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Efficacy of different insecticides against pest complex of tomato and effect on their natural enemies

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Abstract
Tomato fruit borer, *H. armigera* is the most destructive insect pest causing considerable losses in quantity as well as quality of tomato fruits. The field experiments on the bioefficacy of Tetraniliprole SC 200 (w/v) at 200, 250 and 300 ml/ha (40, 50 and 60 g a.i /ha) along with Coragen20% SC at 150 ml/ha (30 g a.i /ha) and Novaluron 10% EC at 750 ml/ha (75 g a.i /ha) against fruit borer and leaf miner was conducted in Randomized Block Design with four replications at Department of Entomology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology Udaipur-313001 (Rajasthan), during *Kharif*, 2013 and 2014. The data revealed that two spray of Tetraniliprole SC 200 (w/v) at 300 ml/ha at 15 days interval caused highest reduction in the population of fruit borer, lowest fruit damage and leaf minor damage and also recorded the higher marketable yield of tomato with a mean of 250.70 and 241.82 q/ha, followed by two spray of Tetraniliprole SC 200 (w/v) at 250 ml/ha at 15 days interval was found at par to above treatment in terms of mean reduction in the population of fruit borer, lowest fruit damage and leaf minor damage and also recorded the higher marketable yield of tomato with a mean of 238.49 and 232.50 q/ha during *Kharif* 2013 and 2014.

Keywords: Tomato, *H. armigera*, Pest complex, Insecticides, Management

1. Introduction
Tomato *Lycopersicon esculentum* (Mill) is one of the most popular and widely grown vegetables throughout the world ranking second in importance after potato in India. Tomato fruits are eaten raw, cooked or used to prepare soup, juice, ketchup, puree, paste and powder etc. Tomato is also rich in medicinal value. The pulp and juice of fruit are digestible, promoter of gastric secretion and blood purifier. Tomatoes contribute to a healthy and well-balanced diet. It is rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. Tomato contains much of vitamin A, B and C, iron and phosphorus. It also contains lycopene, an anti-oxidant that may contribute to protection against carcinogenic substances and decrease the risk of neurodegenerative diseases. In India total cultivated area under tomato was 8, 84, 000 hectares with the production of 1, 78, 74, 000 MT during 2012-13 [1]. Whereas, in Rajasthan, the annual production of tomato is 73.57 thousand MT from 15.51 thousand hectares area with the average productivity of 4.74 MT ha^{-1} [2]. All over the world this pest alone causes annual loss of approximately 5 billion US dollars [3]. This crop is attacked by a number of insects and diseases which became a major constraint in optimum production of tomato [4]. Many pests cause considerable damage to tomato out of which Tomato fruit borer, *Helicoverpa armigera* (Hubner) and leaf miners, *Liriomyza trifolii* (Burgess) are important pest. Tomato fruit borer, which causes 40-50 percent damage to the tomato crop [5]. *H. armigera* is a charismatic insect pest in agriculture accounting for the consumption of over 55 percent of total insecticides used in India [6]. Almost all the stages of tomato crops, right from nursery to maturity are attacked by a large number of insect pests. Yield losses ranged from 14 to 100 percent on different crops and the monetary loss due to this pest in India has been estimated over rupees one thousand crore per year [7]. Keeping this in view to the important of pests and to overcome the problem caused by insecticides and to achieve economic and sustainable management of the pest it is necessary to find out the effective insecticides hence, the present studies was undertaken.

