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INSECTICIDAL ACTIVITY OF FIVE PESTICIDES AGAINST THE RED PALM WEEVIL, *Rhynchophorus ferrugineus* (OLIVIER) (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT

The insecticidal activity of pesticides belonging to different groups, fipronil, cypermethrin, malathion, imidacloprid and azadirachtin was tested against males, females and larvae of the Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* (Olivier), by both the feeding and the topical application methods. Fipronil was the most effective one with LC_{50} values of 0.00033, 0.000024 and 0.000031 % against larvae, males and females, respectively by the feeding method. Azadirachtin was the least effective pesticide with LC_{50} values of 1.68, > 2 and > 2 % against the above mentioned stages , respectively. In the case of topical application toxicity, fipronil was also the most effective insecticide. Generally, insects were more susceptible to the tested insecticides through the feeding route than they were through the topical application route.

Keywords: Red Palm Weevil, *Rhynchophorus ferrugineus*, fipronil, cypermethrin, malathion, imidacloprid, azadirachtin, topical application

INTRODUCTION

The Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae), is the most dangerous and destructive pest of many palm trees in vast areas of the world (Murphy and Briscoe,1999; Abraham *et al.*,1998; Cox, 1993). The insect completely destroys palm trees within 6-8 months (Kurian and Mathen, 1971). The RPW had reached the eastern region of the Kingdom of Saudi Arabia in 1985 and afterwards spread to many other areas in the kingdom (Abozuhairah *et al.*, 1996). The insect had rapidly spread in many mediterranean countries where it causes great economic damages (Barranco *et al.*, 2000 and Kehal, 1999). Although many insecticides were tried against RPW by the feeding method (Ajlan *et al.*, 2000; Abraham *et al.*, 1998; Barranco *et al.*, 1998; Rajan and Nair, 1997; Ganeswara *et al.*, 1989 and 1980; Sathiamma *et al.*, 1982; Abraham *et al.*, 1975; Subba *et al.*, 1973 and Mathen and Kurian, 1970), rare studies on the topical application toxicity of conventional pesticides are found (Al-Rajhi *et al.*, 2005). Topical application studies give a rather good idea about the contact toxicity of these compounds and enable selection of insecticides that could be applied by spray appliction on palm trees to kill the insect when it comes in contact with the tree and before the insect finds out its way to invade the tree. Therefor, we carried out this work to study the toxicity of tested insecticides to RPW by the topical application method compared to their toxicity by the feeding method.

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MATERIALS AND METHODS

Test insects

Insects were reared according to Al-Rajhy *et al.*, 2005. Larvae of 3.5-4 g and adults of 1-1.2 g average weights were used in the bioassay studies

Chemicals

Cypermethrin 10 % EC, Confidor (35 % imidacloprid), malathion (57 % EC), Regent (5 % fipronil) and Neemix (4.5 % azadirachtin) were used in this study.

Bioassays

Feeding assay: Tested concentrations were prepared by serial dilution of stock solutions of formulated insecticides with water , internodes of sugarcane with 12 cm length were immersed in the selected concentrations for one minute. After decantation off the pesticide solution over a wire mesh sieve, treated sugarcane was air-dried over filter papers for one hour. longitudinally split internodes were used in the case of adults; five pieces of treated food were placed in a 12 x 18 x 6 cm plastic box capped with a 12 holes (5 mm diameter) cover. Five larvae or adult males or females were placed into the box. Test concentrations were calculated on the active ingredient bases. Treated food was replaced with fresh, untreated one every 3 days. Each treatment was replicated three times. Control food was immersed in water and boxes were kept at 25 $\pm$ 1 ^{0}C and 55-75 % RH. Dead insects were identified by losing any response to probing and were counted up to 15 days posttreatment. Probit analysis of data was carried out according to Finney, 1971.

Topical application treatment

Larvae and adults were immobilized by keeping them at 4 ^{0}C for 5 minutes. All topical doses of the tested insecticides were administered with the aid of a hand-operated microapplicator. An acetone solution of the appropriate insecticide preparation (5 µl per insect) was applied to the dorsum (behind the head capsule) in case of larvae, or to the thoracic abdomen in case of adults. Control insects were treated with acetone only. After the solvent evaporated, the treated insects were kept in plastic boxes (5 insects per box), with pieces of sugarcane to feed on. Three replicates of five larvae or adults were performed for each dose. Dead insects were counted up to 15 days, as described above.

