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Abundance and Diversity of Natural Enemies Associated with *Tuta absoluta* (Meyrick) in Udaipur District of Southern Rajasthan

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ABSTRACT: The South American tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a major global threat to the tomato crop. It was firstly reported in India in 2014 and since then, the crop has sustained extensive damage. Several initiatives were attempted including the use of neem although pesticides were mostly employed to manage the pest. In this regard, a survey of natural enemies associated with *T. absoluta* spontaneously was carried out in five blocks of Rajasthan's Udaipur district (Sarada, Mavli, Girwa, Gogunda, and Vallabhnagar). To estimate diversity indices, the randomly picked plants were observed for natural enemies. The natural enemies of *Tuta absoluta* recorded during survey falls into two orders: Hemiptera and Hymenoptera, comprising 5 families, which includes *Nesidiocoris tenuis*, *Bracon* sp., *Trichogramma* sp., *Neochrysocharis formosa* and *Goniozus* sp. During the investigation, it was recorded that among the several natural enemies, *Nesidiocoris tenuis* had the highest relative density. The Mavli block had the most diversity, with a Simpson index of 1.10 and a Shannon index of 0.23.

Keywords: *Tuta absoluta*, natural enemies, diversity indices.

INTRODUCTION

The tomato (*Solanum lycopersicum* Mills.) is a commercially important horticultural crop in the Solanaceae family. It is a vital vegetable that is used in the production of medicine in addition to its fruits, leaves, and vines (Bhowmik *et al*., 2012). Tomatoes are widely grown by smallholder farmers as a high-value horticultural product for home consumption, processing, and export. However, tomato yields are poor averaging 5 tonnes per hectare, much below the global average of 34 tonnes per hectare (Anonymous, 2020). This poor yield can be attributable to both biotic and abiotic stresses. Among the biotic stresses, an alien pest, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) has recently caused yield losses of up to 100% in the absence of biological and other management techniques (Desneux *et al*., 2010). The fast distribution and proliferation of this moth may have been aided by the lack of co-evolved natural adversaries in newly invaded areas. Chemicals have been employed to manage the pest, but they are costly and dangerous to the environment (Luna *et al*., 2012). In this situation, biological control may be a cost-effective and ecologically friendly method of controlling *T. absoluta* (Chailleux *et al*., 2012).

In this sense, it is necessary to perform a survey of natural enemies associated with *Tuta absoluta*. Species richness and abundance are calculated using several diversity indices. Diversity may be increased by having a vast number of species. Similarly, improving the uniformity of individual distribution within species will enhance variety. The biodiversity studies will help researchers to understand the number and species richness of pest-associated natural enemies. It provides

a quantitative assessment of the relationship between insect pests and their natural opponents. This information aids in the understanding of insect ecology and hence serves as a guide for building area-specific management techniques that reduce pest damage effectively.

MATERIALS AND METHODS

The survey was carried out during *Rabi* 2021-2022, with the purpose of determining the natural enemies of tomato pinworm. Natural enemy populations were counted at 25 different locations across five Udaipur district blocks (Sarada, Mavli, Girwa, Gogunda, and Vallabhnagar) with five villages selected from each block. Natural enemy observations were collected at 15-day intervals from 10 randomly selected tomato plants using the visual-count technique. Different stages such as eggs, larvae and pupae were collected and marked separately in the field. Based on the availability of the stages at the field visit, a known number of infected *Tuta absoluta* early and late instar larvae were collected. The samples together with the tainted leaves and fruits were brought to the laboratory unharmed and grown to test for parasitoids or diseases. Predators were collected using an aspirator or a direct approach and the collected predators and parasitiods were stored in alcohol and labeled. The specimens were identified at the National Bureau of Agricultural Insect Resources (NBAIR) in Bengaluru.

The following mathematical analyses have been done:

(a) Mean density:

Mean density = $\Sigma\ Xi/N$

Where, *Xi* = *No*. of natural enemies in ith sample

N = Total No. of plants sampled

(b) Relative density:

Relative density (RD %)

$$= \frac{\text{Number of individual of species}}{\text{Total number of individual of all species}} \times 100$$

(c) Diversity indices:

Suitable alpha-diversity indices used as per the recorded data:

Shannon Diversity Index: - Σpi ln(pi)

Simpson's Diversity Index as D: 1/ Σ(pi)2

Where, p*i* = the decimal fraction of individuals belonging to ith species.

