Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(2): 1570-1575

Received: 27-01-2017
Accepted: 28-02-2017

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Chlorantraniliprole 4.3% + Abamectin 1.7% SC: A Safer Insecticide to Natural Enemies (Spiders and Coccinellids) in Tomato Ecosystem

S Selvaraj, RS Bisht and A Kuzhandhaivel Pillai

Abstract
Two field experiments were conducted to study the impact of new formulation of Cholrantraniliprole 4.3% + Abamectin 1.7% SC on spiders and coccinellids occurring on tomato during 2011-2013 in Pantnagar of Uttarakhand. Cholrantraniliprole 4.3% + Abamectin 1.7% SC @ 24, 30, 36, 60 g a.i. ha^{-1} were tested along with standard check, Cholrantraniliprole 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}. Results showed that the new formulation was found to be safer to spiders and coccinellids at all concentrations tested. The highest population was recorded in plots treated with Cholrantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i. ha^{-1} followed by Cholrantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i. ha^{-1}. The present findings revealed that natural enemy population was noticeably lower up to 5 days after application of insecticides. Thereafter, the natural enemy populations had gradually increased from chlorantraniliprole+abamectin treated plots at different doses during both the years.

Keywords: Coccinellids, spiders, safety, natural enemies, Tomato

1. Introduction

Tomato (*Solanum lycopersicum = Lycopersicon esculentum*) is one of the most important and widely grown vegetable crops of both tropics and subtropics. It occupies an area of 4.6 million hectares in the world with a production of 128 million tonnes [1]. 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 [2]. Commonly used 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 [3, 4]. One such new group with reduced risk insecticide Chlorantraniliprole 4.3%+ Abamectin 1.7% SC (mixed formulation) have been recently discovered as a novel class of insecticide having a unique chemical structure with different mode of action and showed excellent activity against a many insect pests which is benign to natural enemies of these pests. Hence, the present study was undertaken to study the safety of Chlorantraniliprole 4.3%+ Abamectin 1.7% SC on natural enemies in tomato ecosystem.

2. Materials and Methods

New formulation (NF) of Cholrantraniliprole 4.3% + Abamectin 1.7% SC was tested at different doses to evaluate safety on natural enemies *viz.*, spider and coccinellids predators occurring in tomato ecosystem 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. The experiments were carried out in randomized block design with eight treatments, each replicated thrice. The treatments imposed were Cholrantraniliprole 4.3% + Abamectin 1.7% SC @ 24, 30, 36, 60 g a.i. ha^{-1} tested along with standard check, Cholrantraniliprole 18.5% SC @ 30 g a.i. ha^{-1}, Abamectin 1.9 EC @ 15 g a.i. ha^{-1}, Lambda cyhalothrin 4.9 CS @ 15 g a.i. ha^{-1} and untreated check. The treatments were imposed two times 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 300 litres of spray fluid / ha. The observation on natural enemies population *viz.*, spiders and coccinellids was taken prior to spraying and 1, 3, 5, 7 and 10 days after spraying on five randomly tagged plants from each plot.

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 different natural enemies 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.

3. Results and Discussion

3.1. Experiment I

The population of spiders ranged from 2.73 to 3.79 spider/plant before imposing treatments in the first field experiment (Table 1). At one day after 1st spray, the spiders population varied from 1.88/plant (minimum) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha to 2.99/plant (maximum) with Abamectin 1.9 EC @ 15 g a.i/ha, Thus data on the mortality of these predators showed that there was slight decrease in spider population in all insecticide treated plots. A more or less similar trend of insecticidal effect was also observed at 3rd and 5th day after 1st spray.

At 7th day after 1st spray, spider population varied from 1.48 spiders/plant with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha to 2.48 spiders/plant with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha. A slight increase in spiders population was recorded in plots treated with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (2.30 to 2.48 spiders/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (2.26 to 2.41 spiders/plant), Abamectin 1.9 EC @ 15 g a.i/ha (1.95 to 2.07 spiders/plant) and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.48 to 1.67 spiders/plant).

