International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(1): 1795-1798

Received: 14-11-2017
Accepted: 15-12-2017

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Evaluate the efficacy of eco-friendly pesticides against the lepidopteran pests

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Abstract
Insect pest act as a limiting factor in harvesting high yields of healthy and quality tomato fruits, especially *Helicoverpa armigera* and *Spodoptera litura*. Botanicals become promising tools against these insect pests, because of the safety and ecofriendly nature as compare to chemical insecticides. The mean larval population of *Helicoverpa armigera* ranged from 0.4 in T_9 to 1.50 in T_1. The treatment T_{10} had the highest mean larval population (2.90/plant). The treatment T_9 caused 84% reduction in larval population followed by T_8 (81.8% reduction), T_4 (76.1% reduction) and T_2 (72.7% reduction). In other hand *Spodoptera litura* mean larval population per plant varied from 0.2 to 0.70. The treatment T_9 caused 84.4% reduction followed by T_8 (77.7% reduction) whereas in other treatments the per-cent larval reduction ranged from 44.4% (T1) to 68.8% (T4).

Keywords: Tomato, Lepidopteran pest, Botanicals and efficacy

Introduction

India is the third largest producer of tomato in the world after USA and China. It is one of the most important protective food crops of India having an area of 880 thousand hectares with an annual production to the tune of 18227 thousand metric tonnes, contributing to 9.4 per cent of total vegetable area and 11.5 per cent of total vegetable production. In India the tomato growing states are Andhra Pradesh, Odisha, Telangana, Madhya Pradesh, Karnataka, West bengal, Chhatishgarh, Maharashtra, Bihar, Gujarat and Rajasthan. In Odisha, tomato is cultivated over an area of 96.56 thousand hectares with an annual production of 1382 thousand metric tones (National Horticulture Production Data Base).

Insect pest act as a limiting factor in harvesting high yields of healthy and quality tomato fruits. Because of its fleshy nature about sixteen insects and other pests species cause damage to the tomato crop in India resulting in use of large volume of pesticides which leave their toxic residues (Bhutani, 1977) [2].

The pest problem has increased manifold on tomato as the number of sprays increased 2-3 folds compared to normal 5-6 sprays. This has enormously increased the cost of cultivation of tomato, making it non-profitable. Quicker control strategy for these pests and quests of getting higher yields, led to indiscriminate use of pesticides. In addition, sole dependence on chemical insecticides resulted in collapse of natural enemy fauna and resulted in resurgence of pests. Study in some countries indicated that *H. armigera* is resistant to major conventional groups of pesticides, such as pyrethroids, organophosphates, organochlorines, and carbamates (Chaturvedi, 2007) [3].

Alternative pest management strategies are hence warranted to reduce the misuse of chemical pesticides in vegetables. Therefore, an eco-friendly alternative is the need of the hour. Biopesticides have the potential to help in the management of these pests as safe alternatives to synthetic insecticides (Schmutterer, 1995; Elshafie and Basedow, 2003; Lowery *et al.*, 1993; Basedow *et al.*, 2002) [9, 6, 8, 1].

Botanicals become promising tool against insect pests by offering many advantages compared to insecticides such as, host specific, non-toxic to mammals and beneficial organisms, less prone to insect resistance, readily biodegradable and less expensive.

Material and Methods

Field trial was conducted during *Rabi*, 2016-17 at the Central Research Farm, Department of Entomology, Orissa University of Agriculture and Technology, Bhubaneswar (OUAT) ($20^0 15'$ N, latitude and $85^0 52'$ E, longitude) at an elevation of 25.9 m above MSL.

The bio efficacy of a few selected safer pesticides and plant products were field evaluated against insect pests on the tomato variety,T-444. The spray liquid was applied with hand operated knapsack sprayer using a spray volume of 500-750 l/ha depending upon the stage of the crop. The insecticides were applied thrice at 15 days interval commencing from fruit initiation stage of the crop (66 DAS).To compare the efficacy of insecticides both tested insecticides as well as untreated check were taken into consideration. Fresh cow urine was used and the neem oil used was marketed product @300ppm azadiractin.

