Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(1): 1552-1555

Received: 04-11-2018
Accepted: 08-12-2018

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Bio-efficacy of Chlorantraniliprole 9.3%w/w +Lambdacyhalothrin 4.6%w/w 150 ZC (Ampligo 15O ZC) against major tomato fruit borer *Helicoverpa armigera* Hubner (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 application of each insecticides at 30 days interval were better in single application. When applied sequentially, chlorantraniliprole 9.3% w/w + lambdacyhalothrin 4.6% w/w 150 ZC gave the best control of *Helicoverpa armigera* and was on par with two sequential applications.

Keywords: bioefficacy, *Helicoverpa armigera*, chlorantraniliprole 9.3%w/w +lambdacyhalothrin 4.6%

1. Introduction
Tomato [*Lycopersicum esculentum* Mill] is an important vegetable crop grown throughout India and important – protective foods because of the special nutritive value. It is worlds third largest vegetable crop after potato and sweet potato. Tomato is consumed in many countries, as it provides several plant nutrients and considered as a important nutritional value for human diet (Willeox, 2003) [1]. In Tamil Nadu tomato is grown in an area of about 26.10 thousand hectares with a production of 519.10 thousand tones 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 to 200 species) are reported in the tomato fields (Lange and Bronson, 1997) [3]. Among them loss incurred to the tomato crop by *Helicoverpa armigera* is an important pest which causes considerable losses in quality of tomato fruits (Tewari GC and Krishnamoorthy PN, 1984) [4]. Reddy NA and Gowdar SB. 2006 [5]. *Helicoverpa armigera* (Hub.) attacks fruits andmakes fruits unfit for human consumption and leads to 55 per cent yield loss (Selvanarayanan, 2000) [6].

2. Materials and Methods
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 *H. armigera* 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 *H. armigera* from 5 randomly selected tomato plants before and at 3,7 and 10 days after treatment (DAT) were recorded. The number of larvae per plant were recorded to calculate and yield on whole plot basis from three pickings from 100 days of planting. The number of natural enemies were recorded from each plot before and at 3, 7 and 10 DAT.

4. Statistical treatment

Randomized block design was followed and analysis was done following Panse and Sukhatme (1957) [7].

The corrected per cent reduction in field population was worked out by using the formula of Henderson and Tilton (1955) [8] as follows

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

5. Result and Discussion

The larval population of *H. armigera* are depicted in Table 1 and 2. The incidence of *H. armigera* was observed pre treatment, 7 and 14 DAT observed as pre treatment and at harvest. The population of *H. armigera* during season I ranged from 0.*37* to 0.*50* nos./plant in various treatments. The mean larval population was the lowest in Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC @ 41.7 g a.i/ha (0.*37* nos./plant) which was on par with Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC @ 35 g a.i/ha (0.*27* nos./plant) Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC @ 28 g a.i/ha (0.*37* nos./plant) followed Novaluron 5.25% + Indoxacarb 4.5% SC @ 85.32 g a.i/ha (0.*50* nos./plant) Chlorantraniliprole 18.5% SC @ 30 g a.i/ha (0.6*3* nos./plant) and Lambdacyhalothrin 4.9% CS @ 15 g a.i/ha (0.6*7* nos./plant). Untreated check plots a recorded a mean larval population of 2.26 nos./plant Table-I. The population of *H. armigera* during season-II ranged from 0.70 to 0.47 nos./plant in various treatments. The mean larval population was the lowest in Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC @ 41.7 g a.i/ha (0.*37* nos./plant) Which was on par with Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC @ 35 g a.i/ha (0.*27* nos./plant) Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC @ 28 g a.i/ha (0.*37* nos./plant) followed by Novaluron 5.26% + Indoxaxcarb 4.5% SC @ 85.32 g a.i/ha (0.*50* nos./plant), Chlorantraniliprole 18.5% SC @ 30 g a.i/ha (0.*63* nos./plant) and Lambdacyhalothrin 4.9%CS @ 15 g a.i/ha (0.*67* nos./plant). Untreated check plots a recorded a mean larval population of 2.30 nos./plant (Table-2). Gadhiya (2014) [9] reporte chlorantraniliprole 0.006%, spinosad 0.018% was effective against *Helicoverpa armigera*. 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].

