

Thrips species composition, biodiversity and seasonal dynamic populations in two vine grape orchards in the north-eastern region of Tunisia

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Abstract –

Thrips species composition study in wine grape orchard and table grape orchard in two locations in the region of Grombalia (Governorate of Nabeul; Tunisia) based on biodiversity parameters (Shannon index, dominance, equitability) revealed the presence of nine species that were identified and monitored. Among those species, six are phytophagous which are *Thrips tabaci*, *Thrips palmi*, *Thrips imaginis*, *Limothrips cerealium*, *Chirothrips manicatus* and *Microcephalothrips abdominalis*. Furthermore two species known as predatory thrips were identified which are *Aeolothrips tenuicornis* and *Aeolothrips collaris* and one genus, *Halplothrips* sp., which species are known to be mostly predators of mites. The most abundant thrips species are *T. palmi* with percentages of 25 and 23.53 %, followed by *L. cerealium* with 18.75 and 17.65%, *T. tabaci* 12.5% and 17.65% and *Haplothrips* sp. 31.25 and 11.76% respectively in vine table grape orchard and wine cellar grape orchard. Dynamic population monitoring of all thrips species in both orchards showed that they occurred especially during spring. However they tend to decrease lately approaching hot season. Evaluation of biodiversity parameters based on thrips species composition revealed that both orchards are well diversified, with a good distribution of numbers on species and an equilibrated population. Thrips listed species all seem to be equally likely to develop in both orchards.

Keywords: Biodiversity, monitoring, thrips species, vine, Tunisia.

1. Introduction

Thysanoptera is an order that includes small insect species know as Thrips (Bournier 1983). Those pests are capable of serious damages by sucking cells' content and transmitting viruses to the host plants (Alford 1991; Brun et al. 2004; Whittaker and Kirk 2004). In fact, thrips damages occurs generally during feeding of larvae and adults leaving leaves, flowers and fruits with white spots that become brown, dry and perforate. On flowers and buds, they prevent them of growing and becoming fruits. And when on fruits, they leave scars (Alford 1991; Brun et al. 2004; Whittaker and Kirk 2004; Guérineau 2003; Chaisuekul and Riley 2005). Most thrips species are phytophagous, attacking thus many botanical species, some of them are polyphagous, others are oligophagous and some are monophagous. Other thrips species are predators of some small insects, including phytophagous thrips, or mites (Bournier 1983; Loomans and van Lenteren 1995; Fraval 2006; Elimem and Chermiti 2012). Thrips dynamic populations is influenced by many parameters among which abiotic ones such as temperature, relative humidity and daylight (Fraval 2006; Elimem and Chermiti 2009; Elimem et al. 2011). On the other hand, biotic parameters my change thrips dynamic populations. Among those parameters, we can cite predators such as those belonging to the genus *Orius* (Heteroptera;



Anthocoridae) that are small insects feeding on thrips larvae especially and adults. Those beneficial insects are present in nature and are even employed in biological control and integrated pest management to control thrips populations (Loomans and van Lenteren 1995; Parker et al. 1995; Elimem and Chermiti 2012; Elimem et al. 2018.a).

The aim of this work is to study different thrips species biodiversity and dynamic populations in two vine grape orchards in the north-eastern region of Tunisia.

2. Materials and Methods

2.1 Experimental site

This work was carried from March 16th to June 03rd 2016 in two vine grape orchards; table vine grape and wine cellar grape. Both orchards are situated in the region of Grombalia (36°36'51'' N, 10°25'38'' E) belonging to the governorate of Nabeul in Tunisia (Figure 1).

