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Diversity and population fluctuations of thrips (Thysanoptera: Thripidae) on carrot crops in M'Sila region (Algeria)

Original Article

Fatiha Djebara
National Institute of Agronomic Research (I.N.R.A.), El-Harrach, 16200 Algiers, Algeria
Soumia Djamai
Faculty of Life and Natural Science, Department of Biology, University of Jijel, PO Box 98, cites Ouled Aissa18000, Jijel, Algeria
Fateh Mimeche
Department of Agricultural Sciences, University of M'Sila, M'Sila, Algeria
fateh.mimeche@univ-msila.dz (corresponding author)
Hayet Mimeche
Department of Ecology and Environment, University of Batna 2, Batna, Algeria
Ikram Boukhenissa
Department of Agricultural Sciences, University of M'Sila, Algeria
Marwa Merzoug
Department of Agricultural Sciences, University of M'Sila, M'Sila, Algeria
Smail Chafaa
Department of Ecology and Environment, University of Batna 2, Batna, Algeria

Abstract:
This study aimed to assess the diversity and population fluctuations of thrips associated with carrot crops in M'Sila region (Northeast Algeria). The study was conducted from February to June 2024. Samples were taken twice a month using sticky traps and basins, each available in two colors (yellow and blue). The fauna documented in this study consists of seven species belonging to four families. The family Thripidae was the most represented, with three taxa, followed by the Aeolothripidae, with two species. The families Melanthripidae and Phlaeothripidae each comprised a single species. Population monitoring revealed two major peaks, the first on April 21 and the second on May 20, reflecting seasonal activity patterns. Trap color preferences varied by species, with *F. occidentalis* predominantly attracted to blue traps, while *A. fasciatus* and *T. tabaci* preferred yellow traps. Diversity indices indicated low overall diversity reflecting the codominance of key species.

Key words:
Daucus carota L., diversity, trap color preference

Apstrakt:
Diverzitet i fluktuacije populacije tripsa (Thysanoptera: Thripidae) na usevima šargarepe u regionu M'Sila (Alžir)
Ova studija imala je za cilj da proceni raznovrsnost i fluktuacije populacije tripsa povezanih sa usevima šargarepe u regionu M'Sila (severoistočni Alžir). Istraživanje je sprovedeno od februara do juna 2024. godine. Uzorci su prikupljani dva puta mesečno pomoću lepljivih klopki i posuda, pri čemu je svaka bila dostupna u dve boje (žuta i plava). Fauna zabeležena u ovoj studiji obuhvatala je sedam vrsta koje pripadaju četirima familijama. Familija *Thripidae* bila je najzastupljenija, sa tri taksona, a sledila ju je *Aeolothripidae* sa dve vrste. Familije *Melanthripidae* i *Phlaeothripidae* bile su zastupljene sa po jednom vrstom. Praćenje populacije otkrilo je dva glavna pika, prvi 21. aprila, a drugi 20. maja, što odražava sezonske obrasce aktivnosti. Afinitet prema bojama klopki razlikovao se u zavisnosti od vrste: *F. occidentalis* je pretežno privlačila plava boja, dok su *A. fasciatus* i *T. tabaci* više preferirale žute klopke. Indeksi diverziteta ukazali su na nisku ukupnu raznovrsnost, što odražava kodominaciju ključnih vrsta.

Ključne reči:
Daucus carota L., diverzitet, preferencija boje klopke

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Introduction

Vegetable production in the Mediterranean basin is supported by favorable climatic conditions. The region's climatic diversity has established the Mediterranean basin as one of the most significant centers for vegetable cultivation.

Vegetable crops occupy second place after cereal crops, covering an area of approximately 268,760 hectares and producing 3,362,203 quintals (DSASI, 2001). They provide a significant nutritional supplement to staple foods such as meat products and cereals. The leading provinces in vegetable crop production include El Oued, with a production of 16.13 million quintals; Ain Defla, with 15.1 million quintals, and Mostaganem, with 9.1 million quintals.

Carrot cultivation plays a significant role in vegetable production programs in Algeria. It is widely

practiced in coastal regions (Alger, Boumerdes, and Mostaganem), the high plateaus (M'Sila, Oum El Bouaghi, and Sétif), and the southern areas (Adrar, Biskra, Ghardaia, and El Oued). The most commonly cultivated varieties include Super Muscade, Muscade, Touchon, Maestro, Carlo, and Bolero.

Thrips are among the most significant pests affecting vegetable crops, particularly carrots, due to the recurrent attacks by native and invasive species. These attacks often directly or indirectly limit crop yields, leading to economic losses (Ryckewaert & Rhino, 2017).

Thrips cause direct damage when they feed on plant organs. The saliva injected during feeding can be toxic to plant tissues (Bournier, 1983). Thrips are also known to be vectors of viruses. According to Mound (2004), over 50 species cause harm to cultivated plants, and 10 species act as vectors for tospoviruses worldwide. Thrips exhibit high adaptability and polyphagy. Additionally, fungi transmitted by thrips can cause diseases such as gray rot and white mold (Ebratt, 2013). The lesions caused by thrips feeding on leaves, flowers, and fruits reduce the leaf area available for photosynthesis, potentially resulting in significant damage (Fraval, 2006).