2. Materials and Methods

2.1 Bio-Efficacy

The experiment on the bioefficacy of Tetraniliprole SC 200 (w/v) at 200, 250 and 300 ml/ha (40, 50 and 60 g a.i /ha) along with Coragen20% SC at 150 ml/ha (30 g a.i /ha) and Novaluron 10% EC at 750 ml/ha(75 g a.i /ha) against fruit borer and leaf miner was conducted in Randomized Block Design with four replications at Department of Entomology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology Udaipur-313001 (Rajasthan), during *Kharif*, 2013 and 2014. Tomato variety Mahy-401 was transplanted on 30th August 2013 and 27th July 2014. Transplanting was done on plots each measuring 5 x 5 sq. m. at row to row and plant to plant spacing of 60 cm x 45 cm. There were six treatments replicated four times. Each treatment was applied two times initiating first spray as soon as a pests infestation starts and the second spray were given at 15 days interval.

2.1.1 Treatment Details

S. No.	Treatments	Dosage	
		g. a.i. /ha	ml/ha
1.	Untreated control	-	-
2.	Tetraniliprole SC 200 (w/v)	40	200
3.	Tetraniliprole SC 200 (w/v)	50	250
4.	Tetraniliprole SC 200 (w/v)	60	300
5	Coragen 20% SC	30	150
6	Novaluron 10% EC	75	750

The first spray was initiated as soon as the infestation of the pests was noticed, and subsequent second spray was done at 15 days interval. Volume of 500 liter/ha water was used in each spray.

2.2 Observation

2.2.1 Fruit borer

(i) Fruit damage

The observation of fruit damage was recorded from each replication at 3, 7 and 10 days after each spray by counting the total number of fruits and damaged fruits and weighing them separately on 5 randomly selected and tagged plants. The percent fruit damage was calculated as below:

$$\text{Percent damage fruits} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

(ii) Reduction in larval population:

The observation of the population of larvae of fruit borer, *H. armigera was* recorded before and at 3, 7 and 10 days after each spray on five randomly selected and tagged plants. The data were subjected to statistical analysis after calculating the percent reduction in the larvae of *H. armigera* at 3, 7 and 10 days after each spray.

The percent correct mortality of the fruit borer was calculated from the formula given by Henderson and Tilton (1955):

$$\text{Percent corrected mortality} = 100 \left[1 - \frac{T_a \times C_b}{T_b \times C_a}\right]$$

T_a = Number of fruit borer after treatment,
T_b= Number of fruit borer before treatment
C_a= Number of fruit borer in control after treatment
C_b= Number of fruit borer in control before treatment

2.3 Leaf Miner

The observation of mined leaves caused by leaf miner was recorded by counting from freshly emerged top leaves from 5 randomly selected and tagged plants and total number of freshly emerged top leaves. The mean mined leaves were calculated as below:

$$\text{Percent mined leaves} = \frac{\text{Number of damaged leaves}}{\text{Total number of emerged leaves}} \times 100$$

2.4 Effect on Natural Enemies

The effect of all treatments on natural enemies was studied by counting the population of common predatory fauna *viz.;* population of grub and adults of *Coccinella spp.*, *Chrysoperla carnea* and *Menochilus spp.* at regular interval in each replication.

2.5 Marketable Yield of Tomato

The periodic picking of tomato fruits was done at regular intervals. The marketable yield from each treatment replicate was recorded separately and yield per hectare was calculated.

3. Results and Discussion

3.1 Mean fruit damage

The data recorded on the fruit infestation are presented in Table 1 and 2. The data reveals that all the treatments were found significantly superior to untreated control. The application of Tetraniliprole SC 200 (w/v) at 300 ml/ha recorded significantly the lowest fruit damage with a mean of 8.65, 8.18 and 7.05; 6.40, 5.75 and 3.32; 9.83, 8.76 and 7.20; 5.90, 5.20 and 2.48 percent mean fruit damage at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively. It was found at par with Tetraniliprole SC 200 (w/v) at 250 ml/ha which caused 9.46, 8.82 and 7.98; 7.05, 6.50 and 4.98; 8.67, 7.40 and 6.67; 6.81, 4.87 and 3.35 percent mean fruit damage at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively. It was followed by Novaluron 10% EC at 750 ml/ha which caused 11.15, 9.35 and 9.56; 8.55, 7.96 and 9.35; 10.34, 8.89 and 7.90; 8.14, 8.99 and 10.76 percent mean fruit damage at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively. Two spray of Tetraniliprole SC 200 (w/v) at 200 ml/ha were also found superior to untreated control.