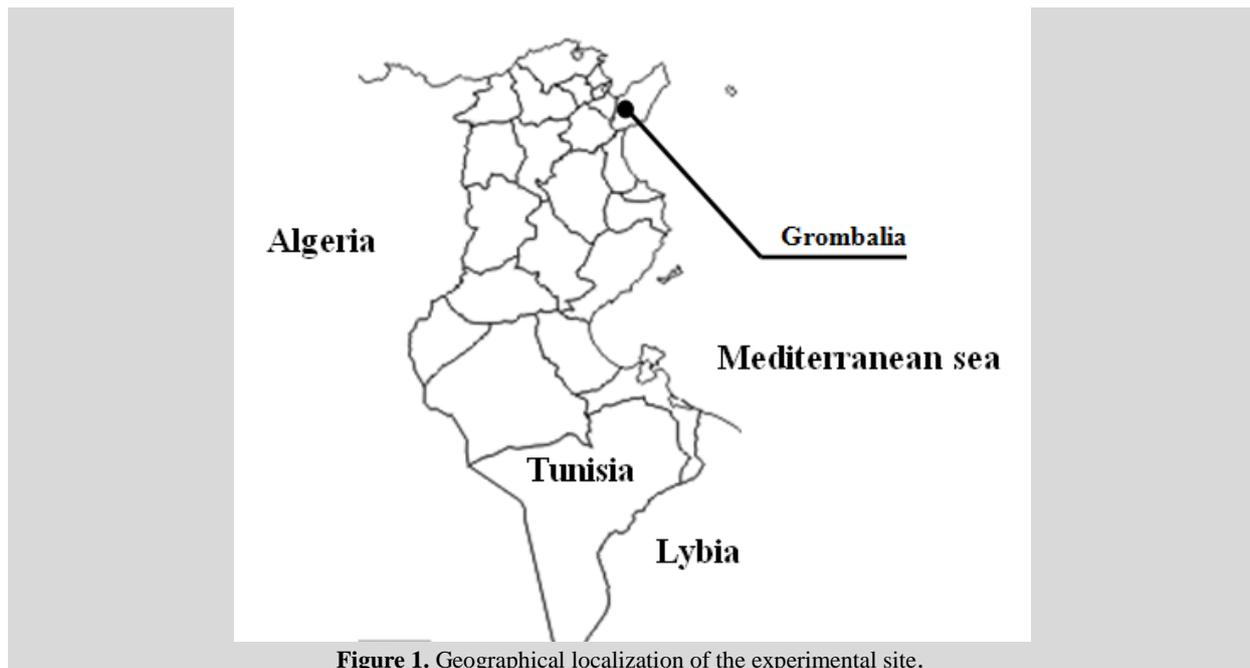


Figure 1. Geographical localization of the experimental site.

Both orchards are characterized by a clay-limestone soil. Vine table orchard has an area of 0.5 ha and conducted in pergola mode with the Muscat grape of Italy. This variety is characterized by golden yellow fruits, very sweet and of a musky flavor. Regarding wine cellar grape orchard, it has an area of 1 ha and planted in Pergolette mode by the Syrah grape variety which has black fruits.

2.2. Sampling

Sampling was done weekly and randomly from each orchard since leaves appearance on March 16th 2016. In each orchard, fifty vine plant were chosen randomly and divided into three strata; upper, medium and bottom. From each stratum, one leaf is sampled making thus a total number of 150 sampled leaves from each orchard. Samples were placed in plastic bags and taken to the laboratory.

2.3. Thysanoptera fauna identification

All collected thrips specimens were mounted according to the method described by Bournier (1983) and identified lately according to the identification keys of Mound et al. (1976), Mound and Walker (1982), Brodsgaard (1989), Palmer et al. (1989), Mound and Kibby (1998) and EPPO (2002).

2.4. Biodiversity study of Thysanoptera fauna

According to Roger (1977), indices of the diversity of a population represent the amount of information represented by a given sample on how individuals are distributed among various species. In this way, changes in diversity indices of samples from the same population spread over time give an idea about the changing structure of the population and monitoring its evolution.

Among the studied parameters to get an idea about the diversity of a population, we find species richness which is the number of recorded species in a habitat. The index of Shannon or Shannon-

Weaver is used to evaluate the spatial and temporal diversity in a habitat or set of habitat (Roger 1977) stands. This index is calculated using the following formula:

$$H' = - \sum_{i=1}^S p_i \log_2 p_i$$

Where H' is the Shannon biodiversity index, i is the species of the studied site, P_i is the proportion of species i relative to the total number of species (S) in the study areas, knowing that $P_i = n_i / N$ where n_i is the number of individuals of species I , and N is the total number of all species. It should be noted that this parameter, in nature, is generally between 0.5, which indicates a very low diversity, and 4.5.

The other parameters that have been measured are dominance and equitability. The first is expressed by: $D = n \times 100 / N$

Where D is the dominance, n is the number of individuals belonging to the species best represented and N is the total number of individuals in a given sample.

Concerning equitability, it is the ratio of the actual diversity observed at the theoretical maximum diversity. Similarly, equitability clarifies the structure of the ecosystem. It is expressed by the following formula: $E = H' / \ln N$

This parameter varies between 0 and 1; it tends to 0 when almost all the encountered individuals are concentrated on a single species and therefore it is the most dominant, and tends to 1 when all species have the same abundance and in this case they are equitably distributed and the population is homogeneous across all species. In addition, a number of less than 0.6 fairness characterizes a turbulent environment (Roger 1977; Graham et al. 2009).

All these parameters were measured using the software PAST® (Paleontological Statistics).

On the other hand, thrips species were classified according their dominance into the following groups according to Kucharczyk et al. (2011) and Elimem et Chermiti (2013); eudominants (> 10%), dominants (5.1 to 10%), subdominants (2.1 to 5%), recedents (1 to 2%) and subrecedents (lower than 1%).

3. Results and Discussion

3.1. Identification and listing of thrips species encountered in both vine grape orchards

During the entire monitoring period, a total of 25 specimens were collected from grape vine sampled leaves. According to the identification keys, a total of 6 genera and 9 species of phytophagous and predatory thrips have been identified. Thrips species identified are listed in table 1.

Table 1. Thrips species encountered in both vine grape orchards.

