J. Agric. Sci. Mansoura Univ., 29 (4): 2053 - 2065, 2004

THE USE OF SOME RELATIVELY SAFE COMPOUNDS FOR THE CONTROL OF CITRUS LEAF MINER *PHYLLOCNISTIS CITRELLA* STAINT.

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ABSTRACT

The efficiency of eight compounds representing different chemical groups was evaluated against the citrus leafminer *P. citrella* larval population on navel orange trees. At the recommended rates, the tested compounds suppressed the level of infestation to different degrees according to the nature of the compound, the rate of use and the time elapsed after spraying.

As an average of the two sprays, three weeks each, λ cyhalothrin, as a potent pyrethroid, was the most effective compound giving 73.7% reduction, followed by the mixture of abamectin + Kz-oil (71.5%) and then chlorpyrifos methyl (59.0%). This effective group was considered as the first category of the tested compounds.

The second category includes: Kz-oil, pyriproxifen + Kz-oil and azatin. They displayed moderate effects amounted to 47 , 44.7 and 43.0% reduction in infestation through the two sprays, respectively. The remaining products (pymetrozine and bio-dux) may be regarded as ineffective in reducing the leafminer incidence under the prevailing experimental conditions.

The bioresidual activity of the tested compounds, even with the potent pyrethroid, did not exceed more than two weeks (for the best cases). Thus, the frequent application would be necessary, particularly when non traditional compounds were used.

The efficiency of the treatments was evaluated by visual estimation of infested or non-infested leaves, intensity of larval infestation and the larval vitality.

The present results clarify that assessment of the test compound using a certain criterion does not conflict with other criteria. Despite of offering more accurate and reliable data by the last two criteria, the order of insecticidal efficacy by using the three tested criteria seems to be almost similar.

INTRODUCTION

The citrus leafminer *Phyllocnistis citrella* Staint (Lepidoptera: Gracillariidae) has been recorded as an important pest of citrus in India by Pandey and Pandey (1964) in Sudan and Yemen by Ba-Angood (1977) in Australia by Beattie (1989) in Canada and the United States by Knapp, *et al*, 1994 and many other countries.

It was first observed in some citrus orchards in Sharkia governorate, Egypt, in 1994, then rapidly spread to threaten in many nurseries and orchards throughout the country (Abdel-Aziz, 1995 and Korashy, 1998).

The leafminer injury to the plant can be manifested through reduction of the leaf surface area responsible for the photosynthetic activity. It prevents newly emerged leaves from fully expanding, causing leaves to be curly, twisted and eventually necrotic (Knapp, *et al.*, 1995). In South Florida, *P. citrella* leaf damage > 25% in lime trees reduces flower production and yield and Increases leaf abscission (Hunsberger, *et al.*, 1996).

Four species of indigenous parasitoids are recently Identified. In the meantime, an applicable biological control programme is not yet, well developed. Many growers allover the world have relied on chemical control of *P. citrella* to reduce its population (Valand *et al.*, 1992 and Rae *et al.*, 1996).

The present work aimed to evaluate the potency of certain candidate compounds alone or mixed with mineral oil against citrus leafminer infestation using three different criteria of assessment.

MATERIALS AND METHODS

An orchard about 2 feddans of Navel orange *Citrus sinensis* (Limn.) at Shebein el-Kanater regions (Kalyoubia Governorates) was chosen for these experiments. The trees, about 15 year old, were naturally infested with the citrus leafminer and they did not receive any insecticidal treatments throughouts the last two years. A randomized block design was used where; each chemical treatment was carried out on 9 trees (representing 3 replicates, 3 trees for each). The other trees were left as borders between treatments.

Eight compounds representing different insecticide groups were used:

1. Pyriproxyfen: (admiral) an insect growth regulator 10% E.C.
2. Azatin: Botanical insecticide (Azadirachtin 3% E.C).
3. Lamdacyhalothrin: (Icon) Pyrethroid insecticide 2.5% E.C.
4. Abamactin: (Vertemic) Naturally derived Insecticide produced by soil microorganism 1.8% E.C.
5. K.z.oil: (Petroleum oil) 98.5% E.C.
6. Chlorpyrifos-methyl: (Reldan) Organophosphorous insecticide 50% E.C.
7. Pymetrozine: (Chess) A now type of insecticide having pyridine azomethrine group. 25% W.P.
8. Bio-Dux: Synthetic oil containing 15% potassium oleate.