RESULTS AND DISCUSSION

Feeding toxicity

The results in Table 1 indicate the great differences among the the tested insecticides in their toxicity to the different stages of the red palm weevil. It is obvious that fibronil was the most effective one against the three stages. Its LC_{50} values against larvae, males and females were 0.00033, 0.000024 and 0.000031 %, respectively. Barranco et al. (1998) reported that mortality in larvae fed on sugarcane with more than 0.2 ppm fibronil was 100 %. The

to each other. Adults were more sensitive to fibronil than the larvae were. The slopes of the mortality curves for the three stages were high, indicating the homogenicity of the insects in their response to this insecticide and explaining the narrow range of concentrations required to achieve high percent mortality (Tablé 1). Fibronil has delayed toxicity since the toxicity symptoms appeared three or four days after treatment. The LT_{50} values for larvae, males and females were 9.08, 7.47 and 9.47 days, respectively.

Cypermethrin was more effective against larvae than for adults. Its LC_{50} values were 0.0032, 0.053 and 0.13 % for larvae, males and females, in sequence. Larvae were more sensitive than males and females by 17 and 38 fold, respectively. Abo-Alsaad *et al.* (2001) recorded similar results for cypermethrin (LC_{50} for larvae was 0.0032 %).

All the three stages almost had equal sensitivity to malathion, LC_{50} values of malathion against larvae, males and females were 0.016, 0.011 and 0.018 %. A previous study by Abraham *et al.* (1975) showed that 100 % mortality of larvae was achieved at 1 % malathion after seven days.

Imidacloprid was as effective as malathion against larvae, with LC_{50} value of 0.012 %. Our data are in the same rank of that obtained by Cabello *et al.*(1997) obtained 100 % mortality of larvae fed on a diet containing 0.01 % imidacloprid is recorded. On the otherhand, imidacloprid was much less toxic than malathion against adults. The LC_{50} values were higher than 5 % for males and females. Larvae were more sensitive than adults by more than 400 fold, this means that imidacloprid could not be recommended to control adults. Azadirachtin was the least effective insecticide against larvae. It gives LC_{50} of 1.68 % against larvae and more than 2 % for adult males and females. These results agreed well with those of Barranco *et al.*(1998). They found that mortality of larvae fed on a diet containing 0.3 % azadirachtin was less than 50 %.

Topical application assay.

The results in Table 2 indicate that fipronil was also very active against the three stages through the topical application route. LD_{50} values against larvae, males and females were 1.84, .038 and 0.047 µg / insect, respectively. Adult males and females were more susceptible to fipronil than larvae by a factor of 48 and 39 fold. Adults were also more sensitive by feeding method (Table 1). Adults did not differ greatly in their sensitivity to cypermethrin from larvae. LD_{50} values for larvae, males and females were 2.3, 1.05 and 166 µg / insect, respectively.

Malathion was more effective against adult males and females than it larvae, LD_{50} values were 0.58, 2.2 and 117 µg / insect for the three stages, respectively. Azadirachtin did not perform well. It did not achieve 50 % kill up to 200 µg / insect against the three stages. This result was expected since azadirachtin is known to affect insects by feeding but not by contact.

Based on our data we can conclude that fipronil is the most promising insecticide to control red palm weevil, it has good effect against all the three stages of the insect at very low rates, either by feeding or the contact (topical application) routes. Fipronil mode of action differs from the modes of action of

Tab1e 1. Feeding toxicity and propit analysis of tested insecticides to Red Palm Weevil