Details of the treatments used in the experiment

Treatment	Treatment details
T_1	3 sprays of Cow urine (0.5%)
T_2	3 sprays of Neem oil (0.3%)
T_3	3sprays of *Bt*(2ml/l)
T_4	Neem oil-*Bt*-Neem oil
T_5	Neem oil-Cowurine-Neem oil
T_6	Cow urine-*Bt*-Cow urine
T_7	Cow urine-Neem oil-Cow urine
T_8	*Bt*-Cow urine-*Bt*
T_9	*Bt*-Neem oil-*Bt*
T_{10}	Utreated Check

Before commencement of first spraying, pre-spraying observation on five randomly selected plants were taken in each sub plot of each treatment. The spray schedule consisted of 3 numbers of sprays with the first spray at 66 days after sowing and thereafter two sprays at 15 days interval. Observation on five randomly selected plants were recorded from each sub-plot at 7 and 10 days after each spray. The observation on borer population were recorded randomly on five plants from each treatment, replication-wise leaving the border rows at one day before first spray and 7 and 10 days after each of first, second and third sprays from fruit initiation to fruit maturity stage of the crop. The borer population was recorded on the five tagged plants of each treatment including the borers present in the affected fruits at each picking. The damaged fruits were cut open to see the larvae inside.

The per cent population reduction over control was calculated by following formula:

$$\text{Per cent reduction over control} = \frac{C - T}{C} \times 100$$

Where, T = Population in treatment
C = Population in control

The data obtained on various aspects were subjected to statistical analysis after necessary transformation. Statistical interpretation of data was done following the Fischer's analysis of Variance technique as given by Panse and Sukhatme (1967) at 5% level of significance.

Results

The incidence of fruit borer *H. armigera* before and after various treatments has been depicted in Table 1. It can be observed from the data that 1 day before spraying there was no difference between the treatments so far the larval population per plant was concerned. At 7 DAT of the first spray, variation between the treatments was noticed. Lowest population (0.20 larvae/plant) was witnessed in T_9 (*Bt*-neem oil-*Bt*) which remained at par with T_4 (neem oil-Bt-neem oil) and T_8:*Bt*-Cow urine-*Bt* (each with 0.40 larvae/plant). The other treatments supported 0.60 to 1.60 larvae/plant regardless of the treatments imposed. However, at this period the control treatment retained as high as 2.4 larvae/plant which was significantly different from the rest of the treatments.

A similar trend was observed with regard to larval population at 10 DAT of first spray. The treatment T_9 retained its superiority (0.60 larvae/plant) which was at par with T_8 (0.60 larvae/plant), T_4 (0.80 larvae/plant) and T_3 (1.00 larva/plant) in which the treatment T_3 was of *Bt*-*Bt*-*Bt*. The control treatment exhibited 2.60 larvae/plant which was significantly different from the rest of the treatments.

After 7 DAT of second spray, the control treatment supported 2.80 larvae/plant while T_9 supported 0.20 larvae/plant. After 2nd spray T_9 was at par with only T_8 (0.40 larva/plant).Similarly at 10 DAT of second spray, in both T_9 and T_8, the larval population was lowest (0.60 larvae/plant) which did not differ from themselves but differed significantly from the rest of the treatments (1.00-1.60 larvae/plant).

After 7 DAT of the third spray, the trend between T_9 and T_8 was similar where both supported 0.40 larva/plant. The treatment T_4 was also at par with T_9 and T_8 (0.60 larva/plant). The control treatment registered 3.20 larva/plant remaining completely different from all of the other treatments. At 10 DAT of the third spray, T_9 and T_8 both supported 0.80 larva/plant without statistical difference between themselves. Other two treatments T_4 and T_3 which supported 0.80 and 1.00 larva/plant were also at par with T_9 and T_8.The control treatment had the highest number of the larvae per plant (3.60) during the entire period of investigation.

The overall mean data envisaged that there was low incidence of *H. armigera* on tomato. In various treatments, the mean larval population ranged from 0.4 in T_9 to 1.50 in T_1.The treatment T_{10} had the highest mean larval population (2.90/plant).The treatment T_9 caused 84% reduction in larval population followed by T_8 (81.8% reduction), T_4 (76.1% reduction) and T_2 (72.7% reduction).

The population of larvae of *Spodoptera litura* on tomato at various pre and post treatments periods has been depicted in Table 2.Throughout the period, the incidence was found to be quite low. Before the initiation of the spray, there was no variation in larval population recorded in different treatments. But variations were noticed among the treatments at different post treatment periods. At 10 DAT of the 1st spray lowest population of 0.20 larvae/plant was observed in T_9 which remained at par with T_8, T_4 and T_2 (each with 0.40 larvae/plant) in which the treatment T_2 comprised of Neem oil-neem oil-neem oil.

At 7 DAT of second spray, the control treatment harboured 1.40 larvae/plant which remained distinctly different from other treatments. At this period T_9 (0.20 larvae/plant) was at par with T_8, T_4 and T_2. At 10 DAT, T_9 registered 0.40 larvae/plant that remained at par with most of the treatments except T_7 and T_1 (1.00 larvae/plant) in which the treatments T_7 and T_1 comprised of Cow urine-neem oil-cow urine and Cow urine-cow urine-cow urine, respectively.