Two sprays were done at May 29 and August 14, 1999.

Each chemical was applied at two rates; the first was recommended by the ministry of Agric. or by the manufacturer, while the second lower rate amounted to 2/3 of the recommended rate as shown in the tables.

Spraying was accomplished by means of a motor sprayer with a 120 liters tank capacity as a foliar treatment, at a rate of 6.0 litres of spray liquid/tree to ensure complete coverage all parts of the tree.

Samples of 7-8 cm length twigs were randomly collected from the canopy periphery of the tree (sites of oviposition). Five twigs were collected from each replicate (3 trees), kept in paper bag, transferred to the laboratory for examination.

Samples for pretreatment counts were taken immediately before spraying whereas those for post treatment counts were taken 1,2 and 3 weeks after application according to the method of Rezk *et al.* (1996).

The efficiency of the treatments on leafminer population was evaluated by three different criteria as follows:

(a) visual estimation of infested or non-infested leaflet in each sample collected throughout the first and second sprays. The percent of infestation was calculated based on the number of infested leaves in relation to the total number of leaves in the sample. The reduction percent in infestation was calculated using Hendrson and Tilton equation (1955).

(b) Fifty new leaves were randomly collected after the first spray, where the number of mines (larvae) per leaf was recorded. The intensity of larval infestation was evaluated based on score rating as the number of mines (0,1,2,3,4, or 5) in each leaflet of the sample. The infestation percent was then calculated using Townsed-Heuberger formula (1981) as follows:

$$\% \text{ Infestation} = \frac{\text{Sum (n.v.)}}{\text{IN}} \times 100$$

Where:

n= Number of leaflet in each category.

v = Category value (no. of mines in a given leaflet).

I = Highest category value.

N = Total number of leaflet in the sample.

The reduction percent in infestation was calculated in comparison to the untreated control values.

(c) The larval vitality: Twig samples were collected in the field from each treatment, at a given time after the first spray, where the infested leaves only were considered. The larval tunnels were peeled off and examined for alive larvae under a disecting microscope. The number of alive larvae was recorded and the percent of larval survival was calculated in relation to the total numbers of larvae in each sample.

All the data were analyzed by the analysis of variance (ANOVA) and Duncan multiple range test (Snedecor, 1970).

RESULTS AND DISCUSSION

Effect of the tested compounds on leafminer infestation:

The percent of infested leaves and percent of reduction in infestation with citrus leafminer are presented in Tables 1 and 2, respectively.

The results showed that the infestation percent of navel leaves by *P. citrella*, before any insecticidal treatment, ranged from 31.3 to 54.0%. The chemical treatments were able to suppress the levels of infestation to different degrees in comparison to that of untreated control. The suppression, however, greatly varied according to the nature of the tested compound, the rate of use and the time elapsed after spraying.

Table (1): Percent of infested leaves with the citrus leafminer, *Phyllocnistis citrella* Staint. before and after treatment with the tested compounds.

