

EFFECTIVENESS OF SIX INSECTICIDES AGAINST CITRUS LEAF MINER, *PHYLLOCNISTIS CITRELLA* STAINT.

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ABSTRACT

Effectiveness and residual effect of six insecticides were evaluated against the citrus leaf miner, *Phyllocnistis citrella* Stainton (Gracillariidae: Lepidoptera) in pummelo, *Citrus grandis* L. The insecticides were: Agromethrin 10 EC (Cypermethrin @ 0.01%), Decis 2.5 EC (Deltamethrin @ 0.0025%), Sobicron 425 EC (Profenofos 40% + Cypermethrin 2.5%, @ 0.425%), Basudin 10 G (Diazinon @ 1.0 g a.i./plant), Ekalux 5G (Quinalphos @ 1.0 g a.i./plant) and Furadan 5 G (Carbofuran @ 1.0 g a.i./plant). The efficacy was determined based on larval mortality and progressive length of mine after insecticide application. After one day of application 100% mortality of larva and no further mining in leaf was found in Furadan treated saplings but Agromethrin, Decis and Sobicron treated saplings had moderate larval mortality. Further leaf miner infestation started after 45.60 days of Furadan application but Ekalux treatment showed further infestation in 24.50 days. Thus, the results revealed significant effectiveness of Furadan @ 1.0 g a.i. per sapling against the leaf miner, followed by Agromethrin @ 0.01% and Decis 0.0025%.

Keywords: Citrus, *Phyllocnistis citrella*, efficacy, insecticides, mortality.

INTRODUCTION

Citrus plants are reported to be attacked by more than 250 insect pests (Nayar *et al.* 1976, Rajput & Haribabu, 1985). Citrus leaf miner, *Phyllocnistis citrella* Stainton (Gracillariidae : Lepidoptera) is the most destructive pest of citrus (Patel & Patel 2001). It attacks the citrus plants both in the nurseries and young plantations and causes considerable economic damage (Hill 1987, Batra *et al.* 1998). Citrus leaf miner feeds on epidermal tissues of young leaves through serpentine tunnel both in abaxial and adaxial surface, causing leaf crumbling and reduction in plant vigor. It has also been reported to encourage incidence of 'citrus

canker' (Prodhan 1992, Muller 1995). As it is an internal leaf feeder, control of the pest is difficult. Although application of insecticide is the principal method of its control in Bangladesh, the effectiveness of different insecticides has not been evaluated properly, so far. Indiscriminate spraying may not provide successful control, rather it would cause hazards to the environment. As information on the effectiveness of different insecticides is not available, the present study was undertaken to determine the comparative efficacy of three emulsifiable concentrates and three granular insecticides against *P. citrella*.

MATERIALS AND METHODS

This experiment was conducted in a citrus nursery under Fruit Tree Improvement Project (FTIP) at Bangladesh Agricultural University, Mymensingh, during July and August, 2002. Pummelo (*Citrus grandis* L.), being the most susceptible citrus species to citrus leaf miner (Singh *et al.* 1988) was used for this study as host plant. One-year-old saplings of uniform growth were used for the experiment and five saplings were selected for each treatment. Six insecticides including three Emulsifiable Concentrates (EC) and three Granular (G) formulations were evaluated for their efficacy against leaf miner using recommended dose. The EC insecticides were Agromethrin 10 EC (Cypermethrin @ 0.01%), Decis 2.5 EC (Deltamethrin @ 0.0025%) and Sobieron 425 EC (Profenofos 40% + Cypermethrin 2.5%, @ 0.425%). The granular insecticides were Basudin 10 G (Diazinon @ 1.0 g a.i./plant), Ekalux 5G (Quinalphos, @ 1.0 g a.i./plant and Furadan 5 G (Carbofuran @ 1.0 g a.i./plant). The emulsifiable insecticides were sprayed with Hudson commet continuous sprayer (Model no. 431A). The granular insecticides were applied by digging the ground area of the saplings followed by mixing the granules with the soil properly. Water was applied thereafter to moisten the soil for easy up-take of the chemicals by the saplings. The control plants were sprayed with water only. All necessary precautions were taken during application of insecticides. Observations were made on the following:

Mortality

Only the larval mortality was observed in this experiment. The data on percentage of mortality were recorded after 1, 3 and 7 days of insecticide application. The percentage was determined by the following formula:

$$\% \text{ Mortality} = \frac{A - B}{A} \times 100$$

A = No. of larva present in the seedling before treatment.

