Journal of Biological Control, 31(2): 69-73, 2017, DOI: 10.18311/jbc/2017/15751

Research Article

Studies on evaluation of *Nesidiocoris tenuis* (Reuter) (Hemiptera: Miridae) preying on invasive insect pest *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and its damage to tomato plant

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ABSTRACT: Recently, in India severe incidence by the invasive insect pest, the South American tomato pinworm, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) was reported for the first time infesting tomato crop in Pune, Maharashtra. Later infestation was reported in the other states of India. In *T. absoluta* infested tomato field, zoophytophagous mirid, *Nesidiocoris tenuis* (Reuter) was observed to be associated with tomato pinworm. A net house experiment was conducted to evaluate *N. tenuis* on *T. absoluta* infested tomato plants. The aim was to ascertain, if releases of *N. tenuis* could reduce *T. absoluta* infestation or due to its phytophagous nature it could lead to damage of tomato plants. The treatments comprised of a) release of *N. tenuis* on *T. absoluta* infested plants, b) releases of *N. tenuis* on uninfested plants and c) *T. absoluta* infested plants were maintained as control. Results indicated that in treatment with *N. tenuis*, number of *T. absoluta* eggs and the % mined area were lesser by 83.25% and 89%, respectively. Overall number of necrotic rings per plant during all 10 weeks caused by *N. tenuis* was significantly lesser in *T. absoluta* infested plants treated with *N. tenuis* (0.74±0.18) compared to treatment with *N. tenuis* alone (2.16±0.35). Flower abortion was also not observed at this density (total release of 6 adults/plant). When mean number of *T. absoluta* eggs were high in 3rd week (9.54 eggs/plant) number of necrotic rings were negligible though average number of *N. tenuis* was 4.1/plant during the same week. During 5th week when number of *N. tenuis* was on peak (11.2/plant), the average numbers of *T. absoluta* eggs and necrotic rings were 3.61eggs/plant and 0.46/ plant, respectively. It shows that number of necrotic rings per plant increased with decreasing *T. absoluta* population. Further studies are needed to investigate the precise role of *N. tenuis* as a natural mortality factor of *T. absoluta* in field situations and its damage potential after a long interaction with plant in pest scarcity and when it occurs at high density.

KEY WORDS: *Nesidiocoris tenuis*, Necrotic rings, Tomato, *Tuta absoluta*, Zoophytophagous

(Article chronicle: Received: 22.03.2017; Revised: 10.05.2017; Accepted: 15.05.2017

INTRODUCTION

Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae), is considered as serious pests of tomato in South America (Miranda *et al*. 1998; Desneux *et al*., 2010; Desneux *et al*. , 2011). Its origin is South America. It was first recorded in India during November 2014 in Pune, Maharashtra, infesting tomato crop. In Karnataka it was first observed in Bangalore and Kolar districts. Because of concealed feeding behavior of this gelechiid moth, chemical control is not effective. During survey of infested tomato fields in Karnataka, *Nesidiocoris tenuis* (zoophytophagous mirid) was found to be associated with tomato pinworm in all the fields (Ballal *et al.,* 2016). *N. tenuis* has been found to control thrips, whiteflies, leaf miners, spider mites and eggs and early larval instars of cutworm, *Spodoptera litura* in greenhouses (Arzone *et al*., 1990; Calvo and Urbaneja, 2003; Carnero *et al*. 2000; Marcos and Rejesus 1992; Solsoloy *et al*., 1994; Urbaneja *et al*. 2005). Recently it has been also reported as a predator of *Tuta absoluta* (Urbaneja *et al.* 2009). In India, *N. tenuis* has already been reported predating on whitefly and eggs and early instars of *Tuta absoluta* in tomato ecosystem (Sridhar *et al*., 2012a; Sridhar *et al*., 2012b; Sridhar *et al*., 2014). Therefore, in present study, we have tried to observe if releases of *N. tenuis*, could reduce *T. absoluta* infestation in Indian condition. In India, it is reported as pest on sesame (Ahirwar *et al*., 2009), tobacco (Patel, 1980). So its status as a predator is not clear. Damage caused by this bug includes brown necrotic rings on shoots, stem, pedicels of leaves and flowers. It may cause flower abortion. There are reports that due to pest scarcity *N. tenuis* causes damage to tomato plant (Calvo *et al*., 2009; Sanchez, 2008). The other objective of this study was to ascertain if *N. tenuis* has to release for control of *T. absoluta*, whether its release could lead to significant damage of tomato plants due to its phytophagous nature. This information could be a basis to optimize role of *N. tenuis* for management of *T. absoluta* in horticultural ecosystem.

