# Laboratory Evaluation of some Insecticides against Larval and Adult Stages of Red Palm Weevil's *Rhynchophorus ferrugineus* (Olivier)

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## ABSTRACT

**The toxicity of eight compounds belong to different groups of insecticides; chlorpyrifos-ethyl and dimethoate (organophosphate); methomyl (carbamate); imidacloprid (neonicotinoid); emamectin benzoate (avermectin); azadirachtin (tetranortriterpenoid), deltamethrin (pyrethroid) and fipronil (phenylpyrazole). was evaluated in the laboratory against larvae and adults of the red palm weevil, *Rhynchophorus ferrugineus* (Olivier), by using dipping food technique. The results showed that imidacloprid was the most toxic insecticide among the tested compounds against the larvae, followed by emamectin benzoate, deltamethrin and fipronil, whereas the $LC_{50}$s were 63.6, 136.6, 290.2 and 773.78 ppm, respectively. The organophosphate insecticides, chlorpyrifos-ethyl and dimethoate were the less toxic compounds ($LC_{50}$s were 2597 and 8466 ppm), against larvae. However, deltamethrin was the most toxic insecticids against the adult followed by emamectin benzoate and imidacloprid, whereas the $LC_{50}$s were 129.8, 136.6 and 287.3 ppm, respectively. The organophosphate insecticides, chlorpyrifos-ethyl and dimethoate, were still the less active compounds ($LC_{50}$s were 790.4 and 11085 ppm) against the adults of *R ferrugineus*. The results revealed that the adults were more sensitive to most of the tested insecticides compared with larvae except for imidacloprid and dimethoate. Moreover, by increasing time of exposure the toxicity of imidacloprid to both larvae and adults increased.**

**Keywords: Red palm weevil, relative toxicity, insecticides, date palm**

## INTRODUCTION

The date palm tree, *Phoenix dactylifera* L. is an important tree to the people all over the world especially to those of the Middle East. Red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier), is one of the most destructive pests of date palm trees in Middle East and North Africa. It was first recorded in Egypt in 1993, now the weevil spread all over the palm cultivated area (Murphy and Briscoe 1999). The infestation cannot be noticed easily, so the grubs keep feeding with no apparent symptoms until it's too late. The problem is still growing and no clear sign of effective control is apparent, making the prospect of the date palm trees in Egypt risky. Early detection of the pest can save the palms; However, the early detection is difficult due to the latent symptoms of the infestation. This makes the problem of palm weevil management intricate (Faleiro *et al.* 1998 and 1999). Current tactics employed to manage the weevil are largely based on insecticide application. Insecticides are applied in a range of preventive and curative procedures designed to limit the infestation (Abuzuhairah *et al*., 1996). Recent researches have focused on integrated pest management (IPM) involving surveillance, pheromone lures, cultural control and chemical treatments for the management of *R. ferrugineus* (Abraham *et al.,* 1998). The choice of the chemicals now regularly used in the field developed through laboratory work on promising compounds. For example, Abraham *et al.* (1975) evaluated seven insecticides for control of *R. ferrugineus*, three of them were effective (dichlorvos, trichlorphon and propoxure). Abraham and Vidyasagar (1992), reported that insecticides such as chlorpyrifos, endosulfan and methiothion at 0.1 % are recommended for *R. ferrugineus* control. Cabello *et al.* (1997) and Kaakeh (2010), concluded that imidacloprid (Confidor) may be used to control all ages of *R. ferrugineus* larvae. Ajlan *et al*. (2000) suggested that a mixture of pirimiphos-methyl and either oxydemeton-methyl or trichlorphon is suitable to control the larval and adult stages of *R. ferrugineus***.** Furthermore, Abdulsalam *et al*. (2001) and Keekh, 2010 mentioned that fipronil is a convenient insecticide to control different life stages of *R. ferrugineus.*

The aim of the present work is to evaluate the biological activity of eight compounds belong to different groups of insecticides against 20-days old larvae and adults of *R. ferrugineus*, in the laboratory, using dipping food technique. These insecticides are chlorpyrifos-ethyl, dimethoate, methomyl, imidacloprid, emamectin benzoate, azadirachtin, deltamethrin and fipronil.