Treatment	Rate of use (%)	% Infestation at weeks after spraying										Overall mean
		1st spray at May,29					2nd spray at August ,14					
		Pre	1	2	3	Avg.	Pre	1	2	3	Avg.	
Pyriproxyfen +KZ oil	0.05+0.3	51.3	39.3	48.0	54.0	47.1	87.3	52.7	58.0	78.7	63.1	55.1 de
	0.04+0.2	52.7	49.3	53.3	50.7	51.1	80.7	64.0	68.3	82.0	71.6	61.4 ef
Azatin	0.08	54.0	45.3	50.7	53.3	49.9	91.3	60.0	69.3	74.0	67.8	58.9 def
	0.06	53.3	48.7	54.7	61.3	54.9	90.0	63.3	82.7	78.0	74.7	64.8 f
λ-Cyhalothrin	0.04	47.3	14.7	18.7	21.3	18.2	80.7	18.7	30.7	41.3	30.2	24.2 a
	0.03	45.3	31.3	33.3	34.7	33.1	75.3	45.3	66.7	64.7	58.9	46.0 bc
Abamectin +KZ oil	0.03+0.3	43.3	16.0	17.3	19.3	17.5	85.3	24.7	32.7	48.0	35.1	26.3 a
	0.02+0.2	45.3	27.3	29.3	31.3	29.3	86.7	57.3	56.7	64.0	59.3	44.3 bc
KZ oil	1.5	45.3	32.7	34.7	37.3	34.9	75.3	35.3	47.3	83.3	55.3	45.1 bc
	1.0	40.7	34.0	50.7	53.3	46.0	78.7	50.3	68.0	92.0	70.1	58.1 def
Chlorpyrifos-methyl	0.13	46.7	22.0	23.3	29.3	24.9	80.0	33.3	42.0	73.3	49.5	37.2 b
	0.08	34.7	31.3	33.3	46.7	37.1	93.3	42.0	69.3	83.3	64.9	51.0 cd
Pymetrozine	0.06	31.3	33.3	42.7	38.7	38.2	89.7	72.0	72.0	86.7	76.9	57.6 def
	0.04	32.7	40.7	45.3	52.7	46.2	86.7	80.0	77.3	94.0	83.8	65.0 f
Bio-Dux	5.0	40.7	59.3	72.7	61.3	64.4	84.7	77.3	77.3	93.3	82.6	73.5 g
	3.4	39.3	67.3	76.0	75.3	72.9	85.3	86.0	74.7	92.0	84.2	78.6 g
Control	-	40.7	69.3	84.7	89.3	81.1	83.3	87.3	92.0	97.3	92.2	86.7 h
L.S.D. at 0.05		11.4	9.4	9.8	7.6	5.2	16.8	20.4	26.6	20.2	12.6	6.8

Means with the same letter are not significantly different.

Table (2): Percent reduction in infestation of citrus leafminer, *Phyllocnistis citrella* Staint. after spraying with certain insecticides on navel orange trees .

Treatment	Rate of use (%)	% Reduction in infestation at weeks after spraying								Overall mean
		1st spray at May ,29				2nd spray at August ,14				
		1	2	3	Avg.	1	2	3	Avg.	
Pyriproxyfen + KZ oil	0.05+0.3	55.1	55.1	52.0	54.4	42.4	39.8	22.8	35.0	44.7
	0.04+0.2	45.0	51.5	56.1	50.9	24.3	22.9	13.0	20.1	35.5
Azatin	0.08	50.8	54.9	55.0	53.6	37.3	31.3	30.6	33.1	43.4
	0.06	46.5	50.7	47.6	48.3	32.9	16.6	25.8	25.2	36.8
λ –Cyhalothrin	0.04	81.8	81.0	79.5	80.8	77.9	65.6	56.2	66.6	73.7
	0.03	59.5	64.7	65.1	63.1	42.6	19.9	26.4	29.6	46.4
Abamectin +KZ oil	0.03+0.3	78.3	80.8	79.7	79.7	72.4	65.3	51.8	63.2	71.5
	0.02+0.2	64.6	68.9	68.5	67.3	37.0	40.8	36.8	38.2	52.8
KZ oil	1.5	57.6	63.2	62.5	61.1	55.3	43.2	0.05	32.9	47.0
	1.0	51.0	40.2	40.1	43.8	39.0	21.8	0.0	20.3	32.1
Chlorpyrifos-methyl	0.13	72.3	76.1	71.4	73.2	60.3	52.5	21.6	44.8	59.0
	0.08	47.1	53.9	38.6	46.5	57.1	32.8	23.6	37.8	42.2
Pymetrozine	0.06	37.5	34.9	43.6	38.9	23.1	27.0	17.0	22.1	30.5
	0.04	26.0	33.5	26.5	29.0	12.0	19.3	0.07	10.4	19.7
Bio-Dux	5.0	14.5	14.3	31.3	20.0	12.9	17.4	0.06	10.1	15.1
	3.4	0.0	0.07	12.6	4.2	0.04	20.7	0.08	6.9	5.6

Out of eight treatments applied early in the season; λ-cyhalothrin at 0.04%, the mixture of abamectin + Kz-oil at 0.03 + 0.3% and chlorpyrifos methyl at 0.13% significantly reduced the number of infested leaves to 80.8, 79.7, 73.2% reduction in infestation, respectively throughout the experimental period (3 weeks), Table 2.