MATERIALS AND METHODS

The experiment was conducted in experimental cage (90cm×45cm×45 cm) in greenhouse of ICAR-National Bureau of Agricultural Insect Resources, Bangalore. *N. tenuis* stages were collected from infested tomato fields in and around Bangalore and were reared on tomato plants and eggs of *Corcyra cephalonica* were provided as prey *ad libitum* in acrylic cages in the laboratory**.**. Tomato seed variety "NS-6237" was sown in the polystyrene tray with cells filled with vermicompost and cocopeat mixture. After three weeks, seedlings were transplanted individually in pots. Afterwards these potted plants were used for the experiment. Two potted plants were kept in each insect rearing cages (3 feet length) in net house. Experiment was carried out consisting of three treatments with 12 replications in a complete randomized design. i) In first treatment (*T. absoluta* + *N. tenuis*) 1 pair of *T. absoluta* adult / plant were released twice at 15 days interval. In this treatment adults of *N. tenuis* were released @ 2 adults (1 pair) per plant and total of 3 releases were made at weekly interval starting from a day after release of *Tuta* moth, ii) In second treatment only *T. absoluta* adult was released at the rate of 1 pair of *T. absoluta* adult /plant, twice at 15 days interval and iii) In Third treatment only adults of *N. tenuis* were released at the rate of 2 adults (1 pair) / plant and 3 releases were made at weekly interval. Each treatment was replicated 12 times. Three releases of predator were made by assuming that pest multiply fast and according to literature *N. tenuis* take some time for establishment.

Observations

Plants were monitored weekly for 10 weeks after transplanting. Observations were made on total number of mines on selected five leaves (upper half portion of each plant) and eggs of *T. absoluta*. For calculation of leaf area damaged by *T. absoluta* 10 leaves were selected randomly from each plant and rated 0, 1, 2, 3, 4 or 5 when the mined area was 0, 1-25%, 26-50%, 51-75%, 76-99% or 100% of the leaf surface, respectively as mentioned by Calvo *et al.* (2012). For *N. tenuis*, nymph and adults were counted from three leaves from upper, one from middle and one from lower third of plant. To measure damage by *N. tenuis* on tomato plant, total number of brown rings around stem, shoot, leaf and petiole of flower cluster were recorded. Number of truss, total number of flowers and fruit set per plant was also observed where *N. tenuis* was released. In addition of that total height of all plants and total number of leaves were also taken in all replications.

Statistical analysis

Data was analyzed using one way analysis of variance (ANOVA) using IBM SPSS (version 16.0). Before analysis, total number of *N. tenuis* adult and nymph, number of *T. absoluta* eggs and necrotic rings and percentage of *T. absoluta* affected tomato leaf area were subjected to log and arcsin transformation, respectively. Graphical expression created using Microsoft Excel (version 2010).

RESULTS AND DISCUSSION

Number of *T. absoluta* eggs peaked in 3rd week after the release of adult moths in both the treatments, *T. absoluta* alone and *T. absoluta +N. tenuis* and were significantly higher in the treatment *T. absoluta* alone compared to *T. absoluta +N. tenuis* ($F_{1,180}$=183.65, P<.0001) (Fig. 1) as third treatment was not considered due to lack of *T. absoluta* infestation. *T. absoluta* larvae start feeding on leaf which results in reduction of healthy leaf area. It was observed that leaf area damage was significantly more in treatment where *T. absoluta* was released alone than the treatment *T. absoluta +N. tenuis* ($F_{1,180}$ =264.02, P<.001) (third treatment was not considered due to lack of *T. absoluta* infestation). % affected leaf area by *T. absoluta* increased continuously and 90% leaf area damage was observed, after 10 weeks of 1st release in the treatment with *T. absoluta* alone compared to treatment *T. absoluta +N. tenuis* where % damaged area was approx. 9 times less at the end of the experiment (Fig. 2). Where *N. tenuis* was released, number of *T. absoluta* eggs and % damaged area by *T. absoluta* were significantly lower, which confirms that at the density of 6 adults per plant (total 3 releases @ 2 adults/plant), *N. tenuis* could control *T. absoluta* population. This result corroborates with earlier findings that demonstrated that *N. tenuis* can suppress *T. absoluta* and whitefly alone in tomato (Urbaneja *et al*., 2009; Calvo *et al*., 2009).