B = No. of larva present in the seedling after treatment.

Length of mine per infested leaf

The data on progressive length of mine (cm) per infested leaf were recorded before and after 1 day and weekly, up to 7 weeks of insecticide application. As the mine is zigzag in shape, it was difficult to measure the length of mine. Hence a fine thread was placed on the tunnel and the length of thread was measured by placing it on a scale, which was the length of mine.

Residual effect

The days required for further infestation was recorded to determine the residual effect of different insecticides in treated saplings.

The experiment was laid out in Randomized Complete Block Design (RCBD) and the data were analyzed statistically after appropriate transformation and mean values separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The comparative study on efficacy of the selected insecticides applied as soil and foliar treatments against the leaf miner, *Phyllocnistis citrella* infesting pummelo *Citrus grandis* L., revealed significant superiority of Furadan (1.0 g a.i./plant) to rest of insecticide tested. The efficacy was determined on the basis of mortality of larvae, progressive length of mine and residual effect of the insecticides.

Larval mortality

The mortality of the leaf miner, *P. citrella* larva was determined at 1, 3 and 7 days after application of insecticides. A significant difference ($P < 0.01$) in mortality was found at 1 and 3 days after insecticide application (Table 1). But after one week, there was no significant variation in the mortality of larval population. Furadan caused 100% mortality of the larva, one day after application. The second effective insecticide was Sobicron (Profenofs 40% + Cypermethrin 2.5%), followed by Agromethrin and Decis. Rade & Kandalkar (1988) reported 64.40% mortality of *P. citrella* after 1 day of spraying with Cypermethrin @ 0.01%. The lowest mortality of leaf miner was found in Basudin treated saplings. Less effectiveness of Diazinon was also reported by Seraj (1999).

The rest of the insecticides were more or less equally effective at 1 and 3 DAT. However, after 7 days all insecticides showed equal effectiveness and causing 100% mortality. Alrubeai *et al.* (1997) found 97% mortality with Imidacloprid (Confidor) treatment. Verma & Phogat (1994) observed 98.14 and 95.93% larval mortality with Monocrotophos and Phosphamidon, respectively. Thus, the effectiveness of insecticides based on larval mortality followed the following order:

Furadan > Sobicron > Agromethrin > Decis > Ekalux > Basudin.

Table 1. Effect of six insecticides on the mortality of *P. citrella* larva.

Insecticides with concentration	% Mortality at different intervals		
	1 DAT	3 DAT	7 DAT
Agromethrin	64.00 ^{bc}	64.00 ^{bc}	100.00 ^a
@ 0.01%	(53.29)	(71.22)	(87.40)
Decis	55.00 ^{cd}	72.96 ^b	100.00 ^a
@ 0.0025%	(47.98)	(61.30)	(87.40)
Sobicron	76.22 ^b	89.81 ^{ab}	100.00 ^a
@ 0.425%	(63.21)	(76.52)	(87.40)
Basudin	31.33 ^d	72.53 ^b	100.00 ^a
@ 1.0g a.i./plant	(33.94)	(58.48)	(87.40)
Ekalux	42.66 ^{cd}	80.00 ^b	100.00 ^a
@ 1.0g a.i./plant	(40.73)	(65.74)	(87.40)
Furadan	100.00 ^a	100.00 ^a	100.00 ^a
@ 1.0g a.i./plant	(87.40)	(87.40)	(87.40)
Control. (Water)	3.03 ^e	10.82 ^c	20.76 ^b
	(6.50)	(13.99)	(24.94)
SE (+)	3.50	4.87	2.12
LSD	13.85	19.24	8.40
P <	0.01	0.01	0.01

Figures in parenthesis are $Y = \sin^{-1}(X)$ transformed value.