3.2 Mean reduction in larval population

The data recorded on mean reduction in the population of fruit borer, *H. armigera* at 3, 7 and 10 days after first and second spray have been presented in Table 3 and 4. The data reveals that all the treatments were found significantly superior to untreated control. The highest mean reduction in the population of fruit borer was recorded in case of two spray of Tetraniliprole SC 200 (w/v) at 300 ml/ha at 15 days intervals which caused 62.30, 72.45 and 76.92; 83.92, 89.98 and 94.72; 63.28, 73.42 and 78.03; 82.98, 87.10 and 91.36 percent reduction in mean population of fruit borer at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively. It was found at par with Tetraniliprole SC 200 (w/v) at 250 ml/ha which caused 56.97, 68.83 and 71.20; 79.35, 85.34 and 90.66; 58.71, 71.30 and 73.86; 79.63, 83.96 and 89.98 percent reduction in mean population of fruit borer at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively. A spray of Novaluron 10% EC at 750 ml/ha caused 42.67, 49.85 and 46.51; 55.90, 66.81 and 63.60; 44.63, 52.36 and 47.20; 56.87, 68.72 and 61.77 percent reduction in mean population of fruit borer at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively. Two sprays of BCS CL 73507 SC 200 (w/v) at 200 ml/ha were also found superior to untreated control which caused 50.35, 45.30 and 41.30; 47.98, 55.92 and 49.42; 49.78, 56.30 and 51.42; 55.90, 60.30 and 51.46 percent reduction in mean population of fruit borer at 3, 7 and 10 days after first and second spray during *Kharif* 2013 and 2014, respectively.

3.3 Mean damage of leaf minor

The data recorded on mean damage of leaf minor in terms of mined leaves in different treatments have been presented in Table 5. The data reveals that all the treatments were found significantly superior to untreated control. The application of Tetraniliprole SC 200 (w/v) at 300 ml/ha recorded significantly the lowest number of mined leaves caused by leaf miner with a mean of 4.50 and 5.00 percent during *Kharif* 2013 and 2014, respectively. It was found at par with Tetraniliprole SC 200 (w/v) at 250 ml/ha with 5.75 and 5.50percent mean mined leaf damage during *Kharif* 2013 and 2014, respectively. It was followed by Novaluron 10% EC at 750 ml/ha with a mean damage of 11.75 and 10.50 percent during *Kharif* 2013 and 2014, respectively and found at par with Coragen 20% SC at 150 ml/ha which caused 12.50 and 11.25 percent mean mined leaf damage during *Kharif* 2013 and 2014, respectively.

3.4 Effects on Natural Enemies

The data recorded on the population of grub and adults of *Coccinella* spp., *Chrysoperla carnea* and *Menochilus spp.* revealed that their population did not vary significantly and were at par to each other in different treatments. It indicates that sprays of Tetraniliprole SC 200 (w/v) at 200, 250 and 300 ml/ha along with other treatments on natural enemies did not cause significant adverse effects on the common natural enemies present in tomato eco-system (Table -6).

The present results were in agreement with findings of who reported that rynaxypyr at 30g a.i/ha recorded in minimum percent larval population of *Spodoptera litura*, *Spodoptera exigua* and *Helicoverpa armigera* (5.16-5.43, 1.08-1.35, and 0.78%) in chilli [8]. According to rynaxypyr at 30g a.i/ha was found to be most effective in controlling the pod borer, *Helicoverpa armigera*, plume moth, *Exelastis atomosa* and was at par with its higher dose of rynaxypyr @ 40g a.i/ha [9]. Similarly, results were also in aggregation with the work of [10 & 11]. Efficacy of novaluron also safer to natural enemies recommended by [12]. The treatment with chlorantraniliprole 18.5 SC @ 30 g a.i./ha was found to be next effective treatment in controlling *Bemisia tabaci* and in preventing transmission of the begomovirus *Tomato yellow leaf curl virus* (TYVMV). These results are confirmatory which has been recommended by [13]. Earlier workers reported as novaluron as better treatments for controlling sucking pests [14-17].

