Journal of Entomology and Zoology Studies 2017; 5(3): 1819-1822

Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 1819-1822

Received: 08-03-2017
Accepted: 09-04-2017

S Selvaraj
Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

RS Bisht
Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Poonam Srivastava
Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

KPS Kushwaha
Department of Plant pathology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Correspondence
S Selvaraj
Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Bioefficacy of Chlorantraniliprole 4.3% + Abamectin 1.7% SC against *Liriomyza trifolii* (*Burgess*) in tomato

S Selvaraj, RS Bisht, Poonam Srivastava and KPS Kushwaha

Abstract

New formulation of Chlorantraniliprole 4.3% + Abamectin 1.7% SC was tested for bioefficacy against *Liriomyza trifolii* (Burgess) in tomato during 2011-12 and 2012-13. Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24, 30, 36 and 60 g a.i. ha^{-1} along with standard check, Chlorantraniliprole 18.5% SC @ 30 g a.i. ha^{-1} abamectin 1.9 EC @ 15 g a.i. ha^{-1} and lambda cyhalothrin 4.9 CS @ 15 g a.i. ha^{-1} tested against *L. trifoli*. Results showed that Chlorantraniliprole 4.3% + Abamectin 1.7% SC was significantly effective when sprayed twice at 15 days interval, minimized the incidence of *L. trifoli* and increased fruit yield.

Keywords: Bioefficacy, *Liriomyza trifolii*, Tomato

Introduction

Tomato (*Solanum lycopersicum = Lycopersicon esculentum*) is one of the most important and widely grown vegetable crops of both tropics and subtropics originated from Peruvian and Mexican regions [1]. Tomato occupies an area of 4.6 million hectares in the world with a production of 128 million tones [2]. In India, it is cultivated in about 0.82 million hectares with a production of 13.77 million tonnes and productivity is 19.5 metric tonnes/ha (www.indiastat.com). Major contribution to national tomato production is made by the states of Bihar, Karnataka, Uttar Pradesh, Uttarakhand, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh and Assam [3].

The crop is severely damaged by many insect pests and the major pests of tomato are tomato fruit borer, *Helicoverpa armigera* (Hubner), leaf eating caterpillar, *Spodoptera litura* (Fab.), American serpentine leafminer *Liriomyza trifolii* (Burgess), two spotted red spider mite *Tetranychus urticae (*Koch) etc [4]. The serpentine leaf miner, *L. trifolii* (Burgess) (Diptera: Agromyzidae), an invasive pest was accidentally introduced into India from America along with chrysanthemum cuttings [5]. In India, it was initially recorded on 55 plant species [6] that included pulses, oil seeds, vegetables, green manures and fibre crops. Due to leafminer up to 90% of tomato foliage may be lost if populations increase uncontrolled [7]. Leafminer often prefers shaded and older leaves that are less productive photosynthetically.

Commonly used systemic insecticides have lost their efficacy because of their continuous and indiscriminate use. Hence, there is a growing interest in the discovery of new classes of insecticides to overcome resistance, resurgence and also to exercise better management of pests [8]. Chlorantraniliprole is a member of a new class of insecticides, the anthranilic diamides. Its selectivity binds to rynaodine receptors (RyR) in insect muscles, which results in an uncontrolled release of internal calcium stores from the sarcoplamic reticulum causing impaired regulation of muscle contraction and leading to feeding cessation, lethargy, paralysis and death in target organisms [9]. Abamectin is a semi synthetic derivative of avermectin produced as fermentation metabolites of soil actinomycetes, *Streptomyces avermitilis* Burg. [10]. It affect the action of picrotoxin (chloride ion channel blocker) and bicuculline (GABA receptor antagonist) and causing excitation of the nervous system, leading to cessation of feeding and paralysis [9,11]. Most of the new insecticides are relatively selective to specific group of insects and even to a specific stage of the target pests, leading to preservation of more of the natural enemies of pests [11]. These compounds may be good alternative for conventional insecticides for a selective insect pest control. Keeping the above facts in view an attempt has been made to study the assess the bio-efficacy of some newer insecticides against leaf miner, *Liriomyza trifolii* in tomato.