Following a case study on thrips affecting carrot crops in M'Sila Province, our objective is to conduct a qualitative and quantitative assessment of the key thrips species associated with carrot varieties cultivated in open fields within the region, and analyze their population fluctuations over the study period. This evaluation aims to inform the development of effective pest management strategies, particularly those targeting thrips that impact carrot production, for application in future studies.

Materials and Methods

Study area

The M'Sila region is situated in a strategic location in northeast Algeria. It is bordered to the northeast by the wilayas of Bordj Bou-Arreridj and Sétif, to the northwest by Médéa and Bouira, to the east by Batna, to the west by Djelfa, and to the southeast by Biskra. Geographically, M'Sila lies in the Algerian High Plateaus, at coordinates 35°42'07''N and 4°32'43''E. Historically, the region was classified a semi-arid and arid zone; however, the effects of climate change have significantly altered its climatic characteristics (Zedam et al., 2016).

The area is characterized by a Mediterranean arid bioclimatic zone with mild winters (Q2 = 17.02–19.84; m = 3.37–4.10°C; M = 38.87–40.06°C; P = 182.94–201.86 mm). The rainy season extends from October to May, while the dry season typically lasts until August. The Mediterranean climate of the region is influenced by the Sahara (Mimeche et al., 2018). M'Sila is also distinguished by its extensive agricultural land, primarily dedicated to cereal crops, vegetable production, and arboriculture.

The study on thrips population fluctuations on *Daucus carota* L. cultivated in open fields was carried out in the El Sagiya region (M'Sila region). The area dedicated to carrot cultivation covers 1.5 hectares within a total farm area of 10 hectares, managed as a private farm. The soil is clayey, and carrots (*Daucus carota* L.) had previously been cultivated in these fields.

The farm supports a variety of agricultural practices, including greenhouse vegetable production (tomatoes, chili peppers, bell peppers, melons, eggplants, zucchinis, and cucumbers), fruit orchards (apple, pomegranate, apricot, pear, fig, and citrus trees), and limited cereal crops (durum wheat and bread wheat).

Sampling technique

Sampling was conducted from February to June 2024 using sticky traps and basin traps as trapping tools. The sticky traps were suspended above the crops with wire; new traps were installed every 15 days, while the old ones were collected and preserved carefully with cellophane. Basin traps of different colors (blue and yellow) were placed on the soil surface. Each basin was filled to one-third of its capacity with water, and a detergent was added as a surfactant to prevent insects from escaping.

Thrips collection and counting

Thrips were collected by filtering the contents of the basin traps using a strainer. The collected specimens were placed in vials containing 96% alcohol, with each vial labeled to indicate the date, collection site, and trap color. In the laboratory, the contents of the vials were transferred to Petri dishes to facilitate the separation of thrips using entomological pins. The identification of the thrips on the sticky traps was conducted directly using a binocular magnifying glass and various identification keys.

The identification process also relied on the works of several authors, including Wang et al. (2010), Mound & Marullo (1996), Bournier (2002), and Moritz et al. (2004). The results were analyzed using ecological indices (Shannon Diversity Index, Pielou's Evenness Index, Simpson's Index of Diversity and Fisher's Alpha Index) with the software PAST (version 2001). For better graphical representation, we applied a logarithmic transformation to the abundance data.

Table 1. Thrips species collected from carrots using sticky traps and basin traps

Families	Sub-Families	Species of Thrips
Aeolothripidae	Aelothripinae	*Aelothrips fasciatus* (Linnaeus, 1758)
		Aeolothrips intermedius (Bagnall, 1934)
Melanthripidae	Melanthripinae	*Melanthrips pallidior* (Priesner, 1919)
Phalaeothripidae	Phalaeothripinae	*Gynaikothrips ficorum* (Marchal, 1908)
Thripidae	Thripinae	*Frankliniella occidentalis* (Pergande, 1895)
		Thrips tabaci (Lindemann, 1888)
		Liothrips sp.

Results

Inventory of thrips species

The results of the faunistic inventory and the fluctuations of thrips species recorded on carrots crops during our study are summarized in **Tab. 1** below.

The inventory of thrips species conducted on a carrot crop in the M'Sila region in 2024 identified seven species, distributed across four families and four subfamilies. The Thripidae family was the most dominant, represented by three species: *Frankliniella occidentalis*, *Thrips tabaci*, and *Liothrips* sp. This was followed by the Aeolothripidae family, with two species: *Aeolothrips fasciatus* and *Aeolothrips intermedius*. Lastly, the Melanthripidae and Phlaeothripidae families each contained a single species: *Melanthrips pallidior* and *Gynaikothrips ficorum*, respectively.

Abundance of thrips populations on carrot crops

The results of thrips trapping using sticky traps and basins traps on carrot crops in the M'Sila region during 2024 are summarized in **Tab. 2** below.

