



Egyptian Journal of Plant
Protection Research Institute

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Efficacy of chemical, biological insecticides and plant extracts against red palm weevil *Rhynchophorus ferrugineus* (Curculionidae : Coleoptera) under laboratory and field conditions

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ARTICLE INFO

Article History

Received: 12 / 10 /2020

Accepted: 23 / 12 /2020

Keywords

Red palm weevil, *Rhynchophorus ferrugineus*, insecticides, plant extracts, *Metarhizium anisopliae* and injection control.

Abstract:

The red palm weevil *Rhynchophorus ferrugineus* (Olivier) (Curculionidae : Coleoptera) is the most serious insect pest of cultivated palm trees in several date palm producing countries. The laboratory study was carried out during year 2020 in Research Laboratory of Red Palm Weevil, Plant Protection Research Institute. Field experiments were carried out at date palm farm of area 10 feddan planted with barhi date palm variety, at the Regional Research Station for Delta East, Qassasin, Ismailia Governorate, Egypt. The aim of research work is to evaluate the efficiency of different group of insecticides; chemical (Profenomex 44% EC), biological (Bio-Magic 1.15 WP) and plant extracts (Palmotto 60% EC) to control this insect under Laboratory and field conditions. Results indicated that the efficiency of tested insecticides varied considerably due to the chemical nature of testing insecticides and the concentrations used. Profenomex 44% EC proved to be the most effective compound followed by palmotto 60% EC and bio-magic 1.15% WP , respectively. Evaluation of the efficiency of certain insecticides to control this pest in field by injection palms, the results shown that profenomex 44% EC proved to be more effective against red palm weevil with low concentration compared with other pesticides.

Introduction

Date palm, *Phoenix dactylifera* (L.) (Family : Palmaceae) was an object of worship in Chaldeas (Babylon) in 7000 before Christ. Shat-Al-Arab is its original home (Sharif and Wajih, 1982).The total number of date palm trees recorded in the ancient life reached about 109 million, which yielded 4.2 million tons. Arab countries, however, contain 78.3% of

the total world date palm trees which demonstrate 75% of the production (Abdel-Megeed *et al.*, 2004).Unfortunately, during the last decade of the 20th century, a new most serious insect pest, namely the red palm weevil, *Rhynchophorus ferrugineus* (Olivier) (Curculionidae: Coleoptera) was first recorded in date palm plantations of Sharkia and Ismailia Governorates in Egypt by Saleh (1992)

and Saleh and Gouhar (1993). It is worthy to mention that the damage of all pests invading date palm trees together cannot be comparable with that of the red palm weevil alone as the latter insect is considered a destructive pest. The red palm weevil is a serious pest of cultivated palm trees in India (Ghosh, 1912 and Nirula, 1956) and Srilanka (Brand, 1917). The present investigation was carried out with the aim of throwing more light and clarifying the toxicological study of following certain insecticides; profenomex 44% EC, bio-magic 1.15 WP and palmotto 60% EC against different stages of larvae and adults of the red palm weevil *R. ferrugineus* under laboratory and field conditions to evaluate the efficiency of tested insecticides to control this pest.

Materials and methods

The laboratory study was carried out during year 2020 in Research Laboratory of Red Palm Weevil, Plant Protection Research Institute, to evaluate the toxic effects of certain insecticides against fourth, eighth larval instars and adults of the red palm weevil *R. ferrugineus* under the constant temperature of $30 \pm 1^\circ\text{C}$.

1. Tested insecticides:

1.1. Profenomex 44% EC Active ingredient: (Profenofos 40% + Cypermethrin 4%)

1.2. Palmotto 60% EC Active ingredient: (Jasmine oil + Citronella oil + Fulvic acid)

1.3. Bio-Magic 1.15% WP Active ingredient: Bio-Magic is a biological insecticide based on a selected strain of naturally occurring entomopathogenic fungus *Metarhizium anisopliae*. It contains spores and mycelial fragments of *M. anisopliae*.