2. Materials and Methods

The two field trials were conducted at Vegetable Research Centre (VRC), G.B. Pant University of Agriculture & Technology, Pantnagar, Udham Singh Nagar (Uttarakhand) using tomato variety 'Pant Tomato 3' in the month of December- April, 2011-12 and 2012-13, respectively. Bioefficacy of new formulation (NF) of Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24, 30, 36, 60 g a.i. ha^{-1} along with standard check, Chlorantraniliprole 18.5% SC @ 30 g a.i. ha^{-1}, Abamectin 1.9 EC @ 15 g a.i. ha^{-1} and Lambda cyhalothrin 4.9 CS @ 15 g a.i. ha^{-1} against *H. armigera* in tomato. The experiments were carried out in plots of 3 × 3 m size in a randomized block design with eight treatments replicated thrice. The treatments were imposed two times based on economic threshold level (ETL) at 15 days interval commencing from 75th day after transplanting (DAT) in the first experiment and 80th DAT in the second experiment. The spraying was done with pneumatic knapsack sprayer using 500 litres of spray fluid / ha.

The observation on leaf miner population was taken prior to spraying and 3, 5, 7 and 10 days after spraying and counts were made on the basis of number of mines per compound leaf from the upper as well as lower portion of each plant.

2.1 Statistical analysis

The computation of analysis of variance of data collected from field experiment were done by using one factor Randomized Block Design (RBD). Per cent data was transformed to angular transformation, while the data regarding leafminer population was subjected to square root transformation. After determination of significance of difference between the treatment means at (0.05) percent probability, critical difference was calculated in order to compare the treatment means. Valid conclusions were drawn by using F-test.

3. Results and Discussion

3.1 Effect of newer insecticides against population of Leafminer, *L. trifolii* during 2011-12

On one day before first spray the mean population of *L. trifolii* varied from 3.89 to 4.52 leafminer $plant^{-1}$ (Table 1). At 3rd day after 1st spray, the population of leafminer was recorded lowest (1.23 leafminer $plant^{-1}$) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha and showed significant difference from all other treatments exhibiting highest efficacy followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.45 leafminer $plant^{-1}$), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (1.46 leafminer $plant^{-1}$) (both at par with each other), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (1.75 leafminer $plant^{-1}$), Chlorantraniliprole 18.5% SC @ 36 g a.i/ha (1.89 leafminer $plant^{-1}$), abamectin 1.9 EC @ 15 g ai/ha (2.12 leafminer $plant^{-1}$), lamda cyhalothrin 4.9 CS @ 15 g a.i/ha (2.61 leafminer $plant^{-1}$) in decreasing order of their efficacy as evident by the increasing trend of leafminer population irrespective to these treatments. However, the population of leafminer in all the treatments was significantly less than untreated control (4.41 leafminer $plant^{-1}$). Highest number of leafminer (4.11 leafminer $plant^{-1}$) on the other hand was recorded with the control experiment. The same trend was observed on 7th day after 1st spray.

At 10th day after 1st spray, the leafminer population was zero with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha which was at par with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (0.58 leafminer $plant^{-1}$), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (0.58 leafminer $plant^{-1}$), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (0.65 leafminer $plant^{-1}$) and Chlorantraniliprole 18.5% SC @ 30 g a.i/ha (0.77 leafminer $plant^{-1}$). Abamectin 1.9 EC @ 15 g ai/ha (1.16 leafminer $plant^{-1}$), lamda cyhalothrin 4.9 CS @ 15 g a.i/ha (2.88 leafminer $plant^{-1}$) were the next which showed less effectiveness as compared to other insecticidal treatments. The population of leafminer (2.81 leafminer $plant^{-1}$) in untreated control was found significant as compared to all the treatments.

