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Laboratory evaluation of some insecticides against nymphal and adult stages of *Pulivanaria tenuivavata* (Hemiptera: Coccidae)

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Key words
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Malathion
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Abstract

The red soft scale insect, *Pulvinaria tenuivalvata* (Newstead) is an economic important insect pest of sugarcane in Upper Egypt. The present study was conducted to evaluate the toxicity of malathion, pyriproxyfen, sulfur, bioranza, KZ. oil and sesame oil on nymphal and adult stages of *P. Tenuivalvata* under laboratory conditions. The obtained results revealed a wide range differences in the response of the two stages to the six tested compounds. It was obvious that, at the two levels of toxicity, the nymphal stage was most susceptible s tested insecticides while the adult stage was the most tolerant one. Malathion was the most effective compound on nymphal and adult stages of *P. tenuivalvata* while sesame oil was the least toxic compound. Based on the obtained results malathion, pyriproxyfen, sulfur, bioranza, kz- oil could be used in IPM program against *P. tenuivalvata*.

Introduction

The red-striped soft scale *Pulvinaria tenuivalvata* (Newstead) (Hemiptera: Coccidae) is a serious pest attacking sugarcane (*Saccharum officinarum* L.) in Upper Egypt. Its suck cell sap of sugarcane leaves and excretes a large amount of honeydew that covers leaves and attracts ants and encourages the growth of sooty mould fungus which gives the infested dirty black appearance that effect on photosynthesis and respiration processes of sugarcane plants. The damage caused by *P. tenuivalvata* resulted in reduction of sucrose content of sugarcane (Abdel-Moniem (2003); Dimetry & Abdel-Moniem 2004); Ahmed *et al*. (2014).

Chemical pesticides are one of most common and widely used methods for controlling *P. tenuivalvata* around the world because they have rapid action and strong toxicity against the target pest *p. tenuivalvata* (Abd Ellatif, 2004; Elwan *et al*. 2005a, b; Bakry *et al.* 2012; and Abdel-Rahman *et al.* 2017). However, the indiscriminate use of pesticides to control this pest resulted in rapid development of resistance and several risks as harmful pesticide residues in sugarcane juice, cause undesirable effects on humans and natural environments, and eliminated natural enemies from crop ecosystems (Furlani *et al*. 2011). Therefore, it is essential to find alternative compounds to manage *p. tenuivalvata*. These alternatives must be safe, cheap and available such as plant oils (Baker *et al.* 2012; Yanar *et al.* 2011; and Siam & Othman, 2020). Therefore, the present work was to evaluate the efficiency of certain chemical compounds against the sugarcane soft scale insect under laboratory conditions.

Materials and Methods

Tested materials

Three chemical insecticides including malathion (Malatox®, 57% EC), pyriproxyfen (Admiral®, 10% EC) and sulfur (Sulfur 30% L), one bio-insecticide (Bioranza®, 10% WP), one mineral oil (KZ.oil 95% EC) and one plant oil (sesame oil) were used.

Laboratory bioassay

Laboratory toxicity experiments were carried out to evaluate the efficiency of the above mentioned tested materials against *P. tenuivalvata* (adult and nymphal stages) in sugarcane leaves under laboratory conditions using the Leaf-dip method. Four concentrations of each tested insecticides and oils were prepared in distilled water; three replicates were used for each concentration (10 leaves / replicate). Samples of infested sugarcane leaves with nymph and adult females of *P. tenuivalvata* were collected randomly from infested sugarcane plants and kept in paper bags then transferred to laboratory. The leaves were dipped in the tested insecticide and oil solutions for 30 seconds and the control treatment leaves were dipped in distilled water only and then, the leaves were air dried. Dead and alive individuals were counted and recorded after 24,48, and 72 hrs. (Shah *et al.*, 2016). The average percentage of corrected mortality of insects for each concentration and for control was calculated according Abbott's formula (Abbott, 1925)

Statistical analysis

Data were considered acceptable if the mortalities observed in controls were less than 20%. If there were mortalities in controls, data were adjusted using Abbott's formula (1925). Concentration-mortality regression lines were analyzed using a computer program modified from the method of Finney (1971) to estimate the LC50, the confidence limits and the slopes of LdP lines.