The analysis of thrips captures across the two traps revealed that *Aeolothrips fasciatus*, *Frankliniella occidentalis*, *Thrips tabaci*, and *Liothrips* sp. were consistently captured in all traps. In contrast, *Gynaikothrips ficorum* was detected exclusively in basins traps. This finding suggests that *G. ficorum* is not closely associated with vegetable crops. According to Ziouani et al. (2016), this species is primarily associated with *Ficus retusa*. Its occurrence in the traps was likely incidental, with no more than four individuals recorded.

The highest number of thrips captures was recorded on sticky traps, with 4,370 individuals collected on blue traps and 1,703 on yellow traps, representing 71.96% and 28.04% of the total population, respectively. In contrast, captures from basins traps were negligible, comprising no more than 62 individuals in blue basins and only 34 in yellow basins.

Aeolothrips fasciatus and *Frankliniella occidentalis* exhibited notable activity in carrot crops. *Aeolothrips fasciatus* was predominantly attracted to yellow traps, where 955 individuals were recorded compared to 419 on blue traps. Conversely, *F. occidentalis* was primarily captured on blue

Table 2. Abundance of thrips populations identified on carrot crops in M'Sila

Thrips species	Sticky traps		Basins traps		Total	
	Yellow	Blue	Yellow	Blue	Yellow	Blue
Aelothrips fasciatus	955	419	8	19	1374	27
Aeolothrips intermedius	0	0	1	5	0	6
Melanthrips pallidior	33	105	2	0	138	2
Gynaikothrips ficorum	0	0	3	4	0	7
Frankliniella occidentalis	488	3717	16	19	4205	35
Thrips tabaci	142	65	1	5	207	6
Liothrips sp.	85	64	3	10	149	13
Total	**1703**	**4370**	**34**	**62**	**6073**	**96**

traps, with 3,717 individuals compared to 488 on yellow traps. Other thrips species, including *Thrips tabaci*, *Liothrips* sp., and *Melanthrips pallidior*, were observed only occasionally, with populations not exceeding 142 individuals. Lastly, thrips showed minimal attraction to basins traps, with only isolated individuals captured, totaling no more than 19 in all.

Performance of various traps

Sticky traps

The initial thrips captures in the carrot crops were recorded at the start of the sampling. On blue sticky traps, 18 individuals were captured, compared to only 8 on yellow traps.

An analysis of the curves in **Fig. 1** reveals a gradual increase in thrips captures on yellow traps throughout April and May. The first peak of 741 individuals was recorded on April 21, followed by a slight population decline, leading to a second peak of 673 individuals on May 5. As the carrot crop cycle approached its end, a sharp decline in thrips captures was observed starting in late May. During the final three sampling periods, the number of thrips captured ranged between 0 and 26 individuals.

The thrips population captured on blue sticky traps was the highest, representing 71.96% of the total individuals recorded. Two major peaks were observed during the study: the first on April 21, with 616 individuals, and the second, more significant peak on May 20, with 3,291 individuals. Following this, a sharp decline in captures occurred during June, with numbers ranging from 0 to 111 individuals.

Basins traps

The thrips population captured using basins traps was significantly lower compared to the numbers recorded on sticky traps, accounting for less than 2% of the total captures. Blue basins consistently attracted the highest number of thrips, with 62 individuals captured, compared to 36 in yellow basins.

For blue basins, the curve in **Fig. 1** indicates a peak of 19 individuals on May 20, followed by a sharp decline, reaching a minimum of 6 individuals

