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Bioefficacy of different organic/biopesticide treatments against tomato fruit borer (*Helicoverpa armigera* Hubner) under field conditions

Geet Gandhi, PC Sharma and Nitika Negi

Abstract
Studies on the bioefficacy of organic/biopesticides viz. *agneyastra*, cow urine, eupatorium leaves extract in cow urine, Eupatorium SFE, *Ha*NPV, melia drupes extract in cow urine, Melia SFE, Neemarin 300 and *panchagavya* against *Helicoverpa armigera* (Hub.) in tomato crop. The maximum incidence of neonate larvae of *H. armigera* was recorded in first week of May (0.92 larvae/plant) with 83.33 per cent per plant infestation.The correlation coefficient (r) for rainfall and RH I&II was negative and significant. The r value for maximum and minimum temperature was positive but non-significant. Field efficacy study revealed that out of nine treatments, Neemarin 300 (0.3%) was found most effective in reducing the larval population of *H. armigera* (96.30%) while cow urine (10%) was less effective (42.42%) on 7th day after treatment.

Keywords: *H. armigera*, tomato, bioefficacy, organic, biopesticides, field condition and safety

1. Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important solanaceous crops of the world ranking second followed by potato and is native to Central and South America (Vavilov, 1951) [18]. Tomato is one of the most important "protective foods" because of its special nutritive value viz., β-carotene, ascorbic acid, lycopene, vitamin and mineral. Globally, tomato is grown on an area of 4.85 million ha with the production of 182.30 million MT and productivity of 37.59 MT/ha. In India, it is cultivated over an area of 8.09 lakh hectare with a production of 19.70 million MT (FAO, 2018) [7]. In Himachal Pradesh, it is grown in about 8.01 thousand hectare area with a production of 22.33 thousand MT (Anonymous, 2018) [1].

In India, fruit borer, *Helicoverpa armigera* (Hubner) is one of the most important pests of tomato, limiting production and market value of crop produce. *H. armigera* is the most destructive pest of tomato in India, which is commonly known as gram pod borer, American bollworm and tomato fruit borer. It has been reported to inflict 20-60 per cent loss in fruit yield (Kakar *et al*. 1990; Pareek and Bhargaya, 2003; Mustafiz *et al*. 2015; Faqiri and kumar, 2016) [9, 14, 10, 5]. *H. armigera* is a polyphagous pest infesting more than 181 plant species from 45 families including a wide range of industrial, ornamental, cereal, legume and vegetable crops throughout the world (Durairaj *et al*. 2005; Ghosh, 2011) [4,8]. It is widely distributed in Asia, Africa, Australia and Mediterranean Europe. In India, the total area under fruits and vegetables is 3 per cent and it receives 13 per cent of total pesticides used in the country. It means fruits and vegetables receive five times more pesticides than the average use of pesticides in the country (Nargeta, 2000) [11]. Moreover, many recommended insecticides are reported to be ineffective against this pest by the farmers. The intensive use of synthetic insecticides in the last few years does not meet the modern criteria of integrated pest management programmes. The large scale use of these chemicals and their persistence calls for the evaluation of some organic preparations/biopesticidesfor the management of tomato fruit borer to avoid the losses and produce a quality crop.

2. Materials and Methods

2.1 Seasonal incidence of *H. armigera* and their monitoring

Tomato crop (F_1 Hybrid Avtar) was grown in plot size of 2.5 m x 3.5 m during summer season of 2017 at Research farm, Department of Entomology CSKHPKV Palampur.

The experiment was conducted in RBD. For the purpose, tomato crop was raised by transplanting 30 days old seedlings in the field on 29th March with a spacing of 60cm x 45cm. Seasonal observations were recorded on larval population. Weekly records on the number of larvae per plant were made on eight randomly selected plants per plot with three replications (i.e. number of larvae/24 plants). The observations were taken starting from ten days after transplanting of the crop.