## MATERIALS AND METHODS

### Insects:

The main culture of *R. ferrugineus* was reared on semi-artificial diet as described by Alfazairy *et al.* (2003). The culture started with specimens collected

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from highly infested palm tree farms at Edko District, Al-Boheira Governorate, Egypt. Restriction measures and care performed during transportation and experimental work to prevent insect escaping. *R. ferrugineus* stages kept in glass Jars (500 cc) having circular holes in the lid for ventilation. The culture maintained at 25±1$^{o}$C, 70-75% R.H. The laid eggs collected and eggs maintained under similar conditions in Petri-dishs 9 cm diameter with wet filter paper, until hatching, then provided with semi-artificial media, larvae were placed individually in small plastic jars. Adults and 20-days old larvae were used for bioassay tests.

**Chemicals:**

Commercial formulations of deltamethrin (Decis 2.5% EC), imidacloprid (Sinodor 70% W.G), emamectin benzoate (Proclaim 5% W.G), dimethoate (Perfekthion 40% EC), azadirachtin (Achook 0.15 % E.C), chlorpyrifos-ethyl (Lirifos 48% EC), fipronil, (Fipromex 20% SC) and methomyl (Methmax 90% SP) were obtained from Ministry of Agriculture, Cairo, Egypt.

**Bioassay:**

Laboratory trials conducted to evaluate the efficiency of insecticides dilutions using dipping food bioassay technique (Ajlan *et al*. (2000). Pieces of sugarcane stem were soaked for 1 min. in different dilutions of the insecticides formulations. Larvae (20 days old) and/or adults were exposed to the treated sugarcane pieces. Every concentration was replicated three times.Similar pieces of sugarcane stem were soaked in distilled water and served as control. Insect stages were examined after 24 hr from exposure and the percentages of mortality were recorded. The insect was considered dead if it neither moved nor responded by reflex movement, when touched.

Regression equations of normal equivalent deviates (y) versus log dose (x), and $LC_{50}$ values and their 95% fiducial limits, were estimated according to Finney (1971). Relative toxicity of the insecticide at the $LC_{50}$ levels was also estimated.

## RESULTS AND DISCUSSION

**Toxicity of insecticides to adults of *R. ferrugineus*.**

In terms of $LC_{50,}$ the data showed that pyrethroid insecticide (deltamethrin) was the most toxic insecticide to the adult of *R. ferrugineus* after 24 hr. of exposure to poisoned medium whereas the $LC_{50}$ was 129.8 ppm, followed by emamectin-benzoate and imidacloprid. The organophosphate insecticides (dimethoate and chlorpyrifose-ethyl) were the less toxic insecticides, $LC_{50}$'s(11085 and 790.4ppm). The rest of the tested insecticides were moderately toxic (Table 1).

**Toxicity of Insecticides to *R. ferrugineus* larvae**

Data of 20 days old larvae that feed on insecticides treated sugarcane showed that imidacloprid was the most toxic one in terms of $LC_{50}$, followed by emamectin-benzoate. Fipronil and methomyl, were moderately toxic ($LC_{50}$= 737.78 and 804.7 ppm, respectively). The organophosphate insecticides (dimethoate and chlorpyrifose-ethyl) were the less toxic insecticides ($LC_{50}$'s were 8466 and 2597 ppm) after 24 hr of exposure (Table 2). However, the mortality of azadirachtin to the larvae were less than 50% after 24 hr of the exposure and the $LC_{50}$s value reached 756.9 ppm after 5 days exposure time.

The relative toxicity of the tested insecticides at the $LC_{50}$ levels showed that the toxicity of imidacloprid, the most toxic insecticide against the larvae of red palm weevil, was about two times of emamectin-benzoate toxicity and about 4.6 fold of the deltmethrin toxicity, while it is about 133 fold of dimethoate toxicity, the least toxic insecticide against the larvae of *R. ferrrugineus*. However the relative toxicity of the insecticides against the adults of *R. ferrrugineus* revealed that deltamethrin and/or emamectin-benzoate were the most toxic insecticides, whereas they are about two fold toxic of imidacloprid or fipronil, while they are about 85 fold toxic of dimethoate insecticide, the less toxic insecticide (Table 3).

