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Thrips species (Thysanoptera: Thripidae) and their abundance on avocado (*Persea americana* Mill.) in Tetela del Volcán, Morelos, Mexico

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ABSTRACT

Objective: To determine the thrips population behavior found in two avocado orchards and their distribution over time.

Design/Methodology/Approach: Twenty trees were sampled from each orchard. Four 1.5-2 m tall inflorescences or plant sprouts (covering all four cardinal points) were taken randomly from each tree. Insects collected in the field were quantified and characterized in the laboratory. Thrips were identified based on their morphological characteristics. Analysis of variance and comparison of means were carried out. Various simulations were also performed to determine the number of predatory thrips that should be released to control the pest population.

Results: Two phytophagous thrips species (*Frankliniella difficilis* and *Scirtothrips perseae*) and two predatory thrips species (*Frankliniella difficilis* and *Leptothrips* sp.) were identified in Orchard 1. In Orchard 2, only phytophagous thrips (*Frankliniella difficilis* and *Scirtothrips perseae*) were identified. Releasing 525 predatory thrips would control the initial pest population in the study orchards.

Study Limitations/Implications: Further research should be carried out regarding the use of morphological identification, which by itself may result in an underestimation of the specific diversity of thrips.

Findings/Conclusions: Only phytophagous thrips species were initially identified in this study, while predatory thrips species were subsequently observed. The simulation indicated that the number of predators was insufficient to control the pest population.

Keywords: predatory thrips, *Franklinothrips* sp., *Leptothrips* sp., phytopathogenic thrips.

INTRODUCTION

Avocado (*Persea americana* Mill.) is a highly sought-after crop in Mexico and across the globe. Its production is impacted by various factors, including climate, soil type, water availability, fertilization, and pest management (CESAVEM, 2010). One of the main insect pests is order *Thysanoptera*, which can be divided into four major species: *Frankliniella*, *Neoliydatothrips*, *Scirtothrips*, and *Pseudophilothrips* (Urías-López *et al.*, 2007). At high densities, thrips can damage leaves, flowers, and fruit. They induce leaf rolling and defoliation and hinder fertilization and cause flower drop. When they attack fruit at an early stage, they can cause scarring, deformation, and fruit drop (Ascensión, 2000). The most common method for controlling this pest is the

use of chemicals (Dughetti, 1990). However, this approach has led to the emergence of resistance and a negative environmental impact. Therefore, alternative strategies should be considered, including the introduction of predators, which can satisfy their nutritional requirements and compete for space on the plant (Lacasa and Llorens, 1998). In Mexico, the ten species of predatory insects known to infest avocado agroecosystems include *Aelothrips mexicanus*, *Franklinothrips vespiformis*, and *Leptothrips mcconnelli* (Johansen *et al*., 1999). Thrips have six or more generations per year (University of California and Natural Resources, 2008). Thrips population behavior should be anticipated to implement an effective control strategy (López *et al*., 2022). Thrips that attack avocado plantation have natural thrips predators, which enables the development of biological control strategies. The objective of this study was to determine the population behavior of thrips species found in two avocado orchards, as well as their distribution over time.