Order	Subordre	Family	Genus	Species	
Thysanoptera	Tubulifera	Phlaeothripidae	<i>Haplothrips</i>	spp.	
		Aeolothripidae	<i>Aeolothrips</i>	<i>tenuicornis</i> Bagnall (1926) <i>collaris</i> Priesner (1919)	
	Terebrantia	Thripidae		<i>Chirothrips</i>	<i>manicatus</i> Haliday (1836)
				<i>Limothrips</i>	<i>Cerealium</i> Haliday (1836)
				<i>Microcephalostrips</i>	<i>abdominalis</i> Crawford (1910)
				<i>Thrips</i>	<i>palmi</i> Karny (1925) <i>imagineis</i> Bagnall (1926)
					<i>tabaci</i> Lindemann (1889)

In the table grape orchard, most important species were those belonging to the genus *Haplothrips* spp. that represent a percentage of about 31.25 % of the total population found, followed by *Thrips palmi* with 25% then *Limothrips cerealium* with 18.75%. In regards to the wine grape orchard, the highest percentages were observed with the species *Thrips palmi* with 23.53%, followed by *Thrips tabaci* and *Limothrips cerealium* with equal percentages of about 17.65% (Table 2). On the other hand, the thrips species were classified according to Kucharczyk et al. (2011) into the following groups: eudominants (> 10%), dominants (5.1 to 10%), subdominants (2.1 to 5%), recedents (1 to 2%) and subrecedents (lower than 1%). Obtained results (Table 2), showed that *T. palmi*, *L. cerealium*, *T. tabaci* and *Haplothrips* spp. are all eudominant species, meaning thus that they were the most abundant and the most encountered species in both orchards. Regarding the rest of identified species, they were even

dominant or absent such as *T. imaginis*, *Ae. collaris*, *Ae. tenuicornis*, *M. abdominalis* and *Ch. Manicatus*.

Table 2. Thrips species composition collected in both vine grape orchards.

Species	Table vine orchard			Wine cellar grape orchard		
	Number	Percentage (%)	Dominance	Number	Percentage (%)	Dominance
<i>Thrips palmi</i>	4	25	+++++	4	23.52	+++++
<i>Limothrips cerealium</i>	3	18.75	+++++	3	17.64	+++++
<i>Thrips tabaci</i>	2	12.5	+++++	3	17.64	+++++
<i>Haplothrips</i> spp.	5	31.25	+++++	2	11.76	+++++
<i>Thrips imaginis</i>	0	0	-	1	5.88	++++
<i>Aeolothrips collaris</i>	1	6.25	++++	1	5.88	++++
<i>Aeolothrips tenuicornis</i>	0	0	-	2	11.76	++++
<i>Microcephalothrips abdominalis</i>	1	6.25	++++	0	0	-
<i>Chirothrips manicatus</i>	0	0	-	1	5.88	++++
Total	16	-	-	17	-	-

Legend: (+++++): Eudominant, (++++): Dominant, (+++): Sub-dominant, (++) Recedent, (+): Subrecedent.

3.2. Thrips populations' monitoring

Monitoring of thrips populations shows the succession of two peaks (Figure 2). The first marks the first generation of individuals that had restarted their activity after the winter rest. The second most important peak was observed on May 04th 2016 with a total thrips number of about 11 individuals which corresponds to the proliferation of thrips with host plant leaf staggering. In fact, it seems that the evolution of thrips on vine orchards is intimately related to the phenological stages of the host plant. Those results concord with those listed by Elimem and Chermiti (2009) in a rose crop greenhouse and Elimem and Chermiti (2013) in citrus orchards, Elimem et al. (2011) and Elimem et al (2018.a) in pepper crop green houses, were thrips species compositions follow the phenological parameters of the host plants. On the other hand, Elimem and Chermiti (2009), Elimem et al. (2011) and Elimem et al. (2018.a, 2018.b), indicated that host plants phenological parameters modulate thrips dynamic populations, their distribution in the host plant different parts, reproduction and even the sex-ratio.

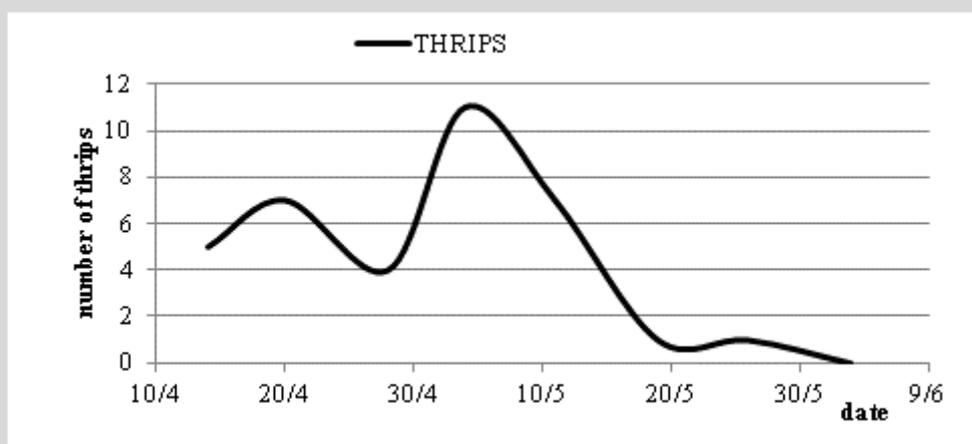


Figure 2. Thrips species monitoring in both orchards in the region of Grombelia.

3.3. Biodiversity parameters

Monitoring thrips species populations and evaluation of biodiversity indexes (Figure 3) and parameters showed that both orchards are characterized by a good diversity which is due to a Shannon indexes exceeding 1.4 (Jayaraman 1999). In fact, it seems that the limited treatments that the table grape orchard receives, and the total absence of chemical interventions in the wine grape orchard in

the other hand, are the origin of these values. Despite the difference between Shannon indexes in both orchards, these values show no significant differences. On the other hand, indexes of dominance and equitability showed a good distribution and repartition of species numbers in both orchards. In fact, analyzing equitability index showed that it tends to 1 in both orchards which shows that all species have the same abundance and in this case they are equitably distributed and the population is homogeneous across all species.