Similar results were obtained for the second spray, where the corresponding values were 66.6, 63.2 and 44.8% reduction were recorded (Tables 1 and 2).

As an average of the two sprays, λ-cyhalothrin as a potent pyrethroid was the most effective compound giving 73.7% reduction, followed by the mixture of abamectin + Kz-oil (71.5%) and then chlorpyrifos methyl (59.0%). This effective group was considered as the first category of the tested compounds.

These results are in accordance with those of other investigators. Pyrethroid insecticides such as fenvalerate, and permethrin proved to be more efficient against *P.citrella* than the organophosphate insecticides (Redke and Kandalkar, 1988, Bhatia and Johki, 1991 and Valand *et al*, 1992). Rézk *et al.*(1996) clarified that application of vertemic at 0.02% mixed with 2.0% mineral oil gave high control (85% reduction) against the citrus leafminer population and its activity was also extended for up to 21 days post treatment.

The other group of the tested compounds includes the three treatments (Kz-oil, pyriproxifen + Kz-oil and azatin). Application of Kz-oil alone at the recommended rate gave 47.0% reduction over the two sprays (Table 2). Similarly, moderate effects were obtained after application of either pyriproxifen + Kz-oil or the botanical insecticide azatin. This group of treatments having Intermediate activity was considered as the second category of the tested compounds.

Tables 1 and 2 also showed that, pymetrozine was determined to be the least effective while bio-dux may be regarded as ineffective in reducing the leafminer incidence under the prevailing experimental conditions.

The rate of pesticide use is a crucial factor in plant protection where more economic and safe rates are usually preferable. The results in Table 2 indicated that the decrease in the rate of the mienral oil Kz, for example, from 1.5 to 1.0% significantly lowered the potency from 47.0 to only 32.1% (average of the two sprays). Thus, the recommended rate was necessary to achieve suitable control of the leafminer. The pyrethroid λ-cyhalothrin applied at the reduced rate (0.03%) caused 27.3% decrement of its potency from 73.7 to 46.4%. The same trend of results was observed in most of the other treatments indicating that the suggested lower rates rather, than the recommended ones, do not provide adequate control against the leafminer population..

The direct effects of the sprayed compounds and their residual activity were also investigated. The results revealed that λ-cyhalothrin treatment was able to drop the infestation percent of navel leaves from 47.3 to 14.7% within the first week of spraying (Table 1). It offered 81.8% protection in the 1st spray indicating high initial kill compared with the other treatments (Table 2). As for the time elapsed after spraying, no changes in the activity either in the 1st or 2nd spray were detected indicating the stability of the compound. Its toxic residues, however, make it suitable to apply in summer season during the vegetative phase of the orange trees and avoiding the time of flourish and fruiting stages.

The pattern of insecticidal activity of abamectin + Kz oil treatment seems to follow that of λ-cyhalothrin, with slight variations. Considerable control was achieved within the first 2 weeks of spraying while the residual activity started to decline afterwards. An average of 57.2% and 60.7% reduction were recorded for the 2 sprays, respectively.

Both treatments of pyriproxyfen + Kz-oil and azalin had ability to prevent damage by the leafminer in the initial samples (giving 55.1 and 50.8% reduction in infestation). The persistence of each treamtent was kept for about 2 weeks, then the bioresidual activity was gradually decreased, particularly in the second spray.

About 57.6% reduction in population density was obtained within the first week after Kz-oil applied early of the season. The respective value in the 2nd spray was 55.3%. Slight fluctuations in the population density were observed in the consecutive treated samples, but the overall activity of the mineral oil did not exceed 47.0% reduction for both sprays (Table 2).

