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Rukesh Pramod KN
Research Scholar, Dept. of Entomology, Junagadh Agricultural University, Junagadh, Gujarat, India

MF Acharya
Professor, Dept. of Entomology, Junagadh Agricultural University, Junagadh, Gujarat, India

Nilesh Sharadarao Rode
Assistant Professor (Entomology), NK College of Agriculture, Aurangabad, Maharashtra, India

Correspondence
Rukesh Pramod KN
Research Scholar, Dept. of Entomology, Junagadh Agricultural University, Junagadh, Gujarat, India

Residual toxicity of different insecticides on tomato against serpentine leaf miner (*L. trifolii*) Burgess

Rukesh Pramod KN, MF Acharya and Nilesh Sharadarao Rode

Abstract
Liriomyza trifolii is an important pest of vegetable crops in many parts of the world including India. In this study potted tomato plants were sprayed with recommended field rates of nine insecticides. To assess the persistent toxicity of these insecticides, the plants were infested with *L. trifolii* adults at 2hr, 1, 3, 5, 10, 12, 14, 16, *etc* days up to the no mortality observed after insecticidal treatments. The adults were allowed to stay on treated plants for eight hours. The treated plants were kept in a cage covered with muslin cloth. Number of larval mines on leaves, as well as pupation and adult eclosion rates were assessed. Two-way ANOVA procedure of SAS was used for statistical analysis. The nine selected insecticides were tested for their residual effects against this pest. All the insecticides under test gave complete control up to 7 days and then the effect was decreased with increase of time. However, spinosad 0.009 per cent, chlorotraniliprole 0.006 per cent and ethion + cypermethrin 0.045 per cent showed longer persistence up to 16 days had no effect on the number of larval mines, but, pupation was severely hampered and adult eclosion was completely ceased even in treatments with five weeks old residues. Determining the residual activity of insecticides used for controlling this pest is useful in avoiding unnecessary treatments.

Keywords: *Liriomyza trifolii*, insecticides, toxicity, residues, persistant toxicity

Introduction

Serpentine leafminer *Liriomyza trifolii* (Burgess) is a polyphagous insect and attacks a wide range of vegetables and ornamentals all over the world [19-9]. Both larvae and adults damage the host plants. The larvae feed on leaf mesophyl and reduce chlorophyll content. The adults also damage the leaves by puncturing them for feeding and oviposition [10]. In recent years, this insect has become one of the major pests of greenhouse crops in India. Biological control of the leaf miners has had limited success so far and at present, chemical control is the main tactic in managing these pests [10]. *Liriomyza* has a potential to develop a resistance to insecticides [9]. This potential affects effective control of leafminers [10]. The strong capability of *L. trifolii*to develop the resistance to insecticides also made a displacement of other species on several crops possible [19]. It was also demonstrated that *L. trifolii* is more tolerant to insecticides than other agromyzid species [11].

Spinosad has a unique mode of action against a variety of target pests, leaf and fruit worms, thrips, flies and mites; and expresses relatively low toxicity to mammals and birds [4-21]. Chlorantraniliprole belongs to the IRAC chemical group 28: Diamides (Ryanodine receptor modulators) with similar mode of action to Cyromazine is an insect growth regulator with good activity against many dipteran species. This insecticide has proved to be effective against leafminer larvae in many studies [13, 15].

The growers apply insecticides when larval mines are visible on leaves and usually make several applications during each growing season. The intention of integrated pest management is to reduce environmental contamination, decrease and delay the development of resistance of pests against pesticides and to reduce pest management costs and increase growers' benefits [3]. Determining the residual activity of insecticides used for controlling pests will be useful in avoiding unnecessary chemical treatments. In this study the residual effect of nine insecticides on *L. trifolii* was assessed.

Material and Methods

Field cum laboratory experiment was conducted to work out residual toxicity of different insecticides on serpentine leaf miner, *L. trifolii* in tomato was conducted in PG laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh. The tomato variety, Junagadh Tomato-3 was sown in small pots. Details of

Insecticidal treatments were given in a Table1. Ten treatments including control with three replications were evaluated against *L. trifolii* in tomato.

Methodology

Different growth stages of serpentine leafminer were collected from instructional farm, College of Agriculture, JAU, Junagadh. The insects were reared on tomato seedlings / plants for several generations in laboratory conditions at 26 ± 2°C 65 ±5 % RH. The adults were fed with 10% diluted honey solution. Synchronization was done according to method used by [2]. Nine to 10-day old tomato plants were infested with 1-2-day old adult leaf miners. The infestations was carried out in wooden framed cages (1x1 ft) covered with muslin cloth. The flies were allowed to stay and oviposit on plants for six hours, after which they were removed. This short-term infestation allowed in obtaining fairly uniformly aged eggs, larvae and adults. Synchronization was performed continuously during the study since the uniform insects were needed for the experiments.