2. Laboratory treatment of larval and adult stages of red palm weevil *Rhynchophorus ferrugineus* :

Fourth, eighth larval instars, as well as adults of red palm weevil *R.*

ferrugineus were carefully selected for the present investigation from laboratory rearing of red palm weevil. Each of insecticides was dissolved in distilled water to preparing several concentration rates : (110, 220, 440 , 660 ppm) for profenomex 44% EC , (1800, 3600, 5400 ppm) for palmotto 60% EC and (57.5, 115, 230 ppm) for bio-magic 1.15% WP. Small square pieces of sugarcane (1.5 x 5 cm. in diameter and length) were dipped in the prepared concentrations for 30 minutes then allowed to dry in air for 2 hours before offering to tested larvae and adults. Treated pieces were transferred in a cylindrical plastic box (9.5 x 5.0 cm. in diameter and depth) and tightly covered with a perforated cover. fourth, eighth larval instars, as well as adults were introduced into the boxes (5 larvae or adult/box), using 20 individuals in 4 replicates for each concentration rate. Mortality records were taken after 24 h to several days. Bioassay data were corrected for control mortality according to Abbott's formula, (1925) and subjected to probit analysis (Finney, 1952) with a probity computer program. Values of LC50, LC90, slope and relative potency (Sun, 1950) were calculated from the results of the last day after treatment for larval and adult stages of red palm weevil.

3. Field injection experiments:

Field experiments were carried out at date palm farm of area 10 feddan planted with barhi date palm variety, at the Regional Research Station for Delta East, Qassasin, Ismailia Governorate, Egypt., to evaluate the effectiveness of using certain insecticides on infested date palm trees. A number of 72 heavily infested date palm trees (24 date palms for each insecticide), were selected and treated by injection with three concentration rates: (220, 440 , 660 ppm) for profenomex 44% EC , (1800, 3600, 5400 ppm) for palmotto 60% EC and (57.5, 115, 230 ppm) for bio-magic

1.15% WP, using 8 date palms as replicates for each concentration rate. The chemical treatment was carried out in the following steps: 1. Definition of heavily infested date palms showing obvious infestation symptoms. 2. Drilled holes inside date palm trunk around the infested places. 3. Injection of infested date palms with different rates of liquid insecticides. 4. Placing a small piece of dry date palm fibers in the opening of the holes. 5. Stopping the opening of the holes by a paste of cement and gypsum. All treated date palms were inspected after 30 days from treatment to assess the potency of tested insecticides that determined as a percentage of date palm recovery according to the disappearance of the most obvious infestation symptoms i.e., dryness of yellowish brown viscous liquid in the infested places of date palm trunk.

Results and discussion

1. Lethality effects of tested insecticides against larval and adult stages of red palm weevil *Rhynchophorus ferrugineus*:

The toxicity of the three tested insecticides profenomex 44% EC (Profenofos + cypermethrin), bio-magic 1.15 WP (Entomopathogenic fungi) and palmotto 60% EC was evaluated as stomach poisons against the fourth, eighth larval instars and adults. Data in Tables (1-3) showed that, the toxicant effects were varied considerably due to the mode of action of tested insecticide, concentration of tested insecticide and the treated stages of red palm weevil. Obtained data revealed that profenomex 44% EC proved to be the most effective insecticide against all tested larval instars and adults followed by palmotto 60% EC and bio-magic 1.15% WP, respectively. The highest percentage of mortality for profenomex 44% EC was in the fourth day either palmotto 60% EC in the fifth day and bio-magic 1.15% WP was in the ten day with

fourth, eighth larval instars and adults. As a general trend, the higher the concentration the higher was the mortality rates and vice versa. Data in Tables (4-6) and graphically illustrated as toxicity lines in Figures (1-3) indicated that the three tested insecticides had differently in their toxicity on different larval instars and adults of red palm weevil due to the chemical nature of testing insecticides. As shown profenomex 44% EC, was the most efficient toxicant at LC50 and LC90 values (149.864 ; 124.377 ; 210.595 and 850.308 ; 1791.656 ; 882.141) ppm., for the 4th, 8th larval instars and adults respectively, followed by palmotto 60% EC accordingly the LC50 and LC90 values (18563.71 ; 19644.02 ; 8501.16 and 43677.52 ; 12222.60 ; 143050.6) ppm., for the 4th, 8th larval instars and adults respectively, and bio-magic 1.15% WP, accordingly the LC50 and LC90 values (58.538 ; 84.149 ; 131.299 and 488.204 ; 819.925 ; 1240.681) ppm., for the 4th, 8th larval instars and adults respectively. The slope values of the three tested insecticides indicated that both eighth larval instar and adult were nearly parallel and were the steepest lines, whereas the fourth larval instar was the flattest one (Figures 1-3). Profenomex 44% EC was the standard at the two tested larval instars and adults, showing the highest efficiency at both LC50 and LC90, whereas the efficacy of the other tested insecticides was lower than the standard toxicant. In general, the tolerance of larvae to all tested insecticides (According to LC50 values) increased with the increment of larval age, accordingly eighth larval instars and adults proved to be more tolerant against all tested insecticides than fourth larval instars. The previous result can be attributed to the small weight of the fourth larval instar and its sensitivity to different concentrations of tested insecticides. From the present

