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Research Article

Fitness and population build-up of a native predatory bug, *Nesidiocoris tenuis,* on tomato pinworm, *Phthorimaea absoluta,* in a modified crop habitat

AMALA UDAYAKUMAR*, H. S. VENU and TIMALAPUR M. SHIVALINGASWAMY

Division of Germplasm Conservation and Utilisation, ICAR-National Bureau of Agricultural Insect Resources, H A Farm Post, P B No 2491, Bangalore – 560024, Karnataka, India
**Corresponding author E-mail:* amala.uday@gmail.com

ABSTRACT: The tomato pinworm damage, population build-up, the damage and longevity of native predatory bug, *Nesidiocoris tenuis* in sole crop and diversified crop of tomato (pumpkin and sunn hemp as border crop + a patch of sunn hemp as hedgerow) were studied. Infestation of tomato pinworm, *Phthorimaea absoluta* was found to be the highest in the sole crop (5.60 live mines/plant at 20 DAP) compared to the diversified crop of tomato (1.50 live mines per plant). No significant difference in the number of necrotic rings per plant was observed between the sole crop and the diversified crop of tomatoes. The development period of nymphs of *N. tenuis* was the shortest in tomatoes followed by pumpkin. The results of the present study confirmed the role of crop diversification in supporting the population build-up of predatory bug *N. tenuis* in effecting the biological control of pinworm in tomato crop.

KEYWORDS: Cover crop, conservation, *Nesidiocoris tenuis*, *Phthorimaea absoluta*

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INTRODUCTION

Tomato pinworm, *Phthorimaea absoluta* (Meyrick) (Lepidoptera, Gelechiidae) is an economically important insect pest reported to infest many solanaceous plants like tomato, eggplant, bell pepper, tobacco and other related weed flora (Urbeneja *et al.,* 2005). The pest was reported in India during the year 2014 causing extensive damage in tomatoes in different parts of Maharashtra (Chandrashekar and Shashank, 2015). *Nesidiocoris tenuis* Reuter (Heteroptera: Miridae) as a naturally occurring predator of eggs and early larval instars of tomato pinworm was reported by many researchers (Sridhar *et al.,* 2012a; Sridhar *et al.,* 2012b; Ballal *et al.,* 2016; Sylla *et al.,* 2016). This predator was commercially used for biological control of different species of whiteflies viz., *Trialeurodes vaporariorum* Westwood and *Bemisia tabaci* (Gennadius) (Hemiptera, Aleyrodidae) (Sanchez, 2009; Hughes *et al.,* 2009) in Australia. *Nesidiocoris tenuis* was reported to feed to the extent of more than 100 eggs of *P. absoluta* per day (Molla *et al.,* 2014). It was also reported to predate upon other soft-bodied insects like thrips, mites and eggs and early instars of lepidopteran insects (Arno *et al.,* 2010). This zoophytophagous bug was also reported to cause minor plant damage like necrotic rings in vegetative and floral parts in tomatoes (Calvo *et al.,* 2009).

Nesidiocoris tenuis, though a well-documented efficient natural predator of tomato pinworm often, has also been reported to cause significant damage to crops under higher population densities (Castane *et al.,* 2011). Thus, there is a conflict of interest. Therefore, there is a need to integrate suitable cover crops to ameliorate the crop damage caused by *N. tenuis* to tomatoes and also to conserve as well as favour the fitness parameters of the natural predator. Cover crops provide natural enemies with pollen, nectar and shelter to increase their survival, reproduction and longevity (Rodriguez-Saona *et al.,* 2012). These companion crops also provide alternate prey to the predators positively influencing their survival (Landis *et al.,* 2000). The activity of beneficial arthropods can be enhanced by the integration of flowering crops into simplified agroecosystems (Bommarco *et al.,* 2013; Tschumi *et al.,* 2016). The present study was taken up to understand the population build-up of *N. tenuis* in a sole crop and diversified crop of tomato and its biological parameters under greenhouse conditions.

MATERIALS AND METHODS

The present study was carried out in the experimental farm of ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Yelahanka Campus, Bengaluru, India,

from January 2017 to April 2017. A field trial was conducted with tomato crop in an area of 0.25 acre where in tomato was grown as a sole crop, and it was also grown along with diversified crops, which included pumpkin and *Lablab* plus sunn hemp (*Crotolaria juncea*) as a border crop. Observations were made on the build-up of the population of predatory mirid bug, *Nesidiocoris tenuis*. The number of live mines per plant by pinworm, *Phthorimaea absoluta* were recorded at 20,40 and 60 Days After Planting (DAP). The number of nymphs and adults of *N. tenuis* per plant was recorded from three leaves each from top, middle and lower at 20, 40 and 60 days after planting. The number of necrotic rings caused by *N. tenuis* around the stem, petiole and flower buds and flower clusters in sole crop as well as diversified crop of tomato was observed and recorded at 20, 40 and 60 DAP.