2.2 Field efficacy

The test treatments were freshly prepared maintaining the accurate spray concentration and were applied as foliar spray by a knapsack sprayer after the pest appearance. All organic/biopesticide treatments were applied in evening hours. Water was sprayed in untreated plots. Larvae count was recorded on randomly selected five plants by observing fruits and leaves. Data were recorded one day before spraying and 1, 7 and 14 days after spraying. Data were statistically analyzed for per cent reduction in pest population. The formula used for the calculation of percentage reduction of pest population over control was a modified Abbott's formula (Flemming and Ratnakaran, 1985) [6] which is given below:

$$P = 100 \times 1 - \left\{ \frac{Ta \times Cb}{Tb \times Ca} \right\}$$

P = per cent population reduction over control
Ta = population in treatment after spray
Ca = population in control after spray
Tb = population in treatment before spray
Cb = population in control before spray

The data were statistically analyzed by correlation analysis between weather parameters and fruit borer.

3. Results and Discussion

3.1 Monitoring the incidence of tomato fruit borer (*H. armigera*)

Studies on the incidence of tomato fruit borer, *H. armigera* were conducted during the cropping season of 2017 and incidence of the pest was first recorded during first week of April, 2017 (14 SW) with a population of 0.21 larvae/plant and 20.83 per cent plant infestation. The corresponding mean maximum and minimum temperature, mean RH I and RH II and total rainfall during this period were 26.6 & 13.3 °C, 58.6 & 41.2 per cent and 51.2 mm, respectively (Table 1 & Fig. 1). Thereafter, the larval population showed increasing trend and reached the maximum of 0.92 larvae/plant with per cent plant infestation of 83.33% during 1st week of May (18 SW) with corresponding weekly mean maximum and minimum temperature of 28.1° and 15.4 °C, mean RH I and RH II of 51.6 and 33.7 per cent with a total rainfall of 9.2 mm. Afterwards, the population started declining and lowest population of 0.08 larvae/ plant with per cent plant infestation of 8.33 per cent was observed during third week of June (24 SW) with corresponding respective mean maximum and minimum temperatures of 32.6 and 20.7 °C, mean RH I and RH II of 56.2 and 56.6 per cent with a total rainfall of 33.2 mm.

Table 1: Incidence of *H. armigera* larvae on tomato during 2017

Sampling date	Standard week	Larvae/ plant	Per cent plant infestation
April 1, 2017	13	0	0
April 8, 2017	14	0.21	20.83
April 15, 2017	15	0.33	33.33
April 22, 2017	16	0.54	54.17
April 29, 2017	17	0.75	66.67
May 6, 2017	18	0.92	83.33
May 13, 2017	19	0.79	70.83
May 20, 2017	20	0.71	58.33
May 27, 2017	21	0.50	41.67
June 3, 2017	22	0.38	29.17
June 10, 2017	23	0.21	20.83
June 17, 2017	24	0.08	8.33
June 24, 2017	25	0	0.00

Table 2: Correlation between weather parameters and incidence of *H. armigera*

Weather parameters	Correlation coefficient (r) value
Maximum temperature (°C)	0.3126
Minimum temperature (°C)	0.3003
Rainfall (mm)	-0.7301*
Relative humidity I (%)	-0.6776*
Relative humidity II (%)	-0.7186*

*Significant at 5% level of significance

These results are in agreement with those reported by Datar and Pawar (1981) who observed maximum temperature of 29.35 °C and relative humidity of 86.6 per cent proved favourable for the rapid infestation of tomato fruit borer on tomato [3]. Chand (1993) observed maximum infestation (22.18%) of *H. armigera* in first week of May when the maximum and minimum temperature was 28.5 °C and 17.2 °C and relative humidity was 88.0 per cent [2].The data on correlation studies between weather parameters and incidence of *H. armigera* are presented in Table 2. The correlation coefficient (r) for rainfall and RH I&II was negative and significant suggesting that with the increase in rainfall and RH I&II there was decrease in incidence of *H. armigera.* There was positive but non-significant correlation between maximum and minimum temperature and pest population. Shinde *et al*. (2014) observed that the positive correlation with minimum temperature (r= 0.808) and maximum temperature (r= 0.767), however it showed negative correlation with relative humidity (r= -0.661) and rainfall (r= -0.108) during 2010-11 [17].