To evaluate nine newer and biorational insecticides against fruit borer, *Helicoverpa armigera* infesting Tomato during the *Rabi* season 2013-14. Among nine insecticides, indoxacarb 14.5 SC (0.01%) was found most effective against fruit borer followed by novaluron 10 EC (0.01%) and acephate 75 SP (0.037%). Bacillus thuringiensis 8L (0.012%) proved least effect followed by HaNPV (250 LE/ha) and quinalphos 25 EC (0.02%).The treatments of chlorantraniliprole 18.5 SC (0.02%), abamectin 5 SG (0.01%) and spinosad 2.5 SC (0.01%) ranked in the order of their efficacy [18]. Field experiments were conducted to observe, the efficacy of some pesticides with novel mode of action (spinosad, rynaxypyr, indoxacarb, flubendiamide) for the management of Helicoverpa armigera on tomato (Var. Pathorkuchi) in field condition. Results of insecticides applied thrice at 15 days interval after borer population build up showed that rynaxypyr 18.5% SC @ 40 g a.i. ha-1 was superior over other treatments against Helicoverpa, with 98.04% reduction, closely followed by spinosad 45% SC @ 60 g a.i. ha-1 (88.03%), flubendiamide 20% WG @ 30 g a.i. ha-1 (87.96%), rynaxypyr 18.5% SC @ 20 g a.i. ha-1 (85.84%) and indoxacarb 14.5 SC @ 75 g g a.i. ha-1 (80.21%) [19].

3.5 Marketable Yield of Tomato

The data presented in Table-5 revealed that all the treatments yielded significantly higher over untreated control. The marketable yield of tomato among different treatments ranged from 160.12 to 250.70 and 152.36 to 241.82 q/ha against 120.45 and 127.72 q/ha in untreated control during *Kharif* 2013 and 2014, respectively. The highest marketable yield 250.70 and 241.82 q/ha were recorded in case of spray of Tetraniliprole SC 200 (w/v) at 300 ml/ha during *Kharif* 2013 and 2014, respectively. It was found at par with Tetraniliprole SC 200 (w/v) at 250 ml/ha which yielded 238.49 and 232.50 q/ha during *Kharif* 2013 and 2014, respectively. It was followed by Novaluron 10% EC at 750 ml/ha which yielded 190.83 and 195.20 q/ha during *Kharif* 2013 and 2014, respectively and found at par with Coragen 20% SC at 150 ml/ha with 185.18 and 187.42 q/ha yield during *Kharif* 2013 and 2014, respectively.

All the insecticides significantly increased the yield of marketable fruits over control [18]. The maximum yield (265.20 q ha-1) was recorded in indoxacarb followed by novaluron (262.85 q ha-1) and acephate (258.22 q ha-1). The maximum cost benefit ration in rynaxypyr @ 40 g a.i. ha-1 was recorded the highest fruit yield of 34.74 q ha-1 in tested insecticides [19].