MATERIALS AND METHODS

Thrips were collected in two Hass avocado orchards in Tetela del Volcán, Morelos. The first orchard was located at 18° 52' 46" N, 98° 42' 48" W, and 2,130 m.a.s.l. The second was located at 18° 54' 38" N, 98° 42' 19" W, and 2,400 m.a.s.l. The specimens were identified in the entomology laboratory of the Department of Agricultural Parasitology of the Autonomous University of Chapingo. Weekly samplings began on January, with the objective of recording the presence or absence of thrips. Once the populations were detected and collected, they were taken to the laboratory, where they were counted per sampling date and classified into families, genera, and species. Three monthly samples were taken from February to April, 2023. Foliage samples were collected to determine the thrips population behavior associated with avocado. Samples were taken from five rows with four trees each. Trees between four and eight years old, in vegetative growth and flowering stage, were selected. The distance between the trees was 5×4 meters (m). Four 1.5-2.0 m tall inflorescences or plant sprouts, distributed across all cardinal points, were randomly selected from each tree. The inflorescences were sprayed with a 9:1 solution of water and Vel Rosita® fabric softener. The dripping from each tree was collected in a plastic tray and subsequently poured into a bottle containing 70% methanol. The samples collected in the field were transported to the laboratory, where they were sieved to recover and count the captured specimens. They were then quantified according to the date of evaluation (February 26, March 5, and April 1, 2023). From each jar, thrips were separated and counted, mounted in a slide with Canada balsam in accordance with the Mound and Marullo technique (1996). The thrips were identified based on their morphological characteristics, at the suborder and family levels, using the taxonomic keys of Triplehorn and Johnson (2005). The genera and species taxonomic keys proposed by Mound and Marullo (1996) were used to define the species. The observations and population size counts were made in accordance with the number of phytophagous and predatory species collected per sample. The proportion of thrips species was calculated using the row count. The error normality and homogeneity of variance were also verified before the analysis of variance. The analysis considered two sources of variation (thrips species and counting date). The results showed differences in both sources. Consequently, a comparison of means was performed using the LSD (Least Significant Difference) method. Statistical analysis was carried out with R and RStudio software. A simulation of the growth of *Franklinothrips* and *Scirtothrips* on avocado was also conducted, incorporating data on daily maximum and minimum temperatures, obtained from the weather data reported by a National Meteorological Service station located in the municipality of Tetela del Volcán, Morelos.

Simulation

The Fortran Simulation Translation (FST) software was employed to simulate the dynamic predator-prey model for *Franklinothrips* and *Scirtothrips* on avocado (López *et al.*, 2022). The model input variables employed were daily maximum and minimum temperatures. Using this data, the model calculates the daily temperature dynamics (T, °C) and subsequently the development, oviposition, and mortality rates. The initial conditions for the simulation were the number of eggs or adults in both populations (*e.g.*, 1,000 phytophagous thrips and 500 predatory thrips) and zero individuals for the other developmental stages.

RESULTS AND DISCUSSION

In February, the presence of *Frankliniella difficilis* was confirmed in orchard 1. One month later, the presence of *Frankliniella difficilis* and *Scirtothrips perseae* was recorded, along with the predator *Franklinothrips* sp. Finally, in April, *Frankliniella difficilis*, *Scirtothrips perseae*, *Franklinothrips* sp. were still present, accompanied by *Leptothrips* sp. In contrast, only the *Frankliniella difficilis* and *Scirtothrips perseae* phytophagous thrips were observed in orchard 2. The latter species, native to Mexico, is widely distributed in Hass avocado orchards in Michoacán, Mexico, and in California, USA (Rugman-Jones *et al.*, 2006).

This study identified one of the biological control species, *Leptothrips* sp. In a taxonomic review of 41 *Leptothrips* species in the Americas, Johansen (1987) identified the scarcity of immature individuals in the wild as the main challenge for the study of its biology.

The orchard under study was free of weeds, as a result of the agronomic management of the grower. Valle de la Paz *et al.* (2003) pointed out that thrips species diversity is associated with weeds in avocado orchards, particularly Asteraceae flowers —such as *Tithonia tubiformis* (79- 920 thrips per head) and *E. karvisnkianus*, (30-102 individuals per head).

On the first day that thrips were found in the orchard, an average of 9 phytophagous thrips were recorded per shoot sampled (*i.e.*, 720 thrips on the sampled trees). Some predatory thrips were also found during the study. Based on the total number of pests and biological control thrips, various simulations were run to determine the number of predatory thrips that would need to be released to control the pest population. Therefore, to control the initial pest population, 525 predatory thrips should be introduced in the sampled orchard. This figure is dependent on the biological control efficiency of the predator species in question. *F. orizabensis* is a generalist predator of arthropods and attacks first and second instar larvae of *S. perseae*. It can consume approximately 20 larvae in a 24-hour period; however, it also feeds on avocado pollen in the absence of prey (Hoddle, 2003). The release of *F. orizabensis* does not achieve the desired preventative pest control when *S. perseae* populations are low (<5 larvae per leaf). The insects died with 14 to 23 accumulated degree days, when food was absent or present in small quantities. Therefore, Hoddle *et al.* (2004) did not recommend preventative releases of mass-reared *F. orizabensis* for the control of low densities of *S. perseae* in avocado orchards in southern California.