Toxicity index (T.I.): was calculated for each pesticide according to the equation of Sun (1950) as follows:

$$\mathbf{T.I.} = \frac{\text{LC50 of the most toxic pesticide}}{\text{LC50 of the tested pesticide}} \times 100$$

Results and Discussions

Toxicity of the six tested insecticides against the

nymphal stage of *P. tenuivalvata*

The toxic action of malathion, pyriproxyfen, sulfur, bioranaza, kz- oil and one sesame oil against the nymphal stage of *P. tenuivalvata* is presented in Table (1) and Figure (1). Data clearly indicate that the descending order of the toxicity of the tested compounds based on the LC_{50} levels as follows: malathion, pyriproxyfen, KZ. oil, sulfur, bioranaza and sesame oil. The corresponding LC_{50} values were 397.79, 416.09, 3537.10, 4261.75, 4296.07, and 6689.39 ppm. It is clear that the organophosphate insecticide malathion was the most toxic compound whereas the plant oil (sesame oil) was least toxic one. On the other hand, the order of the efficiency of the tested compounds at the LC_{90} levels was as follows: pyriproxyfen, malathion, bioranaza, sulfur, kz- oil, and sesame oil, respectively. The corresponding LC_{90} values were 956.79, 1743.02, 10297.69, 17022.36, 17494.84, and 23957.36 ppm. Slope values of the log concentration-probit lines in Table (1) indicated that pyriproxyfen has the highest slope values of 3.54, while KZ- oil has the lowest one (1.85). It is known as reported by Hoskins and Gordon (1956) that slope value of log concentration-probit line is considered as reaction indicator between the chemical and the affected organism. In other words the highest slope value means more homogeneity in response of the organism towards the pesticide and in the same time the pesticide is acting as a selection factor producing an organism strain as pure genetically as possible, while the low slope value indicates heterogeneous mite population, in its response to the chemical.

Concerning the toxicity index at LC_{50} level the data in Table (1) confirmed that, malathion was the most toxic compound to nymphal stage of *P. tenuivalvata* with toxicity index of 100.While sesame oil was the least toxic compounds with toxicity index of 5.95.

It is obvious, as could be seen in Fig. (1), that the malathion had the steepest toxicity line and sesame oil had the flattest one; pyriproxyfen, KZ- oil, sulfur,and bioranaza lie in between; this reflect the superiority of malathion and inferiority of sesame oil. The obtained results are in agreement with the results obtained by Ellaltif (2004) who found that pyriproxyfen 10% EC (1 ml/Lit. water), capl-2, 95% EC (6.25 ml/Lit. water) and methomyl 90% SP (1.25 gm / /Lit. water) were the most efficient tested compounds, against various developmental stages of the red striped soft scale insect infesting sugarcane leaves. Buss and Turner (2004) mentioned that dimethoate, imidacloprid and

IGR (pyriproxyfen) were among the chemical compounds labeled for professional use on ornamental for controlling armoured scales, soft scales and mealy bugs. Elwan *et al*. (2005a) stated that malathion 57% EC at 0.25% reduced the population of *P. tenuivalvata* on sugarcane fields to 95.3%. Khewah (2005) found that Chalinger was the highest effective compound on the nymphal populations of *P. tenuivalvata* (94.8%). Admiral and Mospilan came in the 2nd order (93.6% and 93.4%) followed by Marshal in the 3rd order (88.9%). Sulfer & Actara came in the 4th order (88.1% & 88%) and Orion was the last one (86.8%).