One day before 2nd spray, the populations of leafminer varied from 1.22 to 3.01 leafminer $plant^{-1}$ (Table 1). At 3rd day after 2nd spray, population of *L. trifolii* was again minimum (0.49 leafminer $plant^{-1}$) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (0.68 leafminer $plant^{-1}$), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.04 leafminer $plant^{-1}$), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (1.00 leafminer $plant^{-1}$) (which were at with each other), Chlorantraniliprole 18.5% SC @ 30 g a.i/ha (1.28 leafminer $plant^{-1}$), abamectin 1.9 EC @ 15 g ai/ha (1.17 leafminer $plant^{-1}$). Amongst all the insecticidal treatments the maximum leafminer population was recorded with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (1.46 leafminer $plant^{-1}$). This was in comparison to the untreated control where the population of leafminer was to the extent of 2.60 leafminer $plant^{-1}$, exhibiting a significant difference. A more or less similar trend of efficacy was also observed at 7th day after 2nd spray.

At 10th day after 2nd spray, all the treatments exhibited their effectiveness against the population of leafminer. Zero population was recorded with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha which was at par with all other treatments except lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (1.81 larvae $plant^{-1}$) and control (2.20 larvae $plant^{-1}$).

Thus, on the basis of overall mean population of leafminer the order of efficacy of different treatments as recorded during the course of study was: Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha > Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha > Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha > Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha > Abamectin 1.9 EC @ 15 g a.i/ha> Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha > lamda cyhalothrin 4.9 CS @ 15 g a.i/ha> untreated check (Table 1).

3.2 Effect of newer insecticides against population of leafminer, *L. trifolii* during 2012-13

One day before 1st spray, the leafminer population varied from 3.50 to 4.09 leafminer $plant^{-1}$ which was non-significant (Table 2). At 3rd day after 1st spray, the population of *L. trifolii* was again recorded to be minimum (1.05 leafminer $plant^{-1}$) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (with significant difference from all other treatments) followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (1.43 leafminer $plant^{-1}$), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.47 leafminer $plant^{-1}$) (both at par with each other), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (1.89 leafminer $plant^{-1}$), Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (1.73 leafminer $plant^{-1}$), Abamectin 1.9 EC @ 15 g a.i/ha (1.78 leafminer $plant^{-1}$) and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (2.14 leafminer $plant^{-1}$). However, the number of leafminer/plant in all the treatments was significantly less than untreated control (3.68 leafminer $plant^{-1}$).

At 7th day after 1st spray, all the treatments showed their effectiveness against the population of *L. trifolii.* However, zero population was registered with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (0.50 leafminer plant^{-1}), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (0.79 leafminer plant^{-1}), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (0.80 leafminer plant^{-1}), Abamectin 1.9 EC @ 15 g a.i/ha (1.41 leafminer plant^{-1}), Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (1.71 leafminer plant^{1}) and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (2.31 leafminer plant^{-1}). All the above values were significantly less than untreated control (2.61 leafminer plant^{-1}). A more or less similar trend of efficacy was also recorded at 10th day after 1st spray.

At one day before 2nd spray, the population of leafminer in various treatments varied from 1.02 to 2.40 leafminer plant^{-1}. But, at 3rd day after 2nd spray, population of leafminer was considerably decreased. It was minimum (0.40 leafminer plant^{-1}) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha, followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (0.73 leafminer plant^{-1}), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (0.74 leafminer plant^{-1}), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (0.90 leafminer plant^{-1}). Next in the order of efficacy were: Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (1.03 leafminer plant^{-1}), Abamectin 1.9 EC @ 15 g a.i/ha (1.67 leafminer plant^{-1}) and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (1.85 leafminer plant^{-1}) (all at par with each other) which showed increasing order of leafminer population per plant. However, in all the treatments the population of leafminer was significantly less than untreated control (2.45 leafminer plant^{-1}). A more or less similar trend of efficacy was also observed at 7th and 10th day after 2nd spray.

