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ORIGINAL PAPER

Temperature and tomato variety influence the development and the plant damage induced by the zoophytophagous mirid bug *Nesidiocoris tenuis*

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Abstract

Nesidiocoris tenuis (Hemiptera: Miridae) is an important biocontrol agent of several key arthropod pests, including the South American tomato pinworm, *Tuta absoluta* (Lepidoptera: Gelechiidae). However, it can cause economic damage owing to its herbivory. Risk assessment on plant for the predator under different temperature thresholds is necessary for managing its phytophagy in tomato cultivation. We investigated the predator plant damage and its development under the influence of temperature and tomato variety. Ten commercial tomato varieties of different types (round red, small cherry, date baby plum, piccadilly plum and marmande beefsteak) were tested in the laboratory under five constant temperatures (15, 20, 25, 30 and 35 °C). The amount of fourth-instar nymphs moulted into adults and stem necrotic rings induced by the feeding activity was evaluated. The plant damage differed among the varieties and increased significantly across the temperatures up to 30 °C, with a slight decline at 35 °C. Temperature and variety significantly affected the nymphal development with an increasing number of moulted adults at increasing temperature, but with slight differences among tomato varieties. Our findings provide valuable information on the mirid response to the tested abiotic and biotic factors, which can help in the management and exploitation of *N. tenuis* as a biocontrol agent in tomato crop.

Keywords Omnivory · Biological control · Feeding preference · Generalist predator · Integrated pest management

Key message

- The development and damage of the omnivorous predator *N. tenuis* were evaluated for ten commercial tomato varieties under five constant temperatures.
- The development varied according to the temperature and variety.
- The damage was significantly affected by the temperature but not by the variety.
- The results of this study can be useful for better designing Integrated Pest Management strategies that exploit this important predator.

Introduction

The role of omnivorous mirid bugs (Hemiptera: Miridae) has been largely investigated during the last years, particularly for their predatory activity towards several key crop pests, for their ability to survive feeding on non-pest substrate (Biondi et al. 2016; Ingegno et al. 2011, 2013; Wheeler 2000) and for their role as plant defence inducers (Bouagga et al. 2018; Naselli et al. 2016). *Nesidiocoris tenuis* (Reuter) is a zoophytophagous bug increasingly used for biological control in the Palaearctics (Calvo et al. 2012; Mollá et al. 2011; Sánchez and Lacasa 2008; Sankarganesh et al. 2017; Zappalà et al. 2013; Ziaei Madbouni et al. 2017). The species has a cosmopolitan distribution, although its native range is still unknown (Castañé et al. 2011; Pazyuk et al.

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2013). In the Mediterranean area, the predator is spontaneously present and plays a key role in controlling several tomato pests in both greenhouse and open field, including whiteflies, thrips, spider mites and leaf miners (Castañé et al. 2011; Shaltiel-Harpaz et al. 2016; Vacante and Tropea Garzia 1994). The predatory bug has been reported naturally attacking the invasive South American tomato pinworm, *Tuta absoluta* (Meyrick), (Mansour et al. 2018; Mollá et al. 2014; Urbaneja et al. 2009; Zappalà et al. 2013), and it is routinely commercialized and exploited for pest control (Biondi et al. 2018). With regard to this pest, the role of *N. tenuis* can be crucial in contributing to its sustainable and effective management, considering the high tendency of this pest to develop insecticide resistance, mainly due to its short life cycle and to the overuse of insecticides for its control (Biondi et al. 2018; Campos et al. 2017; Desneux et al. 2010; Guedes et al. 2019).

However, *N. tenuis* feeding activity on tomato plants, which increases exponentially with prey absence, can cause damage up to yield reduction (Castañé et al. 2011; Sánchez and Lacasa 2008). Indeed, mirids feeding on the aboveground tomato plant parts can damage growing plant tissues (e.g. stems, leaves, flowers and fruits) as a result of the combined action of cell wall mechanical destruction and tissue lysis caused by stylet insertion and salivary enzymes, respectively (Sánchez et al. 2006). Although the plant-feeding activity by *N. tenuis* has been reported in many research papers, the actual cost–benefit balance between biocontrol service (pest reduction) and costs to plants due to plant feeding (e.g. growing impairment and yield reduction) has not been clearly assessed (Puentes et al. 2018).

