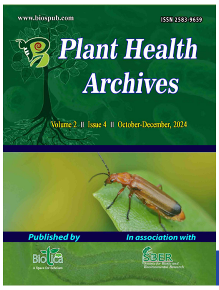

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Research Article

Bio-Intensive Pest Management for Major Insect Pests of Tomato

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Abstract

Field evaluation was carried out in farmers' field at Lality Chapari, Jorhat, Assam, during the year 2022 and 2023 in rabi season. Sucking pests, *A. gossypii* and *B. tabaci* population was significantly reduced in both BIPM and chemical control plots as compared to control. The tomato fruit borer damage was lower and yield was higher in chemical control than BIPM plots. The fruit borer damage was reduced to 72.29% in BIPM Plot and 80.13% in chemical treated plots. There was no significant difference in between the yield of BIPM (67.03 q ha^{-1}) and chemical treated plots (7,050 kg ha^{-1}). Coccinellids populations were significantly higher in BIPM plots. B:C ratio was 1:2.73 and 1:2.62 in BIPM and chemical control, respectively.

Keywords: *Aphis gossypii*, *Bamisia tabaci*, Bio-intensive pest management, Fruit borer, Tomato

Introduction

Tomato, *Solanum lycopersicum* is an important vegetable crop which is commonly grown all over the world. It consists of high amount of vitamins, minerals, which is essential for human health and an important carotenoid called lycopene which has many health benefits (Perveen *et al.*, 2015). According to Agarwal and Rao (2000), dietary intake of tomatoes and its products is associated with decreasing the risk of chronic disease such as cancer and cardiovascular disease.

India occupies second rank in terms of global production after China, contributes 11% of global tomato production (Anonymous, 2021). In India, tomatoes covered an area of 0.78 million hectares with 19.75 million tones production and productivity 250 q ha^{-1} (Anonymous, 2018). According to CEIC (2024) data, the production of tomato in Assam is 432.398 tonnes with an area of 1,600 ha and an average productivity of 16.5 t ha^{-1}.

Several factors control the decreased yield of tomatoes, including bad quality seeds, insect pest infestation, unfavorable weather, *etc*. Insect infestation reduces crop quality and quantity. Tomato fruit borer, *Helicoverpa armigera* (Hubner); aphids (*Aphis gossypii*); serpentine leaf miner, *Liriomyza trifolii*; whiteflies, *Bemisia tabaci*; and thrips, *Frankliniella occidentalis* are the main insect pests affecting tomato production. *H. armigera* (Hubner) can result in significant crop losses, hence causing up to 55% fruit damage (Selvanarayanan, 2000). The invasive pest *Tuta absoluta* was first reported in India in the year 2014. It has spread to several tomato growing states and causes as much as 20% to 30% yield loss (Sridhar *et al.*, 2014). Two most severe tomato pests, the whitefly (*Bemisia tabaci* Gennadius) and aphid (*Aphis gossypii* Glover), account for about 45% and 34% yield loss, respectively (Cruz and Bernardo, 1971; Singh *et al.*, 2011). Being a vector of viral diseases such as tomato mosaic virus, tomato spotted wilt virus, aphids are also regarded as a major pest that significantly reduces crop productivity. In present time people became aware about the adverse effects of chemical pesticides. Application of chemical pesticides causes human health risk, secondary pest out breaks, insecticide resistance and overall environmental hazards (Anonymous, 2022). As a result, concern for use of biotic sources for pest management gets greater emphasis. Therefore, the present investigation on bio-intensive pest management was under taken.

Article History

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Materials and Methods

Field experiment was conducted in farmers' field at Lality Chapori (26.79° N, 94.04° E), Jorhat, Assam during 2022 and 2023 in rabi season under the supervision of AICRP on Biological control project. The experiment was laid out in complete randomized block design (RBD) with three treatments and seven replications. The tomato variety Namdhari F_1 was grown on an area of 1000 m^2 following standard agronomic practices. Each plot was measuring 5×8 m^2. Seeds were initially sown in nursery bed and later transplanted to main field at 15 cm height or 8-10 leaves stage following spacing 45×45 cm^2.

Treatment Details

The treatment details were:

T_1: BIPM Module

• Installation of yellow sticky trap @ 30 numbers ha^{-1} for sucking pests at 10-15 days after transplanting.

• Spraying of *Lecanicillium lecanii* (1×10^8 spores g^{-1}) @ 5 ml L^{-1} at occurrence of aphids or whitefly.

• Installation of Pheromone traps @ 20 ha^{-1} against fruit borer at 20-25 days after transplanting.

• Release of *Trichogramma chilonis* @ 50,000 ha^{-1} (4 releases) from flower initiation stage at weekly intervals for fruit borer.