The effect of exposure time on the toxicity of imidacloprid as one of the highly toxic insecticide against both adults and larvae, revealed that the toxicity increased with increasing the exposure time from 24 hr to 48 hr. In the meantime, the data showed that the susceptibility of *R. ferrrugineus* larvae was more than the adults to this insecticide.

In general, the results showed that imidacloprid and emamectine-benzoate had a remarkable effect on 20 days old larvae or adults of *R. ferrugineus* after 24 hr of exposure to poisoned medium. By increasing time of exposure, the toxicity of imidacloprid increased and that might depend on the amount of insecticide picked up by insects that might sufficient to suppress the biochemical targets. Data revealed that imidacloprid is potent for the larvae, thus, imidacloprid could break down the life cycle of *R. ferrugineus* and might be suitable to incorporate in the control programs of *R. ferrugineus* as a protective or curative agent. The extra usefulness could achieve if this insecticide implemented in the integrated pest management programs (IPM) that delivered to control the palm insect pests. The advantages of imidacloprid are its systemic properties, broad spectrum activity with relative low rate of application, long lasting efficacy and mode of action that different from organophosphates, carbamates and pyrethroids, in addition of low toxicity to mammals (Cox, 2001and Kaakeh, 2010). Furthermore, application technique could add another advantage, so drenched into the root zones of palm offer a practical solution for controlling some palm pests. Foliar application result in drift, which is especially objectionable in urban environment (Howard and Stopek, 1999) and trunk injections are not an option, because affect the beauty of palm trees. The concern about side effect of pesticides on the environment has resulted in the restriction in the use of many toxic products (Gush, 1997). Innovative soil application makes imidacloprid safer to beneficials and bee are not harmed, so that it is used for IPM programs (Zillekens, 2006). Lastly, current efforts are examining the potential developing of biopesticids and focused on IPM, involving surveillance, pheromone lures, cultural control and chemical treatments for the management of *R. ferrugineus* (Abraham *et al*., 1989, Moura *et al*. 1995, Abraham *et al.,* 1998 and Keekh, 2010).

**Table1. Toxicity of insectcides to adults of *R. ferrugineus* after 24 hr of exposure**

| Treatment | $LC_{50}$ (ppm) (95% fiducial limits) | Regression of N.E.D (Y) on log dose (X) | Slope± SD |
|---|---|---|---|
| Imidacloprid | 287.3 (247.5-333.7) | Y =-4.7 + 1.9x | 1.9 ± 0.03 |
| Emamectin-benzoate | 136.6 (96.1-193.8) | Y =-4.4 + 2.0x | 2.0± 0.08 |
| Chlorpyrifose-ethyl | 790.4 (670.2-931.9) | Y =-5.6 + 1.9x | 1.9± 0.03 |
| Dimethoate | 11085 (10045-12233) | Y =-11.4.9 + 2.8x | 2.8±0.20 |
| Fipronil | 290.1( 230.3-365.8) | Y =-2.9 + 1.2x | 3.2±0.10 |
| Deltamethin | 129.8 (119.5-141.0) | Y =-7.7 + 3.6x | 3.6±0.06 |
| Azadirachtin | 708.9 (694.2-724.1) | Y =-47.6 + 16.7x | 16.7± 1.6 |
| Methomyl | 569.8 (518.2-626.5) | Y =-8.5 + 3.1x | 3.1±0.07 |