The damage on the crop can be also made worse by environmental conditions, physiological and behavioural traits of the mirid bug, as well as plant and crop type. Moreover, an increased phytophagy in *N. tenuis* appears to be directly related to predator density and temperature, though inversely dependent on prey density, probably because of the raised water demand (Sánchez 2008). The relation to temperature fluctuations could explain the different damage severities on vegetative organs (necrotic rings) and flower abortion, that may affect tomato crop depending on the geographical area (Castañé et al. 2011; Pazyuk et al. 2013; Perdikis et al. 2009; Sánchez 2008). Thus, being *N. tenuis* a cosmopolitan species, many differences are observed in the areas where the mirid is present, especially in warmer regions during spring–summer season when populations increase suddenly and temperature rises. In this context, the role of the plant is crucial for *N. tenuis* development and feeding activities. The plant is a source of food when the prey becomes scarce and it is a good oviposition site (Perdikis and Arvaniti 2016). Moreover, both plant water supply and the availability of supplementary nutrients are crucially important in the warmest periods for the positive effects in helping the adults to survive under extreme environmental conditions (De Puysseleyr et al. 2013). Several studies on the influence of host plant and prey availability were conducted on *N. tenuis* survival and life cycle, especially for mass-rearing purposes (Biondi et al. 2016; Mollá et al. 2014; Urbaneja et al. 2005), but little is known on host plant variety susceptibility towards mirid bugs, which may affect their biological performance and ecosystem services. Lykouressis et al. (2001) indicated that eggplant varieties played an important role in survival and development of *Macrolophus pygmaeus* Rambur populations, especially with scarcity or absence of prey, both in low- or high-temperature regimes. Similarly, tomato varieties influenced the feeding activity of *N. tenuis* nymphs both in greenhouse and in open field (Cabello et al. 2012). Conversely, under different conditions, no damage was observed on tomato stems and flowers even when the predator population density was high (Perdikis et al. 2009). Nevertheless, the predator feeding activity was proven to induce defensive plant responses in tomato and sweet pepper plants, jointly with the increased attraction of parasitoids (Bouagga et al. 2018; Naselli et al. 2016; Pérez-Hedo and Urbaneja 2015; Pérez-Hedo et al. 2015a, b).

Within this framework, we conducted laboratory bioassays that aimed at assessing the nymphal development and the damage caused by *N. tenuis* in ten tomato commercial varieties under five different constant temperature regimes.

Materials and methods

Insects

Adults of *N. tenuis* were collected in south-eastern Sicily (Ragusa, Italy) on tomato crops [var. Shiren (Vilmorin®) and Creativo (Hm.Clause®)] and maintained at constant laboratory conditions (26 ± 1 °C, 50 ± 10% RH, 14 L:10D h). In order to prevent genetic inbreeding within the rearing, field-collected wild colonies were introduced twice a year. The mirid colony was reared on Sesame plants, *Sesamum indicum* L. (variety T-85 Humera), inside cages (32 × 40 × 70 cm), screened by nylon fine mesh net following the method described by Biondi et al. (2016). This host plant was chosen because it is fully suitable for the mirid development and reproduction (Biondi et al. 2016) and especially for avoiding any selection and/or adaptation of the mirid colony to a specific tomato variety. *Ephestia kuehniella* Zeller eggs mixed with *Artemia* spp. cysts (Entofood® Koppert, the Netherlands) were provided as factitious prey (Messelink et al. 2015), and a source of water through wet cotton was supplied.

Host plant varieties and temperatures

We tested ten tomato varieties by choosing them among those more commonly cultivated in Sicily and Southern Italy. Two varieties for each of five tomato fruit commercial types were selected in order to test different trade types with different agronomical features, development, seasonal adaptation and plant habitus. The tested varieties were as follows: (1) round red type: Faustyno (Gautier®) and Rovente (Monsanto®); (2) small cherry type: Shiren (Vilmorin®) and Tyty (Syngenta®); (3) date baby plum type: Cikito (Monsanto®) and SV 1201 (Monsanto®); (4) piccadilly plum type: Motekino (Monsanto®) and Pixel (ISI Sementi®); (5) marmande beefsteak type: Marinda (Nunhens®) and Delizia (Clause®).

