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Original Research

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Seasonal Population Fluctuation and Sex Ratio of *Frankliniella occidentalis* on Greenhouses Melon in Arid Southeastern of Algeria, North Africa

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ABSTRACT

The western flower thrips, *Frankliniella occidentalis* (Pergande 1895), is a polyphagous and invasive pest that causes serious damage to greenhouse crops. The present study aimed to examine the population changes, relative abundance, sex ratio, and species composition of thrips associated with melon (*Cucumis melo* L.) cultivated under greenhouse conditions in Garta, Algeria. Populations of *F. occidentalis* were monitored weekly from February to June 2017. Thrips densities increased with temperature; however, correlations with temperature (r = 0.54–0.55, p > 0.05) and relative humidity (r = 0.10–0.24, p > 0.05) were weak and not significant. Adults predominated on leaves, while larvae were less abundant (mean 7.44 per 30 leaves). High relative abundance was recorded across all sampling methods. Females largely predominated, accounting for 90.81–91.28% of adults, corresponding to a male-to-female ratio of approximately 1:9. Six thrips species were identified from the melon crop, with *F. occidentalis* being the dominant species. The other species included *Odontothrips loti*, *Aeolothrips intermedius*, *Thrips minutissimus*, *Melanthrips fuscus*, and *Chirothrips manicatus*, along with a few tubuliferous individuals. These results provide new insights into the population dynamics of *F. occidentalis* under arid greenhouse conditions and contribute to a better understanding of its prevalence in North African cropping systems.

Keywords: Arid conditions, *Frankliniella occidentalis*, greenhouse melon, population fluctuation, sex ratio

INTRODUCTION

Melon (*Cucumis melo* L.) exhibits wide morphological variation and is of great economic importance, being cultivated in many countries worldwide (Komala & Kuni 2022; Dantas et al., 2015). In Biskra, Algeria, approximately 1,292 ha are dedicated to melon cultivation annually, with production exceeding 522,030 quintals per hectare (Allache, 2021). Melons are grown in both open fields and greenhouses, with fruits typically harvested at maturity. However, in some regions, unripe fruits are also consumed raw or cooked depending on the variety (Dantas et al., 2015).

The melon crop is affected by several pests and diseases, including whiteflies, aphids, mites, and thrips. Thrips are among the most serious pests in vegetable and fruit production, causing damage to leaves, flowers, and fruits that leads to distortion, discoloration, silvering, bronzing, and reduced market value (Ramachandran et al., 2002). Although only 1 % of described thrips species are economically important, sixteen species act as significant Tospovirus vectors, transmitting 29 Orthotospovirus worldwide. Feeding and oviposition injuries also predispose plants to bacterial and fungal infections (Mound & Teulon, 1995; Ramachandran et al., 2002; Reitz, 2009).

The western flower thrips (*Frankliniella occidentalis* Pergande) is the most important species globally, affecting crops both in open fields and greenhouses (Reitz 2009; Miliczky & Horton 2011). Over the last decades, it has spread worldwide, including North Africa (Kirk & Terry 2003; Paini et al. 2008). Its introduction in Algeria was first reported in 2001 and confirmed in 2015 (Kirk 2002; Laamari & Houamel 2015). Despite being the most studied thrips species globally (Roth et al. 2016), few studies address its ecology in Algeria, partly due to its small size requiring slide-mount techniques. *F. occidentalis* is a major vector of Tospovirus, which are among the most economically damaging plant pathogens, causing significant yield losses in food and ornamental crops (Goldbach & Peters 1994; Zhang et al., 2023). Estimated losses due to WFT damage reach millions of US dollars annually in Europe and Turkey (Roosjen et al. 1998; Sevik & Arli-Sokmen, 2012).Recent findings from Egypt further highlight the threat posed by *F. occidentalis* to cucurbit crops: sequential biocontrol programs applied on squash during the 2021 and 2022 fall seasons significantly reduced infestations of *F. occidentalis*, while improving crop yield (Hassan et al., 2023).