Insecticides

The insecticides and concentrations used in the experiments are shown in the table no. 1. The concentrations used were based on recommended field rates of these products.

Residual Bioassays

Ten-day old potted tomato plants (one plant per pot) sprayed with selected insecticide solutions and those were used in a bioassay test. Three plants were sprayed with each insecticide and after 2 hours they were transferred to the infestation cage (1x1ft). Ninety insects of 1 to 2 days old adult flies (considering 1:1 female: male ratio) were released in the infestation cage and allowed to oviposit for eight hours. Ten per cent honey solution was kept in a cage as a food for adults. After eight hours of infestation the flies were removed from the plants by shaking them and using hand aspirator. Then after plants were transferred to the fly free cage. The procedure was repeated at 2hr, 1, 3, 5, 10, 12, 14, 16, *etc* days up to the no mortality observed. Two days after infestation, fly feeding stipples were counted on each plant. Four days after the infestation, the leaves were clipped and the number of larval mines was recorded.

Then the leaf petiole was wrapped in a wet cotton wool. Each leaf was transferred into a plastic Petri dish lined with tissue paper and were transferred in a growth chamber with a photoperiod of 16:8h (L:D), relative humidity of 65 ± 5% and temperature of 26 ± 2°C. Five days later, the number of larva was recorded and the number of adults was recorded as they emerged.

Larval mortality was calculated using the formula described [7]

$$\%\ \text{larval mortality} = \frac{m-p}{m} * 100$$

Where,

m = the number of mines or larvae in each treatment

p =the number of pupae reared from the treatment with each compound.

Pupal mortality was assessed using the same formula with some modification:

$$\%\ \text{pupal mortality} = \frac{p-a}{p} * 100$$

Where,

p = the number of pupae in each insecticide

a = the number of adults emerged from treatment with each compound.

The zero and cent per cent values were removed by using the formula

$$0\ \%\ \text{mortality} = \frac{1}{4_{\text{n}}} * 100$$

and

$$100\ \%\ \text{mortality} = 1 - \frac{1}{4} * 100$$

-suggested by [1]

Where,

n= number of adult per treatment.

The data, thus, obtained was angularly transformed and subjected to statistical analysis. Persistent toxicity (PT) and relative persistent toxicity (RPT) for each insecticide were worked out as suggested by [16]

Result and Discussion

A field cum laboratory study was carried out to assess the residual toxicity of some insecticides against *L. trifolii* on tomato. The mortality data obtained at different intervals are reported in Table 2 and depicted in Fig. 1.

In spinosad treatment, no larval mines were formed on leaves with residues up to 15 days old. Only in treatments with 25-day old residues, a few larval canals were recorded on leaves. No pupae or adults were formed in thistreatment. Therefore, no analysis of variance could be performed on the data obtained for this compound. The ovicidal and/or larvicidal activity of this compound had an inverse relationship with the number of visible larval mines on the treated leaves. Based on the results obtained, spinosad was the most toxic of all tested insecticides followed by chlorotraniliprole.

The mortality data (Table 2) revealed that chlorotraniliprole 0.006 per cent,ethion + cypermethrin 0.045per cent and profenofos + cypermethrin 0.044 per cent gave effective control. However, the above mentioned three insecticides registered the highest mortality 87.56, 85.06 and 81.19 per cent respectively, after two hours of treatment.

The mortality data recorded first day after the insecticidal application revealed thatindoxacarb 0.02per cent, dimethoate, 0.030 per cent and deltamethrin+ karanj oil 0.028 + 0.1per cent found equally effective, but the highest mortality was observed in chlorotraniliprole 0.006 per cent (84.10%),ethion + cypermethrin 0.045per cent (79.76%)andprofenofos + cypermethrin 0.044 per cent (75.41%). Whereas, the lowest mortality of leafminer was recorded in novaluron 0.010 per cent (64.17%) and NSKE 5 per cent (64.64%).

The mortality data recorded three days after the insecticidal application revealed thatdeltamethrin+ karanj oil 0.028 + 0.1 per cent,indoxacarb 0.02 per cent, dimethoate 0.030 per centand NSKE 5 per cent(64.64%)found equally effective, but the highest mortality was observed in chlorotraniliprole 0.006 per cent (80.17%),ethion + cypermethrin 0.045per cent (79.65%)andprofenofos + cypermethrin 0.044 per cent (78.63%). Whereas, the lowest mortality of leafminer was recorded in novaluron 0.010 per cent (62.43%).

Five days after the insecticidal application, chlorotraniliprole 0.006 per cent andethion + cypermethrin 0.045per cent was significantly superior to rest of the insecticides and registered 80.17 and 79.65 per cent mortality. The remaining insecticides proved less effective.