Figures having different letter(s) in the superscript in same column are significantly different (as per DMRT)

Efficacy of different insecticides in controlling *P. citrella* was reported by many authors. Radke & Kandaekan (1990) found the greatest reduction of larval

Table 2. Effect of different insecticides against citrus leaf miner, *P. citrella* infesting pummelo, based on mine length at different intervals.

Insecticides	Before application	Progressive mine length after insecticide application							
		1 DAT	1 WAT	2 WAT	3 WAT	4 WAT	5WAT	6 WAT	7WATA
gromethrin 0.01%	11.10 ^a (3.48)	2.70 ^b (1.92)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^c (1.00)	0.50 ^c (1.20)	2.70 ^c (1.87)	9.90 ^b (3.30)
Decis 0.0025%	11.34 ^a (3.51)	2.70 ^b (1.91)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^c (1.00)	1.40 ^c (1.49)	5.16 ^b (1.47)	10.00 ^b (3.31)
Sobieron 0.425%	12.00 ^a (3.60)	1.30 ^c (1.51)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^b (1.00)	1.10 ^b (1.41)	1.46 ^c (1.51)	9.44 ^a (3.23)	12.16 ^{ab} (3.62)
Basudin 1.0 g ai/plant	11.82 ^a (3.57)	3.50 ^b (2.11)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^b (1.00)	1.80 ^b (1.59)	5.84 ^b (1.60)	10.90 ^a (3.45)	14.52 ^a (3.94)
Ekalux 1.0 g ai/plant	12.14 ^a (3.62)	2.30 ^{bc} (1.81)	0.00 ^b (1.00)	0.00 ^b (1.00)	1.00 ^b (1.35)	2.10 ^b (1.72)	6.88 ^b (2.79)	10.22 ^a (3.35)	12.74 ^a (3.70)
Furadan 1.0 i/plant	12.60 ^a (3.68)	0.00 ^d (1.00)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^b (1.00)	0.00 ^c (1.00)	0.00 ^c (1.00)	1.00 ^c (1.35)	3.10 ^c (2.01)
Control. (Water)	12.22 ^a (3.63)	11.6 ^a (3.55)	9.80 ^a (3.30) ^a	7.80 (2.92)	9.46 ^a (3.23)	11.06 ^a (3.47)	11.16 ^a (3.49)	12.02 ^a (3.61)	13.72 ^a (3.83)
SE+	-	-0.086	0.024	0.014	0.089	0.136	0.133	0.139	0.094
LSD	-	0.340	0.097	0.055	0.354	0.537	0.528	0.551	0.371
P<	NS	0.010	0.010	0.010	0.010	0.10	0.010	0.010	0.010

Figures in parenthesis are $\sqrt{(X+1)}$ transformed value.

DAT = Day(s) after treatment; WAT = Week(s) after treatment.

Figures having different letter(s) in the superscript in same column are significantly different (as per DMRT)

population of *P. citrella* with Cypermethrin @ 0.01% after 24 h after spraying. Zhang *et al.* (1998) reported that Cypermethrin was more efficacious than Deltamethrin.

In the present study it was evident that among six insecticides including readymix insecticide Sobicron (Profenofos 40% +Cypermethrin 2.5%), Furadan @ 0.05 g a.i./plant could effectively control the leaf miner on pummelo saplings for a considerably longer period. Divender *et al.* (1997) reported that Carbofuran @ 2 g a.i./plant was the most effective soil insecticide giving the highest reduction of leaf miner incidence.