Beyond its role as a vector, the sex ratio of *Frankliniella occidentalis* represents an important factor influencing population dynamics, as it affects reproduction, dispersal, and virus transmission. Female-biased populations may enhance colonization success and larval production (Kasina et al., 2009; Kirk, 2002). Population structure is also influenced by arrhenotokous parthenogenesis, a reproductive system in which unfertilized eggs develop into males whereas fertilized eggs produce females, potentially facilitating rapid population increase (Rosenheim et al. 1990; Reitz, 2002). In greenhouse environments, relatively stable temperature and humidity conditions may accelerate thrips development, emphasizing the role of abiotic factors in shaping population fluctuations and improving the prediction of pest outbreaks (Higgins, 1992; Reitz, 2009). These results confirm the need for a deeper understanding of thrips population dynamics on cucurbits, especially under arid greenhouse conditions such as those in Algeria. The present study aimed to enhance knowledge of crop thrips in Algeria by determining the species composition, relative abundance *of F. occidentalis*, seasonal population fluctuations, and sex ratio on pineapple melon under greenhouse conditions. Such data will inform the development of effective pest management strategies and support quarantine and phytosanitary measures in uninvaded regions.

METHODS

Study Site and Crop Management

Thrips was monitored during one crop season in a 400 m² greenhouse in Garta (34°47.388’N, 005°56.310’E) (Biskra, Algeria), cultivated with the pineapple melon cultivar DRM3241. Plants were transplanted in January 2017, arranged in 8 rows with 90 cm × 80 cm spacing, trellised vertically, and irrigated via drip system three to four times per week. The soil was slightly acidic, calcareous, saline, and fertilized chemically; pest and disease control targeted aphids, whiteflies, and powdery mildew. During the study period, abamectin was the only insecticide applied for pest control.

Temperature and relative humidity were recorded weekly during thrips sampling. Measurements were taken inside the greenhouse using an electronic hygrometer and a digital thermometer, both positioned at plant canopy height to represent the microclimatic conditions experienced by the crop.

Sampling Methods

Thrips were monitored on leaves, flowers, and with blue water traps throughout the crop season. For leaves, 30 randomly selected leaves were shaken weekly on a white plastic plate, and thrips were collected with an alcohol-moistened brush into 70 % ethanol. For flowers, 10 open male flowers were sampled weekly, and thrips were carefully extracted and preserved similarly. Blue water traps (20 cm × 12 cm, two-thirds filled with water and detergent) were placed inside the greenhouse, and collected thrips were recovered, preserved in 70 % ethanol, and identified under a microscope, with sexing and counting of *F. occidentalis*.

Statistical analysis

Data were log-transformed [ln(x + 1)] and analyzed using one-way ANOVA with LSD test *(P = 0.05*), and Pearson's correlation was applied to examine relationships between thrips abundance and abiotic factors (Statistica 6, StatSoft, 1984–2003).

RESULTS AND DISCUSSION

Species composition

Across the three sampling methods, 6.20% of thrips were collected in blue water traps, 60.84% from leaf shaking, and 32.96% from flowers. A total of 6067 adult thrips were collected, of which 5996 (98.83%) were *F. occidentalis*. Identification was confirmed through microscopic examination of slide-mounted specimens using key morphological characters (Figure. 1). The remaining 1.17% belonged to other species, including *Odontothrips loti*, *Aeolothrips intermedius*, *Thrips minutissimus*, *Melanthrips fuscus*, *Chirothrips manicatus*, along with a few unidentified tubuliferan individuals.

Figure 1. Illustration of the insect in question. (a) *Frankliniella occidentalis* adult. (b) Dorsal view. (c) Wings. (d) Antennae. (e) Legs. (f) Thorax.

Larval numbers were highest on leaves (134 larvae), followed by flowers (46) and blue traps (3). However, larvae represented less than 2.93% of the total thrips collected. Adults largely dominated the samples, accounting for 99.21%, 96.50%, and 97.75% in blue traps, leaf shaking, and flowers, respectively (Figure. 2). Overall, 97.07% of all collected thrips were adults.

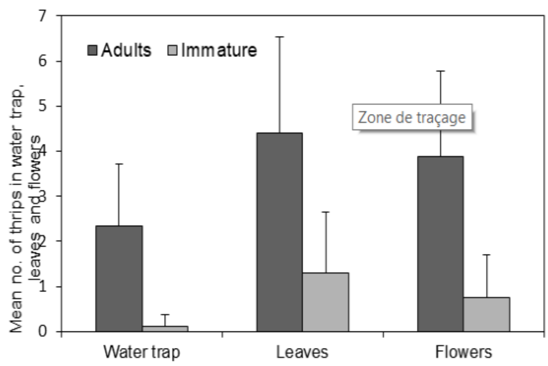

Figure 2. Mean numbers (mean ± SE) of adult and immature thrips collected using blue water trap, leave shaking and flowers in a melon greenhouse.