• Spraying of Azadirachtin 1500 ppm @ 2 ml L^{-1} at occurrence of fruit borer.

T_2: Chorantraniliprole @ 0.4 ml L^{-1} with 3 spraying from occurrence of fruit borer at 15 days intervals.

T_3: Control.

Observations on population of *Aphis gossypii*, *Bemisia tabaci* were recorded at 30 and 45 days after transplanting. Percent fruit damages by *H. armigera* were recorded at harvest. The populations of coccinellids were also recorded at 45 days after transplanting (Figure 1). To record the data, five plants were randomly selected from each plot in each time. The observe the number of sucking pests 3 leaves from upper, lower and middle were selected from each plant. The data was statistically analyzed and the mean difference between the treatments was obtained by the Duncan's Multiple Range Test (1955).

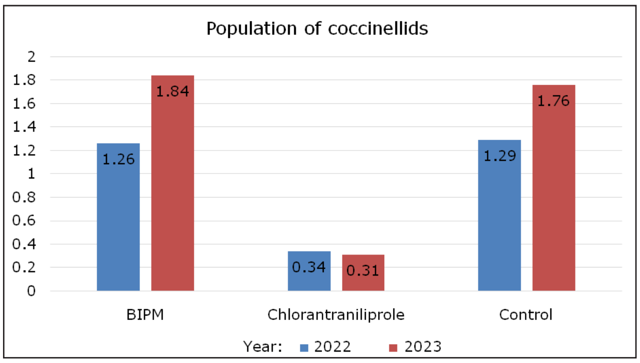

Figure 1: Population of coccinellids at 45 DAT during the year 2022 and 2023

Results and Discussion

Data presented in table 1 revealed that the population of *A. gossypii* and *B. tabaci* was significantly lower in BIPM module than chorantraniliprole treatment at 30 and 45 DAT during both the year 2022 and 2023. In the year 2022, in BIPM treatment, *A. gossypii* was 12.20 and 7.88 numbers per 3 leaves $plant^{-1}$, at 30 and 45 DAT, respectively. Where as in chemical treatment *A. gossypii* population was 17.97 and 11.25 numbers per 3 leaves $plant^{-1}$, at 30 and 45 DAT, respectively, which was significantly higher than BIPM treatment. In control, *A. gossypii* population was reduced from 27.77 to 23.94 per 3 leaves $plant^{-1}$, at 30 and 45 DAT, respectively. Similar trend of results was also observed in case of *B. tabaci* population. At 30 and 45 DAT, the *B. tabaci* populations were 3.91 and 2.97 per 3 leaves $plant^{-1}$, respectively, which was significantly lower than the treatment that consists of chorantraniliprole, *i.e.*, 6.25 and 4.91 per 3 leaves $plant^{-1}$, respectively. In control plot, *B. tabaci* population was reduced from 10.05 to 8.05 per 3 leaves $plant^{-1}$, at 30 to 45 DAT, respectively.

Similarly, during the year 2023 also the population of *A. gossypii* and *B. tabaci* was significantly lower at 30 DAT, *i.e.*, 11.74 and 8.00 per 3 leaves $plant^{-1}$, respectively and at 45 DAT, *i.e.*, 3.50 and 1.97 per 3 leaves $plant^{-1}$, respectively as compared to the treatment with chorantraniliprole. The pool data of both years showed a significant reduction of population of *A. gossypii* and *B. tabaci* in both BIPM and chorantraniliprole treatment as compared to the control (Table 2).

Table 1: Evaluation of BIPM module against sucking pests of tomato against insect (2022 and 2023) pests

Treatments	No. of pest per 3 leaves $plant^{-1}$, 2022				No. of pest per 3 leaves $plant^{-1,}$ 2023			
	30 DAT		45 DAT		30 DAT		45 DAT	
	A. gossypii	*B. tabaci*	*A. gossypii*	*B. tabaci*	*A. gossypii*	*B. tabaci*	*A. gossypii*	*B. tabaci*
T_1	12.20	3.91	7.88	2.97	11.74	3.50	8.00	1.97
T_2	17.97	6.25	11.25	4.91	16.68	7.97	12.48	3.60
T_3	27.77	10.05	23.94	8.05	24.77	11.88	24.74	7.14
S.Ed. ±	1.32	1.65	1.46	1.02	1.46	0.82	1.09	1.02
CD (0.05)	2.74	3.42	2.95	2.14	2.88	1.80	2.38	2.22

[Data are mean of seven replications; DAT = Days after transplanting]

Table 2: Evaluation of BIPM module against sucking pests of tomato against insect pests (pool)

