Int.J.Curr.Microbiol.App.Sci (2018) *7*(10): 3008-3013

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 10 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.710.350

Eco-Friendly Management of Tomato Fruit Borer, *Helicoverpa armigera* under Hill Condition, Uttrakhand, India

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A B S T R A C T

Seven insecticides tested against fruit borer, *Helicoverpa armigera* of tomato, *Solanum lycopersicum* under field condition. The efficiency of insecticides was similar effective after both sprays as indoxacarb 14.5SC > novaluron 10EC > spinosad45 EC > rynaxypyr 20SC > nske 5% > nimbicidine 5% > neemoil 1% against reduction in fruit infestation. The maximum increased seed yield (45.00 q/ha) recorded from Indoxacarb 14.5 SC treated plots. The maximum cost benefit was return from Indoxacarb 14.5 SC treatment, Rs. 16 after per rupee investment.

Keywords

Helicoverpa armigera, Tomato, efficacy, Efficiency, Chemicals

Article Info

Accepted:
20 September 2018
Available Online:
10 October 2018

Introduction

Tomato, *Lycopersicon esculentum* Mill is one of the most important vegetable of the country. India is one of the largest producers of tomatoes in the world, second only to China.

Around 11 % of the total world produce of tomatoes is cultivated in India. All nutrients especially vitamin C, B and K have good source in tomato. India have a total area under tomato cultivation are 773.88 thousand hectares and total production 18731.97 thousand MT during 2015-16 (Anonymous 2017). Tomato is a major vegetable widely produced throughout the Uttarakhand, where it is grown both in hills as well as in plains. Nainital, Dehradun, U.S. Nagar and Haridwar are the four major districts producing tomatoes and constitute about 63 percent of the total production in the state. The major insect pests of tomato are *Helicoverpa armigera*; *Bemisia tabaci*; *Amrasca devastans*; *Liriomyza trifolii*; *Myzus persica* and *Epilachna dedecastigma* (Sharma *et al.,* 2013).

Materials and Methods

The present investigation was carried out at the Agriculture Farm of Doon School of Agriculture and Allied Science, Selaqui, Deharadun, Uttrakhand, India during rabi season 2016-17 and 2017-18. Tomato plants transplanted from nursery to field in Randomized Block Design in trice replication. A total of seven insecticides *viz*., neemoil 5%, nimbicidine 5%, NSKE 5%, rynaxypyr 20SC@ 100ml ha^{-1}, spinosad45 EC @ 75 g.a.i. ha^{-1}, novaluron 10 EC @ 100 g.a.i. ha^{-}1 and indoxacarb 14.5 SC@ 60 g.a.i. ha^{-1} were tested against *Helicoverpa armigera* in tomato crop. The chemical applied two times during study period with the help of Knapsack Sprayer at 20 days interval. The required quantity of chemical applied to the point of run-off for ensuring through coverage of the plant surface. The observations were recorded on fruit infestation from each plot at 3rd, 7th and 10th DAA and calculated fruit infestation per cent. Other field practices timely conducted.

$$\% \text{ fruit infestation} = \frac{\text{Numbers of infested fruits}}{\text{Total numbers of fruits}} \text{ X } 100$$

The calculation of benefit cost ratio as follows:

$$\text{Marginal BCR} = \frac{\text{Net return (Rs.)}}{\text{Total cost of treatment (Rs. ha}^{-1}\text{)}}$$

Results and Discussion

Insecticidal efficacy against fruit infestation

After 1st spray

All the treatments were founded superior to the managing fruit infestation in tomato over the control after first spray. The mean fruit infestation per cent were decreased *viz.*, 17.23±0.9, 20.62±2.3, 28.03±0.7, 29.49±1.8, 32.61±2.4, 34.65±2.6 and 42.60±1.7 from 66.53±4.3, 67.79±2.7, 66.51±8.0, 65.95±4.0, 65.26±3.9, 65.50±5.8 and 66.24±1.2 from indoxacarb, novaluron, spinosad, rynaxypyr, NSKE, nimbicidine and neemoil treated plots, respectively, after 3rd DAS. The fruit infestation per cent over the control were show in increased order *viz.*, 31.27, 44.09, 47.39, 52.41, 54.78, 66.74 and 72.21 from indoxacarb, novaluron, spinosad, rynaxypyr, NSKE, nimbicidine and neemoil treated plots, respectively, after 3rd DAS. Kumar *et al.*, (2017) found flubendiamide 480 SC was superior in recording lower larval population followed by indoxacarb 14.5 SC. The reduction in fruit infestation per cent was significantly superior over the control and a range was 16.12±2.4-39.07±2.5. Spinosad and rynaxypyr was not significantly different to over the control.