Toxicity of the six tested insecticides against the adult stage of *P. tenuivalvata*

The same six compounds were tested for their toxicity to adult stage of *P. tenuivalvata* under laboratory conditions. The mortality was recorded and corrected according to Abbot's formula (1925), and the result were plotted on log concentration - probit papers and regression lines were statistically analyzed according to Litchfield and Wilcoxon (1949).This supplied information on confidence limits of LC_{50} and slope values. Propit regression lines of different tested compounds are presented in Figure (2).The data in Table (2) showed that malathion was the most effective compound on adult of *P. tenuivalvata* with LC_{50} of 590.19 ppm, while plant oil (sesame oil) was the least toxic compounds with LC_{50} of 10068.03 ppm. Referring to Table (2) it appears that malathion has the highest slope value (2.82), while KZ- oil been of the lowest slope values (1.89). The LC_{50} values were 590.19, 613.19, 4496.34, 5102.84, 6229.18, and 10068.03 ppm for malathion, pyriproxyfen, K.Z. oil, bioranza, sulfur, and sesame oil, respectively. The corresponding values at LC_{50} were 1678.76, 2535.94, 21454.17, 18092.05, 18864.12 and 37993.21 ppm. Concerning the toxicity index at LC_{50} level the data in Table (2) confirmed that malathion was the most toxic compound to adult females of *P. tenuivalvata* with toxicity index of 100. Sesame oil was the least toxic compounds with toxicity index of 5.86.

To visualize the comparative toxicity, i.e. selective toxicity of the six tested compounds against nymphal, and adult stages of *P. tenuivalvata*, the data presented in Tables (1&2) regrouped in Table 3 for easeful comparison. Data clearly show that there is a wide range in the response of the two stages to action of the six tested compounds. It is obvious that, at the two levels of toxicity, the nymphal stage was the most susceptible stage to the action of the six tested insecticides while the adult stage was the most tolerant one. The obtained results are in agreement with the results obtained by Helmy *et al*.(1991) found that the nymphal stage of some scale insects was more susceptible to insecticides; Basudin, Reldan, Sumithion, Oleo ekalux, Sumi oil and Kz oil ., followed by adult females. Hariss *et al*. (2005) showed that, the nymphal stages of *P. tenuivalvata*, harbauerd significantly affected by the tested treatments (mixture of miscible oils, IGRS and the miscible oils alone), followed by adult females. On other hand, Mohamed and Bakry (2018) found that the tested the insecticides (Acetamiprid, Chlorpyrifos, Diflubenzuron and Malatox), bio-insecticide (Bioranza), mineral oil (Super Royal oil) and plant oil (Jasmine oil) were effective equally to both the nymphs and adult females, but the adult females of *Icerya aegyptiaca* were less susceptible to the tested compounds than the nymphs.

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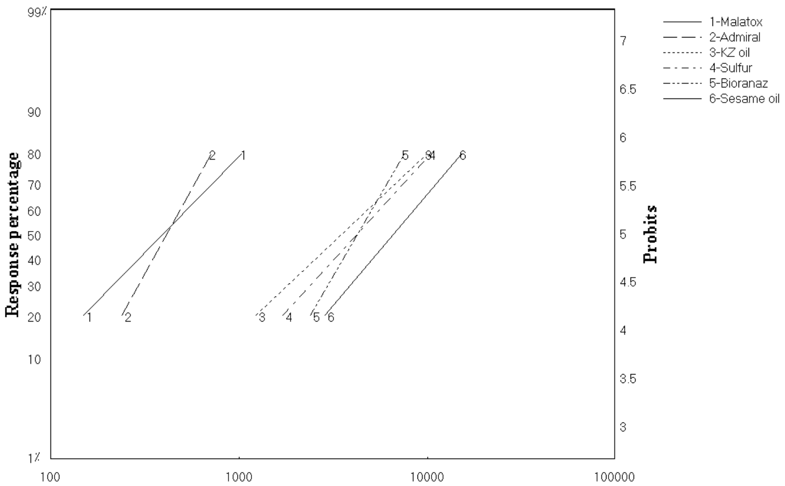
Table 1. Toxicity of the tested compounds against the nymphal stage of *P. tenuivalvata* .