At 10th day after 1st spray, spider population was minimum (1.28 spiders/plant) with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha while it was maximum (2.78 spiders/plant) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha. A slight increase in spiders population was recorded in plots treated with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (2.48 to 2.78 spiders/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (2.41 to 2.52 spiders/plant), Abamectin 1.9 EC @ 15 g a.i/ha (2.07 to 2.20 spiders/plant) and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (1.71 to 1.85 spiders/plant).

After 2nd spray based on mean spider population, Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha appeared to be safest treatment (3.23 spiders/plant) followed by Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (2.96 spiders/plant) Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (2.74 spiders/plant), Abamectin 1.9 EC @ 15 g a.i/ha (2.36 spiders/plant), Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (2.35 spiders/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.82 spiders/plant) and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (1.70 spiders/plant) (Table 2).

The number of coccinellids was observed one day before 1st spray varied from 2.13 to 3.32 coccinellid/plant (Table 3). At one day after 1st spray, the coccinellid population varied from 1.61/plant (minimum) with Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha to 2.27/plant (maximum) with Abamectin 1.9 EC @ 15 g a.i/ha. Thus, data on the mortality of these predators showed that there was slight decrease in coccinellid population in plots treated with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60, 36, 24 and 30 g a.i/ha (population 1.79, 1.82, 1.89, 1.95 and 2.03 coccinellid/plant, respectively). A more or less similar trend of insecticidal effect was also observed at 3rd day after 1st spray.

At 5th day after 1st spray, coccinellid population varied from 1.26/plant with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha to 2.36/plant with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha. A slight increase in coccinellid population was recorded in plots treated with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (1.89 to 2.36/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (1.91 to 2.10/plant), Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (1.43 to 1.59/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.28 to 1.57/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.23 to 1.47/plant), while in plots treated with Abamectin 1.9 EC @ 15 g a.i/ha and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha there was no significant change in the coccinellid population. A more or less similar trend of coccinellid population was also noticed at 7th day after 1st spray

At 10th day after 1st spray, coccinellids population varied from 1.49/plant (with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha) to 2.86/plant (with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha). An increase in the population of coccinellid was observed with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (2.68 to 2.76/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (1.90 to 2.17/plant), and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.91 to 2.16/plant). However, the treatment Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (2.02 to 1.97/plant) and Abamectin 1.9 EC @ 15 g a.i/ha (1.91 to 1.74/plant) resulted slight decrease in coccinellid population.

The average number of cocinellid/plant observed one day before 2nd spray, varied from 1.96 to 3.41/plant (Table 4). At 5th day after 2nd spray, the population of coccinellid was minimum (0.87/plant) in plots treated with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha to maximum (2.36/plant) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha. Slight increase in population was recorded with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (1.95 to 2.13/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (1.62 to 1.71/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.42 to 1.66/plant) and Abamectin 1.9 EC @ 15 g a.i/ha (1.36 to 1.46/plant). A more or less similar trend of increasing the coccineelid population was also observed at 7th and 10th days after 2nd spray. The present study was in agreement with [5] who reported that chlorantraniliprole 20% SC (Rynaxypyr) was non-toxic to coccinellid beetles present in egg plant ecosystem after five applications. Chlorantraniliprole 20% SC (Rynaxypyr®) had an excellent environmental profile with low impact on coccinellidae [6].

The new formulation observed to that it is a safe chemical to natural enemies due to rapid degradation on the surface of foliage, limiting contact of phytophagous insects as its mode of action is mainly by ingestion, ecologically selective to wide range of beneficial species due to rapid breakdown of the active ingredient by photo-oxidation to non-toxic level on the surface, limiting contact activity to a very short period.

