**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 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 farms are characterized by having different levels of infestation incidence by red palm weevil. In each of the three farms, theRandomize Complete Block Design (RCBD) with five treatment and three replicates was used. The 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 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 insect was first described in India as a serious pest of coconut palm (Lefroy, 1906) and later on date palm (Buxton 1918). This insect 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).

Management of this pest 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 adult weevil (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 used in various countries (Abraham et al. 1998; Hallett et al. 1999; Vidyasagar et al. 2000).

Adopting optimum trapping protocols (Hallett et al. 1999; Faleiro 2006; Giblin- Davis et al. 2013) is vital to ensure the beneﬁts of pheromone trapping to manage RPW. The standard four window bucket trap (Faleiro 2006) is widely used in trapping this weevil. Black colored traps have been found to enhance weevil captures (Hallett et al. 1999; Abuagla and Al-Deeb 2012).

The average recommended emission rate for the RPW pheromone is 3 mg / 24 hours. While the pheromone efficiency depends on a number of factors, the most important are the composition, the concentration, emission rate and the stability of emission, which is mainly based on the manufacturer's technology in the manufacture of the 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, which is also have some variations in the membrane manufacturing technology that will controls the pheromone emission rate.

This study aims to evaluate the capturing effectiveness for the different sources from the commercial aggregation pheromone available in the local market to be use in monitoring and mass trapping of RPW which play an important role in the sustainability of date palm sector in the Emirate of Abu Dhabi.

**Materials and Methods**

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

 Five different sources of the commercial aggregation pheromone (treatments) from the local market were evaluated for its effectiveness in capturing red palm weevil. The experimental design in each farm was 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 of the different sources of the aggregation pheromone is the adopted and used one 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. Unmarketable 100 grams date fruits were added to each trap every two weeks, and five liters of water every week.

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 all data and differences between means were separated by using Fisher’s LSD test at P < 0.05. All statistical analyses were conducted by using SAS program.

**Results**

Results of this study confirm the existence of significant difference in the average number of red palm weevils in the three farms. This result is compatible with the objectives of the study to evaluate the efficiency of the different sources of the pheromone under field conditions in the presence of differences in the level of infestation by red palm weevil (Figure 1). The average number of red palm weevils in the second farm has reached about 279 weevils per trap during the study period from June 2014 until March 2015, compared with 80 and 43 weevils per trap in the third and first farms, respectively.

 **Fig.1: Average number of red palm weevils caught by 15 traps in each**

 **farm from the period June, 2014 to March, 2015.**

The different sources of the pheromone efficiency (treatments) comparison revealed significant differences in the average number of RPW captured in each of the three farms (Fig.2). In the first low infestation farm, the average number of RPW reached (33.33) weevils per trap by using the Weevillure pheromone treatment which is significantly lower than that of the average number (54.33) weevils per trap in the Ferrugitom pheromone treatment. While no significant differences were found between these two treatments and the other three treatments where the average number of RPW in the trap reached 39.67, 39.33, and 51.0 weevils per trap for the treatments Rhyfer, Pherocon, and Ferrulure, respectively.

In the second high infestation farm, the efficiency for the different sources of the pheromone seems to be compatible with the results from the first farm. Average number of RPW captured by the Weevillure pheromone treatment (214.33) weevils per trap was significantly lower than that of the average number of weevils caught by other treatments. No significant differences were found between the first two treatments Rhyfer and Pherocon (343 & 284) weevils per trap, as well as no significant differences were found between the second, third, and fifth treatments Pherocon, Ferrugitom, and Ferrulure ( 284, 275.67 & 278.67) weevils per trap, respectively (Fig.2).

The efficacy results for the different sources of the pheromone in the third mid infestation farm were also compatible with the results from the first and second farm (Fig. 2). Weevillure pheromone trap capture significantly lower numbers (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 caught by Ferrugitom pheromone (71.67) weevils per trap were not significant different from the number caught by Weevillure pheromone trap as well as not significant different from the number caught by Rhyfer and Ferrulure pheromone traps. Furthermore, number of RPW caught by the Pherocon pheromone traps were significantly higher that the number of weevils caught by the Ferrugitom and Weevillure pheromones treatments (Fig.2).

 **Fig: 2: Average number of red palm weevil caught by each trap in each**

 **farm from the period June, 2014 to March, 2015.**

Collectively, the comparison between the total numbers of RPW caught by trap in the three farms by using each of the different pheromone sources confirms the previous findings (Fig.3). Weevillure pheromone trap capture significantly lower numbers (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 pheromones as well as between the Pherocon pheromone with Ferrugitom and Ferrulure pheromone sources (Fig.3).

 **Fig.3: Average number of red palm weevil caught by each trap in the**

 **three farms from the period June, 2014 to March, 2015.**

**Discussion**

For the most effective management of this weevil, integrated pest management (IPM) was applied in most of the Gulf countries. As an important module of IPM program, the Agriculture Ministry of Saudi Arabia has been organizing the mass trapping of RPW for over 15 years (Abraham et al., 1998; Faleiro, 2006). Recent researches have also been focusing on finding Pheromone trapping of adult palm weevils 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 Al Qatif region in 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 UAE, by using pheromone trapping in three date palm farms during 2000 and 2001, the populations of RPW was reduced by 29.7-51.7% (Abbas et al., 2002). About two million RPW trapped in Abu Dhabi farms during the first half of 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 farms, where about 118,797 pheromone traps have been installed in the farms following correct scientific practices (Gulf News, 2013).

In an endemic area of RPW infestation, the higher trap density is needed to reduce insect population in a much shorter time frame. It may be suggested to increase the trap numbers sufficiently as well as increasing the traps efficacy to remove higher numbers of weevils rapidly to 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 trapped by 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 RPW by the traps, 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, it 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**

Red palm weevilaggregation pheromone efficiency depends on a number of factors, the most important are the composition, the concentration, emission rate and the stability of emission, which is mainly based on the manufacturer's technology in the manufacture of the membrane that controls the rate of emission, which in turn affects the efficiency of the attractions. Collectively, the comparison between the total numbers of RPW caught by trap in the three farms by using each of the different pheromone sources confirms different efficiency of the attractions according to the manufacturer's technology. Weevillure pheromone trap capture significantly lower numbers RPW than Rhyfer, Pherocon, Ferrugitom and Ferrulure pheromone sources sources.

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