

Evaluating Field Management Protocol of the Invasive Pest Red Palm Weevil, *Rhynchophorus ferrugineus* at Basrah, Iraq

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Abstract

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Monthly monitoring of the red palm weevil (RPW), *Rhynchophorus ferrugineus* populations was conducted using pheromone traps (RHYFER 700). A six-year evaluation (2017-2022) assessed the effectiveness of a twice-yearly chemical control program. This protocol involved aerial spraying and injection of the insecticides imidacloprid and deltamethrin at Safwan County of Basrah, Iraq. The results obtained showed that the infestation levels of RPW across the studied orchards varied in 2017. However, in the year 2022, a noticeable reduction in infestation was observed, suggesting that the control protocol used was effective. The captured numbers of RPW adults per pheromone trap exhibited notable fluctuations during the study years. The monthly population of captured RPW showed also significant variation; the highest mean numbers of captured adults per trap were 2.06 and 2.47 weevils/trap in March and April, respectively. However, the lowest average number of captured weevils was 0.51 and 0.54 weevils/trap in January and December, respectively. Consistently, the sex ratio of RPW populations in Safwan County exhibited a bias towards female weevils. The study emphasized the need for continuous monitoring, which is essential for the adaptive pest management strategies of RPW infestations in date palm orchards.

Keywords: Chemical control, date palm, red palm weevil, *Rhynchophorus ferrugineus*, pheromone trap.

Introduction

Red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier, 1790) is a dangerous insect pest that poses a significant threat to palm trees worldwide (Dembilio & Jaques, 2012). Particularly, it is recognized as the key and most significant pest affecting date palms in the Arabian Gulf States (Abraham *et al.*, 1998). In 1985, this weevil was accidentally introduced to northern United Arab Emirates and since then, it has rapidly spread and became dominant throughout the Arabian Gulf States (Balijepalli & Faleiro, 2019; Ferry & Gomez, 2002). In Iraq, the invasion of RPW in Safwan county, Basrah province, was first recorded in December 2015 (Alderawii *et al.*, 2020).

This insect caused significant economic losses in palm-growing regions (El-Sabea *et al.*, 2009). Certain traditional farming practices, such as removing leaves during harvesting or pruning offshoots, accidentally cause injuries to the trees with the release of volatile compounds that attract male weevils (Gunawardena *et al.*, 1998). The males release aggregation pheromones that draw both males and females to the location. In addition, the date palm's attraction through chemical compounds synergistically enhance the pheromone's potency, ultimately drawing them towards the field (Junejo, *et al.*, 2022; Soroker *et al.*, 2015). Females lay eggs in soft or injured areas on the lower trunk of the palm. The hatched larvae feed on the soft plant tissue, which leads to disrupting nutrient transport to the upper part of the palm, eventually causing death (Murphy & Briscoe, 1999).

Early detection of *R. ferrugineus* infestations has a significant challenge due to the insect's cryptic behavior. Usually, the identification occurs only after considerable

damage to the palm. Consequently, preventive strategies primarily rely on the repeated application of insecticides, which emphasizes the importance of chemical control measures (Peng & Hou, 2017). Several insecticides, such as abamectin, chlorpyrifos, emamectin, imidacloprid, phosmet, and thiamethoxam, are commonly used as sprays on the trunk, or as soil drenches in palm plantations (Hernandez-Marante *et al.*, 2003).

Trunk injection of systemic insecticides provides an efficient method to deliver the product into the vascular system of palm trees. Several systemic insecticides have been authorized in various EU countries for *R. ferrugineus* control, such as clothianidin, imidacloprid, thiamethoxam and avermectin (abamectin and emamectin) (Abo-El-Saad *et al.*, 2013; El-Sebay & Abbas, 2008; Dembilio *et al.*, 2010). This type of treatment targets the various weevil stages, that can help minimize the environmental impact of pesticide application (El-Sebaey, 2004).

Monitoring of adult weevils' plays a fundamental role in Integrated Pest Management (IPM) of RPW through aggregation pheromone traps which are utilized for monitoring and mass trapping of adult weevils (Abraham *et al.*, 1998; Abuaglala & Al-Deeb, 2012; Egonyu *et al.*, 2022; Faleiro *et al.*, 1998). The main aggregation pheromones of *R. ferrugineus* used in the traps are Rhyfer 700, Pherocon RDPW Lure, Ferrugitom 700, Weevil lure, and Ferrulure (Abraham *et al.*, 1998; Jaddou *et al.*, 2017; Hallett *et al.*, 1993; Vidyasagar *et al.*, 2000).

Currently, there is a lack of pesticide efficacy studies for RPW in Iraq. The objective of this study is to assess the chemical control of RPW infesting date palm plantations at Safwan, Basrah.