On the basis of overall mean leafminer population, the order of efficacy of different treatments as recorded during the course of the study was: Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha > Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha > Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha > Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha > Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha > Abamectin 1.9 EC @ 15 g a.i/ha > lamda cyhalothrin 4.9 CS @ 15 g a.i/ha> untreated check (Table 2).

The overall data obtained during the cropping seasons 2011-12 and 2012-13, on the population of *L. trifolii* after the application of seven tested insecticides (after two spray) in different treatments showed almost similar pattern. Thus, the application of Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha in the present study appeared to be most effective treatments followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha, Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha, Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha, Abamectin 1.9 EC @ 15 g a.i/ha and lamda cyhalothrin 4.9 CS @ 15 g a.i/ha (Table 1 and 2).

Two years data revealed that maximum reduction of leafminer population took place with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha. The present finding is in corroborates with [12] who found that chlorantraniliprole 4.3% + abamectin 1.7% SC at 60, 36 and 30 g a.i. ha^{-1}, effected maximum reduction of leafminer damage to the extent of 78.28, 71.75, 69.54 and 59.45, 54.01, 48.66 per cent; leaf miner population to the extent of 99.36, 97.52, 95.12 and 92.09, 89.73, 89.73 maggots plant^{-1} in first and second season. The present finding are in agree with [13] who reported that chlorantraniliprole + abamectin at 50.4 mg a.i. L^{-1} treatment resulted in 100% larval mortality with minimal or no feeding in all populations. Present finding also agrees with that of [14] who reported that chlorantraniliprole and abamectin significantly reduced the leaf miner population and with that of [15] who reported that abamectin at 0.002 per cent was found to be the most effective treatment in reducing leafminer infestation to 13.61 and 16.50 per cent at 5 and 7 DAS respectively. Significant reduction in leafminer damage was observed after II and III spray of chlorantraniliprole 20% SC at 25, 30 and 20 g a.i. ha-1 and per cent leaf damage was 9.48, 9.60 and 9.95 respectively in bitter gourd [16]. The present study also revealed that lambda cyahlothrin 4.9 CS @15 g a.i/ha treated plots gradually increased leafminer population at 5 days after second application, which was agreement with [17] who reported novaluron to be most effective insecticide as it caused lowest leafminer larval density per plant, whereas plants treated with lambda-cyhalothrin increased leafminer density.

Table 1: Effect of newer insecticides molecules against population of leafminer, *L. trifolii* in tomato during 2011-12

Treatments	Dose (g a.i. ha^{-1})	Number of mines per plants *											
		First spray						Second Spray					
		PTC	3 DAT	7 DAT	10 DAT	Mean	% ROC	PTC	3DAT	7 DAT	10 DAT	Mean	% ROC
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	24	4.12	1.46 (1.05)ab	0.75 (0.85)ab	0.58 (0.77)b	1.31	69.35	1.24	0.68 (1.05)ab	0.24 (0.85)a	0.12 (0.77)a	0.49	79.40
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	30	4.08	1.23 (0.97)a	0.28 (0.79)a	0.00 (0.70)a	0.91	78.82	1.22	0.49 (0.97)a	0.13 (0.79)a	0.00 (0.70)a	0.35	85.25
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	36	4.47	1.75 (1.21)ab	0.94 (1.09)bc	0.65 (1.04)b	1.40	67.22	1.72	1.00 (1.21)ab	0.70 (1.09)bc	0.65 (1.04)a	0.89	62.76
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	60	3.89	1.45 (1.23)ab	0.75 (0.91)ab	0.58 (0.93)b	1.17	72.65	1.51	1.04 (1.23)ab	0.36 (0.91)ab	0.42 (0.93)a	0.74	69.02
Chlorantraniliprole 18.5% SC	30	4.21	1.89 (1.33)bc	1.43 (1.19)c	0.77 (1.06)b	1.77	58.58	2.00	1.28 (1.33)bc	1.11 (1.26)c	0.90 (1.14)a	1.17	51.40
Abamectin 1.9 EC	15	4.00	2.12 (1.28)cd	1.32 (1.21)bc	1.16 (1.16)c	1.93	54.94	1.95	1.17 (1.28)ab	0.92 (1.18)c	0.79 (1.09)a	1.02	57.46
Lambda cyhalothrin 4.9 CS	15	4.08	2.61 (1.37)d	2.73 (1.46)d	2.88 (1.51)d	2.82	34.20	2.34	1.46 (1.39)c	1.65 (1.46)d	1.81 (1.51)b	1.61	33.04
Untreated Control	-	4.52	4.41 (1.75)e	4.08 (1.58)e	3.92 (1.64)e	4.28	-	3.01	2.60 (1.75)d	2.01 (1.58)d	2.20 (1.64)b	2.40	-
Sem		0.188	0.221	0.135	0.210			0.183	0.215	0.139	0.284		
CD (0.05%)		0.57	0.67	0.40	0.63			0.55	0.65	0.42	0.86		