The maximum reduction in fruit infestation (73.29%) was recorded from indoxacarb treated plots followed by novaluron (69.22%), spinosad (63.67%), rynaxypyr (60.75%), NSKE (55.52%), nimbicidine (48.95%) and neemoil (35.25%) over the control. Ravi *et al.*, (2008) recorder that indoxacarb 14.5 SC was most effective and in reducing fruit infestation by *H. armigera* tomato crop.

The efficiency of the chemicals was similar and continues performance in reduction of fruit infestation against fruit borer in tomato just after 10th DAS, but indoxacarb and novaluron were not significantly difference.

Hasan *et al.*, (2016) observed that the percent fruit damage over the untreated control is concerned maximum reduction in damage (83.17%) was obtained with Indoxacarb 75 g a.i./ha followed by Indoxacarb 60 g a.i./ha (71.89%). Indoxacarb at 30, 40 and 50 g a.i. /ha reduced the per cent damage by 35.94, 40.57 and 48.72 per cent respectively. Kumar *et al.*, who reported that 18.50 to 32.64 per cent fruit losses could by avoided as results of sprays of insecticides. Wajid (2016) recorded minimum tomato fruit infestation was observed from indoxacarb treated field (Table 1–3).

Table.1 Efficiency of insecticides after first spray against tomato fruit infestation by, *Helicoverpa armigera*

Treatments	Per cent mean of fruit infestation						
	Before application	3rd DAS	Reduction % over control	7th DAS	Reduction % over control	10th DAS	Reduction % over control
Indoxacarb 14.5 SC@ 60 g.a.i. ha^{-1}	66.53±4.3	17.23±0.9	72.21	16.12±2.4	73.29	14.81±1.4	78.83
Neemoil 1%	66.24±1.2	42.60±1.7	31.27	39.07±2.5	35.25	39.88±3.6	42.99
Nimbicidine 5%	65.50±5.8	34.65±2.6	44.09	30.80±2.4	48.95	33.38±2.4	52.28
Novaluron 10 EC @ 100 g.a.i. ha^{-1}	67.79±2.7	20.62±2.3	66.74	18.57±2.5	69.22	17.19±0.3	75.43
NSKE 5%	65.26±3.9	32.61±2.4	47.39	26.84±1.2	55.52	28.76±1.2	58.88
Rynaxypyr 20SC@ 100ml/ha	65.95±4.0	29.49±1.8	52.41	23.69±2.0	60.75	23.03±1.4	67.07
Spinosad45 EC @ 75 g.a.i. ha^{-1}	66.51±8.0	28.03±0.7	54.78	21.92±2.4	63.67	18.65±1.6	73.33
Control	66.40±1.4	61.98±1.8	-	60.34±4.3	-	69.95±5.0	-
CD (at 5% level)	0.89	4.06	-	2.68	-	3.01	-

Table.2 Efficiency of insecticides after second spray against tomato fruit infestation by, *Helicoverpa armigera*

Treatments	Per cent mean of fruit infestation						
	Before application	3rd DAS	Reduction % over control	7th DAS	Reduction % over control	10th DAS	Reduction % over control
Indoxacarb 14.5 SC@ 60 g.a.i. ha^{-1}	61.83±4.1	18.93±2.8	73.45	6.64±0.8	92.08	8.30±1.0	89.61
Neemoil 1%	61.83±4.1	46.35±4.7	35.01	24.94±3.0	70.24	26.42±2.0	68.24
Nimbicidine 5%	65.56±8.6	41.24±1.6	42.16	19.15±1.5	77.15	21.48±0.6	74.07
Novaluron 10 EC @ 100 g.a.i. ha^{-1}	65.56±8.6	26.45±3.0	62.91	11.50±1.7	86.28	10.78±1.0	86.69
NSKE 5%	61.83±4.1	35.02±0.8	50.90	15.38±1.7	81.64	17.31±1.1	78.99
Rynaxypyr 20SC@ 100ml/ha	64.21±3.3	31.30±1.4	56.10	15.27±0.9	81.78	14.06±0.8	82.82
Spinosad45 EC @ 75 g.a.i. ha^{-1}	62.22±6.1	28.83±1.7	59.57	12.52±1.6	85.07	12.39±1.4	84.79
Control	65.16±7.4	71.31±1.8	-	83.81±1.7	-	84.30±2.2	-
CD (at 5% level)	3.58	3.61	-	2.01	-	2.14	-

Table.3 Pooled economics analysis of insecticidal efficacy in tomato crop against *Helicoverpa armigera* during 2016-17 and 2017-18