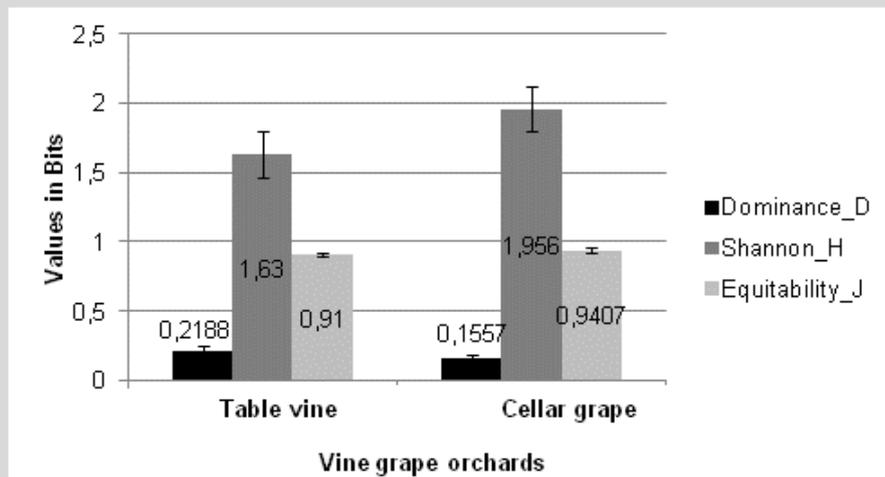


Figure 3. Biodiversity parameters and indexes in both grape vine orchards in the region of Grombelia in 2016.

3.4. Thrips species monitoring

3.4.1. *Thrips palmi* Karny (1925) (Thysanoptera ; Thripidae)

That eudominant species was found with 25% and 23.53% in table grape orchard and wine grape orchard respectively. This species is found in various tropical regions, in Africa and Asia. Furthermore, it has been reported in Australia, Central America and some European countries (Lacasa and Llorens 1996; Palmer et al. 1989). According to Mani et al. (2014) this species has only been reported on grapevine orchards in India. These results indicated that it is reported for the first time in Tunisia in grape orchards.

Monitoring *T. palmi* populations (Figure 4) showed that this species appeared from March and continue its gradual increase as to the summer season. Indeed, this is coherent to the results cited by Nagai (1993), Lakshmi et al. (1993) and Lacasa and Llorens (1996) who reported that *T. palmi* has an optimum of its biotic potential at an average temperature of 25°C. *T. palmi* numbers tend to increase as the phenological state of the host plant improves (Lacasa et Llorens 1996) which is coherent with results cited in this study.

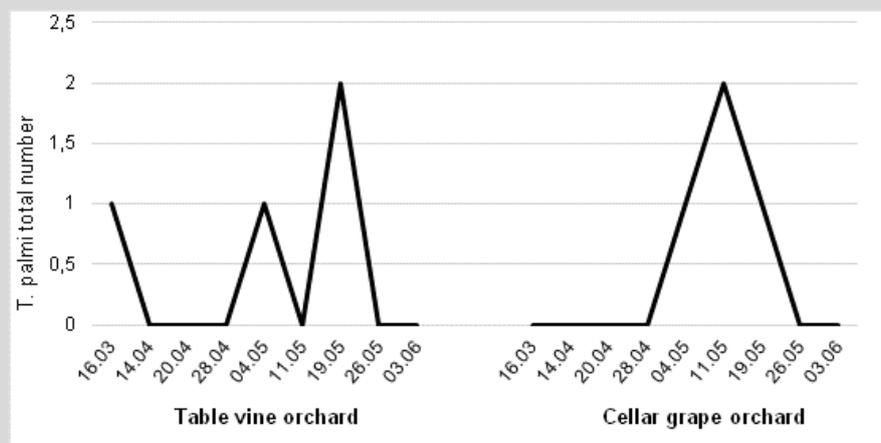


Figure 4. *T. palmi* in both grape vine orchards in the region of Grombelia

3.4.2. *Limothrips cerealium* Haliday (1836) (Thysanoptera ; Thripidae)

This second eudominant species is ubiquitous in the two plots with respective percentages of 18.75 and 17.65% for table grape orchard and wine grape orchard. It has been reported on several host plants such as cereals, citrus and grapevine orchards (Mound et Walker 1982; Navarro et al. 2008; Trabelsi et Boulahia-Kheder 2009; Belaam et Boulahia-Kheder 2012).

This species begins to appear in April, decreases thereafter than rises in the wine grape orchard towards the end of the period of this study (Figure 5).