3.2. Experiment II

In the second field experiment, the pretreatment population of spiders ranged from 2.68 to 3.43 spiders/plant (Table 5). At one day after 1st spray, the spiders population varied from 1.16 spiders/plant (minimum) with Chlorantraniliprole 18.5% SC @ 60 g a.i/ ha to 2.44 spiders/plant (maximum) with Abamectin 1.9 EC @ 15 g a.i/ha. A more or less similar trend of insecticidal effect was also observed at 3rd and 5th day after 1st spray. At 7th day after 1st spray, spider population varied from 1.44 spiders/plant (with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha) to 2.70 spiders/plant (with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha). A slight increase in population of spider was observed with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (2.11 to 2.70spiders/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (1.99 to 2.27 spiders/plant) and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.14 to 1.44 spiders/plant), while in plots treated with Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (2.03 to 1.88 spiders/plant), Abamectin 1.9 EC @ 15 g a.i/ha (2.06 to 2.00 spiders/plant) and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (1.77 to 1.70 spiders/plant) there was slight decrease in spider population. A more or less similar trend of spider population was also noticed at 10th day after 1st spray (Table 5).

After 2nd spray based on mean spider population, Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (2.44 spiders/plant) and Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (2.21 spiders/plant) appeared to be safest treatment followed by Abamectin 1.9 EC @ 15 g a.i/ha (1.55 spiders/plant), Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (1.40 spiders/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 36 g a.i/ha (1.11 spiders/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.11 spiders/plant) and lambda cyhalothrin 4.9 CS @ 15 g a.i/ha (1.04 spiders/plant) (Table 6).

Gradual increase in the spider population was observed after spray in both the seasons. However, the average population of spiders was recorded in the chlorantraniliprole 20% SC (Rynaxypyr 20% SC) treated plot [6]. The present study was in conformity with [7] who reported that chlorantraniliprole 20% SC (30 g/hm^2) had a low killing efficiency on spiders,

The number of coccinellids observed one day before 1st spray, varied from 2.61 to 3.46 coccinellids/plant (Table 7). At one day after 1st spray, the coccinellids population varied from 1.24/plant (minimum) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha to 2.35/plant (maximum) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha. Thus, data on the mortality of these predators showed that there was slight decrease population in all insecticidal treated plots. A more or less similar trend of insecticidal effect was also noticed at 3rd day after 1st spray.

At 5th day after 1st spray, coccinellid population varied from 1.40/plant with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha to 2.53/plant with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha. A slight increase in coccinellid population was recorded in plots treated with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (2.16 to 2.53/plant), Abamectin 1.9 EC @ 15 g a.i/ha (1.94 to 2.50/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @36 g a.i/ha (1.50 to 1.86/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 60 g a.i/ha (1.40 to 1.77/plant) and Chlorantraniliprole 18.5% SC @ 30 g a.i/ ha (1.41 to 1.44/plant). At 5 days after treatment (DAT) coccinellid population was increased in all insecticidal treatments plots and this trend was similarly observed at 7th and 10th days after 1st spray.

One day before 2nd spray, the population of coccinellid varied from 2.67 to 4.12/plant. At 5th day after 2nd spray, the population of coccinellid was minimum (1.52/plant) in plots treated with lambda cyhalothrin 4.9 CS @ 15 g a.i/ha to maximum (2.68/plant) with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha. A Slight increase in population was recorded with Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i/ha (2.49 to 2.68/plant), Chlorantraniliprole 4.3% + Abamectin 1.7% SC @ 30 g a.i/ha (2.42 to 2.65/plant) and Abamectin 1.9 EC @ 15 g a.i/ha (1.83 to 2.39/plant). At 5 days after 2nd spray the coccinellid population was increased in all insecticidal treatments plots and this trend was similarly at 7th and 10th days after 2nd spray (Table 8).

The present findings revealed that natural enemy population was noticeably lower up to 5 days after application of insecticides. Thereafter, the natural enemy populations had gradually increased from chlorantraniliprole+abamectin treated plots at different doses during both the years. Among the different doses of chlorantraniliprole+abamectin, the lowest on natural enemy populations was observed at 24g a.i/ha followed by 30g a.i/ha. Because, Chlorantraniliprole + abamectin acts as safest insecticides for natural enemy upto 30 g a.i/ha. The present results are in corroborates with[8] reported that predatory spider population was considerably lowered immediately following application of insecticides such as metaflumiazone, indoxacarb, novaluron, spinetoram and spinosad but the populations treated with indoxacarb and spinosad had fully recovered by the seven days after treatment. Chlorantraniliprole 20 SC @ 30 g ai/ha did not cause any resurgence in sucking pests and is also safer to natural enemies [9].