RESULTS AND DISCUSSION

The mean density and relative density of natural enemies associated with pest at different locations recorded in Udaipur district of Rajasthan during *Rabi* 2021-2022 were represented in the Table 2.

Table 1: The recorded natural enemies of *Tuta absoluta* during survey in Udaipur district of Rajasthan.

Order	Family	Natural enemies
Hemiptera	Miridae	*Nesidiocoris tenuis*
Hymenoptera	Trichogrammatidae	*Trichogramma* sp.
	Braconidae	*Bracon* sp.
	Eulophidae	*Neochrysocharis formosa*
	Bethylidae	*Goniozus* sp.

As there is scarcity of literature available on abundance and diversity of natural enemies associated with *Tuta absoluta* much discussion could not be possible, related literature have been discussed below.

The natural enemies of *Tuta absoluta* were represented as five families in two orders of Class Insecta (Table 1) (Fig. 1). These natural enemies were also recorded by Ballal *et al*. (2016) during surveys in southern India. At all locations *Nesidiocoris tenuis* was observed to be the highest relative density among the all natural enemies (Table 2). Our findings are in agreement with earlier reports by Arno *et al*. (2009); Zappala *et al*. (2013) indicating *N. tenuis* was a predator of *Tuta absoluta*. Other reports have shown that *N. tenuis* aids in the management of pests such as lepidoptera, thrips, white flies and a variety of other pests in greenhouses by Hughes *et al*., (2009); Gavkare and Sharma (2016). Our findings also agreed with Al-Jboory *et al*. (2012) who recorded that *N. tenuis*, *Orius* sp. and *Brocon sp*. as natural enemies on *Tuta absoluta* in tomato ecosystem, of which *N. tenuis* and *Bracon* sp., also recorded in our investigation; while there was no record of *Orius sp*. in our study. The current findings are consistent with those of Luna *et al*. (2011); Biondi *et al*. (2013) who claimed to have discovered *Neochrysocharis formosa* parasitizing *T. absoluta* larvae in tomato fields in Northern Buenos Aires region, Argentina and Italy, respectively. Desneux *et al*., 2010 stated that *Bracon concolorans* (Marshall) was discovered as a larval parasitoid of *T. absoluta* in Jordan, Cyprus, Egypt, France, Italy, and Spain, which validates our findings.

According to the data enumerated in (Table 3) for the diversity of natural enemies associated with *Tuta absoluta*, was observed that Mavli block had the highest Simpson indices value (1.10) followed by at Vallabhnagar (1.04), Girwa (1.03), Gogunda (1.02); while, at Sarada block this value was lowest (1.01). Correspondingly the highest Shannon index value was noted at Mavli (0.23) followed by Vallabhnagar (0.11), Girwa (0.08), Gogunda (0.06); while it was lowest at Sarada (0.05) (Table 3). The current study found that in the Udaipur district, Mavli block had the most species diversity and Sarada block had the lowest species diversity (Fig. 2).

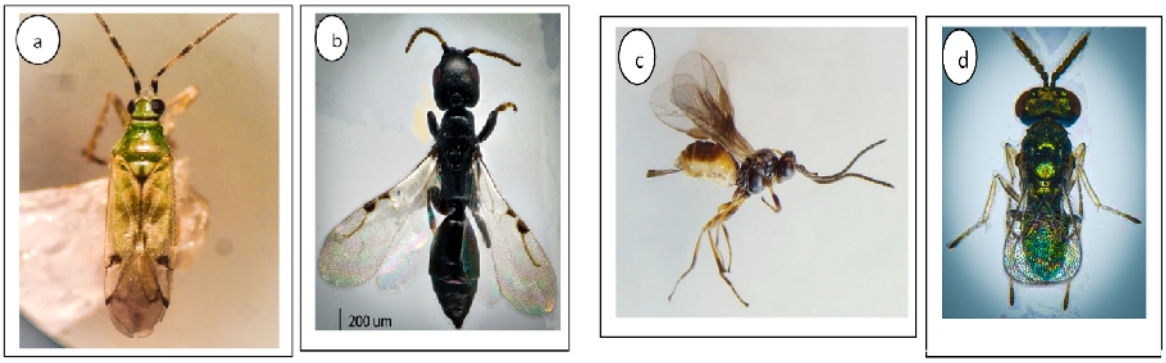
Table 2: The mean and relative density of natural enemies associated with *Tuta absoluta* at different locations of Udaipur district during *Rabi* 2021-2022.

