Scientific Research Publishing

Advances in Entomology, 2025, 13(3), 321-330
https://www.scirp.org/journal/ae
ISSN Online: 2331-2017
ISSN Print: 2331-1991

A Natural Composition to Control the Red Palm Weevil *Rhynchophorus ferrugineus* (RPW)

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How to cite this paper: Mogahed, M.I. (2025) A Natural Composition to Control the Red Palm Weevil *Rhynchophorus ferrugineus* (RPW). *Advances in Entomology*, **13**, 321-330.
https://doi.org/10.4236/ae.2025.133021

Received: May 3, 2025
Accepted: July 26, 2025
Published: July 29, 2025

Abstract

Laboratory experiments showed that the mixture of inorganic salts with mineral oil is effective against 4th larval instar of the red palm weevil, *Rhynchophorus ferrugineus* (RPW). Light trap data showed that insects which help in the spread of *R. Ferrugineus* in palm groves, they appear during the months of February and March. Its peak recorded from May until September. The neglected palm orchards are more susceptible to insect infestation with RPW than those that receive agricultural and pest control services. Field experiments in Nubariya and EL-Marg regions showed that injecting palms with a triple mixture consisting of motor oil—jojoba oil and a solution of inorganic salts at a rate of 1 liter of each substance (which are the components of the natural composition) to treat both two varieties Samani and Ikhlas, as well as the two varieties (Barhi and Zaghloul) of the infected palms) by injecting the natural composition for 6 consecutive months at a rate of 100 cm/infected palm, the treated palm trees recovered by 100% from infection with RPW.

Keywords

A Natural Composition, Control the Red Palm Weevil *Rhynchophorus ferrugineus* (RPW)

1. Technical Background

The date palm crop is one of the important economic crops in Egypt. It is considered an important export crop for national wealth. Palm products, such as palm fronds and palm fibers, also play a vital role in Egyptian industries. Cultivation of date palm varieties is widespread in various governorates of Egypt such Matrouh, New Valley, North and South Sinai and the newly reclaimed lands. Egyptian palm trees, like other fruit trees, are exposed to the invasion of many insect pests, such

as borers and beetles, which helps spread the most dangerous insect that attacks palm trees, which is the red palm weevil, *R. ferrugineus* had been entered Egypt in 1992 and spread in many governorates. It has become a major source of economic loss in date production, especially in the Middle East [1].

Recent studies have proven that the epidemic spread of the red palm weevil, *R. Ferrugineus*, may lead to the death of palm trees within a year or two, which limits the spread of palm farms in many regions and threatens the national wealth in Egypt [2].

Chemical pesticides did not have an effective role in controling it because the spraying with pesticides was on the outer surface of the palm tree's bark, while the red palm weevil (RPW) lived in safety inside the palm tree. It feeds on the internal tissues in the heart of the palm tree. So it weakens It will wither and perhaps die. Immediately, Specialists in pest control began spraying the infested palm trees with different insecticides at several times to reduce the activity of the insect, but to no avail, although there are deep concerns now about environmental pollution and the emergence of insect resistance to the act of pesticides used [3].

In view of the danger of RPW and its economic importance [4] Aqeel mentioned that it is necessary to implement an integrated pest control program with an emphasis on biological methods in order to achieve significant progress in pest control for Protecting the environment from pollution caused by the excessive use of chemical pesticides in pest control. Therefore, this was a strong motivation to search for biological alternatives to combat the red palm weevil and to explore other natural methods to reach the insect inside the infected palm tree. While protecting the environment from pollution and human health from the dangers of chemical pesticides. Research appeared on biochemistry—volatile oils—vegetable oils and mixtures of natural oils with pure pesticides. Such as Studies have been conducted on the insect's preference for certain plants and its biological effects on the red palm weevil to search for alternative biological materials to combat *R. ferrugineus* (Olivier) that infects palm trees [5].