Development parameters of predatory bug, *Nesidiocoris tenuis*

The crops *viz*., pumpkin, sunn hemp, niger and tomato were planted under greenhouse conditions. The host plants were covered with a fine mesh to prevent escape and also migration of bugs to other host plants. Five replicates were maintained. Fifteen numbers of one day old adults of *N. tenuis* were released at uniform crop stage of the four crops, and the longevity of the adult bugs were recorded. Fifteen number of first instar nymphs of *N. tenuis* were released during the pre-flowering stage of the crops. The survival rate of the released nymphs and the time taken to complete the nymphal stage was recorded.

Data analysis

The plant damage caused by the pinworm and abundance of *N. tenuis* in the sole and diversified crop of tomato were compared using Student's t-test. Analysis of variance (GLM in SAS 9.3; SAS Institute, Cary, NC) was used to compare the developmental parameters of *N. tenuis* in different crops. Where significant difference was detected, treatment means were separated using Tukey's HSD Test (0.5%).

RESULTS

Significant differences were observed between the number of live mines per plant caused by the pinworm in tomatoes at 20 DAP (t value = 5.25), 40 DAP (t value = 5.03) and 60 DAP (t value = 6.50) (Figure 1). The number of live mines at 20 DAP in sole crop and diversified crop was 5.60 mines/plant and 1.50 mines/plant, respectively. During 40 DAP, the number of live mines per plant was 3.30 and 1.00 in sole crop and diversified crop, respectively. On 60 DAP, the number of live mines were 4.10 and 0.90 in the sole crop and diversified crop, respectively. There was a steady increase in the number of adults per plant. A significant difference in the number of *N. tenuis* per plant at 20 (t value = 2.75), 40 (t value = 6.38) and 60 DAP (t value = 2.72) was observed (Figure 2).

No significant difference was recorded in the number of necrotic rings per plant at 20 DAP (Figure 3) in both sole (1.2 necrotic rings per plant) and diversified crop of tomato (0.6 necrotic rings per plant). At 40 DAP, there was a significant difference in the number of necrotic rings per plant between the sole crop (0.68 necrotic rings per plant) and diversified crop (1.23 necrotic rings per plant) of tomato (F value = 7.36; P<0.0001). The number of necrotic rings per plant in the sole crop and diversified crop of tomato were 1.21 and 1.70 respectively at 90 DAP.

There was a significant difference in the longevity of female predatory bugs when reared in different host plants (F value = 12.44; P value<0.0001) (Table 1). Tomato crops recorded the highest adult longevity (20.21±1.78 days) which was statistically on par with pumpkin (18.42±1.63 days). Sunn hemp recorded a longevity of 15.80±2.74 days. Niger crops recorded the least adult longevity of 11.81±4.74 days.

The nymphal development period significantly varied between the different crop plants (F value=7.58; P<0.0001). The duration of development was the shortest in tomato (12.63±1.94 days) which was statistically on par with

Table 1. Development parameters of *N. tenuis* in different host plants

Host plants	Nymphal development period (days)	Nymphal survival rate (%)	Longevity of adults (days)
Pumpkin	13.60 ± 2.70^{bc}	60.00^{ab}	18.42 ± 1.63^{ab}
Niger	19.20 ± 1.30^{a}	42.65^{b}	11.81 ± 4.74^{c}
Sunn hemp	16.21 ± 3.21^{ab}	41.33^{b}	15.80 ± 2.74^{b}
Tomato	12.63 ± 1.94^{c}	74.67^{a}	20.21 ± 1.78^{a}
F value	7.58	6.71	12.44
P value	P<0.0001	P<0.0001	P<0.0001

Means followed by same letter do not differ significantly from each other by Tukey's HSD 0.05% level of significance