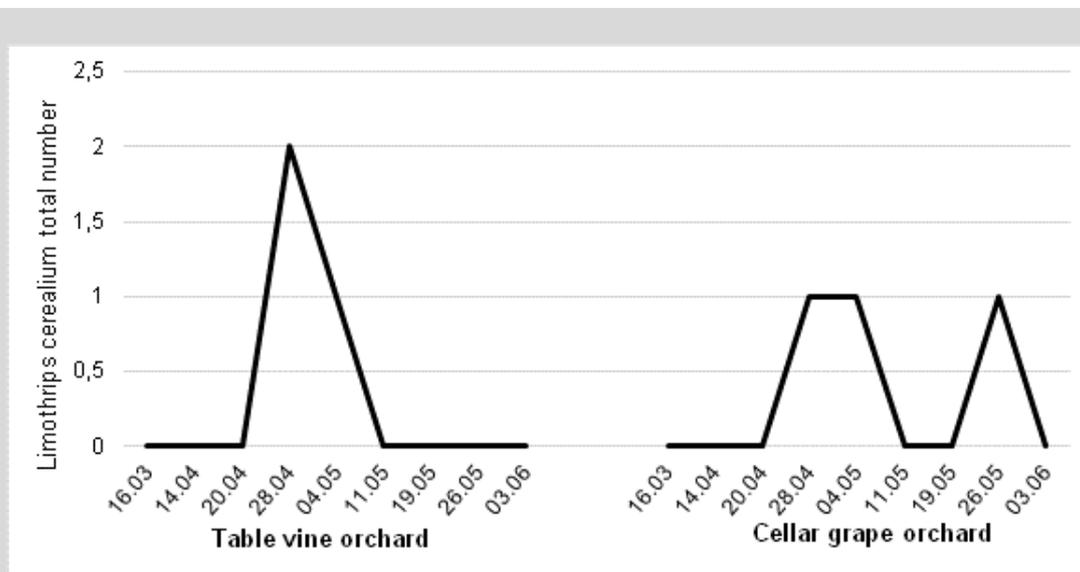


Figure 5. *L. cerealium* in both grape vine orchards in the region of Grombelia.

In citrus orchards, Navarro et al. (2008) in Spain and Elimem and Chermiti (2013) in Tunisia, recorded that in spite of the presence of this species on this host plant but no high numbers were recorded and its appearance starts during January and increases slightly in April and May. Same results were mentioned by Goldarazena (1996) in cereal crops in Spain.

3.4.3. *Haplothrips* spp. Amyot and Serville (1843) (Thysanoptera ; Phlaeothripidae)

In the two orchards eudominants species belonging to the genus *Haplothrips* spp. were found. However, this species was more abundant at the table grape orchard than the wine grape orchard. Most of these species live on Asteraceae, Poaceae, Chenopodiaceae or other plants such as citrus grapevine and rose (Palmer et Mound 1990; Zur Strassen 1995; Kakimoto et al. 2006; Okajima 2006; Elimem 2008; Minaei et Mound 2008; Belaam et Boulahia-Kheder 2012).

Monitoring of *Haplothrips* spp. has shown that this species complex begins to appear on mid-April in the vine table orchard. While, in the wine cellar grape orchard only one peak was observed during the end of May. Indeed, according to Larsson (2005), populations of *Haplothrips* sp. have their proliferation from the end of May and during the month of June. Similarly, Elimem (2008) mentions that populations of *Haplothripsvictoriensis* on rose crops and in Tunisian conditions, start to appear from April to peak in June and decline in July.

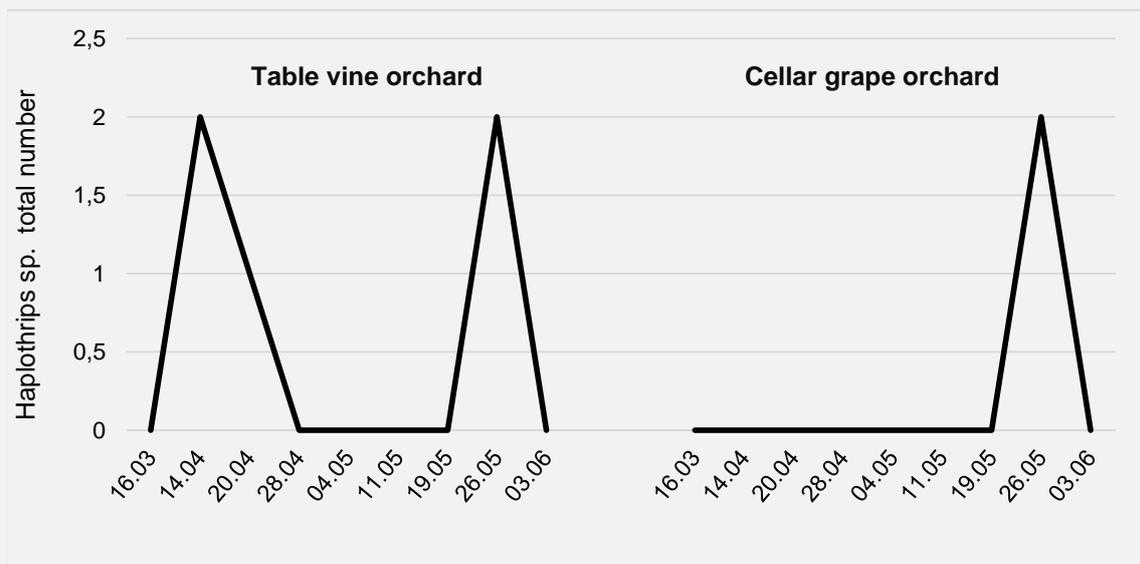


Figure 6. *Haplothrips* spp.in both grape vine orchards in the region of Grombelia.

