer and Ferrulure pheromone traps. Furthermore, mean number of RPW captured by using the Pherocon pheromone traps were significantly higher than that the mean number of weevils captured by using the Ferrugitom and Weevillure pheromones sources (Fig.2).

Collectively, the comparison between the means for the total numbers of RPW captured by trap in the three farms by using each of the different pheromone sources confirms the previous findings (Fig.3). Weevillure pheromone trap captured significantly lower mean number (101.67) of RPW than Rhyfer, Pherocon, Ferrugitom and Ferrulure pheromone sources (158.0, 140.67, 133.89 & 137.22) weevils per trap, respectively. No significant differences were found between the efficacy of the Rhyfer and Pherocon pheromone sources as well as between the Pherocon pheromone source in comparison with Ferrugitom and Ferrulure pheromone sources (Fig.3).

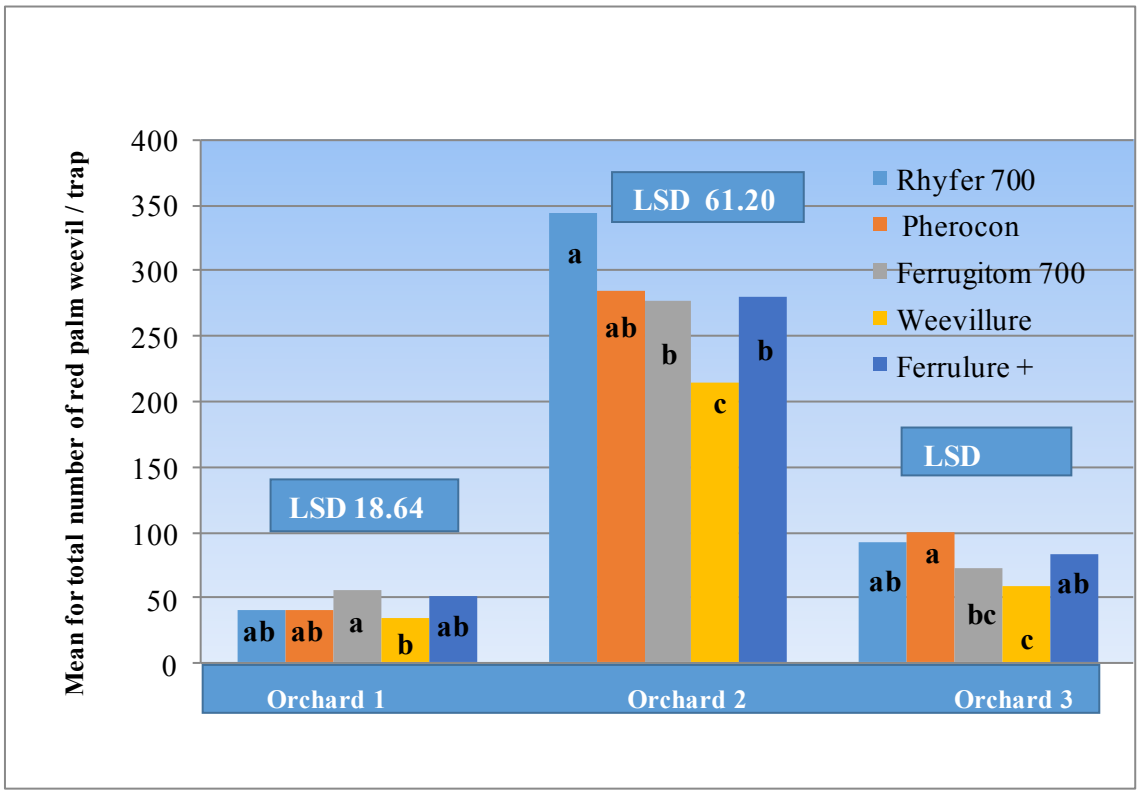

Fig. 2: Mean for number of red palm weevil caught by trap in each orchard from the period June, 2014 to March, 2015. Bars labeled with different letters are significantly different ($p < 0.05$), LSD 18.64, 61.20, 22.39.