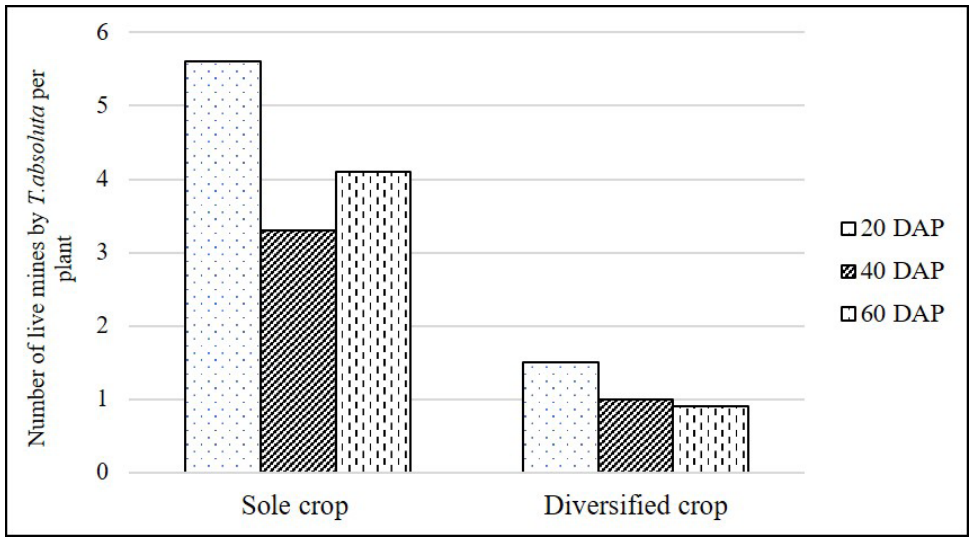

Figure 1. Number of live mines per plant caused by *P. absoluta* per plant.

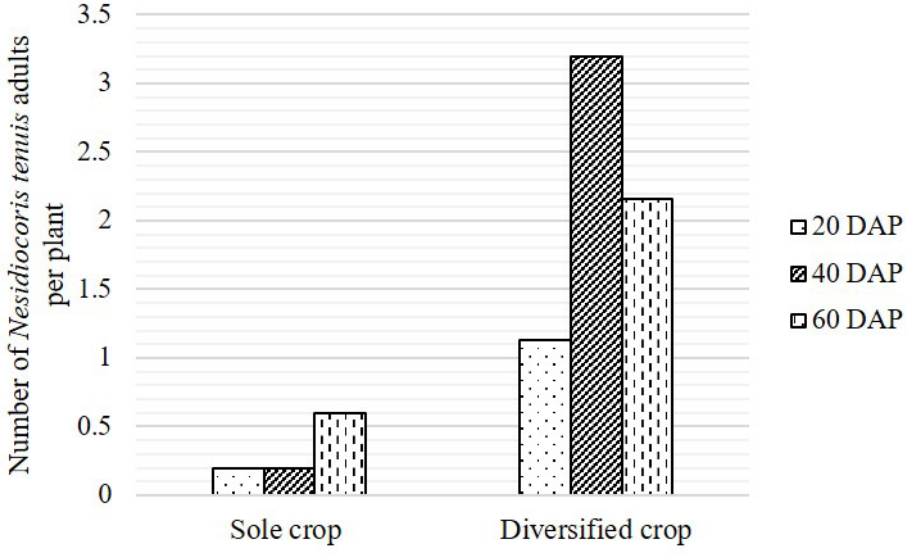

Figure 2. Number of *N. tenuis* adults per plant.

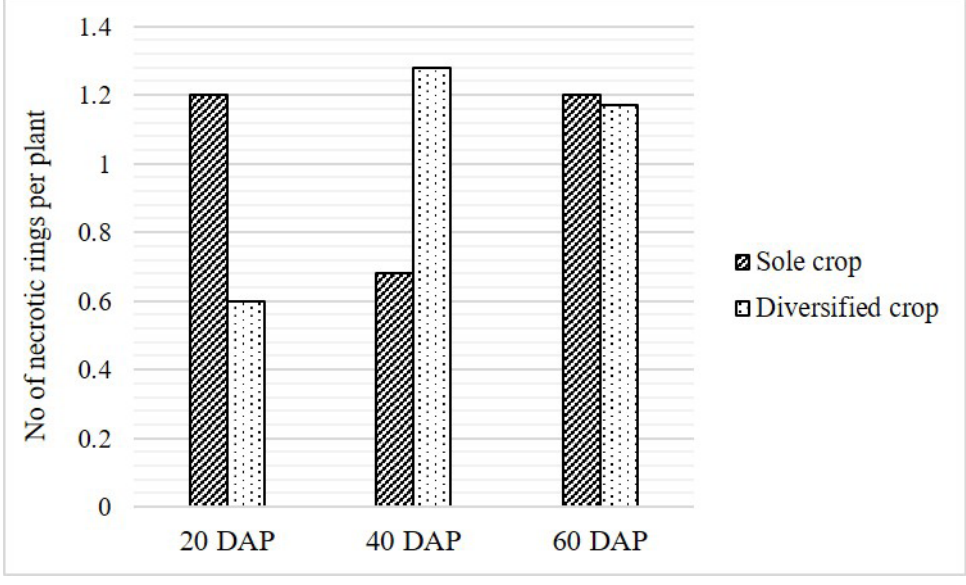

Figure 3. Number of necrotic rings per plant caused by predatory bug, *Nesidiocoris tenuis* in different host plants.

pumpkin (13.60±2.70 days). The nymphal development period recorded in sunn hemp (16.21±3.21 days) and niger (19.20±1.30 days) were statistically on par with each other. There was a significant difference in the survival percentage of the nymphs of *N. tenuis* between the crop plants (F value = 6.71; P<0.0001). The survival rate of the nymphs of *N. tenuis* was the highest in tomato (74.67%) which was on par with pumpkin (60%). Niger recorded a nymphal survival rate of 42.65% which was on par with that of sunn hemp (41.33%).