Laboratory and field studies have proven that *F. orizabensis* dies when it feeds on avocado leaves treated with insecticides exhibiting translaminar activity (Hoddle, 2003).

The analysis of variance shows significant discrepancies between the two sources of variation for the thrips species and dates (Table 1). A comparison of the means for the various thrips species revealed two distinct groups (Table 2). Group A consisted of a higher proportion of the *Frankliniella difficilis* species, while the other species were included in Group B. A similar comparison by sampling date also resulted in two groups (Table 3). Group A showed the highest presence of thrips in the February sampling date, while Group B included the March and April sampling dates.

Figure 1 illustrates the simulation of the behavior of the *Scirtothrips* sp. phytophagous thrips and the *Franklinotrips* sp. predatory thrips, based on the initial population of these species observed during the sampling. Therefore, the population of phytophagous thrips initially increases and the predatory thrips subsequently emerge and its population increases in line with field observations made during the study. After approximately 30

Table 1. Analysis of variance of thrips species and sampling dates in Tetela del Volcán, Morelos.

Source	Degrees of freedom	Sum of squares	Mean square	F	P-value	
Species	3	24168	8056	37.320	3.36e-13	***
Sampling date	2	1908	954	4.419	0.0167	*
Residual	54	11657	216			

Significance level: 0‘***’ 0.001‘**’ 0.01‘*’ 0.05‘.’ 0.1‘’

Table 2. Comparison of means per thrips species.

Species	%	Groups
Frankliniella difficilis	47.27	a
Scirtothrips perseae	2.27	b
Franklinothips sp.	0.53	b
Leptothrips sp.	0.07	b

*Same letter in a column means that there is no significant difference.

Table 3. Comparison of means of sampling dates.

Date	%	Groups*
February	18.75	a
March	13.75	b
April	5.10	b

*Same letter in column means that there is no significant difference.

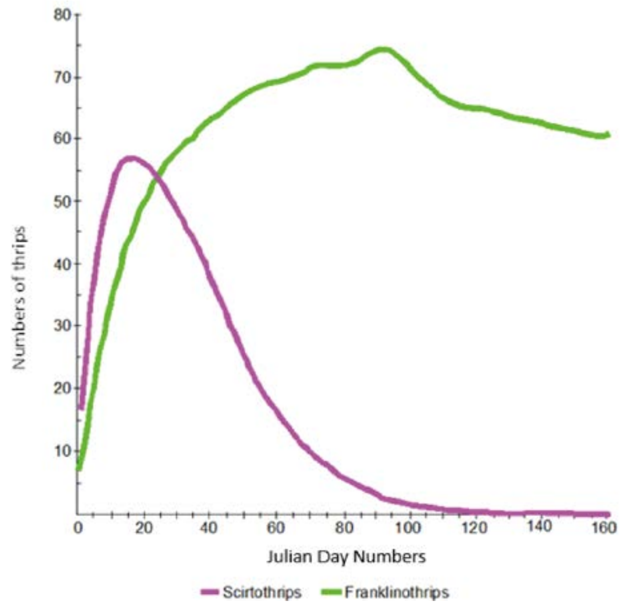

Figure 1. Simulation of phytophagous thrips (*Scirtothrips* sp.) and predatory thrips (*Fraklinotrips* sp.), considering the population recorded in the sampling.

days, the number of pest insects and predatory thrips is roughly equal. Finally, the pest population begins to decline. The predator population continues to grow for a few days, but it also starts to decrease, in the face of the absence of its prey.

CONCLUSIONS

The initial findings of this study indicated the exclusive presence of phytophagous thrips species, while predatory thrips species were detected in subsequent observations. The simulation demonstrated that the number of predatory thrips was insufficient for an effective control of the pest population. The *Frankliniella difficilis* and *Scirtothrips perseae* phytophagous thrips species, as well as the *Franklinothrips* sp. and *Leptothrips* sp. predators, were identified in the field. Further laboratory and field studies are required to assess the effectiveness of predator species. The simulation determined the number of predatory thrips required to control the initial population of thrips pests. This research must be followed up, as using only morphological identification may have underestimated the specific diversity of thrips.

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