PTC- Pre treatment count; DAT- Days after treatments, ROC - Reduction over control, ***** Mean of three replications

Values in parentheses are $\sqrt{x+0.5}$ transformed values

In a column means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

Table 2: Effect of newer insecticides molecules against on population of leafminer, *L. trifolii* in tomato during 2012-13

Treatments	Dose (g a.i. ha^{-1})	Number of mines per plants *											
		First spray						Second Spray					
		PTC	3 DAT	7 DAT	10 DAT	Mean	% ROC	PTC	3DAT	7 DAT	10 DAT	Mean	% ROC
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	24	3.50	1.43 (1.38)ab	0.80 (1.14)b	0.66 (1.07)bc	1.19	60.49	1.04	0.90 (1.18)b	0.13 (0.78)a	0.14 (0.79)a	0.53	78.70
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	30	3.73	1.05 (1.24)a	0.00 (0.70)a	0.00 (0.70)a	0.60	79.93	1.02	0.40 (0.94)a	0.00 (0.70)a	0.00 (0.70)a	0.28	88.70
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	36	4.16	1.89 (1.54)bc	0.79 (1.13)b	0.62 (1.05)bc	1.45	51.84	1.32	0.73 (1.10)ab	0.12 (0.77)a	0.29 (0.88)a	0.53	78.54
Chlorantraniliprole 4.3% + Abamectin 1.7% SC	60	3.71	1.47 (1.40)ab	0.50 (0.99)b	0.20 (0.83)ab	0.98	67.32	1.40	0.74 (1.10)ab	0.27 (0.86)a	0.03 (0.72)a	0.54	78.12
Chlorantraniliprole 18.5% SC	30	3.75	1.73 (1.49)bc	1.71 (1.43)c	1.03 (1.22)cd	1.65	45.27	1.51	1.03 (1.23)b	0.86 (1.16)b	0.99 (1.21)b	1.04	57.99
Abamectin 1.9 EC	15	3.84	1.78 (1.50)bc	1.41 (1.37)c	1.39 (1.37)d	1.86	38.28	1.71	1.67 (1.47)c	0.96 (1.20)b	0.93 (1.19)b	1.33	46.05
Lambda cyhalothrin 4.9 CS	15	3.95	2.14 (1.62)c	2.31 (1.67)d	2.16 (1.62)e	2.31	23.37	1.83	1.85 (1.52)c	2.02 (1.58)c	2.11 (1.61)c	1.94	21.72
Untreated Control	-	4.09	3.68 (2.04)d	2.61 (1.76)d	2.50 (1.73)e	3.01	-	2.40	2.45 (1.71)d	2.48 (1.72)d	2.37 (1.68)c	2.47	-
Sem		0.703	0.172	0.135	0.188			0.184	0.151	0.117	0.125		
CD (0.05%)		NS	0.52	0.40	0.57			0.55	0.46	0.355	0.38		

PTC- Pre treatment count; DAT- Days after treatments, ROC - Reduction over control, ***** Mean of three replications

Values in parentheses are $\sqrt{x+0.5}$ transformed values

In a column means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

4. Conclusion

The present study was concluded that the newer insecticide, Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g ai/ha, proved to be more effective against leafminer. It is also quite that this can be good alternative chemical against conventional insecticides for achieving the rapid control against insect pests.