Treatment	N	LC_{50} (ppm)	50% (Confidence limit)		LC_{90} (ppm)	95% (Confidence limit)		Slope	X^2	P- Value	Toxicity index (T.I.)
			Lower	Upper		Lower	Upper				
Malathion	30	397.79	71.92	646.58	1743.02	1266.46	3648.66	1.99±0.61	5.19	0.07	100.00
Pyriproxyfen	30	416.09	351.48	538.61	956.79	681.91	2078.72	3.54±0.75	0.49	0.78	95.61
KZ.oil	30	3537.10	1058.02	5190.53	17494.84	11665.19	65343.04	1.85±0.56	0.53	0.77	11.25
Sulfur	30	4261.75	2821.23	5501.87	17022.36	11005.43	56049.21	2.13±0.54	0.46	0.79	9.33
Bioranza	30	4296.07	3594.96	5745.31	10297.69	7123.97	24706.54	3.38±0.74	0.73	0.69	9.26
Sesame oil	30	6689.39	4733.36	8479.29	23957.36	16134.83	64308.63	2.31±0.55	0.26	0.88	5.95

Table 2. Toxicity of the tested compounds against the adult stage of *P. tenuivalvata* .

Treatment	N	LC_{50} (ppm)	50% (Confidence limit)		LC_{90} (ppm)	95% (Confidence limit)		Slope	X^2	P- value	Toxicity index (T.I.)
			Lower	Upper		Lower	Upper				
Malathion	30	590.19	323.92	781.17	1678.76	1315.05	2643.68	2.82±0.65	0.71	0.70	100.00
Pyriproxyfen	30	613.19	436.19	1862.77	2535.94	1120.82	64846.32	2.08±0.64	3.83	0.15	96.25
Kz.oil	30	4496.34	1954.39	6201.29	21454.17	13831.56	85891.06	1.89±0.54	1.39	0.49	13.13
Bioranza	30	5102.84	3895.52	9844.37	18092.05	9530.29	140815.46	2.33±0.64	2.14	0.34	11.57
Sulfur	30	6229.18	5010.77	7954.84	18864.12	12750.64	47200.32	2.66±0.58	1.21	0.55	9.48
Sesame oil	30	10068.03	7838.49	14163.29	37993.21	22428.14	168748.49	2.22±0.56	0.24	0.89	5.86



Log concentration (ppm)
Fig.1. Toxicity of the tested compounds against nymphal stage of *P. tenuivalvata*

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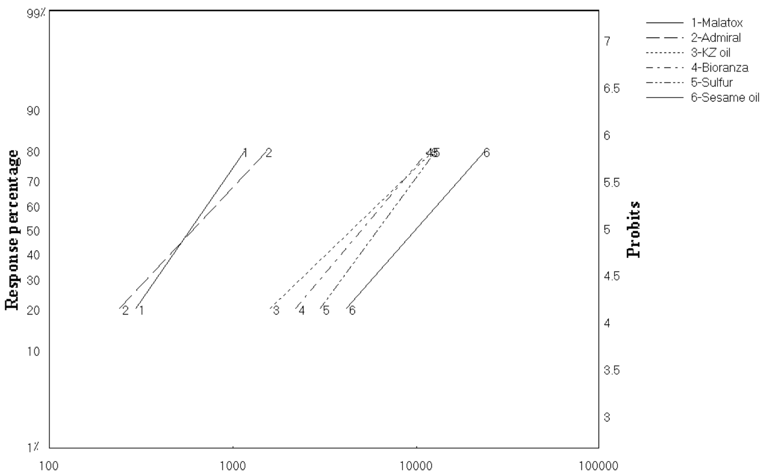

Log concentration (ppm)
Fig.2. Toxicity of the tested compounds against the adult stage of *P. tenuivalvata*

Table 3. Toxicity of the tested compounds against the nymphal and adult stages of *P. tenuivalvata* .

Treatment	LC_{50} (ppm)		LC_{90} (ppm)	
	Nymph	Adult	Nymph	Adult
Malathion	397.79	590.19	1743.02	1678.76
Pyriproxyfen	416.09	613.19	956.79	2535.94
Kz.oil	3537.10	4496.34	17494.84	21454.17
Bioranza	4296.07	5102.84	10297.69	18092.05
Sulfur	4261.75	6229.18	17022.36	18864.12
Sesame oil	6689.39	10068.03	23957.36	37993.21