Table 1: Effect of newer insecticides molecules on population of spiders in tomato eco system after first application during 2011-12

Treatments	Dose (g a.i. ha^{-1})	Number of spiders per plant *						
		PTC	1DAT	3DAT	5 DAT	7 DAT	10DAT	Mean
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	2.73	1.93 (1.55)	1.80 (1.51)	2.26 (1.65)	2.41 (1.70)	2.52 (1.73)	2.18
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	2.80	1.88 (1.54)	1.80 (1.51)	2.30 (1.67)	2.48 (1.72)	2.78 (1.81)	2.25
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	3.27	2.37 (1.68)	1.64 (1.46)	1.80 (1.51)	1.71 (1.48)	1.85 (1.53)	1.87
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	3.37	1.79 (1.51)	1.31 (1.34)	1.48 (1.39)	1.67 (1.46)	1.56 (1.43)	1.56
Cholrantraniliprole 18.5% SC	30	3.77	2.17 (1.63)	1.98 (1.57)	1.91 (1.55)	1.89 (1.54)	1.68 (1.47)	1.93
Abamectin 1.9 EC	15	3.15	2.99 (1.86)	2.48 (1.72)	1.95 (1.56)	2.07 (1.60)	2.20 (1.64)	2.34
Lambda cyhalothrin 4.9 CS	15	3.37	2.54 (1.74)	2.29 (1.66)	1.72 (1.48)	1.48 (1.40)	1.28 (1.33)	1.86

Untreated Control	-	3.79	3.54 (2.00)	3.69 (2.04)	3.87 (2.08)	3.56 (2.01)	3.65 (2.03)	3.66
Sem		0.510	0.242	0.180	0.120	0.196	0.101	-
CD (0.05%)		NS	0.73	0.54	0.36	0.59	0.30	

PTC- Pretreatment count; DAT- Days after treatments, ***** Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 2: Effect of newer insecticides molecules on population of spiders in tomato eco system after second application during 2011-12

Treatments	**Dose (g a.i. ha^{-1})**	**Number of spiders per plant ***						
		PTC	**1DAT**	**3DAT**	**5 DAT**	**7 DAT**	**10DAT**	**Mean**
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	3.83	2.75 (1.80)	2.29 (1.67)	2.87 (1.83)	3.15 (1.90)	3.75 (2.06)	2.96
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	3.95	2.66 (1.77)	2.32 (1.68)	3.01 (1.86)	4.05 (2.13)	4.12 (2.14)	3.23
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	3.79	3.14 (1.90)	2.41 (1.70)	2.35 (1.68)	2.88 (1.83)	2.90 (1.84)	2.74
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	3.67	2.67 (1.77)	2.33 (1.67)	1.29 (1.33)	1.41 (1.38)	1.40 (1.37)	1.82
Cholrantraniliprole 18.5% SC	30	3.66	2.90 (1.84)	2.64 (1.77)	2.22 (1.64)	2.04 (1.59)	1.96 (1.56)	2.35
Abamectin 1.9 EC	15	4.26	3.41 (1.97)	2.21 (1.64)	2.00 (1.58)	2.12 (1.61)	2.04 (1.59)	2.36
Lambda cyhalothrin 4.9 CS	15	3.71	2.31 (1.67)	1.67 (1.47)	1.65 (1.46)	1.52 (1.41)	1.37 (1.36)	1.70
Untreated Control	-	4.67	4.94 (2.33)	4.60 (2.25)	4.66 (2.29)	4.54 (2.24)	4.57 (2.24)	4.66
Sem		0.335	0.283	0.165	0.157	0.169	0.194	
CD (0.05%)		NS	0.85	0.50	0.47	0.51	0.59	