5. Acknowledgement

The authors are thankful Syngenta India Ltd for financial assistance as Senior Research Fellowship.

6. References

1. Jenkins J. The Origin of the Cultivated Tomato. Economic Botany. 1948; 2(4):379-392
2. Anonymous. Horticultural database. National Horticultural Board, Gurgaon, India. 2006.
3. Anonymous. Indian Horticulture Database-2011. National Horticulture Board, Ministry of Agriculture, Government of India. 2012, 178-185.
4. Lange WH, Bronson L. Insect Pests of Tomatoes. Annual Review of Entomology. 1981; 26:345-371.
5. Johnson MW, Oatman ER, Wyman JA Van Steenwyk RA. A technique for monitoring *Liriomyza sativae* in fresh market tomatoes. Journals of Economic Entomology. 1980; 73:552-555.
6. Virakamath CA, Tiwari GC, Srinivasan K, Gupta M. American serpentine leaf miner is a new threat to crops. Indian Farming. 1993; 10:12.
7. Santos CS, Bueno R, Vieira S, Bueno A. Efficacy of insecticides on *Tuta absoluta* (Meyrick) and other pests in pole tomato. Bio Assay. 2011; 6(4):1-6.
8. Vastrad AS, Lingappa S, Basavanagoud K. Insecticide usage pattern in crucifer ecosystem in North Karnataka. Pestology. 2001; 25(1):49-53.
9. Cordova D, Benner EA, Sacher MD, Rauh JJ, Sopa JS, Lahm GP *et al*. Anthranilic diamides: a new class of insecticides with a novel mode of action, ryanodine receptor activation. Pesticide Biochemistry and Physiology. 2006; 84:196-214.
10. Lasota JA, Dybas RA. Avermectins: A novel class of compounds: Implications for use in arthropod pest control. Annual Review of Entomology. 1991; 36:91-117.
11. Lahm GP, Selby TP, Freudenberger JH, Stevenson TM, Myers BJ, Seburyamo G *et al*. Insecticidal anthranilic diamides: a new class of potent ryanodine receptor activators. Bioorganic and Medicinal Chemistry Letters. 2005; 15:4898-4906.
12. Kousika J, Krishnamoorthy SV, Ragumoorthi KN. Efficacy of insecticide mixture-Chlorantraniliprole 4.3% + Abamectin 1.7% SC against tomato pest complex. Indian Journals of Entomology. 2015; 77(1):56-65.
13. Dagli F, Ikten C, Sert E, Bölücek E. Susceptibility of tomato borer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) populations from Turkey to 7 different insecticides in laboratory bioassay. EPPO Bulletin. 2012; 42(2):305-311.
14. Dhakshina SR, Schuster JF, Klassen W. Comparative Effectiveness of New Insecticides in Controlling Armyworms (Lepidoptera: Noctuidae) and Leafminers (Diptera: Agromyzidae) on tomato. Proceedings of the Florida. State Horticultural Society. 2007; 120:170-177.
15. Ramesh R, Ukey SP. Bio-efficacy of botanicals, microbials, and newer insecticides in the management of tomato leaf miner, *Liriomyza trifolii* (Burgess). International Journal Agricultural Science. 2007; 3(1): 154-156.
16. Bharathi K, Mohanraj A, Rajavel DS. Field efficacy of Chlorantraniliprole 20% SC against pests of bitter gourd. Pestology, 2011; 35(7):32-35.
17. Hernández R, Harris M, Liu TX. Impact of insecticides on parasitoids of the leafminer, *Liriomyza trifolii*, in pepper in south Texas. Journals of Insect Science. 2009; 11(61):1-14.