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ORIGINAL ARTICLE

Bio-Efficacy of Different Insecticides on Tomato Fruit Borer and Leaf Miner

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ABSTRACT
The field experiment with tomato crop using variety Parbhani Yashshree in kharif 2016 was conducted at Oilseeds Research Station, Latur (Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani) (MS)-India. The observation of tomato fruit borer Helicoverpa armigera larvae per plant was recorded before spray and 1, 3, 7, 10 and 14 days after application of insecticides and data obtained was analyzed. The observations of leaf miner infestation was recorded from five randomly selected plants in each treatment plot one day before spray, 1,3,7, 10 and 14 days after application of insecticides and data obtained was analyzed.
Keywords: Bio-Efficacy, Insecticides , Tomato Fruit Borer, Leaf Miner

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INTRODUCTION

Tomato (*Solanum lycopersicum* L.), belonging to family Solanaceae is the most important vegetable grown widely both for fresh market and processing. It is said to be a native of tropical America. Tomato fruit contain water 93.1%, protein 1.9%, fat 0.3gm, fibre 0.7%, carbohydrates 3.6%, calorie 23, vitamin 'A' (320 I. U)., vitamin 'B1'(0.07mg,) vitamin 'B2 (0.01mg), nicotinic acid (0.4 mg,) vitamin 'C' (31mg,) calcium (20mg,) phosphorus (36mg) and iron (0.8mg.).

Various methods have been tried for the control of insect-pests. But use of chemical method is an important approach for their control because of its quick action, effectiveness and adaptability to various situations. Several insecticides have been recommended and used for the effective management of tomato insect-pests. But according to several reports many of these label claimed insecticides could not achieved effective results. Hence these label claimed insecticides with some new insecticides should have to be evaluated against insect pests of tomato.

MATERIAL AND METHODS

Experimental details

1. Location:	Oilseeds Research Station, Latur
2. Season:	*Kharif* 2016
3. Date of sowing:	28th July, 2016
4. Crop:	Tomato
5. Variety:	Parbhani Yashshree
6. Plot size:	4.2 M ×4.5 M
7. Spacing:	60 cm ×45 cm
8. Fertilizer dose:	50: 50: 50 kg per hector
9. Treatments:	7
10. Replications:	3

Field layout

The field experiment with tomato crop using variety Parbhani Yashshree in *kharif* 2016 was conducted at Oilseeds Research Station, Latur (Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani) (MS)-India.

The experiment was conducted in a randomized block design (RBD) with seven treatments including untreated control with three replications. The tomato crop was transplanted on 28th July, 2016 in a gross plot of 4.20 M x 4.50 M maintaining net plot of 3.0 M x 3.6 M. The row to row distance of 60 cm and plant to plant distance of 45 cm was maintained. The dose of fertilizer at the rate of 50 kg N, 50 kg P and 50 kg K per hectare was given at the time of transplanting. The crop was grown under protective irrigation. Two sprays were undertaken at 45th and 75th days after transplanting on 12nd Sept. 2016 and 10th Oct. 2016, respectively. Using manually operated knapsack sprayer.

Fruit borer (Larval population): The observation of tomato fruit borer *Helicoverpa armigera* larvae per plant was recorded before spray and 1, 3, 7, 10 and 14 days after application of insecticides and data obtained was analyzed.

Leaf miner: The observations of leaf miner infestation was recorded from five randomly selected plants in each treatment plot one day before spray, 1,3,7, 10 and 14 days after application of insecticides and data obtained was analyzed.

RESULTS AND DISCUSSION

Effect of different insecticides on larval population of fruit borer (*Helicoverpa armigera* Hubner)

First spray

The Data pertaining to effect of different insecticides on larval population of fruit borer after first spray are presented in Table 1 that all the insecticides were found to be significantly superior over untreated control in reducing larval population of fruit borer at 1, 3, 7, 10 and 14 days after first spray of insecticides.