Seasonal abundance patterns

The thrips population was monitored weekly from February to June 2017. Overall, the different sampling methods on melon showed similar population trends (Fig. 3), and WFT was present throughout most of the plant phenological cycle.

On flowers, WFT abundance remained very low until March 31, then increased sharply, reaching a peak of 50.2 individuals per 10 flowers on May 4, followed by a decline after mid-May (Fig. 3a). Leaf-shaking samples showed a comparable pattern: numbers were initially low, then rose after March 31, with a maximum of 21.8 individuals recorded on April 20 (Fig. 3b). Cumulative counts per plant stayed below 100 individuals before March 31, then increased steadily from early April to a peak of 1074 individuals before decreasing at the end of the crop cycle (Fig. 3c). Larval numbers remained low, with a maximum of 45 larvae on April 27.

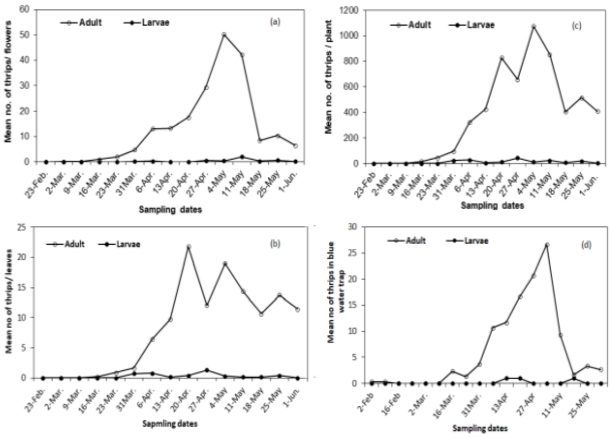

Figure 3. Population changes of *Frankliniella occidentalis* and thrips immature on melon flowers (a), leaves (b), whole plants (c) and in blue water traps (d) during the 2017 cropping season.

Blue water traps captured fewer than 5 adults before March 31. Their numbers increased until May 11, peaking at 26.67 individuals on May 4, then declined gradually (Fig. 3d). Population peaks across methods generally coincided with high temperatures and low relative humidity, except on April 20 when outside conditions were cool and cloudy. Larvae were scarce and irregularly detected across all sampling methods, first appearing on leaves and flowers on March 31 and later in traps on April 13, with leaves being the preferred site.

Sex-ratio structure

F. occidentalis was the dominant species in the greenhouse and occurred similarly on leaves and flowers. Its relative abundance was high on both plant parts, while blue water traps captured significantly fewer adults (Table 1).

Immature stages were generally scarce. Their numbers were highest on leaves, followed by flowers, and both were significantly higher than those recorded in blue traps. From all sampling methods combined, 5996 adults were collected: 5447 females and 549 males. Leaves contained the highest numbers of both sexes, followed by flowers and blue traps. ANOVA revealed significant differences between male and female mean counts, but no difference between leaves and flowers. The male proportion remained below 10% in all sampling methods, resulting in a consistently female-biased sex ratio of approximately 1 male to 9 females.

Relationship with abiotic variables

The correlations between WFT abundance and the studied variables are shown in Figure 4. A positive correlation was observed across all associations, but only the relationship between thrips on flowers and leaves was significant ($t = 4.021$; $P = 0.001$) (Fig. 4a). Correlations between thrips abundance and temperature or relative humidity were weak and not significant (Fig. 4b, 4c).

The highest mean numbers were recorded on flowers (50.2 adults/10 flowers) and in blue water traps (26.97 adults) at 36.5 °C and 30% RH. A notable value on leaves (21.8 adults) occurred at 23.75 °C and 73% RH. Although higher humidity appeared to correspond with lower thrips numbers in some observations, correlation analysis showed no significant relationship between relative humidity and thrips abundance, suggesting that humidity may not be a major factor influencing thrips populations.

Table 1. Means (±SE) of Frankliniella occidentalis adults, immature thrips, male/ female, relative abundance and sex-ratio in the different sampling methods.