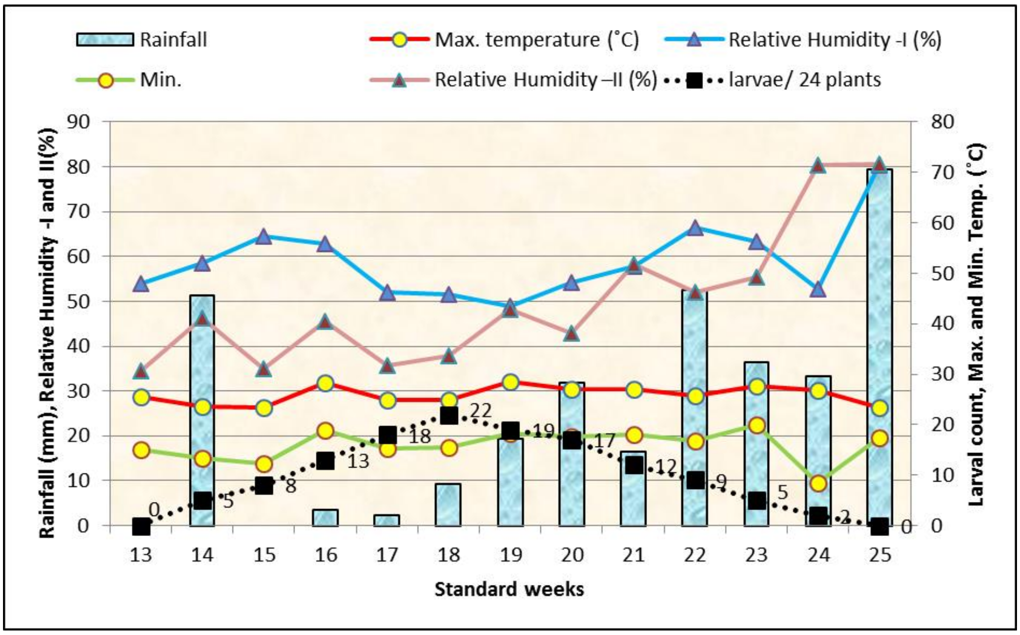

Fig 1: Incidence of *H. armigera* in tomato and correlation with weather parameters during 2017.

3.2 Efficacy of organic/biopesticide treatments against neonate larvae of *H. armigera*

The data on different organic/biopesticide treatments evaluated against tomato fruit borer, *H. armigera* under field conditions are presented in Table 3 and fig. 2**.** The data revealed that one day before spray, the larval population varied between 0.87 to 1.07 larvae/plant in different treatments. All the treatments and observational periods differed among themselves significantly and all the treatments were superior in reducing larval population over untreated check. After 1 day of spray, reduction in population varied from 13.56 to 59.56 per cent in different treatments and the variation was non-significant. Cow urine resulted in minimum reduction (13.56%) being at par to *agneyastra* (18.89%) followed by melia drupe extract in cow urine, eupatorium leaf extract in cow urine and *panchagavya* (23.33 - 33.48%) and these were at par to each other.