Length of mine

To determine the efficacy of insecticides on the basis of progressive length of mine, observations were made before and after 1 day and each week up to 7 weeks of insecticide application (Table 2). All the insecticides caused significant reduction of length of mine. After one day of Furadan application no further mining was found. Sobicron @ 0.425% (Profenofos 40% + Cypermethrin 2.5%), Decis @ 0.0025% and Agromethrin @ 0.01% showed less effectiveness in reducing mining action of leaf miner than Furadan. A marked reduction of mining activity of the pest was found in all the insecticide treated plants after one day of application. Batra & Sandhu (1986), and Bhumannavar (1987) found the best control of citrus leaf miner with Cypermethrin @ 0.01% and Deltamethrin @ 0.005%.

After 1, 2 and 3 weeks of treatment, all foliar and soil insecticides were equally effective and no mining in the leaf was found in any insecticide treated plant, although there was available new flush in the saplings. This indicated that all the six insecticides can control 100% mining activity of leaf miner population upto 3 weeks of application. However, Sobicron, Basudin and Ekalux were found to be less effective from 4th week of application when further mining of leaf miner larvae was found again. Seraj (1999) found least effect in reducing leaf infestation of citrus leaf miner with Diazinon. While further mining in the leaves of the saplings treated with Agromethrin and Decis was observed after 5th week, Furadan treated plants had no infestation upto five weeks. After seven weeks, all the treated plants were found to be mined by the leaf miner and the trend was similar to the pre-treatment. It could thus be concluded that Furadan (1.0 g a.i./plant) is the most effective insecticide in controlling *P. citrella*. The effectiveness of the insecticides followed the order:

Furadan > Agromethrin > Decis > Ekalux > Sobicron > Basudin.

Residual effect

The data on days required for further infestation after application of insecticides are presented in Fig.1. On an average, the saplings treated with Furadan showed the highest (45.60 days) duration for further infestation, but it was statistically identical with Agromethrin (40.20 days) and Decis (36.30 days), indicating their long persistence in the plants. The lowest (24.50 days) duration for further leaf miner infestation was found in Ekalux treated plant but it was identical to Decis, Sobicron and Basudin treated plant, indicating their less persistence. Jordanou & Charalambous (1998) found this duration > 2 weeks with Imidacloprid SL, Abamectin, Lufenuron Pyriproxifan and Hexflumuron. Yamamoto *et al.* (2000) reported this residual period as ranging from 12 to 104 days with Acetamid SL and Imidacloprid.

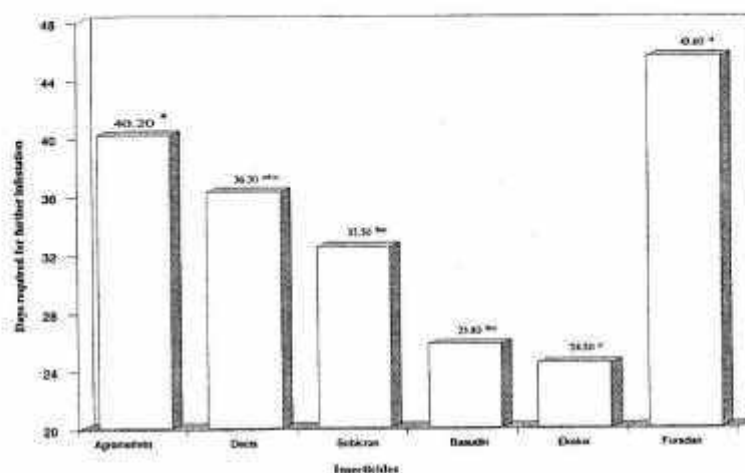


Fig.1. Time required for further infestation by *P. citrella* in the saplings treated with different insecticides.

*Bars having different letter(s) are significantly different.

From the result of different parameters of the present investigation it was clear that Furadan @ 1.0 g a.i. per sapling was the most effective and longer persistent insecticide against *P. citrella*, followed by Agromethrin @ 0.01% and Decis 0.0025%. Since Furadan has systemic action and is applied as soil insecticide in the form of granules, it would be less harmful to the environment and beneficial organisms. Considering the broad ecological aspect the granular insecticide Furadan (1.0 g a.i./ plant) could be recommended for controlling the citrus leaf miner in nursery.

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