The treatment of chlorantraniliprole 0.05 per cent recorded significantly lowest larval population of fruit borer to the tune of 0.33, 0.53, 0.60, 0.77 and 0.83 larvae per plant at 1, 3, 7, 10 and 14 days after spraying, respectively over rest of the insecticides.

At one day after first spray, significantly minimum larval population of fruit borer (0.33 larvae per plant) was registered from the plots treated with chlorantraniliprole 0.05 per cent. The subsequent order of effectiveness was flubendiamide 0.004 per cent (0.40 larva per plant) and quinalphos 0.05 per cent (0.47 larvae per plant). These treatments were at par with each other. The next treatments in order to effectiveness were imidacloprid 0.005 per cent (0.83 larvae per plant), spiromesifen 0.02 per cent (0.87 larvae per plant) and cyantraniliprole 0.01 per cent (0.90 larvae per plant).

Table 1 : Effect of different insecticides on the larval population of *Helicoverpa armigera* in tomato (First spray)

Treatments	Mean population of *Helicoverpa armigera* per plant					
	1 day before spraying	Days after spraying				
		1	3	7	10	14
Quinalphos 0.05 per cent	1.80 (1.52)*	0.47 (0.98)	0.67 (1.08)	0.73 (1.11)	0.83 (1.15)	0.93 (1.19)
Imidacloprid 0.005 per cent	1.87 (1.54)	0.83 (1.15)	0.87 (1.17)	0.93 (1.20)	1.00 (1.22)	1.07 (1.25)
Flubendiamide 0.004 per cent	2.20 (1.64)	0.40 (0.94)	0.60 (1.05)	0.67 (1.07)	0.80 (1.14)	0.87 (1.17)
Spiromesifen 0.02 per cent	2.13 (1.62)	0.87 (1.17)	0.93 (1.19)	1.00 (1.22)	1.07 (1.25)	1.13 (1.28)
Cyantraniliprole 0.01 per cent	2.07 (1.60)	0.90 (1.18)	1.00 (1.22)	1.07 (1.24)	1.10 (1.26)	1.20 (1.30)
Chlorantraniliprole 0.05 per cent	2.00 (1.57)	0.33 (0.91)	0.53 (1.01)	0.60 (1.05)	0.77 (1.13)	0.83 (1.15)
Untreated Control	2.13 (1.62)	2.20 (1.64)	2.40 (1.70)	2.47 (1.72)	2.60 (1.76)	2.67 (1.77)
S.E. ±	0.061	0.053	0.053	0.062	0.053	0.059
C.D. at 5%	NS	0.160	0.161	0.189	0.161	0.178
C.V. (%)	6.665	8.051	7.648	8.767	7.211	7.823

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$)

N.S.: Non significant

On three days after first spray, chlorantraniliprole 0.05 per cent (0.53 larvae per plant) and flubendiamide 0.004 per cent (0.60 larva per plant) and quinalphos 0.05 per cent (0.67 larvae per plant). These treatments were statistically at par with each other. The next effective treatments were imidacloprid 0.005 per cent (0.87 larvae per plant), spiromesifen 0.02 per cent (0.93 larvae per plant), cyantraniliprole 0.01 per cent (1.00 larvae per plant).

Analogously, at seven days after first spraying, significantly least population of fruit borer (0.60 larvae per plant) was evidenced in the plots treated with chlorantraniliprole 0.05 per cent (0.67 larva per plant) followed by flubendiamide 0.004 per cent (0.63 larva per plant) and quinalphos 0.05 per cent (0.20 larvae per plant). These treatments were statistically at par with each other. However, imidacloprid 0.005 per cent, spiromesifen 0.02 per cent, cyantraniliprole 0.01 per cent were next effective treatments in managing larval population on tomato to the extent of 0.93, 1.00, and 1.07, respectively.