Many researchers have contributed to suppress the dangerous of this insect pest, RPW using biochemicals and others in individual methods such as [6] Shukla, et al. evaluated the antifeedant activity of three essential oils (EOs) which found that EOs from *E. adenophorum* flowers and aerial parts of *A. nilagirica*, have potential as environment-friendly alternative method for management of the RPW. Also, [7] Ahmed, et al. [8] Abdel Kareem et al., they suggested that EOs could be included as an integral part of an integrated pest control programme. It is against the egg laying of the red palm weevil *R. ferrugineus* [9] Mogahed and Sharaby mentioned that mixtures of inorganic salts, mineral oils and insecticides (individually and in mixtures) were used against RPW, which gave high protection and 100% recovery for all treated palms. against the red palm weevil and also [10] [11] also injected some natural oils, individually and mixed with pure chemical pesticides, into the affected palm stem. It was effective against the red palm weevil. *R. ferrugineus.*

Specialists such as [7] Ahmed et al. tested four vegetable oils from: *M. offici-*

nalis, *B. officinalis*, *L. nobilis*, and *C. ipecacuanha* to study its insecticidal activity on some biological aspects, the results showed that the four tested oils disrupted some biological aspects of the tested insects. Also, [8] Abdel Kareim, et al. in controlling RPW evaluated oviposition deterrent activity of the Egyptian essential oils and reported that both essential oils (*S. aromaticum* and *C. eucalyptusa*) can be included as an integral parts of an IPM program against the date palm weevil (RPW). Mixtures of inorganic salts, mineral oils and insecticides (individually and in mixtures) were used against RPW, which gave high protection and 100% recovery for all treated palms. against the red palm weevil. Therefore, current applied experiments were conducted to explore the efficiency of the natural composition in combating the red palm weevil that attacks date palm trees in the Marj and Nubariya regions of Egypt.

Experiments in the field have proven that injecting the prepared composition into the trunk of a palm tree infected with the red palm weevil. It was highly effective as a killer of the different stages of insects inside the trunk of the infected palm tree.

2. Materials and Methods

Firstly: indicative laboratory experiments

Laboratory experiments were conducted to find out the effectiveness of some biological alternatives (mineral oils and inorganic salts) alone and mixed with Jojoba oil on the fourth larval instar of the red palm weevil Rhcynhophorus ferrugineus (RPW). The larvae were subjected to compulsory feeding on the treated apple fruits with different concentrations (1%, 3%, 5%, 7.5% and 10%) of the tested compounds

Steps of work on the farm

1. Detecting infected palm trees in the orchard and identifying them with distinctive signs

2. The card attached to the palm tree includes: the type of palm tree—the type of treatment—the date of the experiment and the replicate number.

3. Evidence of injury: holes in the trunk of the palm tree. A foul-smelling, putrid liquid flows from it, which changes color when exposed to the air outside the palm tree.

4. A drill or metal wire is inserted into this hole—the tissue inside the hole is broken up mentioned

5. There is a yellow leaf hanging at the top of the palm tree as another manifestation of injury.

6. The presence of adult stages of the insect wandering between the aerial roots of the infected palm tree. Thus, the palm tree is considered infected. It is collected by daily manual collection.

Secondly: Field application

Implementation method

Field experiments were conducted in a palm grove that includes the Barhi (im-

ported) and Zaghloul (local) cultivars in the Noubariya region of Beheira Governorate –and on varieties of Samani and Ikhlas in EL Marg area, Cairo Governorate. Egypt by injecting the natural composition into the trunks of infected palm trees to combat the red palm weevil, (RPW) which has infected palm trees and spread in various governorates of Egypt.

1. Materials: Motor oil—inorganic salts—Jojoba oil

2. Tools: Drill for drilling holes—Aluminum tubes to be inserted into the holes to pour the tested material into these tubes.