At 7 DAT of third spray, T_9 was the superior treatment (0.20 larvae/plant) that remained at par with T_8 (0.40 larvae/plant) only. At 10 DAT, T_9 and T_8 were equal and remained at par with many treatments. The control treatments showed a rising trend from 0.50 larvae (1DBS) to 2.00 larvae/plant (at 10 DAT of third spray).

It can be noticed from the overall mean population data that while control treatment supported over 1 larva/plant (1.5), in the rest of the treatments the mean larval population per plant varied from 0.2 to 0.70.The treatment T_9 caused 84.4% reduction followed by T_8 (77.7% reduction) whereas in other treatments the per-cent larval reduction ranged from 44.4% (T1) to 68.8% (T4).

Table 1: Efficacy of biopesticides on the larval population of *Helicoverpa armigera*

Treatments	1 Dbs	Larval population(number/plant) after									Overall Mean	Rouc (%)
		1st Spray			2nd Spray			3rd Spray				
		7 Dat	10 Dat	Mean	7 Dat	10 Dat	Mean	7 Dat	10 Dat	Mean		
T_1: Cow urine-cow urine-cow urine (0.5%)	1.40 (1.37)	1.60 (1.44)	1.60 (1.44)	1.60	1.20 (1.30)	1.60 (1.44)	1.40	1.40 (1.37)	1.60 (1.44)	1.50	1.50	48.8
T_2: Neem oil-neem oil-neem oil (0.3%)	0.80 (1.13)	0.60 (1.03)	1.00 (1.22)	0.80	0.60 (1.04)	1.00 (1.22)	0.80	0.80 (1.13)	0.80 (1.13)	0.80	0.80	72.7
T_3: *Bt-Bt-Bt*(2ml/l))	1.00 (1.22)	0.60 (1.03)	1.00 (1.21)	0.80	0.80 (1.13)	1.20 (1.29)	1.00	1.00 (1.21)	1.00 (1.22)	1.00	0.90	68.1
T_4: Neem oil-*Bt*-neem oil	0.80 (1.13)	0.40 (0.90)	0.80 (1.13)	0.60	0.60 (1.04)	1.00 (1.22)	0.80	0.60 (1.04)	0.80 (1.13)	0.70	0.70	76.1
T_5: Neem oil-cow urine-neem oil	1.40 (1.37)	1.20 (1.30)	1.20 (1.30)	1.20	1.00 (1.22)	1.40 (1.37)	1.20	1.20 (1.30)	1.20 (1.30)	1.20	1.20	59.0
T_6: Cow urine-*Bt*-cow urine	1.20 (1.30)	0.80 (1.13)	1.20 (1.30)	1.00	1.00 (1.22)	1.20 (1.30)	1.10	1.00 (1.22)	1.20 (1.30)	1.10	1.10	63.6
T_7: Cow urine-neem oil-cow urine	1.40 (1.36)	1.40 (1.37)	1.40 (1.37)	1.40	1.20 (1.30)	1.20 (1.30)	1.20	1.20 (1.30)	1.40 (1.37)	1.30	1.30	55.6
T_8: *Bt*-cow urine-*Bt*	0.90 (1.16)	0.40 (0.90)	0.60 (1.04)	0.50	0.40 (0.94)	0.60 (1.04)	0.50	0.40 (0.94)	0.80 (1.13)	0.60	0.50	81.8
T_9: *Bt*-neem oil-*Bt*	0.70 (1.06)	0.20 (0.83)	0.60 (1.04)	0.40	0.20 (0.83)	0.60 (1.04)	0.40	0.40 (0.94)	0.80 (1.13)	0.60	0.40	84.0
T_{10}: Untreated check	1.50 (1.40)	2.40 (1.70)	2.60 (1.76)	2.50	2.80 (1.81)	3.00 (1.87)	2.90	3.20 (1.92)	3.60 (2.02)	3.40	2.90	-
SE(m)±	-	0.06	0.05		0.04	0.05		0.05	0.04			
C.D$_{(0.05)}$	N.S	0.19	0.17		0.13	0.16		0.16	0.13			

Table 2: Efficacy of biopesticides on the larval population of *Spodoptera litura*