4. Conclusion

Field experiment on the bio-efficacy of Tetraniliprole SC 200 (w/v) at 200, 250 and 300 ml/ha (40, 50 and 60 g a.i /ha) along with Coragen 20% SC at 150 ml/ha (30 g a.i /ha) and Novaluron 10% EC at 750 ml/ha (75 g a.i /ha) was conducted at Rajasthan College of Agriculture, Udaipur against fruit borer and leaf miner during *Kharif* 2013 and 2014. The data revealed that two spray of Tetraniliprole SC 200 (w/v) at 300 ml/ha at 15 days interval caused highest reduction in the population of fruit borer, lowest fruit damage and leaf minor damage and also recorded the higher marketable yield of tomato with a mean of 250.70 and 241.82 q/ha during *Kharif* 2013 and 2014. however, two spray of Tetraniliprole SC 200 (w/v) at 250 ml/ha at 15 days interval was found at par to above treatment in terms of mean reduction in the population of fruit borer, lowest fruit damage and leaf minor damage and also recorded the higher marketable yield of tomato with a mean of 238.49 and 232.50 q/ha during *Kharif* 2013 and 2014.All insecticides did not cause any adverse effects on natural enemies populations.

Table 1: Efficacy of different insecticides on fruit damage caused by *Helicoverpa armigera* in tomato during *kharif*, 2013

S. No.	Treatments	Formulation Dose ml / ha	PTP	Mean fruit damage, Day after spray (%)					
				1st spray			2nd spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1	Untreated control	---	12.77 (3.64)*	22.70 (14.90)**	27.87 (21.86)	31.22 (26.88)	32.70 (29.20)	34.17 (31.55)	35.76 (34.16)
2	Tetraniliprole SC 200 (W/V)	200	13.10 (3.69)	20.83 (12.65)	22.02 (14.06)	23.45 (15.84)	19.25 (10.87)	21.01 (12.86)	22.39 (14.52)
3	Tetraniliprole SC 200 (W/V)	250	11.96 (3.53)	17.91 (9.46)	17.27 (8.82)	16.41 (7.98)	15.40 (7.05)	14.77 (6.50)	12.89 (4.98)
4	Tetraniliprole SC 200 (W/V)	300	12.40 (3.59)	17.10 (8.65)	16.61 (8.18)	15.39 (7.05)	14.65 (6.40)	13.87 (5.75)	10.50 (3.32)
5	Coragen 20% SC	150	11.60 (3.48)	19.69 (11.36)	19.19 (10.81)	19.17 (10.78)	17.23 (8.78)	19.50 (11.15)	19.15 (10.76)
6	Novaluron 10% SC	750	12.92 (3.66)	19.51 (11.15)	17.80 (9.35)	18.01 (9.56)	17.00 (8.55)	16.39 (7.96)	17.80 (9.35)
S.Em ±			0.05	0.27	0.26	0.29	0.27	0.29	0.19
C.D. at 5%			0.15	0.83	0.81	0.87	0.85	0.89	0.59

** Figures in parenthesis are retransformed percent value.
*Figures inparenthesis are square root (√X+.5) transformation value of population.
PTP = Pre treatment population.

Table 2: Efficacy of different insecticides on fruit damage caused by *Helicoverpa armigera* in tomato during *kharif*, 2014

S. No.	Treatments	Formulation Dose ml / ha	PTP	Mean fruit damage, Day after spray (%)					
				1st spray			2nd spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1	Untreated control	---	13.00 (3.67)*	23.29 (15.64)**	27.18 (20.86)	31.88 (27.90)	33.06 (29.76)	33.96 (31.20)	35.41 (33.57)
2	TetraniliproleSC 200 (W/V)	200	12.36 (3.59)	20.11 (11.83)	21.88 (13.90)	23.80 (16.30)	20.05 (11.76)	21.80 (13.80)	23.39 (15.76)
3	TetraniliproleSC 200 (W/V)	250	11.90 (3.51)	17.12 (8.67)	15.78 (7.40)	14.97 (6.67)	15.13 (6.81)	12.75 (4.87)	10.55 (3.35)
4	TetraniliproleSC 200 (W/V)	300	12.32 (3.58)	18.27 (9.83)	17.21 (8.76)	15.56 (7.20)	14.05 (5.90)	13.18 (5.20)	9.06 (2.48)
5	Coragen20% SC	150	13.10 (3.69)	19.28 (10.90)	17.65 (9.20)	17.12 (8.67)	17.80 (9.35)	19.55 (11.20)	23.10 (15.40)
6	Novaluron10% SC	750	12.86 (3.65)	18.76 (10.34)	17.35 (8.89)	16.32 (7.90)	16.58 (8.14)	17.45 (8.99)	19.15 (10.76)
S.Em ±			0.05	0.21	0.21	0.26	0.20	0.21	0.22
C.D. at 5%			0.17	0.63	0.64	0.81	0.61	0.64	0.67