3. Preparing the natural composition: The natural composition is prepared by mixing vegetable oil and mineral oil with a solution of inorganic salts at a rate of 1 liter of each substance. They are mixed together to prepare the required natural composition in a size of 3000 cm to be distributed among 30 palm trees infested with the red palm weevil at a rate of 100 cm of the mixture (the natural composition), so that it is renewed every month. The affected palm must be treated during the period of agricultural service, as there are no fruits on the palm trees.

3. Results

Laboratory experimental data showed that a mixture of salts with mineral oils is better, but care should be taken to double the concentration of natural materials in the field to meet environmental conditions and dispense completely free from pesticides to protect the human consumer.

Field trials:

Light trapping data (Table 1) indicated that most of the insects caught by light traps that play a role in the spread of the red palm weevil *R. Ferrugineus* in palm groves. They appear in early February and March. Peak numbers have been recorded during May until September. The data showed that Neglected palm gardens are more vulnerable to insect infestation than those that are maintained in terms of agricultural and pest control services.

The results of EL-Noubariya (Table 2) showed that the injection of natural materials individually led to the recovery of the treated palm (Zaghloul variety) from red palm weevil infection with percentages that ranged between 30% - 50% and between 30% - 60%. The Barhi variety recovered from red palm weevil infection.

Table 1. Monitoring the activity of date palm insects in the concerned date palm gardens and those neglected in the agricultural service.

Item	Insect infestation during experiment months												Total	Aver. ± SD
	Feb. 2108	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 2019		
Insect infest.% in cared garden.	0	0	3	4	4	5	6	7	3	3	0	0	35	4.4 ± 1.5
Insect infest.% In aneglected garden	0	0	5	20	25	30	35	40	55	60	70	70	410	41.0 ± 22.0

T value: 4.7, Significantly difference between the two treatments at 0.05 and 15df.

Table 2. Effect of natural materials on the red palm weevil in EL-Noubariya region, Egypt.

Variety	Processing	Materials	No. Tested palm// treat.	Cumulative number post treatment (Month)					
				2		4		6	
				No. Recov. Palm	% recovery	No. Recov. Palm	% recovery	No. Recov. Palm	% recovery
Samani	Single	Salts	10	1 ± 1d	10%	2 ± 0e	20%	6 ± 1cde	60%
		Used Car Oil	10	2 ± 1cd	20%	3 ± 1de	30%	7 ± 1bcd	70%
		Jojopa Oil	10	1 ± 0d	10%	2 ± 1e	20%	4 ± 2e	40%
	Binary	Salts + Used Car Oil	10	3 ± 1bc	30%	4 ± 1cd	40%	8 ± 1 abc	80%
		Salts + Jojopa Oil	10	2 ± 0cd	20%	3 ± 1de	30%	6 ± 0cde	60%
		Used Car Oil + Jojopa Oil	10	2 ± 1cd	20%	3 ± 0de	30%	7 ± 1bcd	70%
	Triple	Used Car Oil + Jojopa Oil + Salts	10	3 ± 1bc	30%	5 ± 2bc	50%	9 ± 1ab	90%
Ekhlas	Single	Salts	10	2 ± 1cd	20%	4 ± 0cd	40%	7 ± 1bcd	70%
		Used Car Oil	10	2 ± 1cd	20%	4 ± 1cd	40%	8 ± 1abc	80%
		Jojopa Oil	10	2 ± 0cd	20%	3 ± 1de	30%	5 ± 2de	50%
	Binary	Salts + Used Car Oil	10	4 ± 1bc	40%	6 ± 1b	60%	9 ± 1ab	90%
		Salts + Jojopa Oil	10	2 ± 1cd	20%	4 ± 1cd	40%	6 ± 0cde	60%
		Used Car Oil + Jojopa Oil	10	3 ± 1bc	30%	4 ± 0cd	40%	7 ± 1bcd	70%
	Triple	Used Car Oil + Jojopa Oil + Salts	10	5 ± 1a	50%	8 ± 2a	80%	10 ± 1a	10%
		$LSD_{0.05}$		1.612	-	1.788	-	2.048	-

The results showed that injecting the Binary mixture of natural materials into the stem of the affected palm tree (Zaghloul variety) led to the recovery of the treated palm trees with percentages that ranged between 40-60% and between 50-80% for the Barhi variety. When the triple mixture of 1 liter of each motor oil—jojoba oil—and inorganic salts (components of Natural Composition) was injected into the stem of the infected palm tree (Barhi and Zaghloul), the percentage of recovery from RPW infestation reached 100% for both varieties After 6 months of follow-up treatment. Against the red palm weevil (RPW).