results, it is worthy to mention that profenomex 44% EC applied as a stomach poison gave The highest mortality with the fourth larval instar followed by adult and eighth larval instar respectively. These results are confirmed by those of the previous studies of (Barranco *et al.*, 2000) showed that, the younger larvae of *R. ferrugineus* were more susceptible compared with the older ones. (Ajlan *et al.*, 2000) mentioned that, pirimiphos-methyl gave more toxic than chloropyrifos to the adults and larvae of the red palm weevil, *R. ferrugineus*, indicating the higher susceptibility of larval stage when compared with adults. (Cabello *et al.*, 1997 ; Abdulsalam *et al.*, 2001 ; Beevi *et al.*, 2004 ; Abbas, 2005 and Al-Rajhy *et al.*, 2005) who

evaluated some insecticides and plant extracts against different larval instars of red palm weevil as stomach or contact poisons under laboratory conditions, They found that the efficacy of pesticides varied according to both type of compound and used concentrations. Also, they mentioned that the susceptibility of larvae decreased with progressed instars age. The extra usefulness could achieve if these insecticides implemented in the integrated pest management programs (IPM), that delivered to control the red palm weevil. The advantages of palmotto 60% EC and bio-magic 1.15% WP are its broad-spectrum activity with relative low rate of application, long lasting efficacy and mode of action in addition of low toxicity to mammals.

Table (1): Relative mortality of tested insecticide profenomex 44% EC against 4th, 8th larval instars and adult stages of *Rhynchophorus ferrugineus*.

Days after treatment	4 th instar kill (%)				8 th instar kill (%)				Adult kill (%)			
	110	220	440	660	110	220	440	660	110	220	440	660
1 day	10	20	40	70	20	5	25	40	10	10	35	55
2 days	40	35	55	80	40	30	45	65	30	20	50	70
3 days	50	55	75	100	50	40	60	85	30	50	70	95
4 days	60	70	100	100	55	60	75	100	50	70	80	100

* No. of 20 individuals for each concentration rate.

Table (2): Relative mortality of tested insecticide palmotto 60% EC against 4th, 8th larval instars and adult stages of *Rhynchophorus ferrugineus*.

Days after Treatment	4 th instar kill (%)			8 th instar kill (%)			Adult kill (%)		
	18000	36000	54000	18000	36000	54000	18000	36000	54000
1 day	0	15	30	0	5	15	0	0	10
2 days	10	35	45	0	20	30	5	5	20
3 days	25	50	70	5	25	45	10	15	40
4 days	45	75	90	25	40	60	35	40	55
5 days	65	80	100	50	60	80	45	50	75

* No. of 20 individuals for each concentration rate.

Table (3): Relative mortality of tested insecticide bio-magic 1.15% WP against 4th, 8th larval instars and adult stages of *Rhynchophorus ferrugineus*.

Days after treatment	4 th instar kill (%)			8 th instar kill (%)			Adult kill (%)			
	Conc. ppm	57.5	115	230	57.5	115	230	57.5	115	230
5 days	5	10	20	0	0	0	0	0	0	5
6 days	5	10	30	0	0	20	0	5	15	
7 days	20	30	45	10	15	30	5	15	35	
8 days	35	50	65	30	40	55	15	30	50	
9 days	55	65	80	40	60	70	35	45	65	
10 days	60	75	90	45	65	70	50	55	75	

* No. of 20 individuals for each concentration rate.