It is evident from table 2 that mortality among all the treatment was drastically reduced from 7th day after insecticidal application. Onlyethion + cypermethrin 0.045per cent and chlorotraniliprole 0.006 per cent gave higher mortality, which ranged from 67.35 and 66.74 per cent, respectively. However, considering the value of "P" the data further revealed that ethion + cypermethrin 0.045per cent and chlorotraniliprole 0.006 per cent persisted up to 16 days after application, but they caused very less mortality, whereas dimethoate 0.030 per cent persisted for 15 days and by registering only 22.24 per cent mortality. Indoxacarb 0.02per cent and profenofos + cypermethrin 0.044 per cent persisted for 14 days and were moderately persistent. Deltamethrin+ karanj oil 0.028 + 0.1 per cent. NSKE 5 per cent and novaluron 0.010 per cent persisted for 12 days and found to be the least persistent among all the insecticides under test.

The relative persistence of toxicity (RPT) was worked out on the basis of PT index and it was taken as a criteria for the relative persistence of toxicity. Considering the RPT values, it can be seen that chlorotraniliprole 0.006 per cent, ethion + cypermethrin 0.045per cent, dimethoate 0.030 per cent, 0.05per cent and profenofos + cypermethrin 0.044 per cent were comparatively more effective in controlling the leafminer than other insecticides under test. Taking the RPT values in to consideration, they can be arranged in descsnding order as follows;

Chlorotraniliprole>ethion + cypermethrin>dimethoate, >profenofos + cypermethrin> indoxacarb>deltamethrin+ karanj oil>NSKE>novaluron.

The similar result were found with synthetic pyrethroids, deltamethrin and cypermethrin remained effective for 14 days [17]. It was reported that spinosad had a longer persistency (up to 14 days) both under laboratory and greenhouse conditions compared to azadirachtin, the activity of which decreased significantly with residual age and especially under green-house conditions against *L. sativae* on tomato [6]. Spinosad gave highest mortality and persisted up to 28 days after application[20].

Spinosad severely affected egg hatching and embryonic development. And also reported that eggs oviposited in leaves with residues of dimethoate up to 5 days old, had reduced hatching. Larval development was also affected by chlorantraniliprole up to four weeks of residues. Indoxacarb reduced larval development and adult eclosion in treatments with up to 20 days old residues. Novaluron had no effect on the number of larval mines, but, pupation was severely hampered and adult eclosion was completely ceased even in treatments with five weeks old residues [18]. So, the present findings are more or less in agreement with the findings of earlier researcher.

In contrast, higher concentrations and more frequent applications of indoxacarb and chlorotraniliprole may be required over time to ensure a sufficient efficacy. Persistence of chlorotraniliprole, indoxacarb and spinosad has been studied by other researchers regarding leafminers (Schuster and Taylor, 1987; Hossain and Poehling, 2009) [6] but the residual efficacy of some of the synthetic pyrethroids and some contact insecticides on *Liriomyza* are new findings. Due to the strong effects obtained against *L. trifolii*, lower dosages may be sufficient, but this will require further investigation. Based on the efficacy and relative safety of biorational insecticides tested in this study, it seems that these compounds would be suitable candidates to be used in leafminer management of greenhouse and as well as field conditions on rotational basis.

Table 1: Insecticides used to study the residual toxicity on tomato leaf miner *L. trifolii*.

Sl. No.	Insecticide	Dose (%)
1	Dimethoate 30 EC	0.03
2	Deltamethrin 2.8 EC+ karanj oil 1%	0. 028 + 0.1
3	Ethion 40 + cypermethrin 5 EC	0.045
4	Novaluron 10EC	0.01
5	Chlorotraniliprole 18.5EC	0.006
6	Profenophos 40 + cypermethrin4EC	0.044
7	NSKE	5
8	Indoxacarb 14.5 SC	0.02
9	Spinosad 45 SC	0.009
10	Control	-

Table 2: Residual toxicity of different insecticides against serpentine leaf miner (*L. trifolii* Burgess.)