Insecticide	Stage	LC_{50} (95 % CL)	LC_{95} (95 % CL)	Slope ± SE
Fipronil	Larvae	0.00033 (0.00032-0.0.00035)	0.00055 (0.00050-0.00061)	7.35 ± 0.38
	Male	0.000024 (0.000023-0.000026)	0.000044 (0.00004-0.000048)	6.46± 0.36
	Female	0.000031 (0.0.000029-0.000033)	0.000062 (0.000054-0.00007)	5.54± 0.27
Cypermethrin	Larvae	0.0034 (0.0028-0.0042)	0.029 (0.020-0.042)	1.77 ± 0.026
	Male	0.53 (0.040-0.060)	0.48 (0.32-0.74)	1.71± 0.023
	Female	0.13 (0.11-0.16)	1.02 (0.66-1.60)	1.83± 0.027
Malathion	Larvae	0.016 (0.015-0.018)	0.04 (0.034-0.047)	4.24 ± 0.118
	Male	0.011 (0.010-0.012)	0.023 (0.02-0.027)	5.26 ± 0.21
	Female	0.018 (0.017-0.020)	0.038 (0.033-0.034)	5.22 ± 0.2
Imidacloprid	Larvae	0.012 (0.010-0.015)	0.11 (0.076-0.160)	1.77 ± 0.024
	Male	> 5	-	-
	Female	> 5	-	-
Azadirachtin	Larvae	1.68 (1.31-2.35)	21.33 (10.17-29.65)	1.49 ± 0.057
	Male	> 2	-	-
	Female	> 2	-	-

Values are % active ingredients

Tab1e 2. Topical application toxicity and Propit analysis of tested insecticides to Red Palm Weevil

Insecticide	Stage	LD_{50} (95 % CL)	LD_{95} (95 % CL)	Slope ± SE
Fipronil	Larvae	1.84 (1.75-1.95)	3.3 (2.9-3.7)	6.6 ± 0.37
	Males	0.038 (0.035-0.041)	0.11 (0.035-0.13)	3.64± 0.17
	Females	0.047 (0.045-0.050)	0.081 (0.073-0.091)	6.95± 0.34
Cypermethrin	Larvae	2.3 (2-2.6)	10.4 (7.7-14.9)	2.51± 0.054
	Males	1.05 (0.89-1.24)	6.45 (4.86-9.31)	2.09± 0.027
	Females	1.66 (1043-1.92)	7.24 (5.66-9.77)	2.57± 0.042
Malathion	larvae	117 (97.8-140.4)	949 (566-1602)	1.81 ± 0.04
	Males	0.58 (0.51-0.67)	1.69 (1.29-2.3)	3.58 ± 0.13
	Females	2.2 (1.95-2.5)	4.65 (3.9-5.5)	5.15 ± 0.34
Azadirachtin	Larvae	> 200	-	-
	Males	> 200	-	-
	Females	> 200	-	-

Values are in µg / Insect

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الفعل الإبادى لخمسة من المبيدات الحشرية ضد سوسة النخيل الحمراء

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تم قياس فعالية خمسة من المبيدات الحشرية من مجاميع كيماوية مختلفة وهى الفيرونيل، السايبر ميثرين، الملاثيون، الإيميداكلوبريد و الأزادايراكتين ضد ذكور وانـاث ويرقـات سوسـة النخيل الحمراء عن طريق التغذية وكذلك المعاملة السطحية.

وأظهرت النتائج أن مبيد الفيرونيل أكثرها سمية حيث بلغت قيمة التركيز المتوسط المميت ٠,٠٠٠٣٣ ، ٠,٠٠٠٠٢٤ ، ٠,٠٠٠٠٣١% ضد اليرقات والذكور والإناث على الترتيـب وذلـك طبقا لطريقة الإختبار بالتغذية بينما كان الأزادايراكتين أقلها فعالية بنفس الطريقة وعلى نفس أطوار الحشرة المختبرة حيث بلغت قيم التركيز المتوسط المميت ١,٦٨ ، أكثر من ٢ ، أكثـر مـن ٢% على الترتيب السابق.

كما أوضحت النتائج بطريقة المعاملة السطحية أن مبيد الفيرونيل أكثر المبيدات المختبرة فعالية ضد الأفة ويمكن إجمالا القول بأن هذه الحشرة بأطوارها المختبرة المختلفة أكثر إستجابة للمعاملة عـن طريق التغذية منه عن طريق المعاملة السطحية.