At 10 days after first spray, chlorantraniliprole 0.05 per cent (0.77 larvae per plant) and flubendiamide 0.004 per cent (0.80 larva per plant) and quinalphos 0.05 per cent (0.83 larvae per plant). These treatments were statistically at par with each other. The next effective treatments were imidacloprid 0.005 per cent (1.00 larvae per plant), spiromesifen 0.02 per cent (1.07 larvae per plant), cyantraniliprole 0.01 per cent (1.10 larvae per plant).Similarly, at 14 days after first spraying, significantly least larval population pod borer was revealed in the plots treated with chlorantraniliprole 0.05 per cent (0.83 larvae per plant) and flubendiamide 0.004 per cent (0.87 larvae per plant) and quinalphos 0.05 per cent (0.93 larvae per plant). These all treatments were statistically at par with each other. Imidacloprid 0.005 per cent (1.07 larvae per plant), spiromesifen 0.02 per cent (1.13 larvae per plant), cyantraniliprole 0.01 per cent (1.20 larvae per plant) were found to be subsequently effective treatments.

Second spray

The Data recorded on effect of different insecticides on larval population of tomato fruit borer after second spray are presented in Table 2 that all the insecticides were found to be significantly superior over untreated control in reducing larval population of fruit borer at 1, 3, 7, 10 and 14 days after application of insecticides.

The treatment of chlorantraniliprole 0.05 per cent recorded significantly lowest larval population of fruit borer to the tune of 0.27, 0.47, 0.47, 0.80 and 1.00 larvae per plant at 1, 3, 7, 10 and 14 days after spraying, respectively over rest of the insecticides. At one day after second spray, significantly minimum larval population of fruit borer (0.27 larvae per plant) was registered from the plots treated with chlorantraniliprole 0.05 per cent. The subsequent order of effectiveness was flubendiamide 0.004 per cent (0.33 larvae per plant) and quinalphos 0.05 per cent (0.40 larvae per plant). These treatments were at par with each other. The next treatments in order to effectiveness were imidacloprid 0.005 per cent (0.80 larvae per plant), spiromesifen 0.02 per cent (0.83 larvae per plant) and cyantraniliprole 0.01 per cent (0.93 larvae per plant).

Table 2 : Effect of different insecticides on the larval population of *Helicoverpa armigera* in tomato (Second spray)

Treatments	Mean population of *Helicoverpa armigera* per plant					
	1day before spraying	Days after spraying				
		1	3	7	10	14
Quinalphos 0.05 per cent	2.27 (1.66)*	0.40 (0.94)	0.60 (1.04)	0.60 (1.05)	0.93 (1.20)	1.13 (1.28)
Imidacloprid 0.005 per cent	2.63 (1.76)	0.80 (1.14)	0.80 (1.14)	0.87 (1.17)	1.13 (1.28)	1.20 (1.30)
Flubendiamide 0.004 per cent	2.47 (1.72)	0.33 (0.91)	0.50 (1.00)	0.55 (1.02)	0.87 (1.17)	1.07 (1.25)
Spiromesifen 0.02 per cent	2.20 (1.64)	0.83 (1.15)	0.87 (1.17)	0.90 (1.18)	1.17 (1.29)	1.27 (1.33)
Cyantraniliprole 0.01 per cent	2.27 (1.66)	0.93 (1.19)	0.93 (1.20)	1.00 (1.22)	1.20 (1.29)	1.33 (1.35)
Chlorantraniliprole 0.05 per cent	2.33 (1.68)	0.27 (0.87)	0.47 (0.98)	0.47 (0.98)	0.80 (1.14)	1.00 (1.22)
Untreated Control	2.40 (1.70)	2.53 (1.74)	2.60 (1.76)	2.63 (1.77)	2.77 (1.81)	2.80 (1.81)
S.E. $\pm$	0.072	0.048	0.051	0.055	0.050	0.054
C.D. at 5%	NS	0.145	0.156	0.166	0.150	0.164
C.V. (%)	7.418	7.273	7.518	7.907	6.549	6.889