Tomato seedlings were grown under greenhouse conditions, into 0.2-L plastic pots with pre-mixed potting soil (Gramoflor blu®, Gramoflor) enclosed in screened cages, without any pesticide application, regularly watered and fertilized (Greenleaf 20.20.20®, Biolchim) as needed. The trials started as soon as the seedlings reached the stage of 4 true leaves, and this happened when the plant was about 30–40 cm high.

The tested temperatures were selected based on preliminary experiments carried out in our laboratories and also referring to other studies (Hughes et al. 2009; Martínez-García et al. 2015; Sánchez et al. 2009; Ziaei Madbouni et al. 2017). In these studies, *N. tenuis* life stages were active between 15 and 35 °C, although to a lesser extent at the extremes of this thermal interval. Moreover, these temperatures are within the thermal range usually recorded during the typical tomato growing conditions in Mediterranean unheated greenhouses, in which *N. tenuis* can develop and reproduce almost all year round.

Bioassays

In order to test the effect of five different constant temperatures (15, 20, 25, 30 and 35 °C) and of ten varieties on the plant damage and the development of *N. tenuis*, an experiment with a full factorial design was set up, i.e. 5 temperatures × 10 varieties. Experimental arenas consisted of transparent polyethylene cylinders (40 cm high and 10 cm diameter) closed at the top with fine net. One potted seedling plant was inserted inside each experimental arena and then placed in climatic chambers with light regime of 14L:10D and 60 ± 5% RH (refrigerated incubator model IRE-475, Raypa® R. Espinar, s.l. Spain). Each seedling plant was then exposed to two newly (0–12 h) moulted fourth-instar *N. tenuis* nymphs for 7 days; during this time only the plants were supplied with water. No additional food (prey or water) was provided to the predators. Mature nymphs were included in the evaluation, as they are considered more capable of causing plant damage than the adults (Arnó et al. 2006).

After 7 days of exposure, all the mirids were removed from the experimental arena. The number of necrotic rings induced on stems and leaf peduncles, as well as the development stage of the two inoculated specimens, was carefully checked. In particular, the number of moulted adults was considered as the biological trait correlated with the developmental suitability of the treatment, i.e. temperature and variety. Five to nine replicates were carried out per each treatment. Replicates with dead specimens were excluded from the experiment. Time exposure, number and nymphal stage of the predator per plant were chosen on the base of preliminary laboratory trials aimed at allowing simultaneously the occurrence of feeding damage, the survival of tomato seedlings and the moulting of released nymphs during the whole experimental duration.

Data analysis

The effects of the factors 'variety' and 'temperature' and their interaction on the damage (number of necrotic rings) and on the development (number of moulted adults) were analysed by a general linear model (GLM) processing the means with a factorial ANOVA. Data sets were first tested for normality and homogeneity of variance using Kolmogorov–Smirnov D and Cochran's tests. To evaluate the effects of a single factor (either temperature or variety) on the damage and nymphal development, each variety and temperature data set was independently subjected to one-way ANOVA analyses. Post hoc analyses were performed using LSD test ($p \leq 0.05$) for those data sets in which ANOVA gave significant results. The statistical analysis was run with the software Statistica® (StatSoft Inc., Tulsa, USA).

Results

Damage

The mirid showed a different feeding response to temperature and variety (Fig. 1). However, the results of the GLM analysis revealed that the number of necrotic rings significantly depended on the temperature, but neither on the variety nor on the interaction between the two factors (Table 1A). The number of necrotic rings reached the lowest value at 15 °C (1.250 ± 0.154 rings/plant) and the highest at 30 °C (2.286 ± 0.138 rings/plant); however, they were not significantly different from the number of rings obtained at 25 °C (2.206 ± 0.160 rings/plant) and 35 °C (1.879 ± 0.156) (Table 1B). Among the tested temperatures, only at 35 °C, we noticed significant differences among varieties (Fig. 1). At this temperature, *N. tenuis* caused a significantly lower