Effect of insecticides on intensity of larval infestation:

In this evaluation method the collected leaf samples from each treatment was scored and recorded as shown in Tables 3 and 4.

The results showed that the canopy of the untreated control trees was heavily infested with the citrus leafminer. In term of figures, the average number of healthy leaves (score 0.0) that recorded in the control tree samples was only 6.3, 4.0 and 1.3/sample for the three successive weeks, respectively (Table 3). Moreover, it is hard to find an intact citrus leaf entirely free from infestation.

In leaf samples having only one mine/leaf (Score I) showed 18.0, 17.6 and 9.7 leaves/sample (50 leaves) at 1,2 and 3 weeks in the untreated trees (Table 3). It represent about 30.2% of the sample content.

Twonsed-Heuberger (1981) formulated his equation depending on a scored rating to judge on the severity of leafminer infestation in various treatments.

According to this equation, λ cyhalothrin showed high initial effect giving 7.0% infestation and 79.4% reduction in infestation (Table 4). Its residual activity, however, gradually decreased with increasing the number of mines in the successive samples. The same trend of results was observed when the mixture of abamectin + Kz-oil was applied. Both treatments are superior and nearly equal where 66.0 and 66.2% reduction through the whole season, were obtained.

The results in Table 4 explain also that treating the orange trees with the reduced tested rates of these efficient compounds did not produce efficient control of the citrus leafminer. However, these reduced rates failed to control the insect in the other tested compounds. Treatments of chlorpyrifos methyl or Kz-oil at the recommended rates displayed moderate effects one week after spraying. Thus, they can be reliad upon to control *P. citrella* larvae.

Table (3): Average number of leaves classified to different scores induced by the citrus leaf miner ,*Phyllocnistis citrella* Staint. at different intervals after application of the tested compounds (second spray ,August 14) .

Treatment	Rate of Use (%)	Number of classified leave into 6 scores / 50 young leaves at weeks after spraying																	
		1st week						2nd week						3rd week					
		0	I	II	III	IV	V	0	I	II	III	IV	V	0	I	II	III	IV	V
Pyriproxyfen + KZ oil	0.05 + 0.3	23.7	18.3	7.3	0.7	0.0	0.0	21.0	20.0	8.0	1.0	0.0	0.0	10.7	12.0	14.0	9.7	2.3	1.3
	0.04 + 0.2	18.0	22.0	7.3	1.3	1.3	0.0	15.7	20.0	11.0	1.6	1.7	0.0	9.0	9.0	13.3	8.7	6.7	3.3
Azatin	0.08	20.0	19.6	9.7	0.7	0.0	0.0	15.3	21.7	9.0	4.0	0.0	0.0	13.0	16.6	13.6	5.6	0.6	0.6
	0.06	18.3	22.3	7.7	1.7	0.0	0.0	8.7	26.0	13.0	1.3	1.0	0.0	11.0	15.4	14.0	5.3	3.0	1.3
λ – Cyhalothrin	0.04	40.7	7.0	1.3	0.3	0.0	0.0	34.7	9.0	5.3	1.0	0.0	0.0	29.3	15.0	4.4	1.3	0.0	0.0
	0.03	27.3	13.0	4.7	2.3	2.7	0.0	16.7	24.0	6.3	3.0	0.0	0.0	17.7	16.3	5.3	4.3	4.0	2.4
Abamectin + KZ oil	0.03 +0.3	37.7	9.3	2.7	0.3	0.0	0.0	33.7	12.3	3.3	0.7	0.0	0.0	26.0	12.7	7.7	3.3	0.0	0.3
	0.02 + 0.2	21.3	14.3	11.3	2.7	0.3	0.0	21.7	14.3	11.3	2.3	0.3	0.0	18.0	13.0	9.7	7.0	1.7	0.6
KZ oil	1.5	32.3	14.7	2.3	0.7	0.0	0.0	26.3	20.7	2.3	0.7	0.0	0.0	8.3	7.7	13.0	12.0	5.7	3.3
	1.0	24.7	13.0	8.0	2.0	2.3	0.0	16.0	22.7	3.0	6.0	2.3	0.0	4.0	9.7	21.3	9.7	3.3	2.0
Chlorpyrifos Methyl	0.13	33.3	12.3	3.0	1.3	0.0	0.0	29.0	17.3	3.0	0.7	0.0	0.0	13.3	8.0	14.7	6.7	3.0	4.3
	0.08	29.0	18.0	2.3	0.7	0.0	0.0	15.3	21.7	9.0	3.0	1.0	0.0	8.3	13.0	13.7	10.0	3.7	1.3
Pymetrozine	0.06	14.0	20.3	8.0	4.0	2.3	1.3	14.0	24.0	7.0	3.7	1.3	0.0	6.7	4.0	13.3	11.3	10.3	4.3
	0.04	9.7	15.7	11.3	8.7	3.7	1.3	11.3	13.3	14.3	6.7	4.0	0.7	3.0	10.0	7.7	14.3	10.3	4.7
Bio – Dux	5.0	11.3	18.7	9.3	6.3	2.7	1.7	11.3	28.0	5.7	4.0	1.0	0.0	3.3	8.7	6.7	12.7	11.6	5.0
	3.4	7.0	15.6	12.0	10.0	4.7	0.7	12.7	14.6	14.7	6.0	2.0	0.0	4.0	6.3	8.7	13.7	12.0	5.3
Control	-	6.3	18.0	16.7	4.0	3.7	1.3	4.0	17.6	18.7	4.3	3.7	1.7	1.3	9.7	13.3	18.0	6.7	1.0

