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Comparative Effectiveness of Some Insecticide Treatments Against Citrus Leafminers, *Phyllocnistis citrella* (Stainton),on Mandarin Orchard at Nubareya District, Beheira Governorate

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ABSTRACT

Citrus leaf miner (CLM), Phyllocnistis citrella (Stainton) is one of the most common insect pests infesting mandarin orchards. The present study was carried out to evaluate some insecticides (Proclaim-Vertemic-Radiant-Mospilan-Runner) treatments in mixture with a mineral oil against larval and pupal stages of the leaf miner to find out the effective treatment in controlling the CLM. Results revealed that, Proclaim / Chemisol mixture (92.9%) achieved the highest reduction percentage in CLM serpentine mines, which is followed by Vertemic / Chemisol (88.3) and Radiant / Chemisol (88.2) in 2014 season. In 2015, Proclaim / Chemisol (88.2) and Radiant / Chemisol (86.5) mixtures achieved the highest reduction percentage in CLM serpentine mines. Mospilan / Chemisol (85.1) mixture achieved the lowest reduction percentage in P. citrella serpentine mines in 2014. Runner / Chemisol mixture achieved the lowest reduction percentage in P. citrella serpentine mines in 2015. Percent reduction of CLM larvae were 95.1, 90.1, 87.1, 84.3 and 81.4% in 2014 and 89.6, 86.5, 83.1, 82.7 and 78.9 in 2015, after treatment by the mixture of Chemisol with each Proclaim, Vertemic, Radiant, Mospilan and Runner, respectively. In respect with the effect of the insecticide treatments on the CLM pupae, Vertemic / Chemisol mixture (86.3 and 86.6%) achieved the highest reduction percentages followed by Proclaim / Chemisol mixture (83.9 and 83.4%) in both seasons 2014 and 2015. Runner / Chemisol mixture (77.5 and 76.0%) achieved the least reduction percentage of CLM pupae in both seasons 2014 and 2015.

INTRODUCTION

Citrus is a globally cultivated fruit crop, which includes orange, sweet orange, acid lime and other related species of citrus. Among the fruit crops, citrus occupies big area and production. Among the citrus group, mandarin (*Citrus reticulata*) is the world fame glorious fruit crop (Lad *et al.*, 2010). Mandarin is attacked by many insect pests; between them is citrus leafminer (CLM), *P. citrella*, (Heppner, 1993). Citrus leafminer is a delicate microlepidopteran insect which causes severe damage for newly tender leaves during the different periods of flushes especially the young trees (Badawy, 1967;Kfoury&El-Amil,1998; Salas and Goane, 2001).

Extensive use of insecticides has selected many insecticide resistant insect populations causing a severe problem in pest management programs of the world. So, there is a greater need to develop alternative or additional techniques, which would allow a rational use of pesticides and provides adequate crop protection for sustainable food production. Among the most promising alternative to conventional insecticides, are avermectin and spinosoid insecticide groups. Abamectin (avermectin B1) is currently the main avermectin compound used as a mitecide/ insecticide in a great variety of crops. Chemical modifications on its original structure with the aim of increasing its insecticidal spectrum resulted in the discovery of emamectin benzoate (MK-244, 4" –deoxy-4"–epi-Nmethy lamineavermectin B1), one of many 4 " – substituted analogs that shows an increased potency against lepidoptera larvae (Mrozik, 1994). The mode of action of emamectin benzoate is similar to abamectin (a GABA and glutamate-gated chloride channel agonist) according to Dunbar *et al*. (1998). Emamectin benzoate is novel semi-synthetic derivative of the natural product abamectin from the avermectin family of 16-membered macrocyclic lactones. This epi-methyl amino derivative is very effective against a broad spectrum of lepidopteran insect pests with good field efficacy and lack of cross-resistance with other commercially-used pesticides (White *et al.*, 1997).

The semi synthetic compound, spinetoram (spinosoids) is the second generation of spinosyns. Spinetoram is the active ingredient in Radiant®. Electrophysiological studies have shown that spinosoids act on the insect central nervous system to increase spontaneous activity, leading to involuntary muscle contractions and tremors. This increase in excitation appears to result from the persistent activation of nicotinic acetylcholine receptors (nAChRs) and prolongation of acetylcholine responses, in a manner that is distinct from other nicotinic active molecules. In addition, the spinosyns can also alter the function of GABA-gated chloride channels (Salgado *et al.*, 1997). Therefore, the present study was carried out to evaluate some insecticide treatments in mixture with a mineral oil against larval and pupal stages of the leaf miner to find out the effective treatment in controlling the CLM.