PTC- Pretreatment count; DAT- Days after treatments, ***** Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 3: Effect of newer insecticides molecules on coccinellids in tomato eco system after first application during 2011-12

Treatments	**Dose (g a.i. ha^{-1})**	**Number of coccinellids per plant ***						
		PTC	**1DAT**	**3DAT**	**5 DAT**	**7 DAT**	**10DAT**	**Mean**
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	2.23	1.95 (1.56)	1.91 (1.54)	2.10 (1.60)	2.37 (1.69)	2.86 (1.83)	2.24
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	2.50	2.03 (1.58)	1.89 (1.54)	2.36 (1.68)	2.68 (1.78)	2.76 (1.80)	2.34
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	2.40	1.89 (1.53)	1.23 (1.31)	1.47 (1.40)	1.90 (1.54)	2.17 (1.62)	1.73
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	2.46	1.82 (1.52)	1.28 (1.32)	1.57 (1.43)	1.91 (1.54)	2.16 (1.62)	1.75
Cholrantraniliprole 18.5% SC	30	2.13	1.61 (1.44)	1.43 (1.37)	1.59 (1.43)	2.02 (1.58)	1.97 (1.56)	1.72
Abamectin 1.9 EC	15	2.28	2.27 (1.66)	2.06 (1.58)	1.71 (1.47)	1.91 (1.53)	1.74 (1.49)	1.94
Lambda cyhalothrin 4.9 CS	15	2.42	1.79 (1.51)	1.43 (1.37)	1.26 (1.35)	1.38 (1.36)	1.49 (1.40)	1.47
Untreated Control	-	3.32	3.00 (1.87)	3.14 (1.90)	2.78 (1.80)	3.07 (1.88)	3.10 (1.89)	3.02
Sem		0.361	0.237	0.212	0.257	0.228	0.222	
CD (0.05%)		NS	0.71	0.64	0.78	0.69	0.67	

PTC- Pretreatment count; DAT- Days after treatments, ***** Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 4: Effect of newer insecticides molecules on coccinellids in tomato eco system after second application during 2011-12

Treatments	**Dose (g a.i. ha^{-1})**	**Number of coccinellids per plant ***						
		PTC	**1DAT**	**3DAT**	**5 DAT**	**7 DAT**	**10DAT**	**Mean**
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	3.32	2.23 (1.64)	2.09 (1.60)	2.36 (1.68)	2.67 (1.78)	2.96 (1.89)	2.46
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	3.41	2.19 (1.63)	1.95 (1.56)	2.13 (1.62)	2.40 (1.70)	2.85 (1.82)	2.31
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	3.14	2.01 (1.58)	1.62 (1.44)	1.71 (1.48)	1.99 (1.57)	2.27 (1.66)	1.92
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	2.96	1.99 (1.57)	1.42 (1.38)	1.66 (1.46)	1.96 (1.56)	2.15 (1.62)	1.84
Cholrantraniliprole 18.5% SC	30	2.35	1.82 (1.52)	1.70 (1.47)	1.63 (1.45)	1.74 (1.48)	1.80 (1.51)	1.74
Abamectin 1.9 EC	15	3.03	2.29 (1.66)	1.46 (1.39)	1.30 (1.34)	1.77 (1.50)	2.12 (1.61)	1.79
Lambda cyhalothrin 4.9 CS	15	1.96	1.40 (1.37)	1.03 (1.23)	0.87 (1.16)	0.91 (1.18)	1.15 (1.22)	1.07
Untreated Control	-	2.90	3.16 (1.91)	3.45 (1.98)	3.37 (1.96)	3.41 (1.97)	3.64 (2.03)	3.41
Sem		0.307	0.230	0.198	0.121	0.182	0.275	
CD (0.05%)		NS	0.69	0.60	0.36	0.55	0.83	