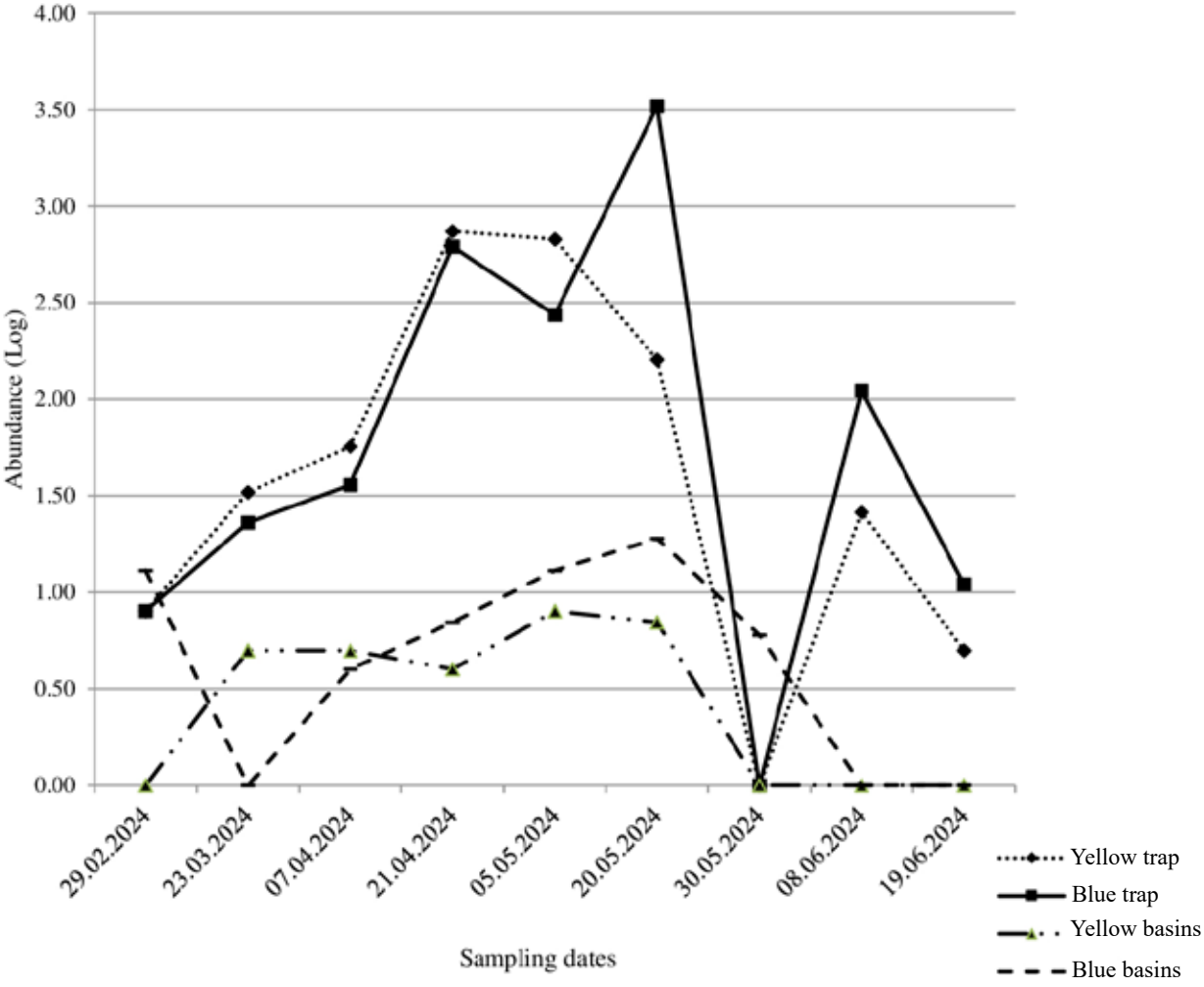

Fig. 1. Temporal dynamics of thrips populations recorded on carrot crops using sticky and basins traps in M'Sila, 2024

by the end of May. In yellow basins, the total thrips population did not exceed 8 individuals, with the highest count recorded on May 5. By late May, captures in yellow basins decreased to a minimum of 5 individuals, signaling the end of the carrot crop's cycle.

Evolution of the main thrips species recorded on carrot crops

Aeolothrips fasciatus

On yellow sticky traps, *Aeolothrips fasciatus* was first detected at the end of February, with a very low population of no more than 8 individuals. A gradual increase in captures was observed throughout April and May, with the first peak of 442 individuals recorded on April 21. This increase was followed by a slight decline in early May, leading to a second peak of 403 individuals. Subsequently, a sharp decrease in captures occurred, with a minimum of 30 individuals recorded on May 20. By June, *A. fasciatus* was completely absent, marking the ending of the carrot crop's vegetative cycle.

The thrips population in the blue basins was low, with a maximum of 172 individuals captured. There were two significant peaks in captures: the first peak occurred on April 21 with 172 individuals, and the second, smaller peak was on May 20 with 119 individuals. Notably, there were no thrips observed in June, coinciding with the ending of the carrot crop cycle (**Fig. 2**).

Frankliniella occidentalis

Unlike the species *A. fasciatus*, the thrips *F. occidentalis* is significantly more attracted to the blue color of the sticky traps. As a result, a total of 3,717 individuals (88.39%) were counted on the blue traps, compared to only 788 individuals (11.61%) on the yellow traps.

The first thrips were captured on April 21, marking an initial peak of 305 individuals. Following a decline in population at the beginning of May, there was a notable increase in both population and captures, reaching a second peak of 3,144 individuals on May 20. Thrips populations declined throughout