MATERIALS AND METHODS

Field experiments on mandarin orchard (7 years old) severely infested with *P. citella* were conducted. An orchard of about 4 feddans at Nubarya district was selected. Mandarin trees were cultivated in sandy loam soil. Experiments were carried out on summer flushes for two seasons (2014 - 2015). Treatments were Proclaim (SG 5%), Vertemic (EC 1.8 %), Runner (SC 24%), Radiant (SC 12%) and Mospilan (WP 10%) each was mixed with Chemisol oil (EC 95%). Mandarin trees in 2014 and 2015 seasons were total coverage sprayed and total covered using ground motor sprayer (600 liters capacity). A mixture of the Chemisol oil at rate of 0.25% was tank mixed with each of the fore-mentioned insecticides. Five replicates from tender twigs 15 - 20 cm in length (each contains 10 twigs) were randomly collected before and after every 3 days of treatment from each treatment as well as untreated control. Five leaves from each twig (i.e. 250 leaves from each treatment) were inspected using a stereoscopic microscope. Number of serpentine mines, larval and

pupal mortalities of *P. citrella* were counted and recorded. Reduction percentages of mines, larvae and pupae for each treatment were calculated according to Hendrson and Tilton (1955). The treatments were compared with each other using one way ANOVA with $LSD_{0.05}$ (CoStat Statistical Software, 1990).

RESULTS AND DISCUSSION

Citrus leaf miner is one of the most common pests in mandarin orchards. Citrus leaf miner is injurious because it occur both in nursery and groves and play havoc if left unattended. It is difficult to estimate the damage extent as all new flushes in well maintained grooves are attacked by leaf miner (Johnson, 2006). The majority of the damage caused CLM is believed to result from mining on the adaxial and abaxial surface of the newly formed leaves. Young leaves curl-up, become chlorotic and eventually become necrotic. Consequently, affected leaves that host a heavy (more than 4 mines / leaf) CLM density are frequently distorted and may abscise. In countries where CLM is a pest, growth of nursery and newly planted trees is retarded by a reduction of the leaf photosynthetic area. As a result fruit yields in older trees are often reduced (Ando *et al.*, 1985). Therefore, there is a need for searching about effective insecticides and control measures for this insect which are compatible with IPM. In the present study, two field studies were carried out during 2014 and 2015 seasons at at Nubarya to evaluate some insecticide treatments (each mixed with the mineral oil Chemisol) against the CLM in the mandarin fields.

Results in Tables (1 and 2) represent the reduction percentages of *P. citrella* serpentine mines during 2014 and 2015. It is clear that, Proclaim / Chemisol mixture (92.9%) achieved the highest reduction percentage in *P. citrella* serpentine mines, which is followed by Vertemic / Chemisol (88.3) and Radiant / Chemisol (88.2) in 2014 season. In 2015, Proclaim / Chemisol (88.2) and Radiant / Chemisol (86.5) mixtures achieved the highest reduction percentage in *P. citrella* serpentine mines, which are followed by Vertemic / Chemisol (84.2), and Mospilan / Chemisol (84.3) mixtures. Mospilan / Chemisol (85.1) mixture achieved the lowest reduction percentage in *P. citrella* serpentine mines in 2014. Runner / Chemisol mixture achieved the lowest reduction percentage in *P. citrella* serpentine mines in 2015 season.

Reduction percentages of CLM larvae in summer flushes mandarin leaves as a result of treatment by different insecticides in 2014 and 2015 seasons illustrated in Tables (3 and 4).

Table 1. Reduction% of*P.citrella* serpentine mines insummer flushes mandarin leaves after different insecticides treatments at Nubareya district (2014 season):

Pesticide+chemisol oil	%Reduction of mines/leaf after different times of application								
	3-days	6-days	9-days	12-days	15-days	18-days	21-days	24-days	Mean
Proclaim	88.6	91.3	94.7	97.2	97.0	95.2	90.0	89.4	92.9 a
Vertemic	84.4	86.0	89.4	92.7	91.5	88.8	88.3	85.1	88.3 b
Radiant	84.5	87.9	90.4	92.1	90.9	89.7	88.2	81.9	88.2 b
Mospilan	82.3	85.6	86.2	88.5	88.0	84.8	84.2	81.2	85.1 c
Runner	79.2	82.7	83.9	92.1	91.4	87.8	87.0	86.6	86.3bc