PTC- Pretreatment count; DAT- Days after treatments, * Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 5: Effect of newer insecticides molecules on population of spiders in tomato eco system after first application during 2012-13

Treatments	Dose (g a.i. ha^{-1})	Number of spiders per plant *						
		PTC	1DAT	3DAT	5 DAT	7 DAT	10DAT	Mean
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	2.93	1.85 (1.53)	1.55 (1.42)	1.99 (1.57)	2.27 (1.66)	2.51 (1.73)	2.03
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	3.03	1.76 (1.50)	1.59 (1.44)	2.11 (1.61)	2.70 (1.78)	2.81 (1.81)	2.20
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	3.07	1.25 (1.31)	1.84 (1.52)	1.63 (1.45)	1.56 (1.43)	1.65 (1.46)	1.59
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	2.68	1.16 (1.28)	1.10 (1.26)	1.14 (1.22)	1.44 (1.39)	1.47 (1.40)	1.26
Cholrantraniliprole 18.5% SC	30	3.41	2.11 (1.61)	2.14 (1.63)	2.03 (1.58)	1.88 (1.54)	2.00 (1.58)	2.03
Abamectin 1.9 EC	15	2.93	2.44 (1.71)	2.22 (1.64)	2.06 (1.60)	2.00 (1.58)	2.25 (1.65)	2.20
Lambda cyhalothrin 4.9 CS	15	3.40	1.60 (1.44)	1.89 (1.54)	1.77 (1.50)	1.70 (1.48)	1.43 (1.38)	1.68
Untreated Control	-	3.43	3.63 (2.03)	3.70 (2.04)	3.55 (2.01)	3.00 (1.86)	3.48 (1.99)	3.47
Sem		0.081	0.126	0.130	0.237	0.162	0.128	
CD (0.05%)		0.54	0.38	0.39	0.72	0.49	0.38	

PTC- Pretreatment count; DAT- Days after treatments, * Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 6: Effect of newer insecticides molecules on population of spiders in tomato eco system after second application during 2012-13

Treatments	Dose (g a.i. ha^{-1})	Number of spiders per plant *						
		PTC	1DAT	3DAT	5 DAT	7 DAT	10DAT	Mean
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	2.85	1.55 (1.42)	1.59 (1.44)	2.14 (1.62)	2.88 (1.83)	2.91 (1.84)	2.21
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	2.61	1.40 (1.37)	1.44 (1.38)	2.70 (1.78)	3.22 (1.92)	3.45 (1.98)	2.44
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	2.15	1.11 (1.26)	1.02 (1.22)	0.85 (1.12)	1.14 (1.22)	1.41 (1.38)	1.11
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	2.20	1.12 (1.26)	1.07 (1.24)	0.73 (1.04)	1.18 (1.23)	1.46 (1.39)	1.11
Cholrantraniliprole 18.5% SC	30	2.58	1.56 (1.43)	1.53 (1.42)	1.10 (1.26)	1.30 (1.34)	1.50 (1.41)	1.40
Abamectin 1.9 EC	15	2.11	1.68 (1.47)	1.63 (1.45)	1.25 (1.32)	1.60 (1.44)	1.61 (1.45)	1.55
Lambda cyhalothrin 4.9 CS	15	2.03	1.30 (1.37)	1.20 (1.30)	0.85 (1.16)	0.91 (1.18)	0.95 (1.19)	1.04
Untreated Control	-	3.47	3.11 (1.89)	3.51 (2.00)	3.48 (1.99)	3.49 (1.99)	3.49 (1.99)	3.42
Sem		0.440	0.170	0.172	0.251	0.328	0.098	
CD (0.05%)		NS	0.516	0.52	0.76	0.99	0.29	

PTC- Pretreatment count; DAT- Days after treatments, * Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 7: Effect of newer insecticides molecules on coccinellids in tomato eco system after first application during 2012-13