Materials and Methods

Chemical control program of invasive Red Palm Weevil *R. ferrugineus* in Safwan County

This investigation was conducted in 19 private date palm orchards (Table 1) located in Safwan County, province of Basrah, Iraq, that had a history of red palm weevil infestation. Over the course of six years (2017-2022), a chemical control protocol was applied to eradicate and control RPW in date palm plantations. This strategy involved using aerial spraying and injection of the insecticides Imidacloprid and Deltamethrin (Table 2), applied twice a year. This protocol is adopted and utilized by Basrah Department of Plant Protection, Ministry of Agriculture, Iraq.

Table 1. The infested date palm orchards which selected for evaluating the chemical control protocol of RPW, *R. ferrugineus* at Safwan in 2017-2022.

Orchard No.	Total number of date palm trees	Number of infested date palm trees in	
		2017	2022
1	200	4	0
2	60	13	0
3	88	2	0
4	300	2	0
5	400	2	0
6	400	4	0
7	450	1	0
8	300	1	0
9	50	3	0
10	3,000	1	0
11	300	2	0
12	700	4	0
13	109	3	0
14	500	1	0
15	100	1	0
16	75	2	0
17	95	3	1
18	700	5	0
19	150	3	1

Table 2. Insecticides used against RPW *R. ferrugineus*.

Trade Name	Active ingredient	Dosage ml/100 L	Manufacturer
Confidor	Imidacloprid 200 g/L	100	Bayer Crop Science
Decis	Deltamethrin 25 g/L	100	Bayer Crop Science

Monitoring the long-term impact of chemical control on the invasive pest RPW, *R. ferrugineus* populations in Safwan County

A comprehensive monitoring program was carried out in RPW-infested date palm plantation (Table 1). Pheromone traps covered an area of two dunams at the orchard border, and each trap was inspected biweekly. A pheromone (RHYFER 700; Red Palm Weevil, Alpa Scents, Inc.) was

placed in standard black bucket traps with a 10-liter capacity. These traps were covered with a rough outer fabric that allowed RPW to climb and enter. The pheromones were positioned in the middle of the trap cover's bottom surface using a metal wire.

New pheromone sources were set up monthly. 100 grams of dried date palm trunk pieces were added to each trap every two weeks. Additionally, five liters of water were added to each trap weekly. The total number of RPW (males and females) caught by each trap were recorded biweekly throughout the period from January 2017 to December 2022.

Statistical analysis

The data was analyzed to determine the mean number of captured adults and their corresponding standard errors by using analysis of variance (ANOVA). Means were compared using the least significant difference (LSD) test at $P=0.05$. The analysis of the sex ratio of RPW was determined with χ^2 test by using R program (R Core Team, 2019).

Results and Discussion

The results obtained (Table 1) summarized RPW monthly counts to evaluate the effectiveness of the chemical control protocol of *R. ferrugineus*. In 2017, the number of date palms infested with RPW was recorded, and the infested date palms ranged from 1 to 13 trees. However, many orchards reported no date palm infestation in 2022, suggesting that the chemical control protocol used has been successful in reducing the weevil infestations over the six-year period.

The average number of RPW adults captured per pheromone trap over six consecutive years is summarized in Table 3. The average number of captured adults per trap per year was 0.640 weevils/trap in 2017, whereas in 2018, it increased to 1.246 weevils/trap, and then slightly decreased to 0.886 weevils/trap in 2019. In 2020, the average number further increased to 1.031 weevils/trap. This increase continued further in 2021 and 2022, with an average of 2.092 and 2.053 weevils/trap, respectively.

The mean number of adults were 0.509 and 0.991 weevils/trap in January and February, respectively. However, the numbers increased in March and April to 2.061 and 2.474 weevils/trap, respectively. Then, numbers declined to 1.867 and 1.018 weevils/trap in May and June, respectively. Finally, the number of captured weevils was 0.544 weevils/trap in December (Table 4).

The sex ratio was consistently shifted towards females; the overall sex ratio was 3.3:1 (112♀:34♂) in 2017, then declined to 1.1:1 (104♀:98♂) in 2019, and increased to 1.8:1 (300♀:166♂) in 2022 (Table 5).

The evaluation of the chemical control protocol of RPW confirmed a significant reduction in infested date palms at Safwan, Basrah (2017-2022). The used insecticides (Imidacloprid and Deltamethrin) were primarily transported through the xylem of both monocotyledonous and dicotyledonous plant species, and they had an effect on the postsynaptic nicotinic acetylcholine receptors of the insects, which ultimately led to their death (Stein-Dönecke *et al.*, 1992). The results of the pest monitoring demonstrated a significant variation in RPW populations. Knowledge of

monthly variation in the RPW populations can help in applying more effective pest management strategies.

Integrated pest management (IPM) of RPW has been widely adopted in Arabian Gulf countries. One crucial component of the IPM program is the mass trapping strategy in the date palm orchards (Abraham *et al.*, 1998; Faleiro, 2006), aiming to reduce insect populations (Abraham *et al.*, 1998; Vidyasagar *et al.*, 2000).