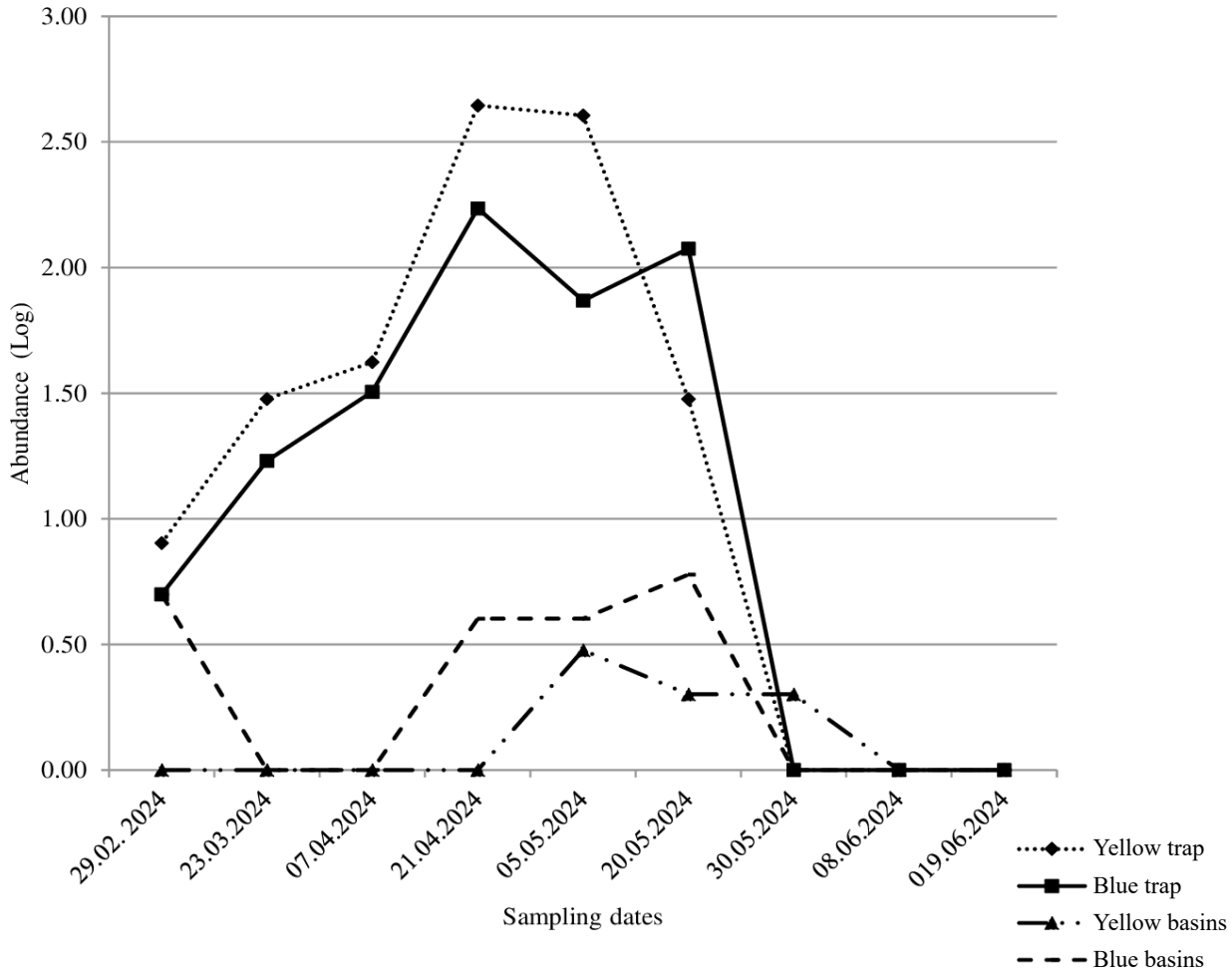

Fig. 2. Temporal dynamics of *Aeolothrips fasciatus* populations recorded on carrot crops in M'Sila, 2024

June, with captures not exceeding 116 individuals.

On yellow sticky traps, the first *Frankliniella occidentalis* individuals were captured around April 7, with a total of only 20 recorded. This was followed by a population increase, reaching a first peak of 206 individuals on April 21. A smaller second peak was observed in early May, with 175 individuals. However, beginning on April 20, the *F. occidentalis* population experienced a significant decline, with captures ranging from 3 to 94 individuals (**Fig. 3**).

Thrips tabaci

Our findings indicate that yellow sticky traps are significantly more effective in attracting *Thrips tabaci* populations. A total of 142 individuals (68.60%) were captured on yellow traps, compared to 65 individuals (31.40%) on blue traps. The first individuals were recorded on April 21, with 49 captured. A slight increase in population was observed in early May, with in a peak of 60 individuals. This was followed by a sharp decrease in captures throughout June, with only 9 individuals recorded during the entire month (**Fig. 4**).

Diversity indices

To characterize the species diversity of thrips populations observed on carrot crops in M'Sila, we calculated several ecological parameters, including dominance, Shannon's diversity index (H'), Pielou's equitability index (E), Simpson's index, and Fisher's alpha index. The results are presented in **Tab. 3** below.

The results summarized in **Tab. 3** indicate that the highest numbers of thrips individuals were recorded on May 20 and April 21, with 3,484 and 1,480 individuals, respectively. Shannon's diversity index was generally low, remaining below 2.00 bits. It ranged from 0.30 to 1.32 bits, with the highest value observed on February 29. When the diversity index is less than 2, the population is considered to have low diversity.

Overall, equitability ranged from 0.18 on May 20 to 0.82 on May 30, approaching 1 in some cases. When equitability nears 1, it indicates that the population is composed of a similar number of individuals across species, with no single