3.4.4. *Thrips tabaci* Lindemann (1889) (Thysanoptera; Thripidae)

T. tabaci is a cosmopolitan and polyphagous thrips species that can attack more than 150 botanical species (Mound and Walker 1982; Lacasa and Llorens 1996) such as citrus and grapevine (Taksim and Tunç 2009; Elimem and Chermiti 2013).

This eudominant species appears from the beginning of the study period at the table grape orchard, and increased thereafter during April and May in both orchards (Figure 7).

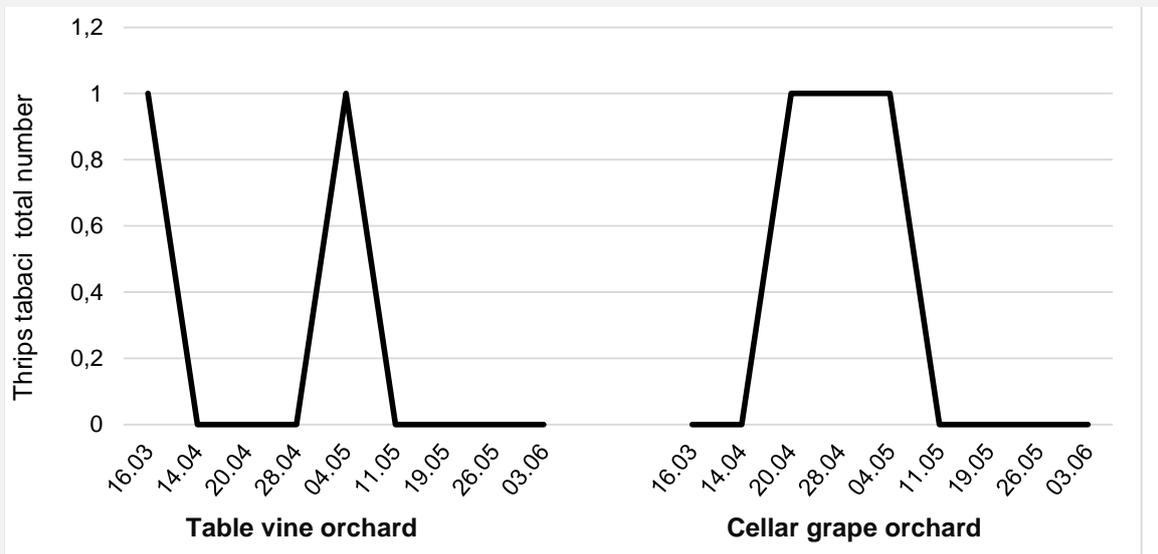


Figure 7. *T. tabaci* in both grape vine orchards in the region of Grombelia.

Navarro et al. (2008) mention that in Spain and on citrus orchards *T. tabaci* begin to proliferate on February. It reaches the maximum of its populations on end of March and April and starts to regress from June. Same results were mentioned in Tunisia by Elimem and Chermiti (2013) in citrus orchards. This may be confirmed by Waiganjo et al. (2008) who indicated that *T. tabaci* populations in high

temperatures and low relative humidity start to increase while high relative humidity decreases this pest numbers.

3.4.5. *Thrips imagines* Bagnall (1926) (Thysanoptera ; Thripidae)

This species was absent at the table vine orchard and occurred only with one individual in the wine cellar grape orchard during the first week of our study (Figure 8). This species cannot persist on crops in the absence of flowers, which may explain its disappearance in the wine grape orchard during the rest of the study (Lacasa and Llorens 1996; Funderberk 2001).

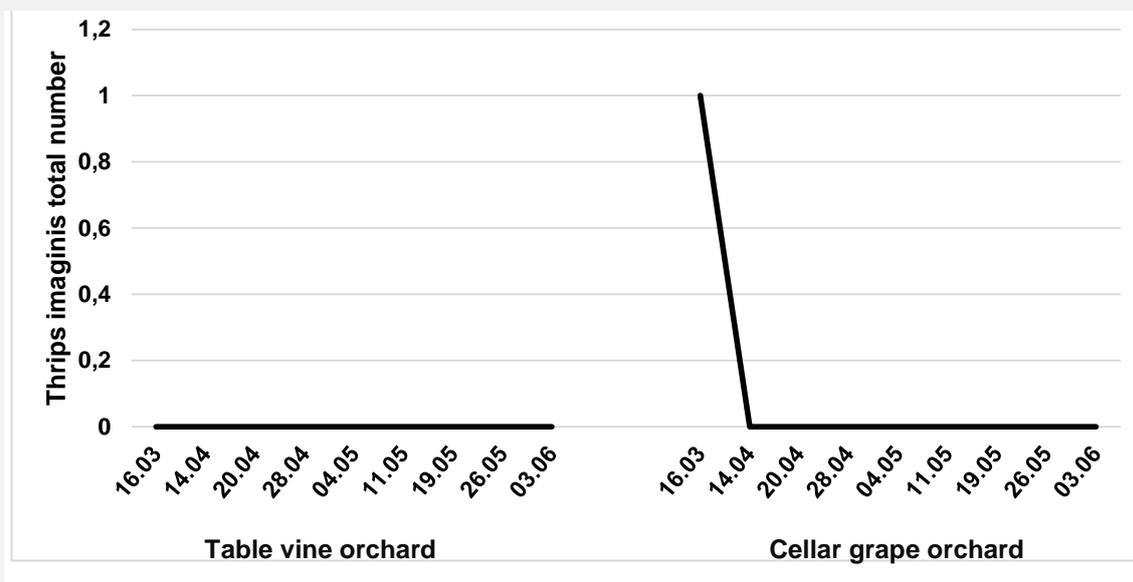


Figure 8. *T. imagines* in both grape vine orchards in the region of Grombelia.