Studied parameters	Mean number of thrips					
	Blue water trap	Leaves	Flowers	*F*	*df*	*P*
Relative (%) abundance	91.49 a	99.19 a	99.55 a	0.26	2, 45	0.773
F.occidentalis (mean± SD)	19.11 ± 23.99 a	203.39 ± 222.73b	110.61 ± 151.05 bc	4.98	2, 45	0.011
Immature thrips (mean± SD)	0.17 ± 0.38 a	7.44 ± 11.11 b	2.56 ± 4.84 bc	9.64	2, 45	0.000
Male (mean± SD)	1.67 ± 3.38 a	18.67 ± 24.20 b	10.17 ± 13.36 bc	8.17	2, 45	0.000
Female (mean± SD)	17.44 ± 21.19 a	184.72 ± 205.81 b	100.44 ± 138.77 bc	4.87	2, 45	0.012
Sex-ratio	0.09 a	0.10 a	0.10 a	1.69	2, 37	0.198

(Numbers in parentheses are percentage of males and females collected in the different sampling method. Means or percentages followed by the same lowercase letter in the same line are not significantly different (LSD test at P > 0.05)).

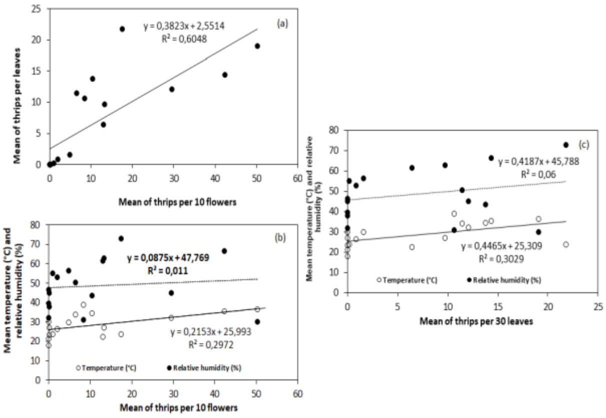

Figure 4 . Relationship between mean numbers of *Frankliniella occidentalis* thrips per flowers and leaves (a), flowers and temperature- humidity (b), leaves and temperature- humidity (c) in a pineapple melon.

At least six thrips species were recorded on melon in the greenhouse, with *Frankliniella occidentalis* being dominant. Previous surveys in Biskra reported up to seven species on vegetable crops, three of which (*F. occidentalis*, *Aeolothrips intermedius*, *Odontothrips loti*) were also found on melon (Razi et al., 2013, 2017). Along the Algiers coastline, two species overlapped with our findings (*F. occidentalis* and *O. loti*) (Benmessaoud-Boukhalfa et al., 2010), while in Tunisia, *F. occidentalis* and *Melanthrips fuscus* were shared with citrus orchards (Belaam & Boulahia-Kheder, 2012). WFT predominance has been reported worldwide, including roses in France (Pizzol et al., 2014), confirming its wide host range and distribution in Biskra.

F. occidentalis populations showed low numbers early in the growing season, likely due to moderate temperatures, and increased in spring, peaking in April–May, coinciding with high flower abundance. This pattern aligns with Nyasani et al. (2013) on French beans and Palomo et al. (2015) on various cucurbits. Population decline at the end of the crop cycle is attributed to plant desiccation, flower depletion, and reduced reproduction (Deligeorgidis et al. 2005; Higgins 1992). Flower sampling showed higher adult abundance, while larval numbers remained low, suggesting that the sampling methods, particularly blue traps and leaf shaking, may be baised toward capturing mobile adults. Furthermore, the cryptic behavior of larvae within leaf and flower tissues likely reduced their detectability during sampling. However, the possibility that melon represents a suboptimal reproductive host for *F. occidentalis* cannot be ruled out, even though melon is known to support its reproduction. Similar patterns were reported for other crops, including tomato and strawberry (Pickett et al., 1988; Miliczky & Horton, 2011; Gonzalez-Zamora & Garcia-Mari, 2003).

Temperature positively influenced adult thrips numbers, consistent with Elimem et al. (2011). Relative humidity showed a weak positive correlation, with the highest WFT numbers observed at 73 % RH and 23.75 °C, possibly due to high plant transpiration and dense canopy (Mailhot et al., 2007; Ahmed et al., 2017). No specific thrips-targeted pesticides were applied; abamectin was used only once for mite control and likely had minimal impact (Welter et al., 1990).

Female *F. occidentalis* predominated throughout the study, resulting in a low sex-ratio, consistent with observations on cucumber and roses (Elimem & Chermiti, 2009; MacIntyre-Allen et al., 2005; Baez et al., 2011). The reproductive mode is arrhenotokous parthenogenesis, producing mainly females under favorable conditions (Rosenheim et al. 1990; Reitz, 2002; Marullo & De Grazia 2012; Wang et al., 2014; Ding et al., 2018). Environmental factors such as temperature, humidity, photoperiod, and flower availability influence sex-ratio dynamics (Hazir & Ulusoy 2012; Elimem & Chermiti 2009; Tao et al. 2022). The dominance of *F. occidentalis* and its population dynamics indicate that melon crops can support both adult and larval development. Although no damage was observed, monitoring is crucial to determine threshold levels and define critical control periods (Pizzol et al. 2010). Understanding seasonal peaks, host preferences, and environmental influences provides valuable information for designing sustainable and effective management strategies for thrips in arid greenhouse conditions.