Table (4): Effectiveness of the tested compounds applied on navel orange trees against the citrus leafminer, *Phyllocnistis citrella* Staint. (second spray ,August 14) .

Treatment	Rate of Use (%)	Mean % infestation* and % reduction** at weeks after spraying			Avg. % infestation	Avg % reduction in infestation
		1	2	3		
Pyriproxyfen +KZ oil	0.05+0.3	23.3 (31.3)	26.0 (28.8)	33.9 (30.5)	27.7 de	30.2
	0.04+0.2	22.9 (32.4)	26.8 (26.7)	42.0 (13.9)	30.6 e	22.9
Azatin	0.08	27.4 (19.2)	34.5 (5.5)	26.4 (45.9)	29.4 e	25.9
	0.06	28.5 (15.9)	30.0 (17.8)	31.1 (35.9)	29.9 e	24.7
λ- Cyhalothrin	0.04	7.0 (79.4)	15.1 (58.6)	18.5 (62.1)	13.5 a	66.0
	0.03	20.1 (40.7)	30.4 (16.7)	27.1 (44.5)	25.9 cd	34.8
Abamectin +KZ oil	0.03+0.3	10.4 (69.3)	14.0 (61.6)	15.8 (67.6)	13.4 a	66.2
	0.02+0.2	23.1 (31.9)	22.5 (38.4)	25.3 (48.2)	23.6 bc	40.6
KZ oil	1.5	14.3 (57.8)	18.3 (49.9)	43.6 (10.7)	25.4 cd	36.0
	1.0	22.1 (34.8)	28.0 (23.3)	41.8 (14.3)	30.6 e	22.9
Chlorpyrifos-methyl	0.13	14.8 (56.3)	16.9 (53.7)	36.4 (25.4)	22.7 b	42.8
	0.08	16.5 (51.3)	26.4 (27.7)	36.7 (24.8)	26.5 d	33.2
Pymetrozine	0.06	25.6 (24.5)	27.2 (25.5)	50.9 (-4.3)	34.6 f	12.8
	0.04	34.3 (-1.17)	32.6 (10.7)	53.2 (-9.0)	40.0 h	-0.75
Bio-Dux	5.0	30.2 (10.9)	27.7 (24.1)	54.2 (-11.1)	37.4 g	5.8
	3.4	36.8 (-8.6)	35.0 (4.1)	55.7 (-14.1)	42.5 i	-7.1
Control	-	33.9	36.5	48.8	39.7 h	-
L.S.D. at 0.05		3.2	4.3	4.5	2.2	

*-Calculated using the formula of Townsed – Heuberger (1981).
**-Compared to the control value.
-Means with the same letter are not significantly different.