** Figures in parenthesis are retransformed percent value.
*Figures inparenthesis are square root (√X+.5) transformation value of population.
PTP = Pre treatment population.

Table 3: Efficacy of different insecticides against fruit borer, *Helicoverpa armigera* in tomato during *kharif*, 2013

S. No.	Treatments	Formulation Dose ml / ha	PTP / five plants	Mean reduction (%) in fruit borer population, Day after spray					
				1st spray			2nd spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1	Untreated control	---	8.75 (3.04)*	---	---	---	---	---	---
2	Tetraniliprole SC 200 (W/V)	200	8.00 (2.91)	45.20 (50.35)**	42.30 (45.30)	39.99 (41.30)	43.84 (47.98)	48.40 (55.92)	44.67 (49.42)
3	Tetraniliprole SC 200 (W/V)	250	8.50 (3.00)	49.01 (56.97)	56.07 (68.83)	57.56 (71.20)	63.01 (79.35)	67.60 (85.34)	72.37 (90.66)
4	Tetraniliprole SC 200 (W/V)	300	7.75 (2.87)	52.13 (62.30)	58.38 (72.45)	61.36 (76.92)	66.51 (83.92)	71.95 (89.98)	77.34 (94.72)
5	Coragen 20% SC	150	8.00 (2.92)	39.41 (40.30)	44.38 (48.92)	41.15 (43.30)	47.08 (53.63)	55.38 (67.72)	51.55 (61.33)
6	Novaluron10% EC	750	8.50 (3.00)	40.78 (42.67)	44.91 (49.85)	43.00 (46.51)	48.39 (55.90)	54.83 (66.81)	52.90 (63.60)
S.Em ±			0.04	0.65	0.76	0.82	1.03	1.41	1.62
C.D. at 5%			0.14	2.01	2.38	2.53	3.18	4.38	4.98

** Figures in parenthesis are retransformed percent value.
*Figures inparenthesis are square root (√X+.5) transformation value of population.
PTP = Pre treatment population.

Table 4: Efficacy of different insecticides against fruit borer, *Helicoverpa armigera* in tomato during *kharif*, 2014

S. No.	Treatments	Formulation Dose ml / ha	PTP / five plants	Mean reduction (%) in fruit borer population, Day after spray					
				1st spray			2nd spray		
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1	Untreated control	---	9.00 (3.08)*	---	---	---	---	---	---
2	Tetraniliprole SC 200 (W/V)	200	9.25 (3.12)	44.87 (49.78)**	48.62 (56.30)	45.81 (51.42)	48.39 (55.90)	50.95 (60.30)	45.84 (51.46)
3	Tetraniliprole SC 200 (W/V)	250	9.00 (3.08)	50.02 (58.71)	57.64 (71.30)	59.29 (73.86)	63.25 (79.63)	66.53 (83.96)	71.91 (89.98)
4	Tetraniliprole SC 200 (W/V)	300	8.75 (3.04)	52.72 (63.28)	58.98 (73.42)	62.11 (78.03)	65.69 (82.98)	69.04 (87.10)	73.10 (91.36)
5	Coragen 20% SC	150	9.50 (3.16)	40.02 (41.36)	45.41 (50.72)	42.94 (46.41)	47.65 (54.61)	53.51 (64.61)	51.27 (60.83)
6	Novaluron10% EC	750	9.25 (3.12)	41.92 (44.63)	46.35 (52.36)	43.39 (47.20)	48.95 (56.87)	56.00 (68.72)	51.81 (61.77)
S.Em ±			0.034	0.66	0.90	0.96	1.06	1.23	1.45
C.D. at 5%			0.102	2.04	2.78	2.95	3.26	3.80	4.46

** Figures in parenthesis are retransformed percent value.
*Figures inparenthesis are square root (√X+.5) transformation value of population.
PTP = Pre treatment population.