Means followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 2. Reduction% of*P.citrella* serpentine mines insummer flushes mandarin leaves after different insecticides treatments at Nubareya district (2015 season):

Pesticide + chemisol oil	%Reduction of mines/leaf after different times of application								
	3-days	6-days	9-days	12-days	15-days	18-days	21-days	24-days	Mean
Proclaim	85.5	88.6	91.1	93.0	92.1	89.9	83.4	82.0	88.2 a
Vertemic	82.5	83.1	85.0	87.2	86.7	83.3	84.2	81.3	84.2 b
Radiant	83.6	87.1	89.2	93.2	90.5	86.4	83.2	79.0	86.5 a
Mospilan	83.3	87.4	88.6	90.5	85.4	81.1	79.9	78.0	84.3 b
Runner	75.1	78.4	80.8	84.0	88.2	84.3	82.0	80.2	81.6 c

Means followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 3. Reduction% of *P.citrella*larvae insummer flushes mandarin leaves after different insecticides treatments at Nubareya district (2014 season):

Pesticide + chemisol oil	%Reduction of *P. citrella* larvae								
	3-days	6-days	9-days	12-days	15-days	18-days	21-days	24-days	Mean
Proclaim	91.7	94.5	96.2	98.1	98.4	96.8	92.7	92.0	95.1 a
Vertemic	87.9	88.7	91.5	95.3	94.0	90.0	88.2	85.2	90.1 b
Radiant	85.5	87.5	89.8	89.9	88.1	86.4	86.0	83.2	87.1 bc
Mospilan	84.4	87.0	87.7	88.7	87.0	81.1	79.2	79.0	84.3 c
Runner	82.2	86.7	89.9	85.2	80.0	77.9	74.8	74.8	81.4 c

Means followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 4. Reduction% of *P.citrella*larvae insummer flushes mandarin leaves after different insecticides treatments at Nubareya district (2015 season):

Pesticide + chemisol oil	%Reduction of *P. citrella* larvae								Mean
	3-days	6-days	9-days	12-days	15-days	18-days	21-days	24-days	
Proclaim	86.4	91.3	92.1	93.9	93.8	89.0	86.1	84.2	89.6 a
Vertemic	85.1	86.6	88.8	90.3	88.5	86.7	84.2	82.1	86.5 a
Radiant	82.3	84.2	85.9	86.4	84.4	81.5	80.3	79.4	83.1 b
Mospilan	83.7	85.3	86.8	86.2	83.1	80.4	78.1	77.7	82.7 b
Runner	78.6	82.5	85.6	86.8	79.6	76.1	72.1	70.2	78.9 c

Means followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Results revealed that, Proclaim / Chemisol mixture achieved the highest %reduction of CLM larvae, followed by Vertemic / Chemisol mixture in 2014 (Table 3). In 2015, Proclain and Vertemic mixtures with Chemisol achieved the highest reduction percentages of CLM larvae and the Runner / Chemisol mixture achieved the least reduction percentage of CLM larvae (Table 4) Mospilan and Runner each mixed with Chemisol oil achieved the least reduction percentages of CLM larvae. Percent reduction of CLM larvae were

95.1, 90.1, 87.1, 84.3 and 81.4% in 2014 and 89.6, 86.5, 83.1, 82.7 and 78.9 in 2015, after treatment by the mixture of Chemisol with each Proclaim, Vertemic, Radiant, Mospilan and Runner, respectively (Table 3 and 4). In respect with the effect of the insecticide treatments on the CLM pupae, Vertemic / Chemisol mixture (86.3 and 86.6%) achieved the highest reduction percentages followed by Proclaim / Chemisol mixture (83.9 and 83.4%) in both seasons 2014 and 2015. Runner / Chemisol mixture (77.5 and 76.0%) achieved the least reduction percentage of CLM pupae in both seasons 2014 and 2015 (Tables 5 and 6).