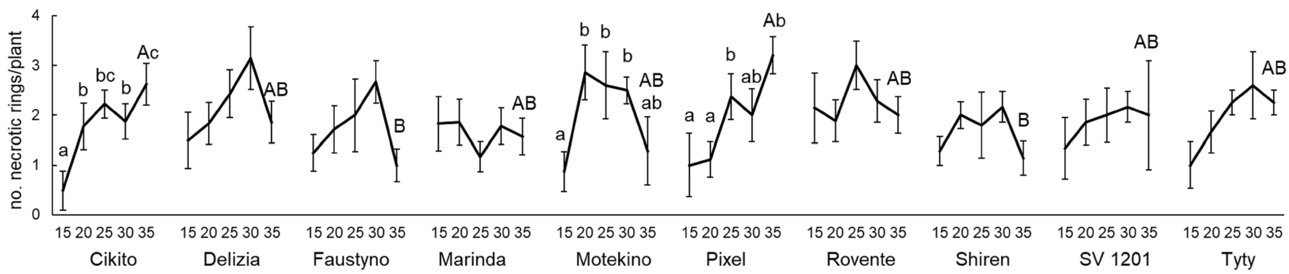

Fig. 1 Influence of temperature and variety on the number of necrotic rings (mean ± SE) observed on tomato plants during 7 days of exposure to two newly moulted fourth instars of *Nesidiocoris tenuis*. Values bearing capital letters are significantly different among varieties and within the same experimental temperature. Lowercase letters indicate significant differences among temperatures within data of the same variety (ANOVA followed by LSD post hoc test at $p \leq 0.05$)

Table 1 Results of the general linear model (GLM) analysis on the damage levels caused by *Nesidiocoris tenuis* as affected by the temperature, variety and the interaction of these two factors (A). Number of necrotic rings (mean ± SE) observed on tomato plants: values grouped by temperature for all the varieties (B) and by variety for all temperatures (C)

Damage	Number of rings	*F*	*d.f.*	*p*
(A) GLM		ANOVA		
Temperature		7.363	4, 292	**< 0.001**
Variety		0.963	9, 292	0.470
Temperature × variety		1.236	36, 292	0.175
(B) Temperature				
15 °C	1.250 ± 0.154a	0.985	9, 58	0.462
20 °C	1.840 ± 0.134b	1.038	9, 65	0.420
25 °C	2.206 ± 0.160bc	0.923	9, 53	0.513
30 °C	2.286 ± 0.138c	0.937	9, 60	0.501
35 °C	1.879 ± 0.156bc	2.047	9, 56	**0.049**
(C) Variety		ANOVA		
Cikito	1.810 ± 0.196	4.158	4, 37	**0.007**
Delizia	2.182 ± 0.220	1.963	4, 28	0.128
Faustyno	1.706 ± 0.226	1.692	4, 29	0.179
Marinda	1.657 ± 0.178	0.438	4, 30	0.780
Motekino	1.971 ± 0.254	3.119	4, 30	**0.030**
Pixel	1.861 ± 0.240	3.117	4, 31	**0.029**
Rovente	2.250 ± 0.220	0.783	4, 31	0.545
Shiren	1.667 ± 0.167	1.584	4, 28	0.206
SV 1201	1.862 ± 0.261	0.274	4, 24	0.891
Tyty	1.931 ± 0.198	2.391	4, 24	0.079

Values statistically significant ($p \leq 0.05$) are reported in bold

Results of the one-way ANOVA carried out per each specific data set, i.e. the effect of the variety was studied for the data grouped for temperature (B) and vice versa (C)

Within the temperature data set, values followed by the same letter are not significantly different (LSD post hoc test at $p \leq 0.05$)

number of rings in the varieties Faustyno and Shiren than in the other tested varieties, while it caused a significantly higher damage on the Cikito and Pixel varieties (Fig. 1). At 15 °C, the lowest number of rings was observed on the variety Cikito, while the highest value was recorded for Rovente, although without significant differences (Fig. 1). At 30 °C, which is considered to be the optimum temperature for the mirid (Sánchez et al. 2009), Delizia had the highest mirid feeding damage, while in Cikito and Marinda the lowest number of rings was observed (Fig. 1).

Among the tested varieties, only Cikito, Motekino and Pixel, suffered significantly different damages at the various temperature regimes (Fig. 1). In particular, *N. tenuis* feeding on these three varieties caused significantly lower damage at 15 °C and also at 20 °C in the case of Pixel, while for Cikito and Pixel a significantly higher damage was reached at 35 °C (Fig. 1).