CONCLUSIONS

In conclusion, this study provides a comprehensive analysis of the population dynamics of *Frankliniella occidentalis*, a major global vector of Orthotospoviruses. In greenhouse melon, the thrips community was dominated by this species, with a significant female-biased sex ratio, indicating high reproductive potential and a risk of rapid crop colonization. Seasonal abundance peaked during hot and dry periods, while higher humidity favored leaf colonization, although it was not a primary driver of overall population fluctuations. These findings have important implications for thrips management in greenhouse ecosystems. Integrated Pest Management (IPM) should prioritize early monitoring from transplanting through the flowering stage, the most critical period for infestation. Establishing science-based monitoring is essential to limit the spread of viral diseases. This study was limited to a single greenhouse over one season. Further multi-season and multi-site research is recommended to validate these patterns and support the development of robust, climate-adaptive management strategies for this invasive pest.

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REFERENCES

Ahmed, M.H., Ullah, M.I., Raza, A.B.M., Afzal, M., Khaliq, A., Iftikhar, Y., & Aatif, H.M. (2017). Population dynamics of *Thrips tabaci* (Lindeman) in relation to abiotic climate factors on Bt and non-Bt cotton cultivars. *Journal of Zoology*, 49(6), 1937–1943. https://doi.org/10.17582/journal.pjz/2017.49.6.1937.1943

Allache, F. (2021). Etude éco-biologique des thrips inféodés aux Cucurbitacées sous serre dans la région de Biskra. University of Biskra.

Aliakbarpour, H., Che Salmah, M.R., & Dieng, H. (2010) Species composition and population dynamics of thrips (Thysanoptera) in mango orchards of northern peninsular Malaysia. *Environmental Entomology*, 39(5), 1409–1419. https://doi.org/10.1603/EN10066

Baez, I., Reitz, S.R., Funderburk, J.E., & Olson, S.M. (2011). Variation within and between *Frankliniella thrips* species in host plant utilization. *Journal of Insect Science*, 11(1), 41. https://doi.org/10.1673/031.011.0141

Belaam, I., & Boulahia-Kheder, S. (2012). Inventory of thrips species in citrus orchards and assessment of scarring fruits in two citrus-producing regions of Tunisia. *Tunisian Journal of Plant Protection*, 7, 1–9

Benmessaoud-Boukhalfa, H., Mouhouche, F., & Belmazouzi, F. Z. (2010). Inventory and identification of some thrips species in coastal and sub-coastal regions of Algeria. *Agriculture and Biology Journal of North America*, 1(5), 755–761. DOI: 10.5251/abjna.2010.1.5.755.761

Chellemi, D.O., Funderburk, J.E., & Hall, D.W. (1994). Seasonal abundance of flower-inhabiting Frankliniella species (Thysanoptera: Thripidae) on wild plant species. *Environmental Entomology*, 23(2), 337–342. https://doi.org/10.1093/ee/23.2.337

Dantas, A.A.C., Holanda, I.S.A., Esteras, C., De Sousa Nunes, G.H., & Pico, M.B. (2015). Diversity of melon accessions from northeastern Brazil and their relationships with germplasms of diverse origins *Journal of the American Society for Horticultural Science*, 140(5), 504–517. https://doi.org/10.21273/JASHS.140.5.504

Deligeorgidis, P.N., Ipsilandis, C.G., Fotiadou, C., Kaltsoudas, G., Giakalis, L., & Garsen, A. (2005). Fluctuation and distribution of *Frankliniella occidentalis* (Pergande) and *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) populations in greenhouse cucumber and tomato 8(8):1105-1111. *Pakistan Journal of Biological Sciences*, 8(8), 1105–1111. https://doi.org/10.3923/pjbs.2005.1105.1111

Ding, T., Chi, H., Gokçe, A., Gao, Y., & Zhang, B. (2018). Demographic analysis of arrhenotokous parthenogenesis and bisexual reproduction of *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae). *Scientific Reports*, 8, 334. https://doi.org/10.1038/s41598-018-21689-z

Elimem, M., & Chermiti, B. (2009). Population dynamics of *Frankliniella occidentalis* Pergande (1895) (Thysanoptera: Thripidae) and evaluation of its different ecotypes and their evolution in a rose (*Rosa hybrida*) greenhouse in the Sahline region, Tunisia. *African Journal of Plant Science and Biotechnology*, 3(1), 53-62.