It should be mentioned that slight variations between the efficiency calculated using the two criteria, were sometimes noticed. The activity of the mixture of pyriproxyfen + Kz oil or Azadiractin (Azatin) were relatively less pronounced using Townsed-Heuberger formula. The leaf samples, in this criteria, were examined based on the absolute changes in the number of mines only in a given treatment, while Hendrson and Tilton equation known to involve other parameters such as pre-count insect (before treatment) as well as the level of the natural population in the control trees.

Pena and Duncan (1994) pointed out that most of the tested chemicals (Agrimek + mineral oil, fenoxycarb and RH 2485) reduced the number of *P. citrella* larvae per leaf, one weeks after spray, but their efficacy was reduced 14 days after spraying. They also emphasized that the number of mines per leaf provided a better assessment of citrus leafminer infestation than the number of dead larvae.

Effect of insecticides on leafminer larvae:

The number of alive larvae and the percent of larval survival of *P. citrella* after insecticide treatments are presented in Table 5.

Complete control of larvae was achieved for at least the first week after applying λ-cyhalolthrin at 0.04% where no alive larvae were recorded in all examined samples. High mortality was also observed after the application mixture of abamectin + Kz oil at 0.03 + 0.3% or chlorpyrifas methyl at 0.13% as the percent of survival amounted only to 11.1 and 16.7%, respectively. The toxicity of the two treatments extended for up to 14 days where the insect population regained its activity afterwards.

Application of what we called the second group (Pyriproxyfen + Kz-oil, azatin and Kz-oil) at the recommended rates ascertained the previous results obtained; they have moderate effects against *P. citrella* larvae. They exhibited 46.2, 50.0 and47.1% larval survival, respectively, one week after spraying, compared to 86.5% in the samples collected from untreated control trees (Table 5). The rest of the tested compounds had week effect in this respect.

It could be concluded that the bioresidual activity of the tested compounds, even with the potent pyrethroid, did not exceed more than two weeks for the best cases. Thus, the frequent application would be necessary, particularly when non-traditional compounds were used.

The present results clarify that assessment of the test compound using a certain criterion does not conflict with the other criteria either in determining the actual activity or the relative efficiency among other tested compounds. Thus, the order of insecticidal efficacy of the tested compounds by using the 3 tested criteria seems to be almost similar.

Evaluation of a candidate compound against a leafminer by using the percentage of infested leaves gives a quick estimation of its efficacy directly in the field. However, counting the number of mines as well as the number of living larvae in the laboratory should offer more accurate and reliable data, particularly when studying the delayed effects of candidate compounds against leafminer larvae inside their mines.

Table (5): Survival larvae of the citrus leafminer, *Phyllocnistis citrella* Staint. in the leaf samples collected after spraying the tested compounds on orange trees(second spray ,August 14) .