Table 5. Reduction%of *P.citrella*pupae insummer flushes mandarin leaves after different insecticides treatments at Nubareya district (2014 season):

Pesticide + chemisol oil	%Reduction of *P. citrella* pupae								
	3-days	6-days	9-days	12-days	15-days	18-days	21-days	24-days	Mean
Proclaim	84.3	86.6	86.5	87.4	84.7	83.2	80.0	78.4	83.9 b
Vertemic	82.9	86.8	89.2	88.4	89.3	86.7	84.6	82.8	86.3a
Radiant	83.6	85.7	84.2	82.1	81.6	80.4	78.7	77.1	81.7bc
Mospilan	80.1	82.7	83.4	82.8	80.4	78.3	76.5	75.9	80.0 c
Runner	77.0	79.3	82.1	80.7	78.2	75.1	74.2	73.6	77.5 d

Means followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 6. Reduction% of *P.citrella*pupae insummer flushes mandarin leaves after different insecticides treatments at Nubareya district (2015 season):

Pesticide + chemisol oil	%Reduction of *P. citrella* pupae								Mean
	3-days	6-days	9-days	12-days	15-days	18-days	21-days	24-days	
Proclaim	83.7	84.6	85.3	87.0	84.1	82.8	80.3	79.3	83.4 b
Vertemic	82.3	86.8	88.4	89.6	88.2	87.5	86.4	83.7	86.6 a
Radiant	81.7	82.0	82.6	84.7	83.4	82.1	80.5	78.0	81.9 b
Mospilan	79.5	80.1	81.4	83.0	79.7	77.4	75.2	73.9	78.8 c
Runner	75.5	76.7	78.2	79.5	77.0	75.2	73.8	71.9	76.0 c

Means followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Our results are in agreement with El-Abbassi *et al.*, (2009) when they found that, abamectin + mineral oil achieved good control for the CLM larvae, pupae and reduced the leaf mines on orange orchard. Mosallam *et al.*, (2008) reported that acetamiprid was more effective than KZ oil in the control of CLM on orange orchard.

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تاثير بعض معاملات المبيدات على مقاومه حشرة صانعة أنفاق الاوراق على اشجار اليوسفى بالنوبارية محافظة البحيرة

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حشرة صانعة انفاق الاوراق من الافات التى تصيب اشجار اليوسفى .قامت هذه الدراسة بملاحظه بتاثير معاملات خلط المبيدات (بروكليم- فرتمك- راديانت- موسبلان- رانرمع الزيت المعدنى لى اطوار اليرقة و العذارا لهذه الافه للحصول لى المعاملة الاكثر فعالية للتحكم فى خفض نسبة الإصابة لهذه الحشرة . وكانت نتيجة خلط البروكليم مع الزيت المعدنى ٩٢.٩%كانت ا لى نسبة خفض و يليها المعاملة بالمخلوط فرتمك مع الزيت المعدنى بنسبة ٨٨.٣% ثم المعاملة بالخليط راديانت مع الزيت المعدنى بنسبة ٨٨.٢% وذلك فى موسم ٢٠١٤ . فى موسم ٢٠١٥ كانت نسبة الخفض بالمعاملة بخليط بروكليم مع الزيت المعدنى ٨٨.٢% و الراديانت مع الزيت المعدنى ٨٦.٥% و ها ا لى نسبة خفض لهذه الافه بالمقارنه بالمعاملات الاخرى كانت اقل نسبة خفض بالمعاملة بالمخلوط موسبلان مع الزيت المعدنى ٨٥.١% لموسم٢٠١٤ .واقل نسبة خفض بالمعاملة بالمخلوط رانر مع الزيت المعدنى ٨١.٦% . وكانتنتائج تأثير هذه المعاملات لى اليرقات فى موسم ٢٠١٤ كانت نسنة الخفض كالتالى ٩٥.١% -٩٠.١% -٨٧.١% -٨٤.٣% -٨١.٤% وفى موسم٢٠١٥ كانت نسبة الخفض كالتالى ٨٩.٦% -٨٦.٥% -٨٣.١% -٨٢.٧% - ٧٨.٩% و ذلك بمخاليط المبيدات(بروكليم – فرتمك – راديانت – موسبلان – رانر)مع الزيت المعدنى لى التوالى . و كانتنسبة الخفض لى ذارى هذه الافة الحشرية بالمخاليط السابقة كالتالى : أ لى نسبة خفض بالمعاملة بالمخلوط فرتمك مع الزيت المعدنى (٨٦.٣% -٨٦.٦%) و يليه المعاملة بمخلوط بروكليم مع الزيت المعدنى بنسبة (٨٣.٩% - ٨٣.٤%) و ذلك فى الموسمين (٢٠١٤ – ٢٠١٥) ، و كانت اقل نسبة خفض بالمعاملة بمخلوط رانر مع الزيت المعدنى بنسبة (٧٧.٥% - ٧٦.٠%) فى الموسمين (٢٠١٤ -٢٠١٥) .