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Bio-efficacy of Ampligo 15O ZC (chlorantraniliprole 9.3% +lambdacyhalothrin 4.6%) against leaf eating caterpillar in tomato (Lepidoptera: Noctuidae)

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Abstract
The field efficacy of chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC, chlorantraniliprole 18.5 SC, lambda-cyhalothrin 4.9 CS, novaluron 5.25% + indoxacarb 4.5% SC in sequential application to tomato crop is reported. Two sequential applications of each insecticide at 30 days interval were shown better result in single application. When applied sequentially, chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC gave the best weed control and was on par with two sequential applications.

Keywords: Bioefficacy, *Spodoptera litura,* chlorantraniliprole 9.3%w/w + lambdacyhalothrin 4.6%w/w 150 ZC

1. Introduction
Tomato *Lycopersicum esculentum* Mill is an important vegetable crop grown throughout India and important – protective foods because of the specific nutritive value. It is world's third largest vegetable crop after potato and sweet potato. Tomatoes are used for soup, salad, pickles, ketchup, puree and sauces. Tomato is consumed in any countries, as it provides several plant nutrients and considered as a important nutritional value for human diet Willeox, 2003 [1]. In India, tomato is cultivated over an area of about 884.02 thousand hectares with an annual production of 1787.43 thousand tones. In Tamil Nadu tomato is grown in an area of about 26.10 thousand hectares with a production of 519.10 thousand tonnes (National Horticulture Board, 2011). Madhya Pradesh, Karnataka, Orissa, Maharashtra and Bihar are the major tomato growing states in India. India ranks second in area as well as in production of tomato followed by China, U.S.A and Turkey Anonymous, 2011 [2]. Tomato crop is affected by several biotic, physiochemical and mesobiotic factors. Amoung the biotic factors insect pests are predominant and occur regularly at different stages of crop growth. A number of insect pests (nearly 100-200 species) are reported in the tomato fields Lange and Bronson, 1997 [3]. Among them loss incurred to the tomato crop by leaf eating caterpillar (*Spodoptera litura* Fabricius.). And it is a serious and regular pest. The peak incidence of *Spodoptera litura* caused 30 to 50% crop loss Patil *et al.,* 2002 [4]. So Considering the economic importance of tomato and the losses caused by the pest, the present investigation is planned to evaluate the bioefficacy of newer insecticide formulation chlorantraniliprole 9.3%w/w + lambdacyhalothrin 4.6%w/w 150 ZC in tomato ecosystem.

2. Materials and Methods
The present investigation have been designed to evaluate the bioefficacy of chlorantraniliprole 9.3%w/w + lambdacyhalothrin 4.6%w/w 150 ZC against major pests of tomato *Spodoptera litura* Fabricius, under tolerance in field conditions during 2016-2018.

2.1 Test insecticides
Chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC (Syngenta India Pvt Ltd) chlorantraniliprole 18.5 SC (Syngenta India Pvt Ltd) lambda-cyhalothrin 4.9 CS (Du Pont India Pvt Ltd) novaluron 5.25% + indoxacarb 4.5% SC (Adama India Pvt Ltd)

3. Field Evaluation

Field experiments were conducted for two seasons during 2017-2018 to evaluate the bioefficacy of chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC against larval population of *S. litura* on tomato at shivapuri in Chidambaram experiments were laid out in a randomized block design. The plot size was 50 m^2 with the spacing of 45cm × 60cm in both the seasons. Each treatment was replicated three times.

Three doses of chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC @ 28, 35, and 41.7 g a.i/ha were evaluated and compared with the standard chlorantraniliprole 18.5 SC @ 15 g a.i/ha lambda-cyhalothrin 4.9 CS @ 83.4 novaluron 5.25% + indoxacarb 4.5% SC @ 30 g a.i/ha and control. The insecticides treatments were done using manually operated Knapsack sprayer with cone nozzle @ 500 L/ha employing water for dilution. Single insecticidal application was given at the onset of flowering (after 90 days of planting). Observation on population of *S litura* Number of young and grown up larvae on five randomly selected plant per plot were record Singh and Jalali, 1997[5]. And calculate the yield on whole plot basis from three pickings from 100 days of planting. The number of natural enemies was recorded from each plot before and at 5, 10 and 15 DAT.

3.1 Statistical Treatment

Randomized block design was followed and analysis was done following Panse and Sukhatme 1957[6].

The corrected per cent reduction in field population was worked out by using the formula of Henderson and Tilton 1955 [7] as follows

Corrected percent reduction $=1-\frac{Ta\times Cb}{Tb\times Ca}\times 100$

4. Results and Discussion

Mean population of S. litura observed in pre-treatment count was in the range of 1.07 to 1.27 nos/plant (Table 1)

After first spray, chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC at 41.7 g a.i/ha recorded the lowest larval population of 0.30, 0.20 and 0,83 nos/plant during 5,10 and 15 days respectively which was on par with chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC at 35 g a.i/ha with the larval population 0.33, 0,27 and 0,87 nos/plant during 5, 10 and 15 days respectively, while it was 2.00, 2.20 and 2.27 nos/plant in untreated check (Table 1). Compared to all the treatments of first spray, number of *S litura* larvae per plant reduced significantly in all the treatments of the second application leading to highest per cent reduction of *S. litura* larvae population in the second application

During the second application, chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC @ 417 g a.i/ha recorded least larval population of 0.43, 0.20 and 0.37 nos/plant during 5, 10 and 15 days respectively which was on par with chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC @ 35 g a.i/ha with the larval population of 0.47, 0.20 and 0.37 nos/plant during 5, 10 and 15 days respectively, while it was 2.47, 2.33 and 2.26 nos/plant in untreated check (Table 1).