Natural enemies	Locations				
	Sarada	Mavli	Girwa	Gogunda	Vallabhnagar
N. tenuis	4.28 (99.7)	9.28 (95.2)	7.5 (98.4)	6.86 (98.8)	7.2 (97.8)
Bracon sp.	0 (0.00)	0.12 (1.23)	0.12 (1.57)	0.08 (1.15)	0.06 (0.81)
Trichogramma sp.	0.04 (0.92)	0.31 (3.08)	0 (0.00)	0 (0.00)	0 (0.00)
N. formosa	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.10 (1.35)
Goniozus sp.	0 (0.00)	0.04 (0.41)	0 (0.00)	0 (0.00)	0(0.00)
Total	4.32	9.74	7.62	6.94	7.36

*Values outside the parenthesis are mean density (no. / plants).
** Values inside the parenthesis are relative density

Table 3: Summarized diversity indices of natural enemies associated with *Tuta absoluta,* in different locations of Udaipur district of Rajasthan.

Location	Shannon diversity index	Simpson diversity index
Sarada	0.05	1.01
Mavli	0.23	1.1
Girwa	0.08	1.03
Gogunda	0.06	1.02
Vallabhnagar	0.11	1.04



(a) *Nesidiocoris tenuis* (b) *Goniozus* sp. (c) *Bracon* sp. (d) *Neochrysocharis formosa*

Fig. 1. a-d. Natural enemies of *Tuta absoluta*.

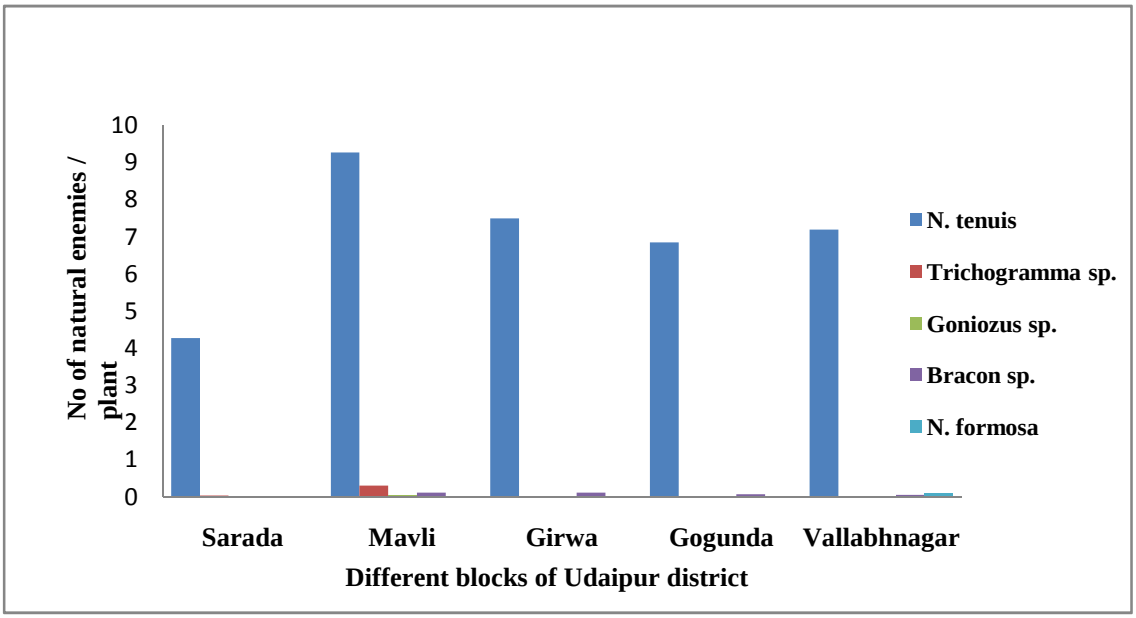


Fig. 2. Diversity of natural enemies associated with *Tuta absoluta*, in Udaipur district.

CONCLUSION

From the current study, it can be inferred that the Mavli block had the highest diversity index value, which denotes the highest species richness and quantity of natural enemies. It was observed that the diversity varied depending on the region. However, *Nesidiocoris tenuis* populations dominated all of the Udaipur district's localities in southern Rajasthan.

FUTURE SCOPE

There is plenty of scope to build the studies that can enhance and integrate biological control. This research would aid grenuy in the implementation of pest IPM tactics. In order to manage the pest, future research should concentrate on mass production and field release of natural enemies.

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Conflinct of Interest: None.

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