It was noted from the results of El-Marj (Table 3) that a single injection of raw natural materials (Engine oil—Jojoba oil) and a solution of inorganic salts at a rate of 100 cm per infected palm tree for a period of 6 consecutive months (the period of agricultural service) gave recovery rates of 50 to 80% for trees of treated palm (Samani and Ikhlas) from infection with the red palm weevil.

However, treating the infected palm trees with a binary mixture of natural materials at a rate of 1 liter for each. resulted in the treated palms being cured by a rate ranging between 60% - 90% from the red palm weevil infection. When the infected palm trees (Samani-and-Ikhlas vars) were treated by injecting the triple mixture (engine oil—jojoba oil—and a solution of inorganic salts) at a rate of 1

Table 3. Effect of Natural materials on the red palm weevil in EL-Marg region, Egypt.

Variety	Processing	Materials	No. Tested palm//treat.	Cumulative number post treatment (Month)					
				2		4		6	
				No. Recov. Palm	% recovery	No. Recov. Palm	% recovery	No. Recov. Palm	% recovery
Samani	Single	Sc	19	1 ± 0cd	10%	3 ± 1cd	30%	1 ± 0cd	10%
		Uco	19	2 ± 1bc	20%	4 ± 2c	40%	2 ± 1bc	20%
		Fujo	19	0 ± 0d	0%	0 ± 0e	0%	0 ± 0d	0%
	Binary	Sc + uco	19	2 ± 1bc	20%	3 ± 0cd	30%	2 ± 1bc	20%
		Sc + fujo	19	0 ± 0d	0%	2 ± 1d	20%	0 ± 0d	0%
		Uco + ujo	19	1 ± 0cd	10%	3 ± 1cd	30%	1 ± 0cd	10%
	Triple	Sc + uco + fujo	19	3 ± 1ab	30%	6 ± 2b	60%	3 ± 1ab	30%
Ekhlas	Single	Sc	19	1 ± 0cd	10%	3 ± 0cd	30%	1 ± 0cd	10%
		Uco	19	2 ± 1bc	20%	4 ± 2c	40%	2 ± 1bc	20%
		Fujo	19	0 ± 0d	0%	0 ± 0e	0%	0 ± 0d	0%
	Binary	Sc + uco	19	3 ± 0ab	30%	8 ± 1a	80%	3 ± 0ab	30%
		Sc + fujo	19	1 ± 1cd	10%	2 ± 0d	20%	1 ± 1cd	10%
		Uco + ujo	19	2 ± 0bc	20%	3 ± 1cd	30%	2 ± 0bc	20%
	Triple	Sc + uco + fujo	19	4 ± 1a	40%	7 ± 1ab	70%	4 ± 1a	40%
		$LSD_{0.05}$		1.094	-	1.896	-	1.094	-

liter of each of the tested natural materials, each infected palm tree was treated. An injection at a rate of 100 cm/cf resulted in a 100% recovery of the treated palm trees from infection with the red palm weevil.

4. Discussion

Laboratory experimental data showed that mixing a solution of inorganic salts with mineral oils is effective against the fourth larval stage of the RPW insect, so consideration must be given to doubling the concentration of natural materials in the field to confront environmental conditions and dispensing with the pesticide completely to protect the human consumer.