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$) N.S.: Non significant

After three days of second spray, chlorantraniliprole 0.05 per cent (0.47 larvae per plant), flubendiamide 0.004 per cent (0.50 larva per plant) and quinalphos 0.05 per cent (0.60 larvae per plant) registered significantly lowest larval population of fruit borer. These treatments were statistically at par with each other. The next effective treatments were imidacloprid 0.005 per cent (0.80 larvae per plant), spiromesifen 0.02 per cent (0.87 larvae per plant), cyantraniliprole 0.01 per cent (0.93 larvae per plant).
Analogously, at seven days after second spraying, significantly least population of fruit borer (0.47 larvae per plant) was evidenced in the plots treated with chlorantraniliprole 0.05 per cent followed by flubendiamide 0.004 per cent (0.55 larvae per plant) and quinalphos 0.05 per cent (0.60 larvae per plant). These treatments were statistically at par with each other. However, imidacloprid 0.005 per cent, spiromesifen 0.02 per cent, cyantraniliprole 0.01 per cent were next effective treatments in managing larval population on tomato to the extent of 0.87, 0.90, 1.00.
On 10 days after first spray, chlorantraniliprole 0.05 per cent (0.80 larvae per plant) and flubendiamide 0.004 per cent (0.87 larvae per plant) and quinalphos 0.05 per cent (0.93 larvae per plant) registered significantly lowest larval population of fruit borer. These treatments were statistically at par with each other. The next effective treatments were imidacloprid 0.005 per cent (1.13 larvae per plant), spiromesifen 0.02 per cent (1.17 larvae per plant), cyantraniliprole 0.01 per cent (1.20 larvae per plant).
Similarly, at 14 days after first spraying, significantly least larval population pod borer was revealed in the plots treated with chlorantraniliprole 0.05 per cent (1.00 larvae per plant) and flubendiamide 0.004 per cent (1.07 larvae per plant) and quinalphos 0.05 per cent (1.13 larvae per plant). These treatments were statistically at par with each other. imidacloprid 0.005 per cent (1.20 larvae per plant), spiromesifen 0.02 per cent (1.27 larvae per plant), cyantraniliprole 0.01 per cent (1.33 larvae per plant) were found to be subsequently effective treatments. The significance efficacy of treatment chlorantraniliprole effective for the reduction of Helicoverpa armigera population is proved by Prasad and Rao (2010). Similarly, Mohanraj *et al*. (2012), Gadhiya et al. (2014) evaluated chlorantraniliprole 20 per cent SC effective against H. armigera. However, flubendiamide 480 SC at 100 ml per ha caused significantly high reduction in larvae by Ameta et al. (2011), Priyadarshini et al. (2013), Gadhiya et al. (2014). Similarly, Ghoshal *et al.* (2012) reported that flubendiamide 20% WG @ 30 g a.i./ha was effective against H.armigera.

Effect of different insecticides on population of tomato Leaf miner, *(Liriomyza trifolli).*

First spray

The efficacy of different insecticides on population of tomato Leaf miner after first spray are presented in Table 3 that all the insecticides were found to be significantly superior over untreated control in reducing population of leaf miner at 1, 3, 7, 10 and 14 days after application of insecticides.
The treatment of Chlorantraniliprole 0.05 per cent recorded significantly lowest population of leaf miner to the extent of 10.23, 11.70, 13.20, 15.07 and 16.00 per cent at 1, 3, 7, 10 and 14 days after spraying, respectively over rest of the insecticides.

Table 3 : Effect of different insecticides on the population of Leaf miner in tomato (First spray)