Table 5: Efficacy of different insecticides against Leaf Miner and marketable yield in tomato during *kharif*, 2013 and 2014

S. No.	Treatments	Formulation Dose ml / ha	Mean Leaf Damage of Leaf Minor (%)		Marketable Yield (q/ha)	
			2013	2014	2013	2014
1	Untreated control	---	30.49 (25.75)**	31.63 (27.50)	120.45	127.72
2	Tetraniliprole SC 200 (W/V)	200	23.77 (16.25)	22.98 (15.25)	160.12	152.36
3	Tetraniliprole SC 200 (W/V)	250	13.87 (5.75)	13.56 (5.50)	238.49	232.50
4	Tetraniliprole SC 200 (W/V)	300	12.24 (4.50)	12.92 (5.00)	250.70	241.82
5	Coragen 20% SC	150	20.70 (12.50)	19.60 (11.25)	185.18	187.42
6	Novaluron10% SC	750	20.04 (11.75)	18.91 (10.50)	190.83	195.20
S.Em ±			0.22	0.21	4.95	4.83
C.D. at 5%			0.67	0.65	14.90	14.56

** Figures in parenthesis are retransformed percent value.

Table 6: Effect of different insecticides on natural enemies in tomato ecosystem during *kharif,* 2013 and 2014

S. No.	Treatments	Formulation Dose ml/ ha	Natural enemies population / 5 plant (Mean of two years)					
			CoccinellaSp.		*Chrysoperla cornea*		*Menochilus Sp.*	
			Grub	Adult	Grub	Adult	Grub	Adult
1	Untreated control	---	6.25 (2.60)*	2.35 (5.00)	2.06 (3.75)	1.73 (2.50)	2.24 (4.50)	2.55 (6.00)
2	Tetraniliprole SC 200 (W/V)	200	6.00 (2.55)	2.29 (4.75)	2.12 (4.00)	1.87 (3.00)	2.12 (4.00)	2.45 (5.50)
3	Tetraniliprole SC 200 (W/V)	250	5.75 (2.49)	2.40 (5.25)	2.00 (3.50)	2.00 (3.50)	2.18 (4.25)	2.50 (5.75)
4	Tetraniliprole SC 200 (W/V)	300	5.25 (2.40)	2.34 (5.00)	2.06 (3.75)	1.87 (3.00)	2.12 (4.00)	2.45 (5.50)
5	Coragen 20% SC	150	5.50 (2.45)	2.50 (5.56)	2.00 (3.50)	1.94 (3.25)	2.18 (4.25)	2.50 (5.75)
6	Novaluron10% EC	750	5.00 (2.34)	2.40 (5.25)	2.00 (3.50)	2.00 (3.50)	2.18 (4.25)	2.55 (6.00)
S.Em ±			0.06	0.04	0.03	0.01	0.02	0.03
C.D. at 5%			NS	NS	NS	NS	NS	NS

*Figures in parenthesis are square root transformed value of population.

5. References

1. Anonymous. Area and production of horticultural crops- All India 2012-13. 3rd Advance Estimates, 2013; www.nhb.gov.in
2. Anonymous. Indian Horticulture Database, National Horticulture Board, ministry of agriculture, govt. of India, krishi bhawan, New Delhi, India. 2012-13, 192-297.
3. Sharma HC. Cotton Bollworm/Legume Pod Borer, *Helicoverpa armigera* (Hubner) (Noctuidae: Lepidoptera): Biology and Management. Crop Protec. Compend. CABI Int'l., Wallingford, 2001; 70.