3.4.6. *Microcephalothrips abdominalis* Crawford (1910) (Thysanoptera ; Thripidae)

Results found showed that this species was present only at the table grape orchard with only one individual and a percentage of 6.25% (Figure 9).

Mound and Walker (1982) indicate that in Australia specimens of this species are collected during February and March. However, and during this this study, *M. abdominalis* showed a later appearance during May with a very small population. This species is reported on different host plants.

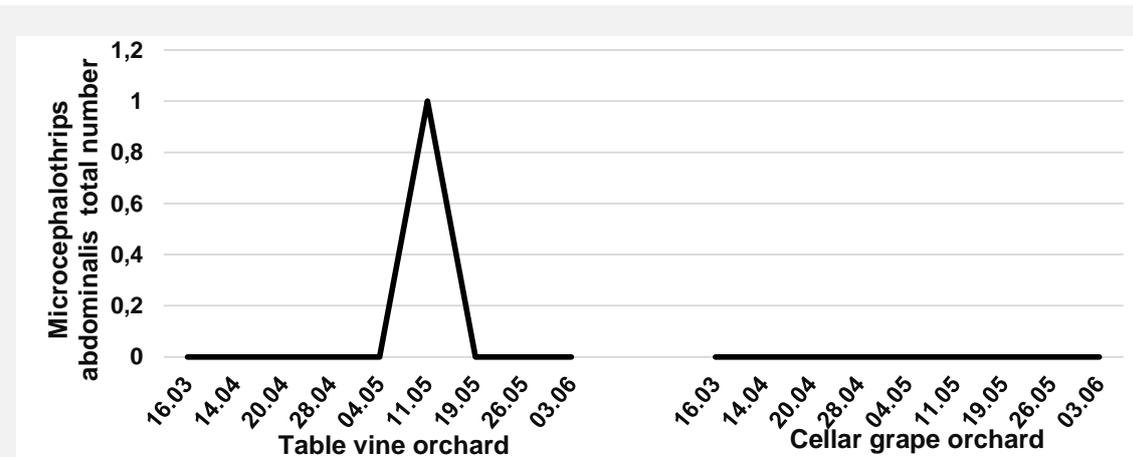


Figure 9. *M. abdominalis* in both grape vine orchards in the region of Grombelia

3.4.7. *Chirothrips manicatus* Haliday (1836) (Thysanoptera; Thripidae)

C. manicatus was manifested with a single individual at the wine grape orchard (Figure 10). According to Minaie and Mound (2010) and Mound and Palmer (1972), species of the genus *Chirothrips* develop mainly on the Poaceae family. As a result, its presence on vine orchards can be accidental due to the presence of several weeds all around the crop. Besides, *C. manicatus* was reported for the first time in Tunisia in 2018 by Elimem et al. (2018.c) on grape vine orchard.