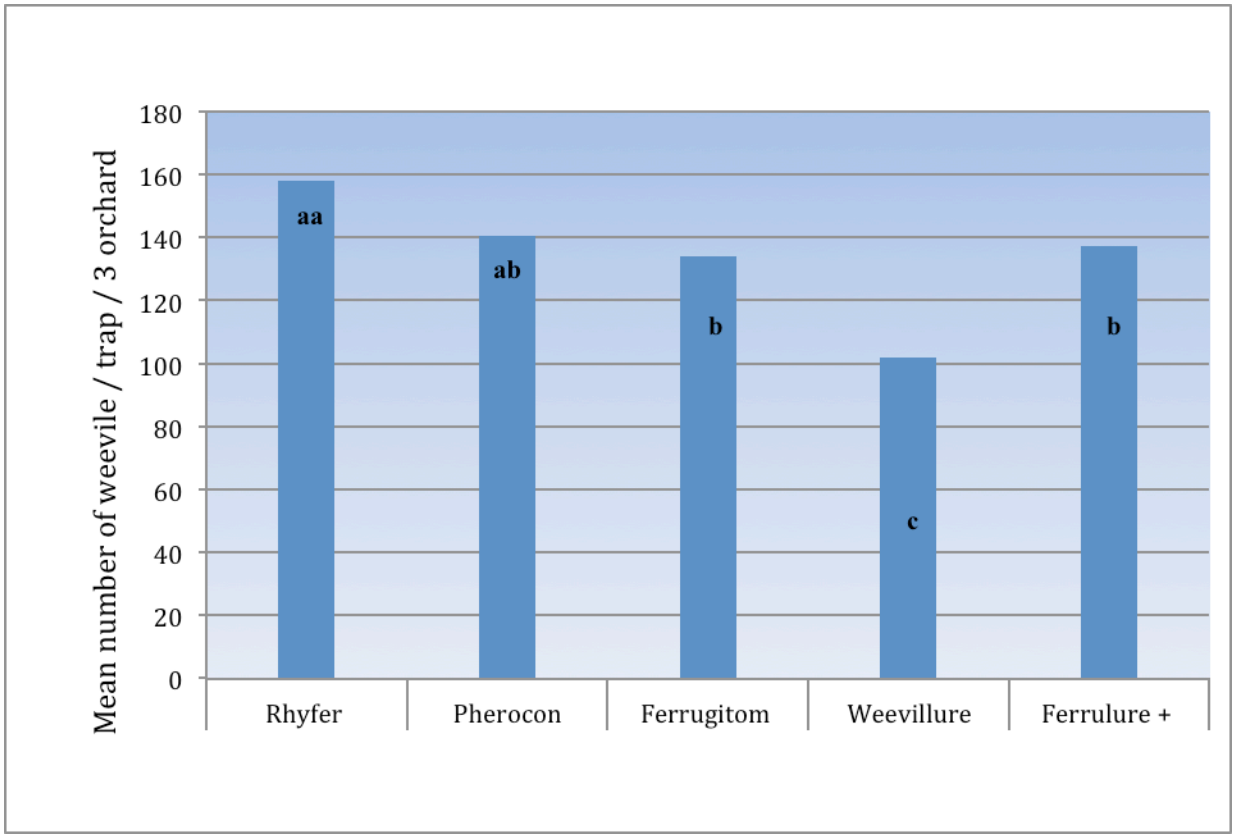

Fig.3: Mean number of red palm weevil caught by trap in the three orchards from the period June, 2014 to March, 2015. Bars labeled with different letters are significantly different ($p < 0.05$), LSD 18.72..

Discussion

For the most effective management of the red palm weevil, integrated pest management (IPM) was applied in most of the Gulf countries. As an important module of IPM program, the mass trapping to this weevil for over 15 years has been organized by the Ministry of Agriculture in Saudi Arabia (Abraham et al., 1998; Faleiro, 2006). Recent researches have also been focusing on finding Pheromone trapping of adult palm weevil to capture and kill the insect in order to reduce the insect populations in the field (Abraham et al. 1998; Vidyasagar et al. 2000). A total of 2,252 pheromone traps were used in the mass trapping system in an area of more than 10,000 ha in Al Qatif region, Eastern Province of Saudi Arabia (Vidyasagar et al. 2000). They reported that from an initial level of 4.12 weevils per trap per week in 1994, the adult population was reduced to 2.02 weevils per trap per week at the end of 1997. In United Arab Emirates, by using pheromone trapping in three date palm orchards during 2000 and 2001, the populations of RPW was reduced by 29.7-51.7% (Abbas et al. 2002). In Abu Dhabi Emirate, it has been reported that about two million of red palm weevil adults were trapped during the first half of the year 2013 through a project implemented by Abu Dhabi Farmers' Services Centre (ADSFC) in coordination with Abu Dhabi Food Control Authority (ADFCA), that covers about 23,050 orchards, where about 118,797 pheromone traps have been installed in these orchards (Gulf News, 2013).

In an endemic area of RPW infestation, and to reduce the weevil population in a much shorter time frame. It is recommended to increase the number of traps per unit area as well as to improve the trap efficacy in order to remove as much as from the weevil population, which will reduce the risk of new and re-infestations. In this study it is clear that the efficacy of the traps were different according to the pheromone sources. Collectively, and according to the number of RPW captured per trap in the three farms, the percentage of RPW captured by using the different sources of the pheromone were 23.6, 21.0, 19.9, 15.1 & 20.4% for the Rhyfer, Pherocon, Ferrugitom, Weevillure & Ferrulure, respectively. If we take into consideration that the IPM control program aims to remove two million from the RPW by using the trapping techniques, it means that in case of using the different sources of the pheromone, the numbers that can be collected through the use of Rhyfer, Pherocon, Ferrugitom, Weevillure & Ferrulure were 472000, 420000, 398000, 302000 &408000 weevils, respectively. From these data, we can be concluded that Rhyfer pheromone is about 1.12, 1.18, 1.56 & 1.16 % more efficient than Pherocon, Ferrugitom, Weevillure & Ferrulure, respectively.

Conclusions

The efficiency of the aggregation pheromone used by farmers to monitor and mass trapping of the red palm weevil depends on a number of factors, the most important are the composition, the concentration, the emission rate and its stability, which is mainly based on the company technology in manufacturing of the pheromone membrane, that is controls the rate of emission and its stability with the recommended life time of the pheromone, which in turn affects the efficacy of the attractions. Collectively, the comparison between the total numbers of RPW captured by the traps in the three orchards by using each of the five different pheromone sources confirms differences in the attractions efficiency according to the manufacturer's technology. Weevillure pheromone trap capture significantly lower numbers of RPW than Rhyfer, Pherocon, Ferrugitom and Ferrulure pheromone sources.

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