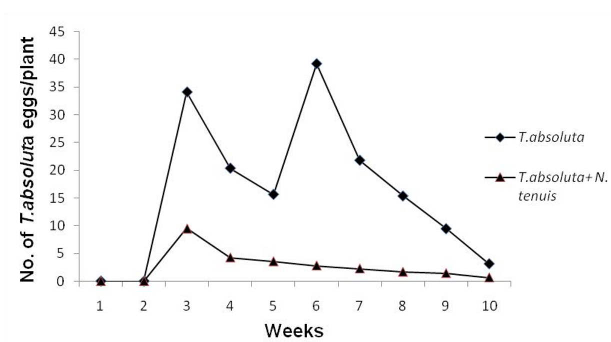

Fig. 1. Mean number of *Tuta absoluta* eggs per plant per week.

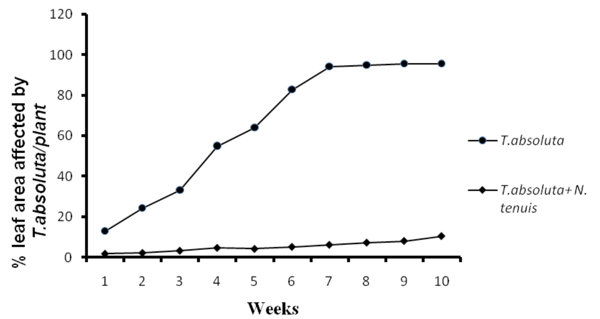

Fig. 2. Mean % affected leaf area by *Tuta absoluta* per week.

Mean number of *N. tenuis* was significantly higher in treatment *T. absoluta* +*N. tenuis* compared to treatment *N. tenuis* alone ($F_{1, 180}$ =25.06, P<.001) (here only two treatments were considered as in treatment 2, only *T. absoluta* was released alone). In treatment *T. absoluta* +*N. tenuis*, number of *N. tenuis* peaked in 5th weeks of first release of predator, then number of predator decreased during next two weeks; further increased during the following weeks (Fig. 3). In the same treatment, first nymph appeared after a week of first release of predator with mean number 3.92/plant. Slowly they attained first peak in 5th week followed by decrease in number and again attained second peak in 10th week. Late instar nymphs were prevalent in the population. Total 2-3 generations of this bug were observed in treatment *T. absoluta* +*N. tenuis*. In treatment *N. tenuis* alone, number of bug increased during first four weeks after which it started decreasing during following weeks. Number of adult was low compared to nymphs. Mostly 3rd and 4th instars nymphs were observed. In our study it is observed that *N. tenuis* could survive and multiply in presence of *T. absoluta.* It was also observed that *N. tenuis* could not complete one generation without pest and number of adults and nymphs were very less when released alone. This corroborates with the Urbaneja *et al.,* (2005) results where they found that the bug although survive on tomato plant but could not complete development in absence of supplemental food (*E. kuehniella*). It shows the low ability of *N. tenuis* to survive without pest solely on tomato plant. This low ability to survive may result in low damage potential by this bug. It was also observed that nymphs and adults were aggregated in the top part of tomato plant. This bug prefers this region contains 18% protein content compared to lower part which as it contains 10 % protein content (El-Dessouki *et al*., 1976).

First necrotic ring was appeared in 4th week in treatment *T. absoluta* +*N. tenuis* while in treatment *N. tenuis* alone first necrotic ring was observed in second week and continuously it started to increase till the end of experiment. Consequently, the number of necrotic rings increased with time in both the treatments (Fig. 4). However, number of necrotic rings in treatment *T. absoluta* +*N. tenuis* were significantly lower compared to treatment *N. tenuis* alone ($F_{1, 180}$=73.92, P< 0.001). It shows although *N. tenuis* has capacity for controlling insect pests, but when there is scarcity of pest, it starts feeding on the plant which is evident in form of necrotic rings in present study. At low prey densities, *N. tenuis* cause damage to tomato and becomes phytophagous (Sanchez *et al*., 2006; Calvo *et al*., 2009; Arno *et al*., 2009, 2010; Castane *et al*., 2011). Although no. of necrotic rings in treatment *T. absoluta* +*N. tenuis* are not enough to cause economic damage to plant. In our findings, which also corroborates with Sanchez (2008) we have also found that *N. tenuis* has a low damage potential on tomato as the number of necrotic rings was low (in the range not associated with yield loss) (Sanchez, 2008) and we have not observed flower abortion. Therefore, from the current study it is clear that damage caused by *N. tenuis* does not seem to be significant for the current conditions. However Sanchez (2008) reported that *N. tenuis* could cause 50% flower abortion when whitefly number was almost negligible and *N. tenuis* occurred at 2 individuals per plant in tomato.