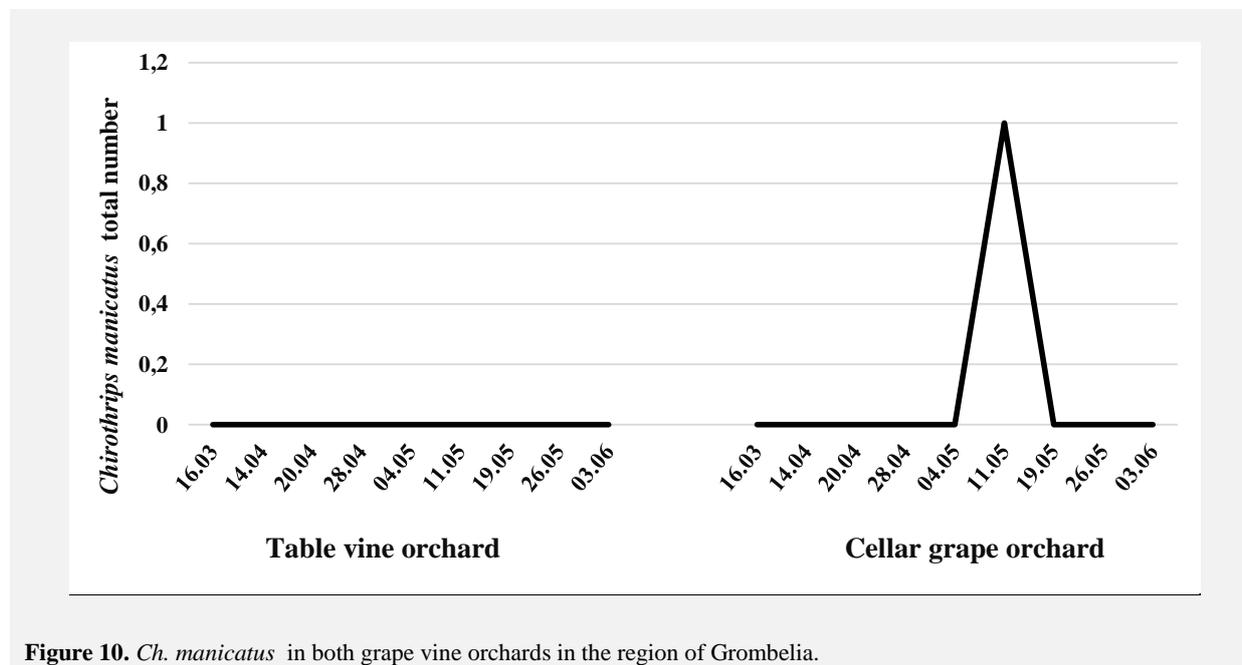


Figure 10. *Ch. manicatus* in both grape vine orchards in the region of Grombelia.

3.4.8. *Aeolothrips* spp. Haliday (1836) (Thysanoptera ; Aeolothripidae)

Two species of predatory thrips were also recorded. Indeed, *Ae. tenuicornis* and *Ae. collaris*. Obtained results show that *Ae. tenuicornis* was present only in the wine grape orchard and only occurred once during May. *Ae. Collaris* was present in both orchards with lower numbers during the beginning and end of April (Figure 11).

According to Navarro et al. (2008) and Elimem and Chermiti (2013), the species of *Aeolothrips* begin their evolution from February and March to reach their maximum towards the beginning of April. The difference with the present study is that *Ae. collaris* made its appearance in April while *Ae. Tenuicornis* did not manifest until May.

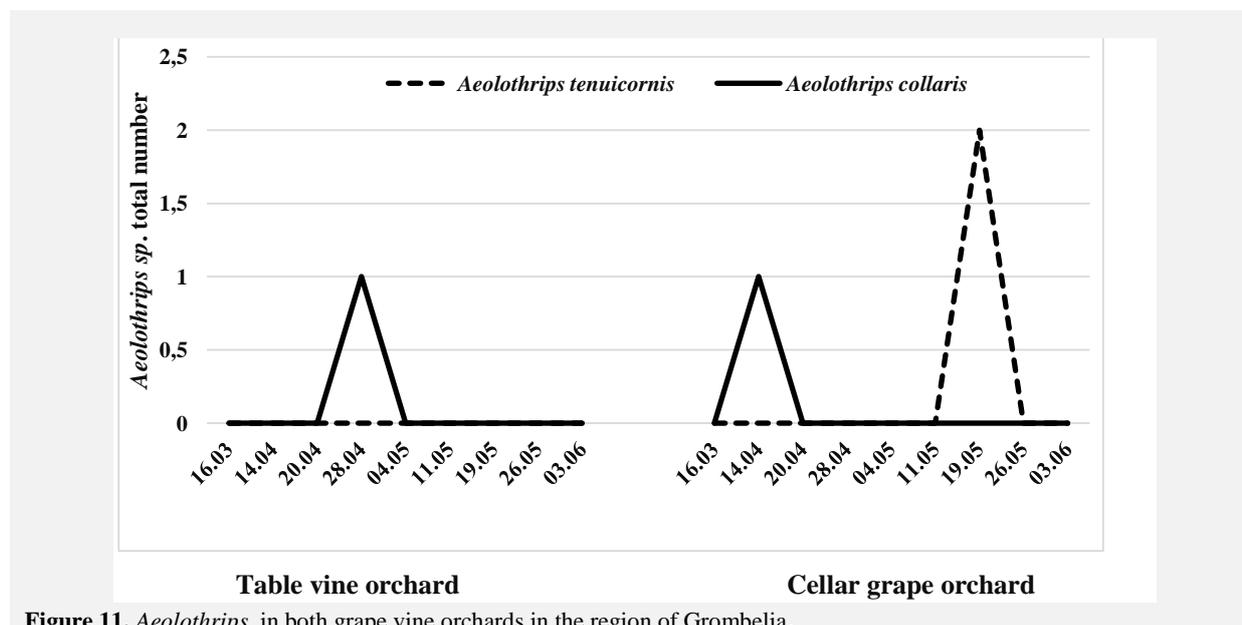


Figure 11. *Aeolothrips* in both grape vine orchards in the region of Grombelia.

4. Conclusion

During an inventory and monitoring of thrips species in two grape vine orchards in the region of Grombelia in Tunisia, nine thrips species were recorded and identified among which *Thrips tabaci*, *Thrips palmi*, *Thrips imaginis*, *Limothrips cerealium*, *Chirothrips manicatus* and *Microcephalothrips abdominalis* that are phytophagous thrips species, and two species of predatory thrips belonging to the genus *Aeolothrips*; *Ae. Collaris* and *Ae. Tenuicornis*. The genus *Haplothrips* was also encountered. Study of thrips species compositions in relation with biodiversity parameters and indexes indicated that the grape vine orchards are characterized by a good diversity, equitability and abundance due to the absence of chemical treatments. Monitoring all thrips species populations allowed to know critical appearance periods of each species. Those results allowed to establish an adequate integrated pest management on the future based on these results.

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