Table (4): LC values of tested insecticide profenomex 44% EC against 4th, 8th larval instars and adult stages of *Rhynchophorus ferrugineus* after 4 days of treatment.

Stage	LC ₅₀ (ppm)	LC ₉₀ (ppm)	Slope (b)	Relative Potency
4 th	149.864 (124.9732 - 176.4327)	850.308 (643.0442 - 1254.401)	1.7	0.973
8 th	124.377 (67.396 8 - 171.9741)	1791.656 (1003.746 - 6390.488)	1.1062	0.9048
Adult	210.595 (176.3253 - 245.0302)	882.141 (679.5329 - 1306.301)	2.0602	0.9823

Table (5): LC values of tested insecticide palmotto 60% EC against 4th, 8th larval instars and adult stages of *Rhynchophorus ferrugineus* after 5 days of treatment.

Stage	LC ₅₀ (ppm)	LC ₉₀ (ppm)	Slope (b)	Relative Potency
4 th	18563.71 (15391.63 - 21194.79)	43677.52 (38652.63 - 51595.07)	3.4489	0.9528
8 th	19644.02 (11913.5246 - 24927.3272)	12222.6 (40723.8-76948.78)	1.6143	0.9302
Adult	8501.16 (2012.179 - 10852.33)	143050.6 (115329.4 - 801979.3)	1.5955	0.9638

Table (6): LC values of tested insecticide bio-magic 1.15% WP against 4th, 8th larval instars and adult stages of *Rhynchophorus ferrugineus* after 10 days of treatment.

Stage	LC ₅₀ (ppm)	LC ₉₀ (ppm)	Slope (b)	Relative Potency
4 th	58.538 (32.5155 - 77.9927)	488.204 (294.4875 - 1682.155)	1.3913	0.9988
8 th	84.149 (55.6045 - 108.9653)	819.925 (422.7379 - 4637.095)	1.2962	0.9851
Adult	131.299 (101.7239 - 182.8218)	1240.681 (565.4765 - 10270.36)	1.3139	0.9391

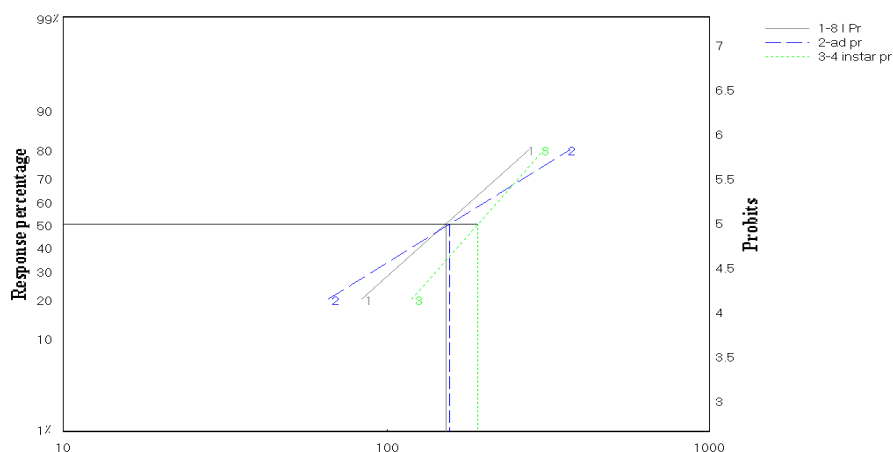


Figure (1): Toxicity lines of Profenomex 44% EC against different stage of *Rhynchophorus ferrugineus*