Nymphal development

The data analysis of the number of moulted adults showed that both the factors, temperature and variety, significantly affected the nymphal development. However, the interaction of these two factors was not significant (Table 2A). Significantly more adults moulted at the three highest temperatures, with the highest value at 35 °C (1.788 ± 0.159 adult/plant), while significantly fewer adults moulted at 15 °C (0.529 ± 0.088 adult/plant) (Table 2B), with zero adults in the case of the varieties Delizia and Marinda (Fig. 2). Among the tested temperatures, only at 30 °C we noticed significant differences among varieties (Fig. 2). Two varieties, Marinda and Rovente, allowed a mirid development that was lower than Cikito, Faustyno, Motekino, SV 1201 and Tyty although not significantly different (Fig. 2).

At all temperatures, in Marinda (1.114 ± 0.147) and Cikito (1.548 ± 0.109) were observed, respectively, the lowest and the highest ratios of moulted adults (Table 2C). All tested varieties, except Shiren, supported the mirid development in a significant different way depending on the experimental temperature (Fig. 2). The number of moulted adults was always lower at 15 °C and in most of the cases higher at 25, 30 and 35 °C (Fig. 2).

Table 2 Results of the general linear model (GLM) analysis on *Nesidiocoris tenuis* development as affected by the temperature, variety and the interaction of these two factors (A). Number (mean ± SE) of moulted adults observed on tomato plants: values grouped by temperature for all the varieties (B) and by variety for all temperatures (C)

Development	Number of moulted adults	*F*	*d.f.*	*p*
(A) GLM				
Temperature		53.744	4, 292	< **0.001**
Variety		2.066	9, 292	**0.032**
Temperature × variety		0.954	36, 292	0.578
(B) Temperature		ANOVA		
15 °C	0.529 ± 0.088a	1.493	9, 58	0.172
20 °C	1.147 ± 0.092b	0.784	9, 65	0.632
25 °C	1.730 ± 0.061c	0.743	9, 53	0.668
30 °C	1.714 ± 0.062c	2.868	9, 60	**0.007**
35 °C	1.788 ± 0.059c	0.869	9, 56	0.558
(C) Variety		ANOVA		
Cikito	1.548 ± 0.109a	7.952	4, 37	< **0.001**
Delizia	1.424 ± 0.145c	20.482	4, 28	< **0.001**
Faustyno	1.353 ± 0.119abc	9.147	4, 29	< **0.001**
Marinda	1.114 ± 0.147c	11.703	4, 30	< **0.001**
Motekino	1.543 ± 0.125a	3.907	4, 30	**0.011**
Pixel	1.500 ± 0.123a	4.189	4, 31	**0.008**
Rovente	1.194 ± 0.137bc	5.885	4, 31	**0.001**
Shiren	1.364 ± 0.143abc	1.615	4, 28	0.198
SV 1201	1.276 ± 0.148abc	3.211	4, 24	**0.030**
Tyty	1.345 ± 0.151abc	6.198	4, 24	**0.001**

Values statistically significant ($p \leq 0.05$) are reported in bold

Results of the one-way ANOVA carried out per each specific data set, i.e. the effect of the variety was studied for the data grouped for temperature (B) and vice versa (C)

Within temperature and variety data sets, values followed by the same letter are not significantly different (LSD post hoc test at $p \leq 0.05$)

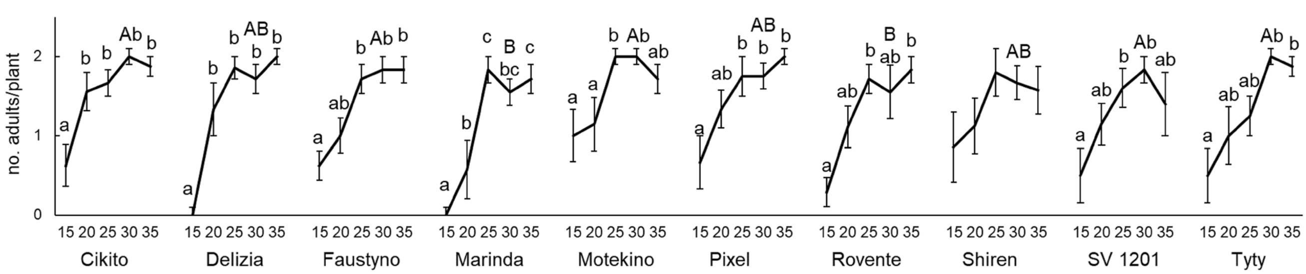

Fig. 2 Influence of temperature and variety on the number of moulted adults (mean ± SE) from two newly moulted fourth instars of *Nesidiocoris tenuis* released on tomato plants during 7 days. Values bearing capital letters are significantly different among varieties and within the same experimental temperature. Lowercase letters indicate significant differences among temperatures within data of the same variety (ANOVA followed by LSD post hoc test at $p \leq 0.05$)