4. Mwajombe KK, Maerere AP, Sibuga KP. Baseline Survey Report of Tomato Productionin Mvomero District, Morogoro Region, Tanzania. IPM CRSP Regional Program in East Africa. 2006, 21.
5. Pareek PL, Bhargava MC. Estimation of avoidable losses in vegetables caused by borers under semi arid condition of Rajasthan. Insect Envioronment. 2003; 9:59-60.
6. Puri SN. Present status of IPM in India. Proceeding of National Seminar on Integrated Pest Management in Agriculture, Nagpur, Maharashtra, 1995.
7. Jayaraj S, Ananthakrishnana TN, Veeresh GK. Biological pest control in India: Progress and prospective. RGICS Project No. 2, Rajiv Gandhi Institute of Contemporary Studies, New Delhi. 1994, 101.
8. Hosamani AC, Sharanabasappa Bheemanna M, Sreenivas AG, Suresh BK, Sheevaleela, Patil BV. Bioefficacy of Chloranthraniliprole against chilli fruit borer complex in irrigated chilli ecosystem. Pestic. Res. J. 2008; 20(2):240-242.
9. Bhosale BB, Nishantha KMDWP, Patinge NR, Kadam DR. Comparative efficacy of microbial insecticides with new insecticide molecule E2Y45 against pod borer complex of pigeonpea. Pestology. 2008; 33(9):38-42.
10. Jarrod T, Gus Lorenz, Kyle Colwell, Craig Shelton, Richard Edmund. Rynaxypyr: A novel insecticide for control of *Heliothines* in conventional and bollgard cotton. Beltwide Cotton Confc, Memphis, 2008, 8-11.
11. Bheemanna M, Hosamani AC, Sharanabasappa, Patil BV. Bioefficacy of new insecticide Chloranthraniliprole (E2Y45 20 SC) against bollworms in cotton ecosystem. Pestology. 2008; 32(10):37-39.
12. Murthy KS, Reddy RK, Yogi K. Efficacy of certain eco friendly pesticide against citrus butterfly. Indian Journal of Plant. Protection. 2009; 37(1, 2):46-49.
13. Schuster DJ, Natalia AP, Williams RW, Marcon PC, Hector EP. Dupontrynaxypyr a novel anthranilamide insecticide for managing *Bemisiatabaci* and interfering with transmission of tomato yellow leaf curl virus on tomato transplants. J Insect Sci. 2013; 8(4).
14. Christopher G Cutler, Cynthia D Scott Dupree. Novaluron: prospects and limitations in Insect Pest Management. Pest Technol. Global Sci. Books, 2007.
15. Raghvani BR, Poshiya YK. Field efficacy of newer insecticide against *H. armigera* (Hub) in chickpea. Pestology. 2006; 30(4):18-20.
16. Cordero RJ, Kuhar TP, Speese IJ, Youngman RR, Bloomquist JR, Kok LT *et al*. Field efficacy of insecticides for control of lepidopteran pests on collards in virginia. Plant Health Progress, 2006.
17. Ishaaya I, Yablonski S, Mendelson Z, Mansour Y, Horowitz AR. Novaluron (MCW-275), a novel benzoylphenyl urea, suppressing developing stages of lepidopteran, whitefly and leaf miner pests. Proceedings of the bright on Crop Prot. Conference, Pests and Diseases. 1996; 3:1013-1020.
18. Singh N, Dotasara SK, Kherwa B, Singh S. Management of tomato fruit borer by incorporating newer and biorational insecticides. Journal of Entomology and Zoology Studies. 2017; 5(2):1403-1408.
19. Ghosal A, Chatterjee ML, Manna D. Studies on some insecticides with novel mode of action for the management of tomato fruit borer (*Helicoverpa armigera* Hub.). Journal of Crop and Weed. 2012; 8(2):126-129.