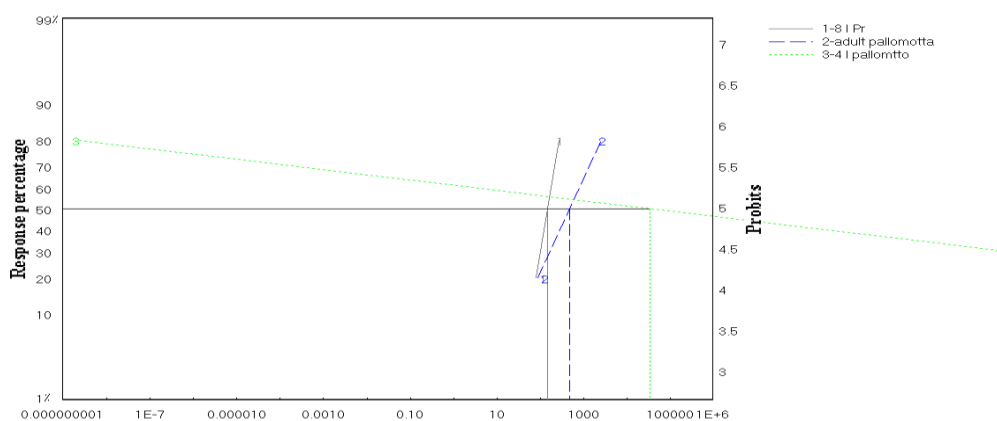


Figure (2): Toxicity lines of palmotto 60% EC against different stage of *Rhynchophorus ferrugineus*

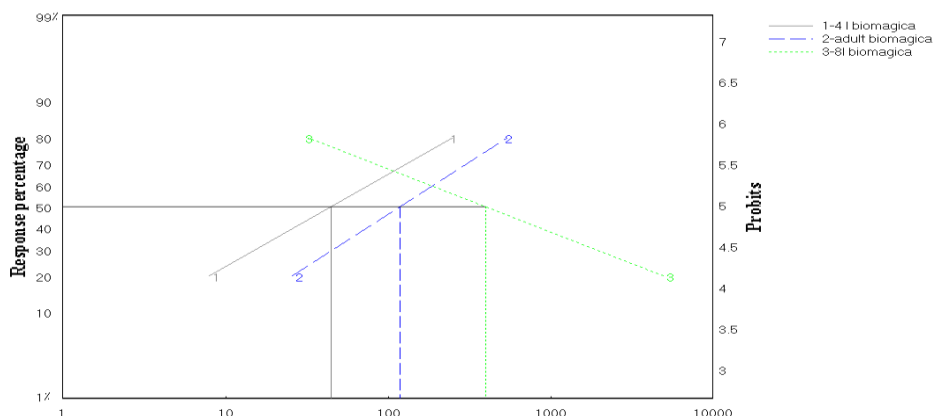


Figure (3): Toxicity lines of bio-magic 1.15% WP against different stage of *Rhynchophorus ferrugineus*

2. Injection palms:

The results of injection date palms with tested insecticides; profenomex 44% EC, palmotto 60% EC and bio-magic 1.15% WP were tabulated in Table (7). The percentages of palm recovery due to injection with the tested insecticides being (62.5% ; 87.5% ; 100% at 220 ; 440 ; 660 ppm. respectively), for profenomex 44% EC and (50% ; 62.5% ; 87.5% at 18000 ; 36000 ; 54000 ppm. respectively), for palmotto 60% EC and (37.5% ; 62.5% ; 75% at 57.5 ; 115 ; 230 ppm. respectively), for bio-magic 1.15% WP after 30 days from application. The obtained results showed that, profenomex 44% EC proved to be more

effective against the red palm weevil in field injection followed by palmotto 60% EC and bio-magic 1.15% WP, respectively. The obtained results are in agreement with those recorded by many researchers who tried to evaluate the efficiency of certain insecticides with different methods of application as chemical control agents against the red palm weevil under field conditions such as (Saleh, 1992 ; Saleh and Gouhar, 1993 ; El-Sebay, 2004 and Muthiah and Nair, 2006). They recorded that the efficacy of the tested compounds that belonging to different groups varied against *R. ferrugineus* and resulted in good control for this pest.

Table (7): Numbers and Percentages of palm recovery due to injection with different rates of tested insecticides on *Rhynchophorus ferrugineus* after 30 days of treatment.

Insecticides	Injection dose (ppm)	Number of palm recovery	Percentages of Palm recovery
Profenomex 44% EC	220	5	62.5%
	440	7	87.5%
	660	8	100%
Palmotto 60% EC	18000	4	50%
	36000	5	62.5%
	54000	7	87.5%
Bio-Magic 1.15% WP	57.5	3	37.5%
	115	5	62.5%
	230	6	75%

* No. of 8 date palms for each concentration rate.

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