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.

Table 1-2: Effect of Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC against fruit borer and tomato fruit damaged *by Helicoverpa armigera* (Season: I)

Treatments	Dose (g a.i/ha)	No of *Helicoverpa armigera* larvae per plants*								
		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)	1.73	0.90 (0.94)	0.47 (0.68)	0.83 (0.91)	0.63 (0.79)	0.37 (0.60)	0.37 (0.60)	0.60 (0.75)	74.35
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	35 (23.25 + 11.50)	1.70	0.77 (0.87)	0.43 (0.65)	0.77 (0.87)	0.60 (0.77)	0.33 (0.57)	0.27 (0.50)	0.53 (0.71)	77.23
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	41.7 (27.90 + 13.80)	1.77	0.73 (0.85)	0.37 (0.60)	0.73 (0.85)	0.57 (0.75)	0.33 (0.57)	0.37 (0.60)	0.52 (0.70)	77.73
Lambdacyhalothrin 4.9% CS	15	1.87	1.00 (0.99)	0.57 (0.75)	1.07 (1.03)	0.77 (0.87)	0.60 (0.77)	0.67 (0.81)	0.78 (0.87)	66.38
Chlorantraniliprole 18.5% SC	30	1.67	1.10 (1.04)	0.57 (0.75)	1.13 (1.06)	0.80 (0.89)	0.57 (0.75)	0.63 (0.79)	0.80 (0.88)	65.52
Novaluron 5.25%+ Indoxacarb 4.5% sc	85.32 (45.94 + 39.38)	1.77	1.07 (1.03)	0.53 (0.73)	1.03 (1.01)	0.83 (0.91)	0.53 (0.72)	0.50 (0.70)	0.75 (0.85)	67.74
Untreated check	-	1.73	2.03 (1.42)	2.27 (1.50)	2.23 (1.49)	2.47 (1.57)	2.43 (1.56)	2.50 (1.58)	2.32 (1.52)	-
CD (0.05%)		NS	0.07	0.07	0.06	0.07	0.11	0.12	0.08	-

Treatments	Dose (g a.i/ha)	% fruit damage*								
		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 +	18.56 (25.52)	12.56 (20.76)	4.12 (11.71)	5.00 (12.92)	4.12 (11.71)	4.56 (12.33)	5.00 (12.92)	5.89 (14.05)	80.52

	9.20)									
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	35 (23.25 + 11.50)	18.15 (25.22)	10.00 (18.43)	3.40 (10.63)	4.12 (11.71)	3.00 (9.97)	3.40 (10.63)	3.95 (11.46)	4.65 (12.45)	84.65
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	41.7 (27.90 + 13.80)	18.89 (25.76)	9.45 (17.88)	3.25 (10.39)	3.80 (11.24)	3.00 (9.97)	3.25 (10.39)	3.89 (11.38)	4.44 (12.16)	85.33
Lambdacyhalothrin 4.9% CS	15	18.90 (25.77)	17.71 (24.89)	7.67 (16.08)	8.00 (16.43)	7.89 (16.31)	7.00 (15.34)	7.89 (16.31)	9.36 (17.81)	69.07
Chlorantraniliprole 18.5% SC	30	18.67 (25.52)	13.25 (21.35)	4.35 (12.04)	5.13 (13.09)	4.20 (11.83)	4.60 (12.38)	5.14 (13.10)	6.11 (14.31)	79.80
Novaluron 5.25%+ Indoxacarb 4.5% sc	85.32 (45.94 + 39.38)	18.56 (25.52)	14.80 (22.63)	6.23 (14.45)	7.65 (16.05)	5.50 (13.56)	5.67 (13.78)	6.45 (14.71)	7.72 (16.13)	74.50
Untreated check	-	18.53 (25.53)	23.89 (29.26)	27.45 (31.60)	29.80 (33.03)	33.56 (35.40)	31.24 (33.98)	35.60 (36.63)	30.26 (33.37)	-
CD (0.05%)		NS	2.12	1.78	1.75	2.12	1.95	1.90	1.80	-