In the Eastern Province of Saudi Arabia, a mass trapping system involving 2,252 pheromone traps covering an area of over 10,000 hectares in Al Qatif region produced useful results. The weevil population decreased from 4.12 weevils/trap in 1994 to 2.02 weevils/trap per week by the end of 1997 (Vidyasagar *et al.*, 2000). Similarly, in the United Arab Emirates, pheromone trapping in three date palm orchards during 2000 and 2001 led to a reduction of RPW populations by 29.7% to 51.7% (Abbas *et al.*, 2002).

In Abu Dhabi Emirate, a project covered approximately 23,050 orchards, with the installment of around 118,797 pheromone traps, which successfully captured about two million red palm weevil adults during the first half of the year 2013. In the UAE, the Weevil lure trap captured significantly fewer RPW adults compared to other aggregation pheromones (Jaddou *et al.*, 2017).

It can be concluded that the chemical control protocol assessed in this study for managing RPW infestations was successful. The regular monthly monitoring for RPW populations emphasizes the need for continuous application of RPW chemical control in date palms at Safwan County.

Table 3. Effect the chemical control on the average of annual captured RPW, *R. ferrugineus* adults per pheromone trap at Safwan (2017-2022).

Year	RPW population (weevil/trap)	
	Total	Mean±SE
2017	146	0.640±0.099 c
2018	284	1.246±0.106 b
2019	202	0.886±0.109 bc
2020	235	1.031±0.106 bc
2021	477	2.092±0.194 a
2022	468	2.053±0.174 a

Mean values followed by the same lowercase letters in the same column are not significantly different at P=0.05.

Table 4. The effect of chemical control on the average of monthly captured RPW *R. ferrugineus* adults/pheromone trap at Safwan.

Month	RPW population (weevil/trap)
	Mean±SE
January	0.509±0.105cd
February	0.991±0.150 bcd
March	2.061±0.303 ab
April	2.474±0.301 a
May	1.867±0.254 ab
June	1.018±0.146 bcd
July	1.456±0.203 ab
August	0.965±0.143 bcd
September	0.921±0.120 bcd
October	1.386±0.149 ab
November	1.702±0.189 abc
December	0.544±0.098 d

Mean values followed by the same lowercase letters in the same column are not significantly different at P=0.05.

Table 5. Sex ratio of RPW *R. ferrugineus* in Safwan over a period of six years (2017-2022).

Year	No. of weevils/trap		Sex ratio	
	Male	Female	Female: male	χ^2
2017	34 d	112 b	3.3:1	372.18, $p < 0.00$
2018	105 c	179 b	1.7:1	123.42, $p < 0.00$
2019	98 c	104 b	1.1:1	239.41, $p < 0.00$
2020	112 bc	122 b	1.1:1	104.98, $p < 0.00$
2021	182 a	296 a	1.6:1	321.86, $p < 0.00$
2022	166 ab	300 a	1.8:1	124.95, $p < 0.00$

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المخلص

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تم إجراء رصد شهري للمجموع العددية لسوسة النخيل الحمراء (*Rhynchophorus ferrugineus*) باستخدام المصائد الفرمونية (RHYFER 700). وأجري تقييم لمدة ست سنوات (2017-2022) لفاعلية برنامج مكافحة الكيمائية بواقع مرتين في السنة. تضمن هذا البروتوكول رشّ وحقن المبيدات الحشرية Imidacloprid و Deltamethrin في قضاء سفوان بمحافظة البصرة، العراق. أظهرت النتائج أن مستويات الإصابة بسوسة النخيل الحمراء في بساتين الدراسة كانت متنوعة في عام 2017، وانخفضت بعد ذلك مستويات الإصابة حتى عام 2022، مما يشير إلى فعالية بروتوكول المكافحة الكيمائية. كما أظهرت أعداد الحشرات البالغة للسوسة التي تم اصطيادها باستخدام المصائد الفرمونية حدوث تقلبات ملحوظة خلال سنوات الدراسة. أما بالنسبة لمراقبة الآفة خلال أشهر السنة، فقد لوحظ وجود اختلافات واضحة في المجموع العددية خلال أشهر السنة، حيث سجل أعلى متوسط لأعداد البالغات (2.06 و 2.47 بالغة/مصيدة) في شهري نيسان/أبريل وأيار/مايو، على التوالي.

ومع ذلك، كان أدنى عدد لمتوسط للخنافس التي تم اصطيادها هو 0.51 و 0.54 بالغة/مصيدة في شهري كانون الثاني/يناير وكانون الأول/ديسمبر، على التوالي. كما أظهرت النسبة الجنسية للمجاميع العددية لسوسة النخيل الحمراء انحيازاً نحو الإناث في منطقة سفوان. وأخيراً، أكدت الدراسة على ضرورة الرصد المستمر، وهو أمر أساسي لاستراتيجيات الإدارة المتكاملة لسوسة النخيل الحمراء في بساتين نخيل التمر.

كلمات مفتاحية: مكافحة كيميائية، نخيل التمر، سوسة النخيل الحمراء، *Rhynchophorus ferrugineus*، مصادد فرمونية.

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