Treatments	Percentage infestation of Leaf miner					
	1 day before spraying	Days after spraying				
		1	3	7	10	14
Quinalphos 0.05 per cent	32.28 (34.94)*	17.67 (24.83)	20.37 (26.78)	24.53 (29.68)	26.33 (30.87)	27.52 (31.51)
Imidacloprid 0.005 per cent	31.93 (34.39)	18.30 (25.31)	20.90 (27.19)	25.20 (30.13)	27.20 (31.43)	28.93 (32.54)
Flubendiamide 0.004 per cent	31.50 (34.14)	11.00 (19.32)	12.15 (20.32)	13.80 (21.77)	15.80 (23.39)	16.97 (24.32)
Spiromesifen 0.02 per cent	32.63 (34.82)	21 (27.27)	24.10 (29.40)	28.40 (32.20)	30.40 (33.46)	31.90 (34.39)
Cyantraniliprole 0.01 per cent	31.77 (34.27)	21.90 (27.90)	25 (30.00)	28.60 (32.33)	30.90 (33.77)	32 (34.45)
Chlorantraniliprole 0.05 per cent	30.93 (33.77)	10.23 (18.89)	11.70 (19.96)	13.20 (21.27)	15.07 (22.81)	16.00 (23.56)
Untreated Control	32.77 (34.82)	32.17 (34.53)	31.36 (34.05)	33.71 (35.42)	35.03 (36.29)	36.07 (36.91)
S.E. ±	1.377	1.036	1.222	1.219	1.228	1.278
C.D. at 5%	NS	3.141	3.707	3.698	3.725	3.875
C.V. (%)	6.918	7.053	7.896	7.289	7.023	7.116

* Figures in parentheses are angular transformed values; N.S.: Non significant

At one day after first spray, significantly minimum population of Leaf miner (10.23%) was recorded from the plots treated with chlorantraniliprole 0.05 per cent and was followed by flubendiamide 0.004 per cent (11%) and which were found significantly superior and statistically at par with each other. The next effective treatments were quinalphos 0.05 per cent (17.67%) and imidacloprid 0.005 per cent (18.30%). Subsequently effective treatments were spiromesifen 0.02 per cent per cent (21%) and cyantraniliprole 0.01 per cent (21.90%).

Similarly, at three days after spray, chlorantraniliprole 0.05 per cent recorded significantly lowest population of leaf miner to the tune of 11.70% followed by flubendiamide 0.004 per cent (12.15%). These two insecticides were found to be on par with each other. However, quinalphos 0.05 per cent (20.37%) and imidacloprid 0.005 per cent (20.90%) were observed to be the next effective treatments. The next efficient treatments in minimizing population of leaf miner were spiromesifen 0.02 per cent (24.10) and cyantraniliprole 0.01 per cent (25%).

As on the seven days after spraying, significantly least population of leaf miner (13.20%) was evidenced from the plots treated with chlorantraniliprole 0.05 per cent. Which was at par with flubendiamide 0.004 per cent reported 13.80% of leaf miner infestation. The next effective treatments were quinalphos 0.05 per cent (24.53%) and imidacloprid 0.005 per cent (25.20%). The next treatments spiromesifen 0.02 per cent (28.40%) and cyantraniliprole 0.01 per cent (28.60) were also effective in minimizing population of leaf miner.

At 10 and 14 days after spraying, chlorantraniliprole 0.05 per cent recorded significantly lowest population of leaf miner (15.07 and 16%) which was found to be at par with flubendiamide 0.004 per cent (15.80 and 16.97%), which were followed by treatments quinalphos 0.05 per cent (26.33 and 27.52%) and imidacloprid 0.005 per cent (27.20 and 28.93%) for minimizing the population of leaf miner. Spiromesifen 0.02 per cent and cyantraniliprole 0.01 per cent were noted subsequently effective insecticides with 30.40 and 31.90, 30.90 and 32 at 10 and 14 days after first spray, respectively.

Second spray

The data recorded in respect of effect of different insecticides on population of leaf miner after second spray are presented in Table 4 that all the insecticides under investigation were observed to be significantly superior over untreated control in reducing the population of leaf miner on tomato at 1, 3, 7, 10 and 14 days after spray.