Treat-ments	No. of pest per 3 leaves plant^{-1}			
	30 DAT		45 DAT	
	A. gossypii	*B. tabaci*	*A. gossypii*	*B. tabaci*
T_1	11.94	3.91	7.94	2.02
T_2	17.28	6.25	12.12	4.26
T_3	26.22	10.05	24.28	7.56
S.Ed. ±	1.36	1.20	1.25	1.05
CD (0.05)	2.77	2.52	2.62	2.12

[Data are mean of seven replications; DAT = Days after transplanting]

No infestation of *Tuta obsoluta* was observed in both the year. The percent fruit damage at harvest by *H. armigera* was observed the lowest at chorantraniliprole treatment (14.57 and 15.85%, respectively) in 2022 and 2023, followed by BIPM treatment (18.57% and 19.24%, respectively), which were significantly lower than control (68.45% and 65.55%, respectively). Based on the pool data, 72.29 and 80.13% of fruit damage reduction was observed over control. No significant difference of yield was observed between BIPM and chorantraniliprole treatment plots. In 2022, yield was 67.35 and 70.72 q ha^{-1} in BIPM and chorantraniliprole treatment, respectively, which were significantly higher than control (43.16 q ha^{-1}). During 2023 also, 66.84 and 70.46 q ha^{-1} yield was observed in BIPM and chorantraniliprole treatment, respectively. In control, the yield was 42.40 q ha^{-1}, which was significantly lower than both the treatments (Table 3). Based on the pool data, 36.22 and 39.36% yield increase was observed over control with 1:2.73 and 1:2.62 B:C ratio, in BIPM and chorantraniliprole treatment, respectively.

There was no significant difference of coccinellids population in BIPM and control treatment *i.e.*, 1.26 and 1.29 m^{-2}, respectively in 2022 and 1.84 and 1.76 m^{-2}, respectively in 2023; while in chorantraniliprole treatment, it was significantly reduced to 0.34 and 0.31 m^{-2} in 2022 and 2023, respectively.

The entomopathogenic fungi *Lecanicillium lecanii*, yellow sticky traps, azadirachtin and application of *Trichogramma chilonis* at various time intervals significantly reduced the pest population as these treatments acts against a wide range of pests of various crops (Harshita *et al.*, 2019; Bajya *et al.*, 2015; Halder *et al.*, 2022). The neem and its derivatives have anti-feedant, oviposition deterrent, toxicity and insect growth regulation action (Prakash *et al.*, 2008). The percent fruit damage was significantly lower and yield was higher in chlorantranileprole treatment. Chlorantarliprole is a new molecule group of insecticides belongs to diamides group which has the specific action cite and act as insect ryanodine receptor modulators and inhibit muscle actions (IRAC, 2022).

The BIPM module registered statistically at par yield with chlorantraniliprole, which might be due to the combine action of entomopathogen, azadirachtin, yellow sticky trap and *Trichogramma chilonis* which could successfully controlled the insect pest of tomato by conserving the coccinellid populations. The higher B:C ratio in BIPM was observed due to the lower price of inputs like *Lecanicillium*, yellow sticky trap, *Trichogramma* and azadiractin and lower B:C ratio in chemical control was the cause of higher price of chlorantraniliprole. Similar results in higher B:C ratio in BIPM was also observed by Halder *et al.* (2022) and Kumari *et al.* (2021).

Table 3: Evaluation of BIPM module against fruit borer of tomato (2022 and 2023)

Treat-ments	Percentage fruit damage (%)		Pool (damage %)	Damage reduction over control (%)	Yield (q ha^{-1})		Pool yield (q ha^{-1})	Yield increase over control (%)	B:C ratio
	2022	2023			2022	2023			
T_1	18.57 (25.76)	19.24 (26.01)	17.63 (24.79)	72.29	67.35	66.84	67.03	36.22	1:2.73
T_2	14.57 (22.32)	15.85 (23.46)	12.64 (20.78)	80.13	70.72	70.46	70.50	39.36	1:2.62
T_3	68.45 (55.91)	65.55 (54.04)	63.64 (52.94)		43.16	42.40	42.75		
S.Ed. ±	1.48	1.78	1.76		1.40	1.84	1.72		
CD (0.05)	2.86	3.66	3.85		2.92	3.78	3.58		

[Price of tomato Rs. 30.00 kg^{-1}]

Conclusion

In present study, based on pest population reduction, percent fruit damage, yield, coccinellids populations and overall cost benefit ratio BIPM is the most suitable practice for management of insect pests which contain yellow sticky trap, *Lecanicillium lecanii* (1×10^8 spores g^{-1}) @ 5 ml L^{-1}, pheromone traps *Trichogramma chilonis* @ 50,000 ha^{-1} (4 releases) and azadirachtin 1500 ppm. In future, we will go for development of other entomopathogenic microbes-based BIPM modules or combined product of two or more microorganisms for management of insect pests of vegetables.

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