Per cent reduction was maximum in chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC at 41.7 g a.i/ha (85.4) where as chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC at 35 g a.i/ha recorded 80.9 followed by novaluran 5.25% + indoxacarb 4.5% SC at 85.32 g a.i/ha (78.3) where as chlorantraniliprole 18.5% SC at 30 g a.i/ha and lambdacyhalothrin 4.9% CS at 15 g a.i/ha recorded per cent reduction of 72.5 and 69.9 respectively.

The order of efficacy exhibited by insecticides against *S. litura* after second spray was chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC 41.7> 35>28 g a.i/ha > novaluran 5.25% + indoxacarb 4.5% SC @ 85.32 g a.i/ha > chlorantraniliprole 18.5% SC @ 30g a.i/ha > lambdacyhalothrin 4.9% CS @ 15 g a.i/ha.

Chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC @ 35 g a.i/ha was found to be more effective against *Leuciodes orbonalis* in brinjal ecosystem Rajavel *et al.*, 2011 [8].

Chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w150 ZC @ 22.50 and 33.75 g a.i/ha was found to be more effective against cotton fruit borer Zhen Hu *et al.*, 2012[9].

The chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC @ 37.5 g a.i/ha was found to be effective against cotton boll worm Bajya *et al.*, 2015 [10].

Table 1: Effect of chlorantraniliprole 9.3% + lambdacyhalothrin 4.6% ZC against tomato leaf eating caterpillar *S. litura* (Season: I & II)

Treatments	Dose (g a.i/ha)	No of *Spodoptura litura* larvae per plant *								
		PTC	First Spray		Secound Spray				MEAN	%ROC
			5 DAT	10 DAT	15 DAT	5 DAT	10 DAT	15 DAT		
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	28 (18.60 + 9.20)	1.07 (1.03)	0.60 (0.77)	0.40 (0.63)	0.73 (0.86)	0.47 (0.68)	0.27 (0.52)	0.13 (0.65)	0.48 (0.65)	80.9
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	35 (23.25 + 11.50)	1.13 (1.06)	0.33 (0.58)	0.27 (0.52)	0.87 (0.93)	0.47 (0.68)	0.37 (0.60)	0.37 (0.60)	0.37 (0.60)	83.6
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	41.7 (27.90 + 13.80)	1.10 (1.06)	0.30 (0.42)	0.20 (0.45)	0.83 (0.91)	0.43 (0.65)	0.33 (0.58)	0.33 (0.58)	0.33 (0.58)	85.4
Lambdacyhalothrin 4.9% CS	15	1.00 (1.00)	0.87 (0.93)	0.73 (0.86)	0.87 (0.93)	0.73 (0.86)	0.68 (0.82)	0.68 (0.82)	0.68 (0.82)	69.9
Chlorantraniliprole 18.5% SC	30	1.07 (1.03)	0.80 (0.89)	0.67 (0.82)	0.87 (0.93)	0.67 (0.82)	0.62 (0.78)	0.62 (0.78)	0.62 (0.78)	72.5
Novaluron 5.25%+ Indoxacarb 4.5% sc	85.32 (45.94 + 39.38)	1.20 (1.10)	0.6 (0.82)	0.53 (0.73)	0.73 (0.86)	0.53 (0.73)	0.49 (0.70)	0.49 (0.70)	0.49 (0.70)	78.3
Untreated check	-	1.27 (1.13)	2.00 (1.41)	2.20 (1.41)	2.27 (1.57)	2.47 (1.57)	2.26 (1.50)	2.26 (1.50)	2.26 (1.50)	-
CD (0.05%)		NS	0.11	0.18	0.19	0.17	0.21	0.14	0.14	-
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	28 (18.60 + 9.20)	1.30	0.70 (0.83)	0.50 (0.70)	0.87 (0.93)	0.50 (0.70)	0.30 (0.54)	0.27 (0.51)	0.27 (0.51)	73.83
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	35 (23.25 + 11.50)	1.33	0.63 (0.79)	0.47 (0.68)	0.73 (0.85)	0.43 (0.65)	0.27 (0.50)	0.23 (0.48)	0.46 (0.66)	77.00

Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	41.7 (27.90 + 13.80)	1.30	0.53 (0.73)	0.43 (0.65)	0.67 (0.81)	0.40 (0.62)	0.27 (0.50)	0.20 (0.44)	0.42 (0.63)	79.17
Lambdacyhalothrin 4.9% CS	15	1.33	0.83 (0.91)	0.73 (0.85)	0.90 (0.94)	0.67 (0.81)	0.57 (0.75)	0.47 (0.68)	0.70 (0.82)	65.25
Chlorantraniliprole 18.5% SC	30	1.40	0.80 (0.89)	0.67 (0.81)	0.97 (0.98)	0.70 (0.83)	0.50 (0.75)	0.43 (0.65)	0.68 (0.81)	66.08
Novaluron 5.25%+ Indoxacarb 4.5% sc	85.32 (45.94 + 39.38)	1.37	0.77 (0.87)	0.60 (0.77)	0.93 (0.96)	0.63 (0.79)	0.53 (0.73)	0.47 (0.68)	0.66 (0.80)	67.25
Untreated check	-	1.40	1.60 (1.26)	1.70 (1.30)	1.93 (1.39)	2.20 (1.48)	2.27 (1.50)	2.30 (1.51)	2.00 (1.41)	-
CD (0.05%)		NS	0.11	0.05	0.07	0.12	0.11	0.06	0.10	-

5. Effect on Natural Enemies

A non-significant difference was recorded on natural enemies' *viz*., spider coccinellid as compared to untreated check during both the seasons.

The chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC @ 37.5 g a.i/ha was found to be comparatively safer to spiders Bajya *et al.*, 2015 [11].

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