Discussion

The tested varieties were shown to support the mirid development, from fourth instar to adult, during seven days under all tested temperatures, except two cases at the lowest tested temperature, i.e. Delizia and Marinda at 15 °C. Data also suggest that the damage caused by the omnivorous mirid *N. tenuis* is positively correlated with increasing temperatures, with an optimal temperature comprised between 25 and 35 °C. Although the variety does not play a statistically significant role on the number of necrotic rings, the highest number of rings was observed on average on Rovente, while the lowest on Marinda at all temperatures, and as a general trend at 30 °C and 15 °C the highest and lowest damage for all varieties were, respectively, observed. The temperature data are partly in accordance with data by Sánchez (2008a). The damage reduction observed at 35 °C in some varieties could be due to the fact that this high temperature exceeds the optimum range of temperature that for this mirid was assessed between 20 and 30 °C (Sánchez et al. 2009).

It is worth mentioning that the feeding behaviour of the nymphs at lower temperature was unexpected, as *N. tenuis* is considered being the most thermophiles species among the Dicyphinae in the Mediterranean area (Sánchez et al. 2009). Indeed, on the base of relevant scientific reports, we estimated that at 15 °C the damage should not have occurred since this temperature approximates the lower nymphal development threshold assessed in previous studies [11.7 °C in Sánchez et al. (2009) and 12.9 °C in Hughes et al. (2009)]. Moreover, this temperature is considered detrimental to the mirid development, survival and reproduction (Sánchez et al. 2009). Finally, in previous studies it was observed that the feeding activity increased proportionally to the temperature (Sánchez 2008; Sánchez et al. 2009; Vacante and Tropea Garzia 1994). This clearly suggests that the higher damage registered at higher temperatures in our study is related to an increased feeding activity rather than other potential factors.

Despite its relevance for plant protection, few studies were carried out to assess the influence of thermal regime on the feeding behaviour of *N. tenuis* and often irrespectively to varieties. In Sánchez (2008), the damage intensity was correlated with prey availability (e.g. whiteflies) and temperature but only at 20 and 30 °C. The impact of the mirid feeding activity on tomato yield was assessed in order to define an economic threshold in greenhouse condition (Sánchez and Lacasa 2008), but only for one variety and in this case regardless of temperature regime. More recently, the influence of tomato variety on the damage by *N. tenuis* was evaluated on five commercial varieties and in greenhouse conditions within a wider field trial aimed to set up various biological control strategies (Cabello et al. 2012). The progression of damage induced for each variety was followed during the entire growing cycle, and only in partial agreement with our findings, a significant difference among varieties was evidenced. In our work, tomato variety significantly affected the nymphal development while not the damage, although numerical differences were observed. This discordance is to be related to the different experimental conditions (variable temperature and prolonged permanence of the mirid in the field trial), to the prey availability, the potential intraguild interactions, and most likely also to the different methods of damage evaluation that, indeed, was not clearly referred in the text of Cabello et al. (2012). In the same study, *N. tenuis* progression number of nymphs and adults per leaf were recorded and a correlation between damage and nymphs was evidenced; data showed that the cluster fruit tomato type suffered more feeding damage compared to the others.

In the present study, we observed that at constant temperature, there is no apparent correlation between fruit commercial types, plant damage and nymphal development. Indeed, the highest number of rings was observed (although without any significant difference) in Rovente and Delizia, round and marmande types, respectively, while the highest number of adults was recorded in Cikito and Motekino, date plum and piccadilly types, respectively. It was postulated that the differences observed within different varieties could be correlated with plant nutrients of each variety, which may affect the feeding behaviour of the mirid (Cabello et al. 2012).