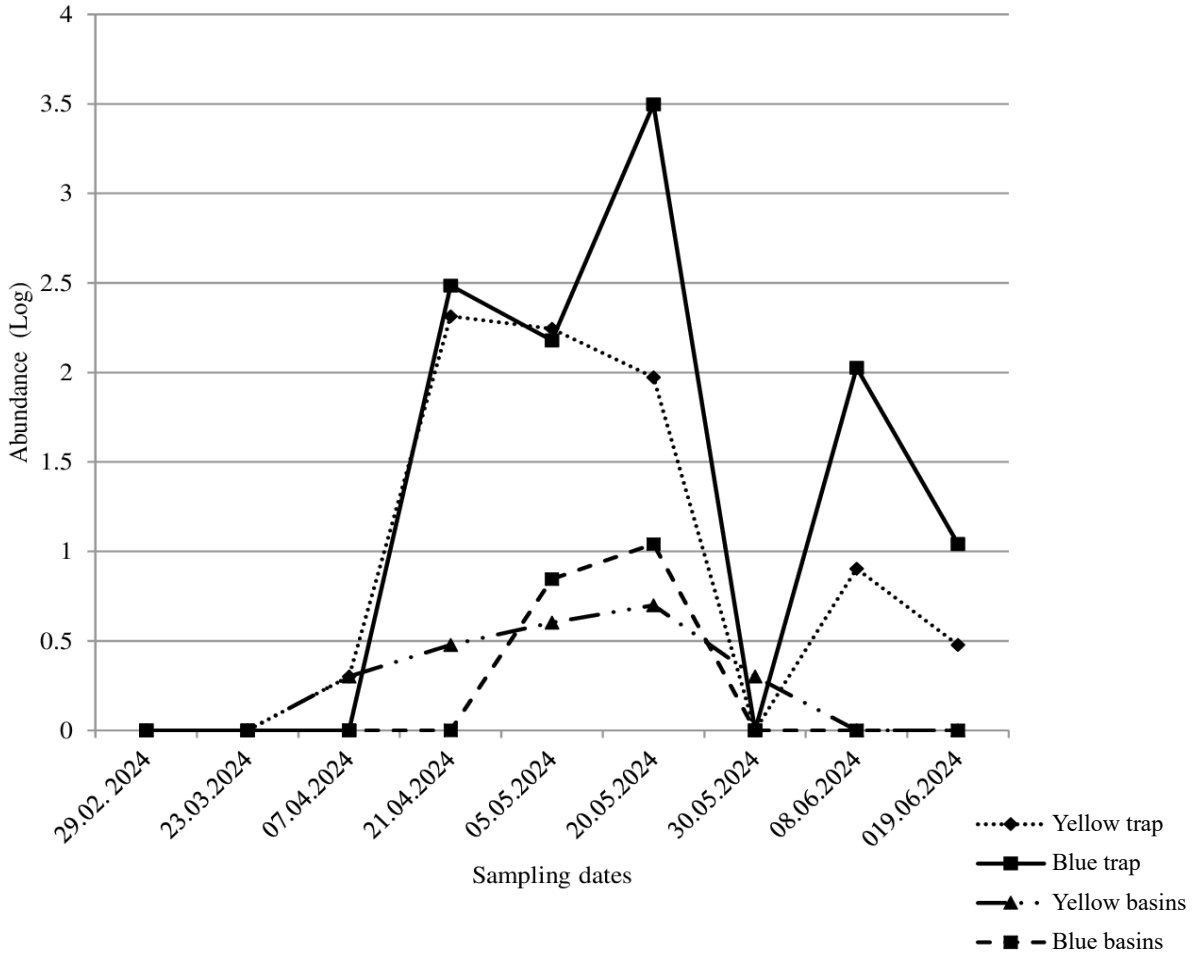

Fig. 3. Temporal dynamics of *Frankliniela occidentalis* populations recorded on carrot crops in M'Sila, 2024

species dominating. Simpson's index measures the probability that two randomly selected individuals belong to the same species within a population. The closer the index is to 1, the more homogeneous the population. In this study, Simpson's index ranged from 0.12 in May to 0.68 on April 21. It is worth noting that Simpson's diversity index gives greater weight to abundant species than to rare ones, reflecting the co-dominance of multiple species as the index approaches 1.

Fisher's alpha index (α) is an abundance model based on a logarithmic series, calculated using only the number of species (S) and the total number of individuals (N). Higher α values indicate lower

Table 3. Abundances and diversity indices of thrips species on carrot crops in M'Sila by sampling period in 2024

Sampling period	29.02. 2024	23.03. 2024	07.04. 2024	21.04. 2024	05.05. 2024	20.05. 2024	30.05. 2024	08.06. 2024	19.06. 2024
Individuals	30	62	106	1480	983	3484	11	137	16
Dominance_D	0.39	0.62	0.51	0.31	0.37	0.87	0.47	0.70	0.78
Shanon_H	1.32	0.75	1.04	1.29	1.16	0.30	0.90	0.56	0.37
Equitability_J	0.68	0.47	0.53	0.80	0.72	0.18	0.82	0.51	0.54
Simpson 1-D	0.60	0.37	0.48	0.68	0.62	0.12	0.52	0.29	0.21
Fisher_alpha	2.87	1.28	1.68	0.64	0.68	0.57	1.35	0.54	0.60