The results of light traps indicate that most of the insects caught by light traps that play a role in the spread of the red palm weevil in palm groves appear in early February and March. The peak numbers were recorded during the month of May to September based on the activity of each of them, and they are more consistent with the results obtained [9] Mogahed and Sharabi, where they found that the largest number of insects caught by the light trap in the palm grove was in the months From April to August, the number decreases in December-January. One of the most widespread insect pests in neglected palm groves is *O. elegans*, which helped spread the red palm weevil among palm groves, and caused the death of infected palm trees, which led to a decrease in date fruit production.

The results of (Figure 1) showed that the recovery of palm trees in the two treated varieties (Zaghloul and Barhi) increases with the continuation of treatment for two consecutive seasons of the infected palm trees when using a mixture

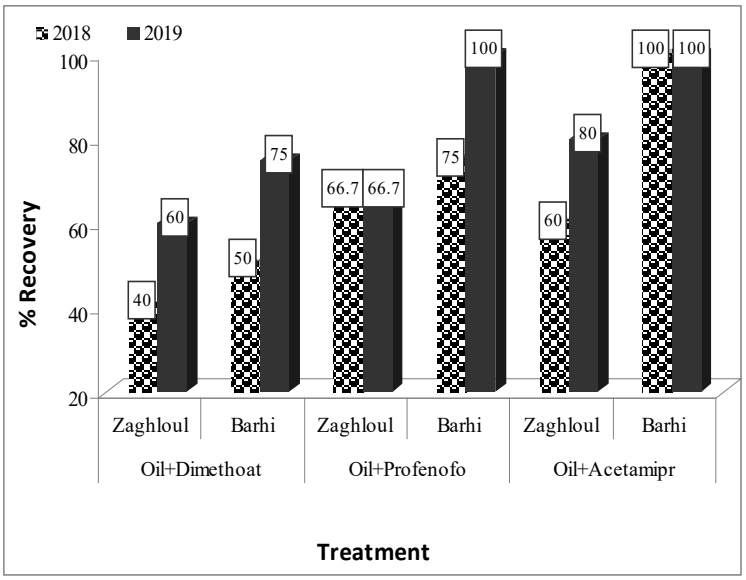

Figure 1. Effect of petroleum oil in combination with chemical insecticides on the red palm weevil *Rhynchophorus ferrugienus* under field conditions. F value (0.05):1.2; No significant difference between averages of recovered holes (post treatment) and injection treating the tested mixtures.

of mineral oil (petroleum oil) with chemical pesticides (Mosspilan or Silicron). Since the results of using mixtures of natural materials have proven to be as effective as chemical pesticides. Therefore, it is better to use mixtures made from natural materials only without pesticides this is the so-called natural composition that has proven effective in combating the red palm weevil (RPW)in the Al-Marj and Al-Nubaria regions, in addition to its natural components being safe for the consumer and not polluting the environment.

The successive studies indicate that the difference in the susceptibility of palm varieties to infection with the red palm weevil may be due to the difference in the components of the palm varieties, which makes it necessary to take all control measures in an integrated manner, to reduce infestation and avoid damage caused by this devastating pest *R. ferrugineus*. Based on the exposure of palm trees to severe damage caused by the red palm weevil, [12] mentioned by Abraham and Vidyasagar (1992AD). [13] Abraham et al The main components of an integrated pest management strategy are trapping the weevil using a pheromone lure and monitoring infestation through continuous inspection of palm trees, disinfection of abandoned gardens, preventive and curative chemical control and implementation of quarantine procedures.

It has become clear through current experiments that injecting the natural composition (the triple mixture consisting of engine oil—jojoba oil—and inorganic

salts) into the stem of the infected palm tree (Barhi and Zaghloul var.) and the infected palm tree (Samani and Ikhlas var.) for processed items after 6 months of follow-up treatment gave a percentage of recovery reached 100% from RPW infection in ELMarj and Nubariya regions from against *R. ferrugineus* infestation.