Melia SFE, Eupatorium SFE and *Ha*NPV resulted in 36.94 to 45.56 per cent reduction in larval population and were at par to each other. Neemarin 300 resulted in highest reduction (59.56%) in larval population. However, it differed significantly on 7th day of spray. On 7th day, reduction in population varied from 42.41 to 96.30 per cent in different treatments. Cow urine resulted in minimum reduction (42.41%) being at par to *agneyastra* (52.22%). Melia drupe extract in cow urine, eupatorium leaf extract in cow urine and *panchagavya* resulted in 68.15, 61.11 and 58.89 per cent reduction and were on par to each other. Melia SFE, Eupatorium SFE and *Ha*NPV resulted in 74.07-82.96 per cent reduction in larval population being on par to each other. Neemarin 300 resulted in 96.30% reduction of larval population and differed significantly to all other products. After 14 days of spray, reduction in population varied from 37.70 to 78.94 per cent in different treatments. Neemarin 300, Melia SFE and Eupatorium SFE resulted in 78.94, 75.66 and 70.32 per cent reduction in larval population, respectively and were at par to each other.

Table 3: Effect of different organic/biopesticide treatments against neonate larvae of *H. armigera* under field conditions

Treatment	Dose (%)	Larval population per plant	Reduction in larval population (%) over control Days after spray		
		Before spray	1	7	14
Agneyastra	10	0.87 (1.37)*	18.89 (25.48)**	52.22 (46.26)	42.86 (40.87)
Cow urine	10	1.00 (1.41)	13.56 (21.53)	42.41 (40.59)	37.70 (37.81)
Eupatorium leaf extract in cow urine	10	0.87 (1.36)	30.28 (33.35)	61.11 (51.42)	52.52 (46.43)
Eupatorium SFE	0.05	1.07 (1.43)	39.52 (38.93)	80.00 (63.47)	70.32 (57.02)
*Ha*NPV	1x10^{8} POBs	0.93 (1.39)	36.94 (37.40)	74.07 (59.46)	60.32 (50.99)
Melia drupe extract in cow urine	10	0.93 (1.39)	33.48 (35.32)	68.15 (55.77)	55.98 (48.42)
Melia SFE	0.05	1.00 (1.41)	45.56 (42.42)	82.96 (65.65)	75.66 (60.49)
Neemarin 300	0.3	1.01 (1.43)	59.56 (50.53)	96.30 (83.48)	78.94 (62.83)
Panchagavya	10	1.00 (1.41)	23.33 (28.63)	58.89 (50.11)	48.81 (44.30)
Untreated check	-	0.87***	1.07***	1.14***	1.26***
CD(P=0.05)		(NS)	(6.41)	(8.35)	(6.97)

*Values in parentheses are square root transformed
**Values in parentheses are arc sine transformed
*** Larval population per plant