S. No.	Treatment	Total cost of treatment (Rs./ha)*	Yield (q/ha)	Increase yield (q/ha)	Value of increase yield (Rs/ha)#	Net return (Rs.)	CBR
1.	Indoxacarb 14.5 SC@ 60 g.a.i. ha^{-1}	3812.50	305.50	45.00	65250.00	61437.50	1 : 16
2.	Neemoil 5%	3254.25	265.50	05.00	07250.00	03995.75	1 : 1
3.	Nimbicidine 5%	3478.50	270.11	09.61	13934.50	10456.00	1 : 3
4.	Novaluron 10 EC @ 100 g.a.i. ha^{-1}	3525.50	299.25	38.75	56187.50	52662.00	1 : 15
5.	NSKE 5%	3594.50	272.35	11.85	17182.50	13588.00	1 : 4
6.	Rynaxypyr 20SC@ 100ml ha^{-1}	2939.50	280.25	19.75	28637.50	25698.00	1 : 9
7.	Spinosad45 EC @ 75 g.a.i. ha^{-1}	3550.50	290.25	29.75	43137.50	39587.00	1 : 11
8.	Control	-	260.50	-	-	-	-

*(Including =labor charge + machine charge + insecticide cost), # (Rs.14.50 kg^{-1}).

After 2nd spray

Observation on fruit infestation in tomato before second spray was not significant difference in fruit infestation in each plot after second spray and data collected at 3rd day after spray (DAS) of insecticides that were significantly difference. The mean per cent fruit infestation were recorded from neemoil, nimbicidine, NSKE, rynaxypyr, spinosad, novaluron and indoxacarb treated plots after 1st spray at 3rd DAS *viz*., 46.35±4.7, 41.24±1.6, 35.02±0.8, 31.30±1.4, 28.83±1.7, 26.45±3.0 and 18.93±2.8 followed by 61.83±4.1, 65.56±8.6, 61.83±4.1, 64.21±3.3, 62.22±6.1, 65.56±8.6 and 61.83±4.1 before spray, respectively. The fruit infestation reduction per cent over the control in ascending order, 35.01, 42.16, 50.90, 56.10, 59.57, 62.91 and 73.45 from neemoil, nimbicidine, NSKE, rynaxypyr, spinosad, novaluron and indoxacarb treated plots, respectively. Second observation noticed at 7th DAS. The maximum mean fruit infestation per cent reduction recorded from indoxacarb treated plots with 92.08% (6.64±0.8) over the control, where minimum fruit infestation was recorded from neem oil treated plots with 70.24% (24.94±3.0) over the control.

Novaluran & spinosad and rynaxypyr & NSKE were equally significantly over the control. Kolarath *et al.*, (2015) recorded that the novaluron was best result followed by spinosad and rynaxypyr against bod borer in field bean where similar result was found by Ghosh *et al.*, (2010). Data recorded on fruit infestation at 10th DAS in descending order *viz*., 26.42±2.0, 21.48±0.6, 17.31±1.1, 14.06±0.8, 12.39±1.4, 10.78±1.0 and 8.30±1.0 from neem oil, nimbicidine, NSKE, rynaxypyr, spinosad, novaluron and indoxacarb treated plots, respectively, where fruit infestation reduction over the control were 68.24, 74.07, 78.99, 82.82, 84.79, 86.69 and 89.61 per cent, respectively.

Marginal benefit cost ratio

The crop yields of tomato from all treated plots were increase over the control. The field yield were recorded in ascending order *viz.*, 5.00, 9.61, 11.85, 19.75, 29.75, 38.75 and 45.00q^{-1} from neemoil, nimbicidine, NSKE, rynaxypyr, spinosad, novaluron and indoxacarb treated plots. The maximum value of increased yield was recorded from indoxacarb with Rs. 65250.00 ha^{-1} followed by other treatments. The maximum return was indoxacarb treatment plots *viz.*, Rs. 16 after each rupee investment followed by novaluron (Rs. 15), spinosad (Rs.11), rynaxypyr (Rs.9), NSKE (Rs.4), nimbicidine (Rs.3) and neemol (Rs.1). Kumar *et al.*, (2017) were recorded that the highest grain yield (928 kg ha-1) as well as cost benefit ratio (1:9.57) was obtained from the treatment flubendiamide 480 SC and followed by indoxacarb 14.5 SC. Hasan *et al.*, (2016) recorded that the indoxacarb treated treatments at 60 and 70 g a.i. /ha dosage yielded the highest yield of marketable fruits 29.16 and 29.50 tons/ ha respectively. While in untreated control, it was 16.66 tons/ha. Aheer *et al.*, 1998() reported 72.19 to 77.79 per cent yield losses.

Acknowledgement

I am highly thankful to the Chairman, DBS College of Agriculture and Allied Science, Selaqui, Dehradun, Uttrakhand for partially supported to carry out the research work. My thankfulness also goes to Principal and other staff members of the college, who provided insight and expertise that greatly assisted the research.

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How to cite this article:

Sundar Pal, D.K. Singh, Ram Singh Umrao and Omendra Sharma. 2018. Eco-Friendly Management of Tomato Fruit Borer, *Helicoverpa armigera* under Hill Condition, Uttrakhand, India. *Int.J.Curr.Microbiol.App.Sci.* 7(10): 3008-3013.
doi: https://doi.org/10.20546/ijcmas.2018.710.350