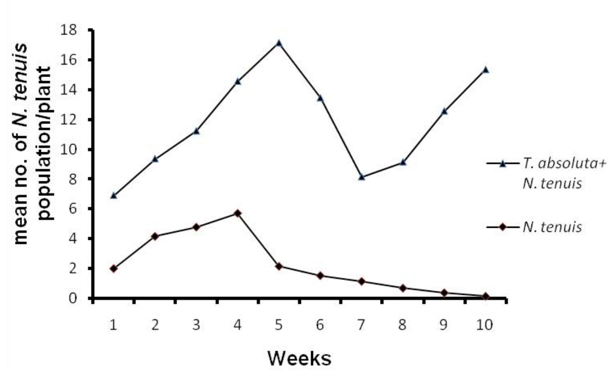

Fig. 3. Mean number of *Nesidiocoris tenuis* per plant per week.

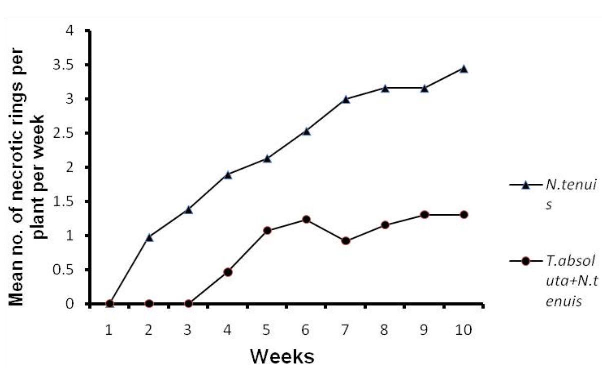

Fig. 4. Mean number of necrotic rings per plant per week.

Number of necrotic rings per plant increased with decreasing number of *T. absoluta* eggs indicating that in the presence of the pest, necrotic rings caused by *N. tenuis* are less and survivability of zoophytophagous mirid is more (Fig. 5). When mean number of *T. absoluta* eggs were high in 3rd week (9.54 eggs/plant) number of necrotic rings were negligible though average number of *N. tenuis* was 4.1/ plant during the same week. Gradually mean number of *N. tenuis* increase with decrease of *T. absoluta* eggs. During 5th week when number of *N. tenuis* was on peak (11.2/plant), the average number of *T. absoluta* eggs and necrotic rings were 3.61eggs/plant and 0.46/ plant, respectively. Further in last week (10th week) mean number of *N. tenuis* was 8.7/ plant with mean number of *T. absoluta* eggs and number of necrotic rings were 0.69 eggs/plant and 1.59 necrotic rings/ plant, respectively. It justifies the above statement. It is also clear that when pest density decreases, *N. tenuis* may feed on plant. However, in field condition survivability of *N. tenuis* is not a question as it can feed on other insect pests. In the current study, no flower abortion was observed in treatment where *N. tenuis* adults were released alone.

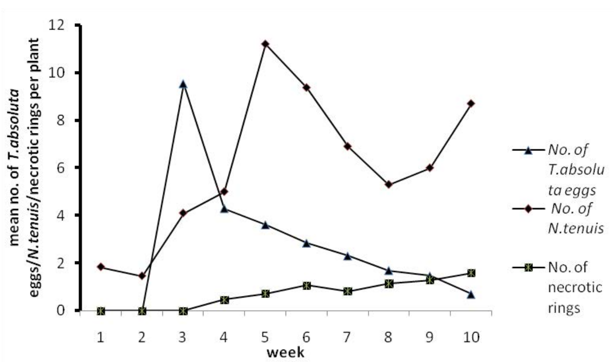

Fig. 5. Mean number of *Tuta absoluta* eggs/*Nesidiocoris tenuis*/ necrotic rings per plant per week in treatment *T. absoluta* + *N. tenuis.*

In summary, we could observe that *Nesidiocoris tenuis* was able to feed on *Tuta absoluta* in tomato. However, at the time of pest scarcity it may become phytophagous so it is mandatory to monitor and keep check on its population to avoid any further risk and economic damage to tomato crop. However in real field conditions there is many more pests on which it can feed and avoid plant damage. *N. tenuis* is polyphagous predator and it can survive by preying upon other sucking pests like thrips, spider mites etc (Urbaneja *et al*., 2003, 2009). As per current study it has low potential of damage, therefore it can be considered beneficial predator at densities similar to those used in current study. Further research on long term interaction with the plants at different densities of *N. tenuis* should be carried out to determine whether *N. tenuis* can be used in augmentative biological control or in IPM in India. Further studies should explore its ability to survive on tomato in presence of different pest, *viz*., *T. absoluta*, thrips, spider mites etc.

ACKNOWLEDGEMENTS

The authors are grateful to the Indian Council of Agricultural Research, India, for the facilities provided for conducting the study.

CONFLICT OF INTEREST

The authors declared that they have no conflict of interest because this paper is a part of institute project. The study was conducted by first author. Second author technically supported and encouraged the first author.

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