DISCUSSION

The damage caused by the pinworm, *P. absoluta*, in the sole crop of tomato, was significantly higher compared to the diversified crop. The number of adults of the predator, *N. tenuis*, per plant was significantly more in the diversified crop of tomato compared to the sole crop. *N. tenuis* was reported to more actively predate upon the eggs and early instar larvae of *P. absoluta* when the population of the latter is higher. The population of the predator was found to be relatively higher in the cover crops comprising pumpkin, niger and sunn hemp. The cover crops had more ovipositional scars as compared to tomato as a sole crop. The adult bugs were found actively feeding on the pollen of pumpkin flowers in the diversified crops. In the present study, pumpkin and niger crops were found infested with the aphids, *Aphis craccivora* Koch and *Brevicoryne brassicae* Linnaeus (Hemiptera, Aphididae). These, in addition to *N. tenuis*, harboured considerable number of other predators like Coccinellid beetles and Sphecid wasp, *Carinostigmus* sp.

Cover crops shelter alternative prey, thus indirectly benefiting the natural population of predators (Finke and Denno, 2002; Janssen *et al.,* 2007). These eco-feast crops play a vital role in sustaining the natural enemy pool in agricultural ecosystems during a time of less abundance of target insect hosts. Increasing plant diversity was reported to provide ecological service by regulating insect pests through enhanced activity of natural enemies (Andow *et al.,* 1991; Gurr *et al.,* 2003). Thomine *et al.* (2020) reported that though polyculture of tomato with squash and soybean reduced the abundance of *N. tenuis*, it contributed to the sustained activity of this predator resulting in more efficient biological control of the pinworm than in tomato grown as a monocrop.

The survival rate of nymphs of *N. tenuis* was the highest in tomato, the main host, followed by pumpkin. The released bugs were observed toactively orient towards the crops in the glasshouse and during the flowering stage of the crop, they were found to congregate on the flowers of the pumpkin to feed on the pollen. Nymphal development period was the shortest in tomato followed by pumpkin. Necrotic feeding damage was observed in the plants released with the nymphs of *N. tenuis*. Lundgren and Wiedenmann (2004) reported that when phytophagous and zoophytophagous hemipteran predators fed on pollen, it enhanced their longevity and survival rate. In another interesting study, it was found that the zoophytophagous mirid predator, *Macrolophus pygmaeus* Rambur, was able to complete its development on several crop and non-crop plants like tomato, pepper, cucumber and eggplant even in the absence of its insect prey (Lykouressis *et al.,* 2001).

The reason for the relatively lower level of necrotic rings per plant caused by *N. tenuis* might be due to its lower population as compared to the number of live mines per plant caused by pinwormin the present study. The predatory bug was reported to cause more damage at higher levels of population compared to its prey (Sancheza, 2008). Though *N. tenuis* is reported to be zoophytophagous in nature (Sanchez, 2008), the population of the predator was found to decrease in tomato crop in the absence of the prey. The predator was reported to cause minor feeding damage in tomato only under high population density (Biondi *et al.,* 2016). Urbaneja *et al.* (2005) reported that *N. tenuis* could not complete its lifecycle unless it feeds on insect prey. The lower feeding damage recorded in the alternate crop plants in the present study suggested that these plants could be integrated with tomato to reduce or prevent phytophagy of *N. tenuis* even under higher levels of population. Arno *et al.* (2010) reported that *Sesamum indicum* could be used as a trap crop to favour the multiplication of *N. tenuis* during the later crop cycle of tomato. The results of the present study suggest that in addition to tomato crop, pumpkin could also be cultivated for the on-field conservation of *N. tenuis*.

CONCLUSION

Tomato crops planted with diversified crops enhanced the population build-up of a generalist predator, *N. tenuis* in tomato. The number of live mines of pinworm per plant was significantly lower in the diversified crop of tomato compared to the sole crop. Pumpkin in tomato crops was found to enhance the population build up of the predatory bug and could be utilised for on-farm conservation of *N. tenuis*.

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