Treatments	Dose (g a.i. ha^{-1})	Number of coccinellids per plant *						
		PTC	1DAT	3DAT	5 DAT	7 DAT	10DAT	Mean
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	2.69	2.17 (1.63)	2.16 (1.63)	2.53 (1.73)	2.88 (1.83)	3.41 (1.97)	2.63
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	2.73	2.35 (1.68)	2.04 (1.59)	1.67 (1.47)	1.74 (1.49)	2.00 (1.57)	1.96
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	2.78	1.52 (1.41)	1.50 (1.41)	1.86 (1.53)	2.13 (1.62)	2.31 (1.67)	1.87
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	2.85	1.24 (1.25)	1.40 (1.36)	1.77 (1.50)	2.07 (1.60)	2.32 (1.67)	1.76
Cholrantraniliprole 18.5% SC	30	2.61	1.76 (1.50)	1.41 (1.37)	1.44 (1.32)	1.71 (1.48)	1.97 (1.57)	1.66
Abamectin 1.9 EC	15	2.69	1.97 (1.57)	1.94 (1.56)	2.50 (1.73)	2.92 (1.84)	3.45 (1.98)	2.55
Lambda cyhalothrin 4.9 CS	15	2.72	1.68 (1.47)	1.24 (1.31)	1.40 (1.37)	1.46 (1.39)	1.55 (1.42)	1.47
Untreated Control	-	3.46	3.22 (1.92)	3.34 (1.95)	3.47 (1.99)	3.38 (1.96)	3.58 (2.01)	3.40
Sem		0.215	0.276	0.137	0.323	0.120	0.209	
CD (0.05%)		NS	0.83	0.41	0.97	0.36	0.63	

PTC- Pretreatment count; DAT- Days after treatments, * Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

Table 8: Effect of newer insecticides molecules on coccinellids in tomato eco system after second application during 2012-13

Treatments	Dose (g a.i. ha^{-1})	Number of coccinellids per plant *						
		PTC	1DAT	3DAT	5 DAT	7 DAT	10DAT	Mean
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	24	3.32	2.53 (1.73)	2.49 (1.72)	2.68 (1.78)	2.99 (1.86)	3.32 (1.95)	2.80
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	30	3.43	2.42 (1.70)	2.42 (1.70)	2.65 (1.77)	3.00 (1.87)	3.41 (1.97)	2.78
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	36	3.02	2.04 (1.59)	1.89 (1.53)	2.11 (1.61)	2.38 (1.69)	2.57 (1.75)	2.20
Cholrantraniliprole 4.3% + Abamectin 1.7% SC	60	2.84	2.42 (1.70)	2.14 (1.62)	1.83 (1.52)	1.87 (1.53)	2.04 (1.59)	2.06
Cholrantraniliprole 18.5% SC	30	2.67	2.05 (1.59)	1.86 (1.53)	1.55 (1.42)	1.70 (1.48)	2.02 (1.58)	1.84
Abamectin 1.9 EC	15	3.60	1.99 (1.57)	1.83 (1.52)	2.39 (1.69)	2.97 (1.86)	3.09 (1.89)	2.45
Lambda cyhalothrin 4.9 CS	15	2.78	1.92 (1.55)	1.61 (1.45)	1.52 (1.41)	1.61 (1.45)	1.77 (1.50)	1.69
Untreated Control	-	4.12	3.91 (2.09)	4.11 (2.14)	3.82 (2.07)	3.86 (2.08)	3.70 (2.05)	3.88
Sem		0.172	0.108	0.157	0.146	0.167	0.145	
CD (0.05%)		0.52	0.32	0.47	0.44	0.50	0.44	

PTC- Pretreatment count; DAT- Days after treatments, ***** Mean of three replications

Values in parentheses are $\sqrt{x+0.05}$ transformed values

4. Conclusion

It is concluded that, the new insecticide mixture Cholrantraniliprole 4.3% + Abamectin 1.7% SC @ 24 g a.i. ha^{-1} recorded safer to natural enemies (Spiders and Coccinellids) population in the tomato ecosystem. In view of the safety these new insecticide mixture molecules they can be incorporated as the chemical component in the integrated pest management of tomato.

5. Acknowledgement

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

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