Treatment	1 Dbs	Larval population(number/plant) after									Overall Mean	Rouc (%)
		1st Spray			2nd Spray			3rd Spray				
		7 Dat	10 Dat	Mean	7 Dat	10 Dat	Mean	7 Dat	10 Dat	Mean		
T_1: Cow urine-cow urine-cow urine (0.5%)	0.60 (1.04)	0.60 (1.04)	0.80 (1.13)	0.70	0.60 (1.04)	1.00 (1.22)	0.80	0.80 (1.13)	1.20 (1.29)	1.00	0.80	44.4
T_2: Neem oil-neem oil-neem oil (0.3%)	0.40 (0.94)	0.20 (0.83)	0.40 (0.94)	0.30	0.40 (0.94)	0.60 (1.04)	0.50	0.60 (1.04)	0.80 (1.13)	0.70	0.50	66.6
T_{r3}: *Bt-Bt-Bt*(2ml/l)	0.40 (0.94)	0.40 (0.94)	0.60 (1.04)	0.50	0.40 (0.94)	0.80 (1.13)	0.60	0.60 (1.04)	0.80 (1.13)	0.70	0.60	60.0
T_4: Neem oil-*Bt*-neem oil	0.20 (0.83)	0.20 (0.83)	0.40 (0.94)	0.30	0.40 (0.94)	0.60 (1.03)	0.50	0.60 (1.04)	0.60 (1.04)	0.60	0.40	68.8
T_5: Neem oil-cow urine-neem oil	0.50 (1.01)	0.40 (0.94)	0.60 (1.04)	0.50	0.40 (0.94)	0.80 (1.13)	0.60	0.80 (1.13)	1.00 (1.22)	0.90	0.60	55.5
T_6: Cow urine-*Bt*-cow urine	0.40 (0.94)	0.40 (0.94)	0.60 (1.04)	0.50	0.40 (0.94)	0.80 (1.13)	0.60	0.80 (1.13)	0.80 (1.11)	0.80	0.60	57.7
T_7: Cow urine-neem oil-cow urine	0.50 (0.98)	0.40 (0.94)	0.60 (1.04)	0.50	0.60 (1.04)	1.00 (1.22)	0.80	0.80 (1.13)	1.20 (1.29)	1.00	0.70	48.8
T_8: *Bt*-cow urine-*Bt*	0.20 (0.83)	0.00 (0.70)	0.40 (0.94)	0.20	0.20 (0.83)	0.60 (1.04)	0.40	0.40 (0.94)	0.40 (0.94)	0.40	0.30	77.7
T_9: *Bt*-neem oil-*Bt*	0.20 (0.83)	0.00 (0.70)	0.20 (0.83)	0.10	0.20 (0.83)	0.40 (0.94)	0.30	0.20 (0.83)	0.40 (0.94)	0.30	0.20	84.4
T_{10}: Untreated check	0.50 (1.01)	1.00 (1.22)	1.20 (1.30)	1.10	1.40 (1.37)	1.60 (1.44)	1.50	1.80 (1.51)	2.00 (1.58)	1.90	1.50	-
SE(m) ±	-	0.04	0.05		0.04	0.07		0.06	0.08			
C.D$_{(0.05)}$	N.S	0.13	0.16		0.14	0.21		0.18	0.25			

Figures in the parentheses are transformed √ (x+0.5) ROUC-Reduction Over Untreated Control DAT-Days After Treatement DBS-Days Before Spraying

Discussion

The present investigation revealed that the treatment *Bt*-neem oil-*Bt* (T_9) excercised better efficacy which was more or less similar to *Bt*-cow urine-*Bt* (T_8). The next better treatment was Neem oil-*Bt*-neem oil (T_4). All these three treatments reduced the *H. armigera* population by more than 75%, highest being 84% in T_9 treatment. Efficacy of Bt in controlling *H. armigera* was studied by Justin *et al*. (1989). Similarly Venkadasubramanian and David (1999) [11] also have observed that the combination of *Bt* and neem oil caused effective control of *H. armigera*. Efficacy of neem oil against *H. armigera* studied by Dhingra *et al*. (2002) [5]. Daneti and Rath (2007), have also studied the effect of *Bt*-neem oil-*Bt* in controlling *H. armigera* to a high degree. Singh (2007) [10] also studied a similar effect of combined application of *Bt* and neem (1500ppm azadiractin) against *H. armigera*. Thus our finding corroborate with the above findings.

It has been envisaged from the experiment that the population *of S. litura* throughout the experiment period was quite low, as regards to efficacy of various treatments Bt-neem oil-Bt combination was found to be the best treatment which accounted for 84.4% reduction in larval population as compared to control. *Bt* has been proved as a potential botanical pesticide against a number of lepidopteran pests. First application of *Bt* might have caused more mortality in treated larvae and subsequent application by neem oil might have excercised antifedant/detterant action; thus suppressing *S. litura* population. The present finding is in same line of finding of Venkateswarlu *et al*. (1992) [12] who also observed a similar behavior. Kanani *et al*. (2015) [7] also witnessed the higher efficacy of *Bt* against *S. litura*.

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