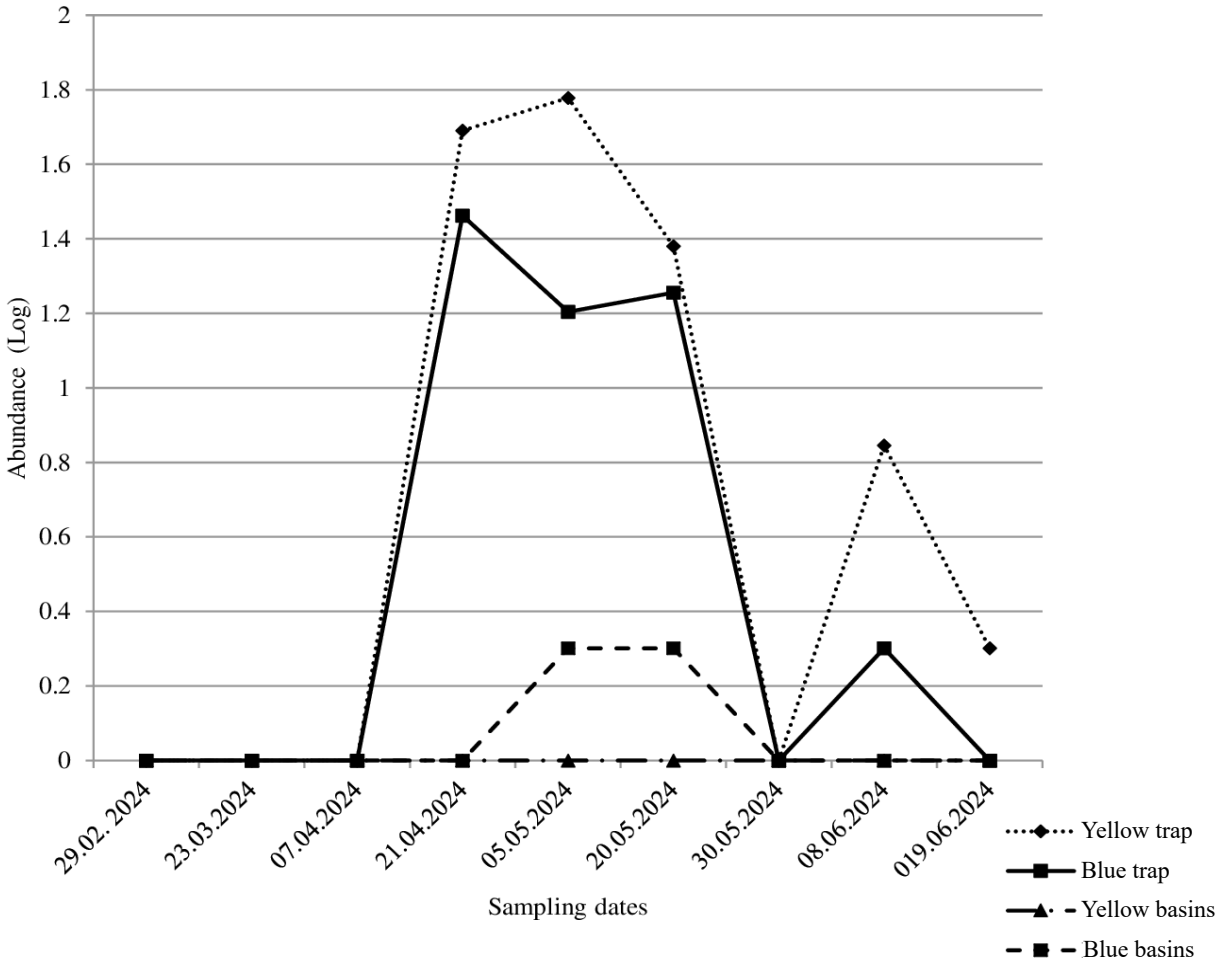

Fig. 4. Temporal dynamics of *Thrips tabaci* populations recorded on carrot crops in M'Sila, 2024

dominance by a single species. In this study, Fisher's alpha values were moderate, ranging from 0.54 on June 8 to 2.87 on February 29. These values suggest that the ecosystem is relatively unbalanced, with at least one species dominating the population at the study site.

Discussion

Thrips are highly adaptable insects that can thrive on a wide range of crops, including vegetables, cereals, fruit trees, and ornamental plants (Ullman et al., 1997). They can cause both direct and indirect damage to crops through their feeding habits and their potential role as vectors of plant diseases (Bournier, 1968; Bournier, 1983).

The study of thrips diversity conducted for the first time in Algeria on carrot crops (*Daucus carota* L.) in 2024, in the El Sagiya region (M'Sila province), identified seven species belonging to four families and four subfamilies. In a separate study conducted in the Batna region, Djerah (2022) documented 19 thrips species associated with six species of fruit trees from the Rosaceae family. Djebara et al. (2018) found four thrips species in greenhouse-grown tomatoes in Algiers (North Algeria). Additionally, Milat-Bissaad et al. (2011) were the first to investigate the diversity of thrips associated with vineyards in Algeria. Their inventory revealed four species: *Frankliniella occidentalis*, *Drepanothrips reuteri*, *Aeolothrips fasciatus* and *Liothrips* sp.