Based on the applied results obtained, the focus in the regions of El-Marg and Al-Nubariya experiments was on the use of natural materials only because their results are equivalent to the results of chemical pesticides in combating the RPW insect that attacks palm varieties (Samani and Al-Ikhlas vars) in El-Marg area. The Barhi and Zaghloul varieties in El Nubariya region. It is safe for the consumer, easy to prepare, and does not pollute the environment. Accordingly, the focus was on mixtures of natural materials to equal their results with chemical pesticides in combating the insect that attacks the date palm varieties (Samani-Ikhlas) in the Marj region—and the varieties (Barhi-Zaghloul) in the Nubariy a region, given that the natural composition is safe for the consumer, easy to prepare, and does not Pollutes the environment.

5. Conclusions

In this applied study, data obtained from light traps showed that the most common insect pest in palm gardens is the palm stem borer, *P. excavus*. Long-horned palm borer *P. testaceus*, and the frond borer *P. frontalis* which has an influential role in insect reproduction. The spread of the red palm weevil (RPW) in palm groves in Egypt. Auxiliary insect pests begin to appear in early February and March. The peak occurs during May until September. The lowest population numbers were obtained in December and January.

The results showed that the recovery of palm trees in the two treated varieties (Zaghloul and Barhi) increases with the continuation of treatment for two consecutive seasons of the affected palm trees.

However, the results of using mixtures of natural materials have proven equal effectiveness to the effect of chemical pesticides, so it is better to use mixtures of natural materials only without pesticides, which is what is called the natural composition that has proven effective in combating the red palm weevil in the Al-Marj and Noubariya areas. The results of applied experiments showed that continuing the injection of palm trees infected with the red palm weevil into the trunk of the infected palm tree for 6 consecutive months using a binary mixture consisting of motor oil with a solution of inorganic salts led to trees of samani and Ikhlas vars recovered by 100% from insect infestation with RPW.

The current study suggested to do the following:

= Control is carried out after the completion of collecting the date crop, that is, during the agricultural service of the palm tree (pruning the leaves, removing the fibers, hoeing, getting rid of weeds, and fertilizing).

= Repeat treatment for the infected palm and for the new infestation continues for two consecutive seasons

= The necessity of having 2 traps in summer and winter/acr = The necessity of

continuous inspection of palm trees daily to collect adult insects that wander on the aerial roots of the palm tree to search for mating or a shelter to lay eggs, then place them in a glass jar containing an amount of diesel fuel to kill them or burn them—whichever is available.

The present natural composition is characterized by the following:

1. Use raw vegetable oil (jojoba oil) and not volatile oils as is clear in published articles (a list of these articles is attached).

2. Use mineral oil (car oil) that no one has used before, whether in the laboratory or the field also inorganic salts: They have not previously been used practically

3. Components of this composition are Natural and environmentally friendly, Safe for humans and farm animals.

4. This natural composition showed high effectiveness during field trials to combat the red palm weevil, as it led to 100% recovery of the treated palms from infection with the red palm weevil, *R. ferrugineus*.

5. Continuing treatment of infected palm trees for 6 consecutive months using natural composition it leads to 100% recovery of the affected palm. Accordingly, the mentioned natural composition (patented) can be used to combat the red palm weevil with high efficiency, as it is a natural means that kills the red palm weevil and is safe for the environment and humans. It is easy to prepare, its costs are cheap, and it is safe for the environment and humans and valid—for combating the red palm weevil under the title: (A natural composition for control the red palm weevil) it was registered in the Patent Office of the Academy of Scientific Research in Egypt under No.EG/P/2023/757.EG/P/2023/757. Receipt number: 20230519000003 Date: 05/21/2023

This invention is based on the use of a natural formula consisting of vegetable and mineral oils mixed with a solution of inorganic salts at a rate 1 liter for each to prepare the natural composition (subject of the invention) to control the red palm weevil *R. Ferrugineus* instead of chemical pesticides that have serious harm to the environment, plants, humans and farm.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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