Table 4 : Effect of different insecticides on the population of Leaf miner in tomato (second spray)

Treatments	Percentage infestation of Leaf miner					
	1 day before Spraying	Days after spraying				
		1	3	7	10	14
Quinalphos 0.05 per cent	32.55 (34.78)*	22.90 (28.51)	22.87 (28.55)	25.30 (30.19)	27.39 (31.49)	29.30 (32.76)
Imidacloprid 0.005 per cent	32.49 (34.74)	23.60 (29.05)	23.56 (29.03)	29.81 (33.04)	29.87 (33.93)	31.01 (33.80)
Flubendiamide 0.004 per cent	31.40 (34.07)	11.47 (19.74)	13.47 (21.40)	13.63 (21.56)	15.63 (23.20)	16.97 (24.25)
Spiromesifen 0.02 per cent	32.28 (34.61)	26.60 (31.05)	27.27 (31.47)	32.30 (34.63)	34.30 (35.84)	35.06 (36.24)
Cyantraniliprole 0.01 per cent	31.65 (34.22)	28.00 (31.94)	30.96 (33.80)	34.54 (35.93)	36.43 (37.12)	36.03 (37.52)
Chlorantraniliprole 0.05 per cent	31.04 (33.82)	11.37 (19.64)	11.50 (19.65)	12.17 (20.39)	15.40 (23.11)	15.43 (23.12)
Untreated Control	32.84 (34.85)	40.27 (39.39)	45.67 (42.51)	47.67 (43.66)	48.67 (44.24)	49.33 (44.62)
S.E. ±	1.338	1.184	1.198	1.300	1.376	1.330
C.D. at 5%	NS	3.592	3.634	3.944	4.173	4.033
C.V. (%)	6.731	7.172	7.037	7.186	7.285	6.940

* Figures in parentheses are angular transformed values

N.S.: Non significant

At one day after second spray, significantly minimum population of Leaf miner (11.37%) was recorded from plot treated with chlorantraniliprole 0.05 per cent and was followed by flubendiamide 0.004 per cent (11.47%) and this two treatments were found to be statistically at par with each other. The

subsequent order of effectiveness was quinalphos 0.05 per cent (22.90%) and imidacloprid 0.005 per cent (23.60%). The next effective treatments were spiromesifen 0.02 per cent (26.60%) and cyantraniliprole 0.01 per cent (28%).

On three days after second spray, chlorantraniliprole 0.05 per cent recorded significantly lowest population of leaf miner (11.50%) followed by flubendiamide 0.004 per cent (13.47%) recorded lowest population. However these two treatments were found statistically at par with each other. The next effective treatments were quinalphos 0.05 per cent (22.87%) and imidacloprid 0.005 per cent (23.56%). Spiromesifen 0.02 per cent (27.27%) and cyantraniliprole 0.01 per cent (30.96%) were also effectively reduced the population of jassids.

As on the seven days after second spray, chlorantraniliprole 0.05 per cent evidenced significantly least population of leaf miner (12.17%) which was followed by and at par with flubendiamide 0.004 per cent (13.63%). The plot treated with quinalphos 0.05 per cent (25.30%) and imidacloprid 0.005 per cent (29.81%) were noticed subsequently effective treatments. The next effective treatment were spiromesifen 0.02 per cent (32.30%) and cyantraniliprole 0.01 per cent (34.54%).

Similarly, at 10 and 14 days after second spray chlorantraniliprole 0.05 per cent recorded significantly lowest population of leaf miner to the tune of 15.40 and 15.43%, respectively followed by flubendiamide 0.004 per cent (15.63 and 16.97%). These two treatments were found statistically at par with each other. Subsequently quinalphos 0.05 per cent (27.39 and 29.30%) and imidacloprid 0.005 per cent (29.87 and 31.01%) were noticed effective treatments. The next effective treatments were spiromesifen 0.02 per cent (34.30 and 35.06%) and cyantraniliprole 0.01 per cent (36.43 and 36.03%).

The findings were in agreement to the findings of Ahmed *et al*. (2015) reported that chlorantraniliprole effective treatment against leaf miner. However, the result on the effectiveness of quinalphos 25 per cent against leaf miner infesting tomato in the present investigation is in accordance with Mutkule *et al.* (2010).

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