Toudji & Benrima (2022) highlighted the widespread presence of thrips on various plants in Algeria, highlighting the importance of continuous monitoring to prevent damage caused by these pests. In the Biskra region (Southern Algeria), during the 2010/2011 agricultural season, Laamari & Houamel (2015) reported, for the first time in Algeria, the presence of *Thrips tabaci* and *Frankliniella occidentalis* on greenhouse crops.

Our results show that the species *Aeolothrips fasciatus*, *Frankliniella occidentalis*, *Thrips tabaci*, and *Liothrips* sp. were captured in all traps. In contrast, *Gynaikothrips ficorum* was only captured in the basins. Ziouani (2019) reports that this thrips species is primarily associated with *Ficus retusa*. The highest number of thrips captures was recorded in the sticky traps, with 4,370 individuals in the blue traps and 1,703 individuals in the yellow traps, accounting for 71.96% and 28.04% of the total population, respectively.

The monitoring of the overall thrips population fluctuations during our study revealed the presence of two main peaks. The first was recorded on April 21 with 616 individuals, while the second, even more significant peak, was observed on May 20, with no fewer than 3291 individuals. For the species *Aeolothrips fasciatus*, the first individuals were captured towards the end of February. The species showed intense activity from late April to early May, with a peak of 442 individuals recorded on April 21 in the yellow sticky traps. In contrast to *A. fasciatus*, the thrips *Frankliniella occidentalis* is much more attracted to the blue color of the sticky traps.

The highest number of captures was noted on May 20 in the blue traps, totaling 3,144 individuals. The fluctuations of *Thrips tabaci* were much less pronounced than the two previous species. The number of captures did not exceed 60 individuals, regardless of the type of trap. *Thrips tabaci* was notably more attracted to the yellow sticky traps.

The two notable peaks in thrips activity that we observed on April 21 and May 20 align with the typical seasonal patterns of these insects. Research has shown that thrips populations often follow distinct seasonal cycles, which are closely tied to environmental factors like temperature, humidity, and the availability of plants they feed on (Ullman et al., 1997). In this case, the peaks in April and May likely reflect the ideal conditions for thrips development and reproduction. This is especially true in temperate regions, where the warming temperatures of spring create an environment that allows their populations to grow rapidly. Such seasonal fluctuations are common among various thrips species, including *F. occidentalis* and *A. fasciatus* (Loomans & Lenteren, 1995).

We observed that *F. occidentalis* is attracted to blue sticky traps while *A. fasciatus* prefers yellow ones supports what previous research has shown: different thrips species are attracted to specific colors. Studies have consistently found that *F. occidentalis* has a strong preference for blue traps (Gillespie & Vernon, 1990), finding them much more appealing than other colors like yellow or white (Ullman et al., 1997). This preference may be linked to the resemblance of blue to their favored host plants or to its high contrast with the surrounding background, enhancing detectability. On the other hand, our results show that *A. fasciatus* favors yellow traps, which aligns with findings from other studies as well (Nguyen et al., 2017).

The early appearance of *Aeolothrips fasciatus* in late February fits its usual springtime behavior, as this species is often among the first thrips to appear as the season changes. Its noticeable activity in late April and early May, particularly in yellow sticky traps, suggests that *A. fasciatus* may be one of the most common thrips species found in carrot crops during this period, especially when spring conditions are ideal for their development. Similarly, the peak in *F. occidentalis* populations on

May 20 aligns with its typical late-spring to early-summer activity. This species tends to reach its highest numbers around this time, due to its quick reproductive cycle and preference for specific crops (Morse & Hoddle, 2006).

The relatively low fluctuations in the population of *Thrips tabaci*, with a maximum of just 60 individuals captured across all traps, suggest that this species might be less attracted to carrot crops or possibly less common in the area during the observation period. This is consistent with research indicating that *T. tabaci* is generally less abundant in certain crops compared to others, with its activity affected by factors such as the availability of host plants and competition with other thrips species (Perring et al., 1993). Our study noted a preference for yellow traps, which is typical for *T. tabaci*; this species tends to be more attracted to yellow than to other colors (Bournier, 1968).

Conclusion

The dominance of thrips as pests in carrot crops highlights their remarkable adaptability and economic significance. These tiny insects not only inflict direct damage by feeding on the plants but also pose a serious threat as potential carriers of plant pathogens. This study underscores the need for integrated pest management (IPM) strategies. By combining regular monitoring with blue and yellow sticky traps, along with cultural practices like crop rotation and removing plant residues, farmers can better manage thrip populations. In situations where it's necessary, adding biological or chemical control methods can also be beneficial. This research marks the first comprehensive assessment of thrips in carrot crops in Algeria, laying the groundwork for future investigations. There is great potential to explore biological control options, such as using predatory mites or examine how thrips operate as vectors of plant diseases. Additionally, studying the effects of climate variability on thrips populations could enrich our understanding and lead to better long-term management strategies.

In summary, this study provides valuable insights for farmers, agronomists, and pest management professionals. The data gathered can help develop more effective strategies to safeguard carrot crops and minimize economic losses due to thrips in Algeria.

The results confirm that at least two species, *Aeolothrips fasciatus* and *Frankliniella occidentalis*, dominate the population, while *Thrips tabaci* plays a less significant but still has notable role in the community structure.

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