**Table 2. Toxicity of insectcides to larvae of *R. ferrugineus* after 24 hr of exposure**

| Insecticide | $LC_{50}$ (ppm) (95% fiducial limits) | Regression of N.E.D (Y) on log dose (X) | Slope± SD |
|---|---|---|---|
| Imidacloprid | 63.6 (54.2-74.5) | Y =-4.3+ 2.4x | 2.4 ± 0.06 |
| Emamectin-benzoate | 136.6 (96.1-193.8) | Y =-4.4 + 2.0x | 2.0± 0.08 |
| Chlorpyrifose-ethyl | 2597 (2053-3286) | Y =-3.9 + 1.1x | 1.1± 0.02 |
| Dimethoate | 8466 (8098-8851) | Y =-27.7 + 7.1x | 7.1±0.30 |
| Fipronil | 773.78 ( 741.58-807.32) | Y =-23.57 + 8.22x | 8.22±0.41 |
| Deltamethin | 290.2 (154.0-331.6) | Y =-5.4 + 2.2x | 2.2±0.03 |
| Azadirachtin# | 756.9 (732.1- 782.5) | Y= -24.1 + 8.3x | 8.3±0.67 |
| Methomyl | 804.7 (731.4-885.4) | Y =-8.2 + 2.8x | 2.8±0.06 |

# Mortality after 5 days.

**Table 3. Relative toxicity of the insecticides at the $LC_{50}$ levels for larvae and adults of *R. ferrugineus***

| Insecticide | Relative toxicity after 24 hr | |
|---|---|---|
| | larve | adults |
| Imidacloprid | 1.0 | 2.2 |
| Emamectin-benzoate | 2.2 | 1.1 |
| Chlorpyrifose-ethyl | 40.8 | 6.1 |
| Dimethoate | 133.1 | 85.4 |
| Fipronil | 12.2 | 2.2 |
| Deltamethin | 4.6 | 1.0 |
| Azadirachtin | -- | 5.5 |
| Methomyl | 12.7 | 4.4 |

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## الملخص العربي

## التقييم المعملي لبعض المبيدات الحشرية ضد طوري اليرقة والحشرة الكاملة لسوسة النخيل الحمراء

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تم تقييم النشاط الإبادي الحيوي لثمانية مركبات تنتمي إلى المجاميع المختلفة من المبيدات الحشرية ضد طوري اليرقة عمر ٢٠ يوم والحشرة الكاملة معملياً باستخدام تقنية غمر الغذاء. وشملت المبيدات كل من الكلوربيريفوس إيثيل، دايميثويت(الفوسفات العضوية)؛ الميثوميل(كربامات)؛ إميداكلوبريد (مشابهات النيكوتين)؛ بنزوات الإيمامكتين (أفيرميكتين)؛ الأذدراكتين(التترانورترايتربينات)، دلتاميثرين (بيريثرويد)، وفيبرونيل (فينايل بيرازول).

أظهرت النتائج أن مبيد الأيميداكلوبريد كان الأكثر سمية على اليرقات بين المركبات المختبرة يليه بنزوات الإيمامكتين، ثم الدلتاميثرين وفيبرونيل، حيث كانت قيم $LC_{50}s$ ٦٣.٦، ١٣٦.٦، ٢٩٠.٢ و٧٧٣.٧٨ جزء في المليون على التوالي. كانت مركبات الفوسفات العضوية، الكلوربيريفوس إيثيل والدايميثويت أقل سمية حيث كانت $LC_{50}s$ (٢٥٩٧ و٨٤٦٦.٦ جزء في المليون)، ضد اليرقات. ومن ناحية أخرى كان مبيد الدلتاميثرين الأكثر سمية(ضد الحشرات البالغة يليه بنزوات الإيمامكتين وإميداكلوبريد حيث كانت $LC_{50}s$ ١٢٩.٨، ١٣٦.٦ و٢٨٧.٣ جزء في المليون على التوالي. مازالت مبيدات الفوسفات العضوية الكلوربيريفوس إيثيل والدايميثويت أقل نشاطا حيث كانت قيم التركيز القاتلة لـ ٥٠% من الحشرات الكاملة ٧٩٠.٤ و١١٠٨٥.٦ جزء في المليون. وأظهرت النتائج أن الحشرات الكاملة كانت أكثر حساسية من اليرقات لمعظم المبيدات الحشرية المختبرة باستثناء إميداكلوبريد والدايميثويت. كما أوضحت النتائج أنه بزيادة وقت التعرض فإن سمية مبيد إميداكلوبريد تزداد لكل من الحشرات الكاملة واليرقات.