Treatment	Rate of use (%)	Avg. number of alive larvae and % survival at weeks after spraying.									Mean % Survival
		1			2			3			
		* Total	No. of alive larvae	% Survival	* Total	No. of alive larvae	% Survival	* Total	No.of alive larvae	% Survival	
Pyriproxyfen +KZ oil	0.05+0.3	26.0	12.0	46.2	24.0	14.0	58.3	26.5	22.0	83.0	62.5 cde
	0.04+0.2	20.0	10.0	50.0	16.5	13.0	78.8	22.5	19.5	86.7	71.8 de
Azatin	0.08	18.0	9.0	50.0	16.0	8.0	50.0	22.0	18.0	81.8	60.6 cde
	0.06	19.5	10.0	51.3	19.0	14.0	73.6	23.0	19.0	82.6	69.1 cde
λ –Cyhalothrin	0.04	19.0	0.0	0.0	17.0	3.0	17.6	18.0	13.0	72.2	29.9 a
	0.03	14.0	4.0	28.6	21.0	8.5	40.5	25.0	22.0	88.0	52.4 bc
Abamectin +KZ oil	0.03+0.3	18.0	2.0	11.1	20.0	3.0	15.0	22.0	15.5	70.5	32.2 a
	0.02+0.2	20.0	7.0	35.0	20.0	10.0	50.0	28.0	23.5	83.9	56.3 bcd
KZ oil	1.5	17.0	8.0	47.1	22.0	12.0	54.5	36.0	29.5	81.9	61.1 cde
	1.0	19.0	11.5	60.5	24.0	18.5	77.1	29.5	25.0	84.7	74.1 de
Chlorpyrifos-methyl	0.13	18.0	3.0	16.7	19.5	8.0	41.0	25.0	17.5	70.0	42.6 ab
	0.08	22.5	10.0	44.4	22.0	10.5	47.7	20.0	16.0	80.0	57.4 bcd
Pymetrozine	0.06	16.0	7.0	43.8	24.0	15.0	62.5	20.5	17.0	82.9	63.1 cde
	0.04	14.5	8.5	58.6	24.5	16.0	65.3	33.0	28.0	84.8	69.7 cde
Bio-Dux	5.0	17.5	8.5	48.6	29.5	23.0	77.9	32.5	28.0	86.2	70.9 cde
	3.4	14.5	8.5	58.6	24.0	20.0	83.3	34.0	31.0	91.2	77.7 e
Control	-	26.0	22.5	86.5	24.0	22.0	91.7	36.0	33.5	93.1	90.4 f
L.S.D. at 0.05				9.5			7.8			7.6	11.6

* Total number of larvae that found in the leaf sample.

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J. Agric. Sci. Mansoura Univ., 29 (4), April, 2004

استخدام بعض المواد الآمنة نسبيا فى مكافحة حشرة صانعة انفاق الموالح

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تم تقييم فعالية ثمانية مركبات تابعة لمجاميع كيماوية مختلفة بغرض مكافحة حشرة صانعة أنفاق الموالح على أشجار البرتقال أبو سرة. أدت المعاملات بالمعدلات الموصى بها لجميع المركبات المختبرة إلى خفض مستوى الإصابة بدرجات متباينة تبعا لطبيعة المركب المختبر، ومعدل استخدامه والفترة بعد المعاملة.

كان مركب البيريثرويد أكثر المركبات المختبرة تأثيرا خلال الرشتين حيث خفض الإصابة بمقدار ٧٣,٧% خلال ثلاثة أسابيع من الرش، يليه مخلوط الابامكتين والزيت (٧١,٥%) ثم الكلوربيريفوس- مثيل (٥٩%) وقد اعتبرت هذه المجموعة فى المرتبة الأولى بالنسبة للمركبات المختبرة.

تضمنت المجموعة الثانية المركبات الثلاثة (زيت ك زد، بيروبروكسيفين والزيت معا، والمستخلص النباتى (زانين) حيث اظهرت تأثيرات متوسطة وانخفضت الإصابة فى معاملاتها بنسب ٤٧، ٤٤,٧، ٤٢% على التوالى خلال الرشتين. أما المركبات المتبقية (بيمتروزين وزيت البيوتكس) فتعتبر مركبات غير فعالة فى هذا الصدد.

ويمكن القول أن النشاط المتبقى للمركبات المختبرة، تحت الظروف الحقلية السائدة، لم يتعد أسبوعين بعد المعاملة حتى فى أحسن الحالات بالنسبة للمركب البيريثرويدى، لذا يفضل تكرار المعاملة إذا ما دعت الضرورة لذلك خاصة عند استخدام المركبات الغير تقليدية فى المكافحة.

وقد قيمت المعاملات السابقة باستخدام ثلاثة معايير تشمل التقدير الظاهرى المباشر للأوراق المصابة وغير المصابة، وشدة الإصابة على الأوراق، وحيوية اليرقات المعاملة. أوضحت النتائج أيضا أن استخدام أحد المعايير للتقييم لا يتعارض مع المعايير الأخرى ورغم أن المعيارين الأخيرين أعطيا نتائج أكثر دقة وثقة إلا أن ترتيب الكفاءة الأبادية للمركبات محل الدراسة كان متشابها لحد كبير.