On the base of data acquired in our experiment, we can confirm that the nymphal performance can vary with the variety but without any clear correlation with fruit types. However, it is noteworthy that the highest damage level was observed on the two varieties Rovente and Faustyno both with round fruit type. Indeed, in these two varieties more severe ring induction was observed and consequently leaf or stem drying derived. As a consequence, research trials in field conditions are thus needed to provide reliable indications and to draw a risk assessment of *N. tenuis*. This is particularly relevant because thermal regimes, characterized by wide daily variations, in Mediterranean cold greenhouses occur. According to our data, *N. tenuis* is potentially able to induce plant tissue necrosis in protected crops throughout the year. Damage and development observed at 15 °C indicate that nymphs are capable to injure tomato plants even during cooler periods of the cultivation cycle. It is known that this mirid demonstrates a wide thermal adaptability (Sánchez et al. 2009), and its distribution area includes Africa, Asia, Southern Europe and the Mediterranean basin. Data collected in our experiment at 15 °C, where a low number of necrotic rings as well as moulted adults were observed, are not in accordance with previous laboratory studies carried out on the biology of the mirid, surprisingly showing much longer fourth and fifth nymphal development time at 15 °C (Hughes et al. 2009). However, the discordance could be explained by the different *N. tenuis* strains tested and the different feeding substrates adopted in the two experiments. Indeed, Hughes et al. (2009) employed a commercial strain that was reared on tobacco leaves and *E. kuehniella* eggs as factitious prey, while the strain used in our study is a strain locally collected in the field reared on sesame plants (Biondi et al. 2016). Based on these considerations on the thermal range in protected crops and the data collected in our experiment, there are not enough elements to identify a variety suitable for each transplant period and/or fruit commercial type. Indeed, although some varieties have shown to be less susceptible at certain temperatures, this cannot eliminate the risk of necrotic rings induced by the mirid. The common occurrence of temperatures between 20 and 30 °C, corresponding to the thermal optimum for the mirid (Sánchez et al. 2009), increases the risk of damage, since all the varieties tested have shown similar susceptibility under these temperature conditions. However, although several studies reporting *N. tenuis* feeding activity on the plants also provide the costs in terms of yield reduction (Arnó et al. 2010), flower and fruit abortion (Sánchez and Lacasa 2008; Sánchez 2009), most of them do not make a thorough estimation of the result of omnivore-mediated plant protection (Puentes et al. 2018).

Our work aimed to evaluate the influence of tomato variety and temperature on the herbivory of *N. tenuis*. The initial hypothesis was that data on the susceptibility of different tomato varieties to the mirid feeding damage could be useful to draw a risk analysis across seasons, in order to manage tomato cultivations during the year, so to mitigate the feeding damage by the mirid either released or spontaneously present. To the best of our knowledge, the combined influence of temperature and tomato variety under controlled conditions was evaluated in this study for the first time. The results show that *N. tenuis* damage and development are influenced by tomato variety and temperature, although with varying intensities. These preliminary findings are useful for the selection of suitable tomato varieties for the optimized *N. tenuis* exploitation in IPM programmes. In addition, predator risk assessment on crop varieties under different temperature regimes may support tomato industry in selecting the most compatible varieties for IPM tomato packages that include *N. tenuis* as a beneficial antagonist. For example, the variety Shiren proved to sustain the mirid development at tested temperatures, and at high temperature, it had a significantly lower damage; the varieties Delizia and Marinda are not suitable varieties for *N. tenuis* at low temperatures despite having damage. Moreover, the varieties Cikito and Pixel apparently are more susceptible at high temperature and then are not suitable for summer cultivation; at the same time, the varieties Faustino and Shiren should be adapted for summer crops. However, further laboratory and field studies are needed to better entangle other aspects of the tomato variety suitability for this mirid. For example, new knowledge should be gained for detecting the potential differences in volatile attractivity towards *N. tenuis* of the various tomato varieties both as healthy and as infested plants, that is crucial for host plant location by the mirid after artificial releases or during natural colonization processes. Moreover, the potential damage found in the present study needs to be confirmed with the concomitant availability of prey.

Author contribution statement

GS, LZ and AB conceived the research. CLP, GTG, MR, ST and AG carried out the experiments. GS and MR analysed the data. GS, LZ, GTG and AB interpreted the data. GS, GTG, LZ wrote the first manuscript draft. All authors read, revised and approved the manuscript.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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