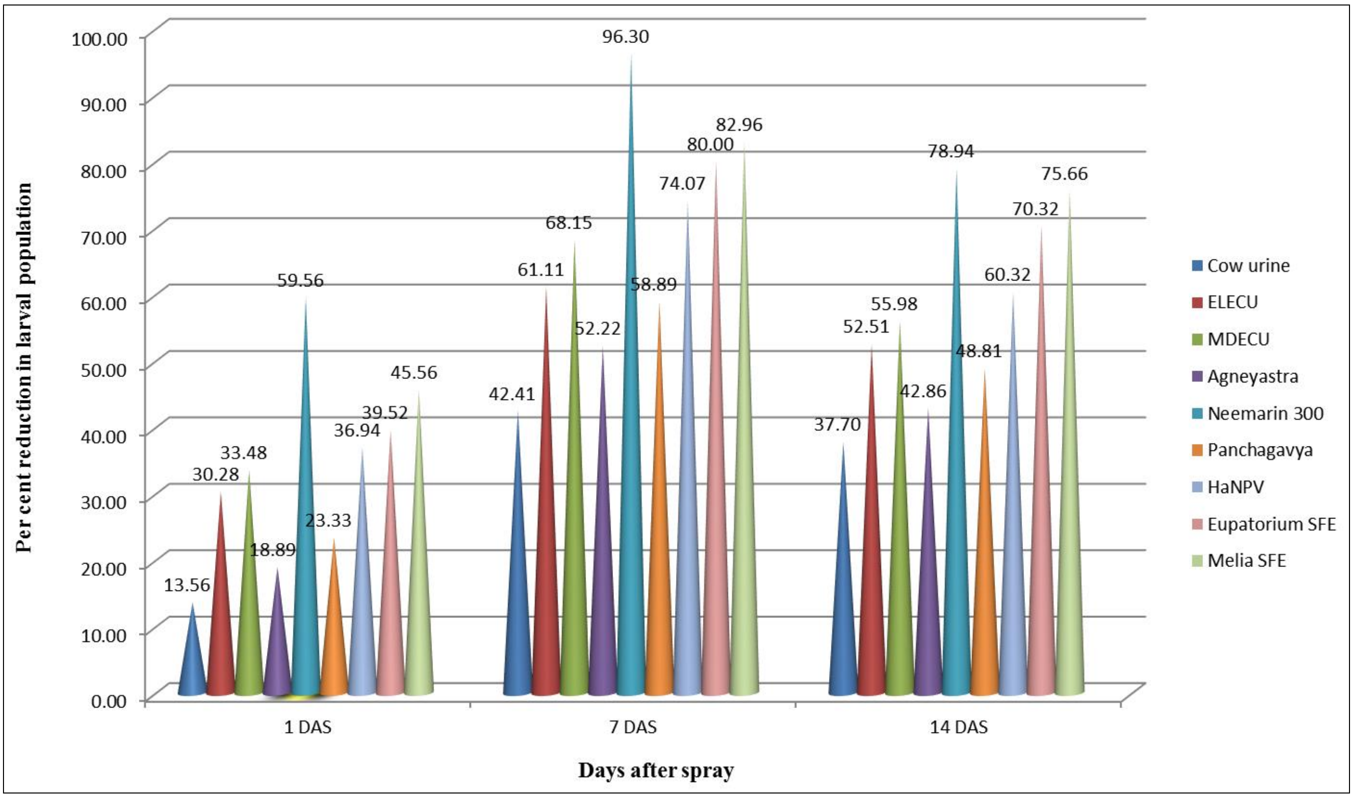

Fig 2: Per cent reduction of larval population of *H. armigera*

*Ha*NPV, melia drupe extract in cow urine and eupatorium leaf extract in cow urine followed them (52.52 - 60.32%) and were at par to each other. Cow urine resulted in minimum reduction in larval population of *H. armigera* (37.70%) being at par to *agneyastra* (42.86%) and *panchagavya* (48.81%). Neemarin 300 proved to be the best in per cent larval reduction under field conditions which was similar to the findings of Rao *et al*. (1999) who reported satisfactory control of *H. armigera* on pigeon pea with neem oil (Azadirachtin 0.3%) @ 0.33 per cent [15]. Pant (2000) also reported that neemactin (0.00075%) and neem gold (0.00045%) were very effective in reducing larval population of *H. armigera* on tomato [13]. Nboyine *et al*. (2013) showed that 10% NSKE significantly (P<0.05) reduced the abundance of bollworms, aphids and whiteflies followed by neem seed oil [12]. Reza (2013) revealed that neem oil @ 3 ml/L was superior for the management of chickpea pod borer (*H. armigera*) [16]. All these reports support present findings on efficacy of neem products against *H. armigera* on tomato.

4. Conclusion

The incidence of *H. armigera* was recorded maximum on 18th standard week i.e. on 6th May 2017 (0.92 larvae/ plant) when plant infestation was 83.33%. The correlation coefficient (r) for rainfall and RH was negative and significant suggesting that with the increase in rainfall and RH there was decrease in incidence of *H. armigera*. After 1 day of spray, Neemarin 300 resulted in highest reduction (59.56%) in larval population followed by Melia SFE, Eupatorium SFE and *Ha*NPV (45.56-36.94%) and were at par to each other. However, cow urine resulted in minimum reduction (42.41%) being at par to *agneyastra* (52.22%).

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