Insecticide	Concentration (%/a.i./ ha)	Per cent mortality of leafminer at different interval after treatment									P	T	PT	RPT
		2hr	1(DAT)	3(DAT)	5(DAT)	7(DAT)	10(DAT)	12(DAT)	14(DAT)	16(DAT)				
Dimethoate	0.03%	59.77 (74.66)	55.62 (68.12)	57.99 (71.90)	58.83 (73.21)	52.14 (61.33)	45.81 (51.42)	37.70 (37.39)	32.54 (28.94)	23.76 (16.24)	15	57.69	865.35	0.902
Deltamethrin + Karanj oil	0.028+0.1%	58.49 (72.68)	54.69 (66.59)	60.90 (76.34)	56.63 (69.75)	51.08 (60.54)	41.05 (43.13)	30.09 (25.13)	-	-	12	48.70	584.4	0.608
Ethion + Cypermethrin	0.045 %	67.26 (85.06)	63.26 (79.76)	63.40 (79.95)	63.19 (79.65)	55.15 (67.35)	46.73 (53.02)	37.82 (37.59)	33.26 (30.07)	29.81 (24.72)	16	59.68	954.88	0.995
Novaluron	0.01%	54.38 (66.08)	53.23 (64.17)	52.20 (62.43)	58.07 (72.03)	51.18 (60.70)	38.89 (39.41)	29.11 (23.67)	-	-	12	44.90	538.8	0.562
Chlorotraliniprole	0.006%	69.34 (87.56)	66.50 (84.10)	63.55 (80.17)	63.21 (79.69)	54.74 (66.74)	46.86 (53.24)	37.93 (37.79)	32.54 (28.93)	27.39 (21.17)	16	59.99	959.84	1.000
Profenphos + Cypermethrin	0.044 %	64.30 (81.19)	60.27 (75.41)	62.46 (78.63)	60.88 (76.32)	51.79 (61.74)	41.86 (44.52)	33.24 (30.04)	27.34 (21.09)	-	14	53.60	750.4	0.782
NSKE	5%	55.77 (68.36)	53.51 (64.64)	57.07 (70.45)	56.47 (69.49)	47.40 (54.19)	39.66 (40.74)	27.76 (21.69)	-	-	12	45.44	545.28	0.568
Indoxacarb	0.014%	62.95 (79.32)	58.66 (72.95)	59.66 (74.48)	57.36 (70.91)	51.22 (60.77)	41.23 (43.43)	28.30 (22.48)	26.30 (19.63)	-	14	50.27	703.78	0.733
S.Em.±		2.59	2.48	2.31	1.59	1.59	1.32	1.36	1.29	1.84				
C.D.at 5%		7.86	7.51	7.01	4.84	4.81	4.01	4.12	3.92	5.58				
C.V.%		7.29	7.37	6.71	4.65	5.26	5.36	7.18	7.93	16.38				

*Figures in the parentheses indicate the retransformed values. Zero and cent per cent values removed by using formulae 1/4n x 100 and (1-1/4n) x 100, respectively.

P = Period of time; T = Average toxicity of the insecticides; PT = Persistant toxicity; RPT = Relative persistent toxicity Chlorotraliniprolewas taken as unity.

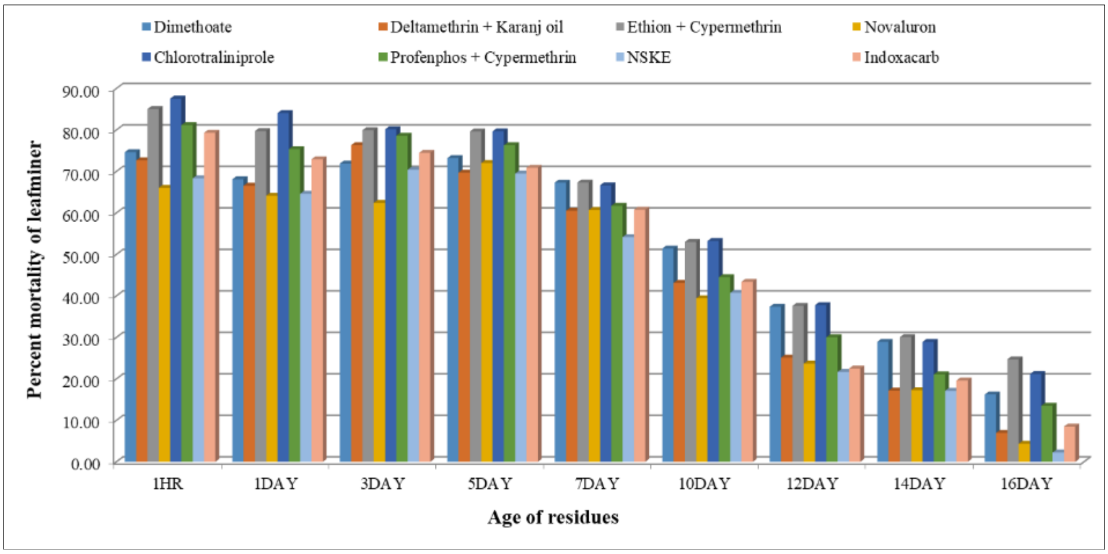

Fig 1: Residual toxicity of different insecticides on serpentine leaf miner, *L. trifolii* on tomato

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