Table 3-4: Effect of Chlorantraniliprole 9.3% + Lambdacyhalothrin 4.6% ZC against fruit borer and tomato fruit damage by *Helicoverpa armigera* (Season: II)

Treatments	**Dose (g a.i/ha)**	**No of *Helicoverpa armigera* larvae per plants***								
		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)	1.73	0.90 (0.94)	0.47 (0.68)	0.83 (0.91)	0.63 (0.79)	0.37 (0.60)	0.37 (0.60)	0.60 (0.75)	74.35
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	35 (23.25 + 11.50)	1.70	0.77 (0.87)	0.43 (0.65)	0.77 (0.87)	0.60 (0.77)	0.33 (0.57)	0.27 (0.50)	0.53 (0.71)	77.23
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	41.7 (27.90 + 13.80)	1.77	0.73 (0.85)	0.37 (0.60)	0.73 (0.85)	0.57 (0.75)	0.33 (0.57)	0.37 (0.60)	0.52 (0.70)	77.73
Lambdacyhalothrin 4.9% CS	15	1.87	1.00 (0.99)	0.57 (0.75)	1.07 (1.03)	0.77 (0.87)	0.60 (0.77)	0.67 (0.81)	0.78 (0.87)	66.38
Chlorantraniliprole 18.5% SC	30	1.67	1.10 (1.04)	0.57 (0.75)	1.13 (1.06)	0.80 (0.89)	0.57 (0.75)	0.63 (0.79)	0.80 (0.88)	65.52
Novaluron 5.25%+ Indoxacarb 4.5% sc	85.32 (45.94 + 39.38)	1.77	1.07 (1.03)	0.53 (0.73)	1.03 (1.01)	0.83 (0.91)	0.53 (0.72)	0.50 (0.70)	0.75 (0.85)	67.74
Untreated check	-	1.73	2.03 (1.42)	2.27 (1.50)	2.23 (1.49)	2.47 (1.57)	2.43 (1.56)	2.50 (1.58)	2.32 (1.52)	-
CD (0.05%)		NS	0.07	0.07	0.06	0.07	0.11	0.12	0.08	-

Treatments	**Dose (g a.i/ha)**	**% fruit damage***								
		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)	16.03	12.70 (20.87)	6.03 (14.18)	7.70 (16.10)	5.73 (13.80)	6.13 (14.32)	7.10 (15.43)	7.57 (15.80)	62.33
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	35 (23.25 + 11.50)	17.40	12.07 (20.31)	5.73 (13.76)	7.40 (15.77)	5.43 (13.47)	5.73 (13.81)	7.03 (15.35)	7.23 (15.44)	63.99
Chlorantraniliprole 9.3% w/w+ Lambdacyhalothrin 4.6 w/w ZC	41.7 (27.90 + 13.80)	16.77	11.37 (19.70)	5.13 (13.07)	5.43 (13.41)	4.37 (12.04)	5.03 (12.92)	5.77 (13.85)	6.18 (14.20)	69.21
Lambdacyhalothrin 4.9% CS	15	16.70	15.37 (23.07)	7.03 (15.35)	8.07 (16.47)	6.73 (15.02)	7.13 (15.46)	7.40 (15.77)	8.62 (16.87)	57.06
Chlorantraniliprole 18.5% SC	30	17.40	13.40 (21.46)	6.43 (14.68)	8.70 (17.13)	6.10 (14.27)	5.73 (13.84)	6.47 (14.72)	7.81 (16.03)	61.13
Novaluron 5.25%+ Indoxacarb 4.5% sc	85.32 (45.94 + 39.38)	16.77	13.03 (21.15)	6.40 (14.62)	8.40 (16.81)	5.73 (13.84)	6.47 (14.72)	6.03 (14.19)	7.68 (15.91)	61.77
Untreated check	-	16.70	17.73 (24.90)	19.03 (25.86)	19.73 (26.36)	21.47 (27.59)	20.80 (27.13)	21.73 (27.78)	20.08 (26.61)	-
CD (0.05%)		NS	1.15	2.20	1.45	1.84	1.79	1.71	1.73	-

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