Elimem, M., Harbi, A., & Chermiti, B. (2011).Populations of *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae) in a greenhouse pepper crop in the region of Moknine (Tunisia) in relation to environ mental conditions. *African Journal of Plant Science and Biotechnology*, 5(1), 30–34.

Frantz, G., & Mellinger, H.C. (2009). Shifts in western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae), population abundance and crop damage. *Florida Entomologist*, 92(1), 29–34. https://doi.org/10.1653/024.092.0106

Garrick, T.A., Liburd, O.E., & Funderburk, J. (2016). Effect of humidity on fecundity and egg incubation of *Frankliniella bispinosa* and *Frankliniella occidentalis* (Thysanoptera: Thripidae). *Florida Entomologist*, 99(3), 505–508. https://doi.org/10.1653/024.099.0324

Ghosh, A., Dey, D., Timmanna, Basavaraj, Mandal, B., & Jain, R.K. (2017) Thrips as the vectors of tospoviruses in Indian agriculture. Mandal B., Rao G., Baranwal V. & R. Jain (Eds.) A Century of Plant Virology in India (hlm. 537–561). Springer.

Goldbach, R., & Peters, D. (1994). Possible causes of the emergence of tospovirus diseases. *Seminars in Virology* 5(2), 113-120. https://doi.org/10.1006/smvy.1994.1012

Gonzalez-Zamora, J.E., & Garcia-Mari, F. (2003). The efficiency of several sampling methods for *Frankliniella occidentalis* (Thysan., Thripidae) in strawberry flowers. *Journal of Applied Entomology*, 127, 516–521. https://doi.org/10.1046/j.0931-2048.2003.00783.x

Hansen, E.A. Funderburk, J.E., Reitz S.R., Ramachandran,S., Eger, J.E.& Mcauslane, H. (2003). Within-plant distribution of *Frankliniella* species (Thysanoptera: Thripidae) and *Orius insidiosus* (Heteroptera: Anthocoridae) in field pepper. *Environmental Entomology*, 32(4), 766–772.

Hazir, A., & Ulusoy, M.R. (2012). Population fluctuation of thrips species (Thysanoptera : Thripidae) in nectarine orchards and damage levels in Mediterranean region of Turkey east. *Journal of the Entomological Research Society*, 14(1), 41–52.

Higgins, C.J. (1992). Western flower thrips (Thysanoptera: Thripidae) in greenhouses: population dynamics, distribution on plants and associations with predators. Journal of Economic Entomology, 85(5), 1891–1903. https://doi.org/10.1093/jee/85.5.1891

Kasina, M., Nderitu, J., Nyamasyo, G., Waturu, C.,Olubayo, F., & Obudho, E. (2009). Within-plant distribution and seasonal population dynamics of flower thrips (Thysanoptera: Thripidae) infesting French beans (*Phaseolus vulgaris* L.) in Kenya. *Spanish Journal of Agricultural Research*, 29(2), 82–90. https://doi.org/10.5424/sjar/2009073-450

Kendall, D.M. & Capinera, J.L. (1990). Geographic and temporal variation in the sex-ratio of onion thrips. *Southwestern Entomologist*, 15, 80–88.

Kirk, W.D.J. (2002). The pest and vector from the West: *Frankliniella occidentalis*. Thrips and Tospoviruses: Proceedings of the 7th International Symposium on Thysanoptera, 2, 33-42.

Kirk, W.D.J., & Terry, L.I. (2003). The spread of the western flower thrips *Frankliniella occidentalis* (Pergande). *Agriculture and Forest Entomology*, 5(4), 301–310. https://doi.org/10.1046/j.1461-9563.2003.00192.x

Laamari, M., & Houamel, S. (2015). Première observation de *Thrips tabaci* et de *Frankliniella occidentalis* sur les cultures sous serre en Algérie. *EPPO Bulletin* 45(2), 205-206. https://doi.org/10.1111/epp.12202

Macintyre-Allen, J.K., Scott-Dupree, C.D., Tolman, J.H., & Harris, C.R. (2005). Evaluation of sampling methodology for determining the population dynamics of onion thrips (Thysanoptera: Thripidae) in Ontario onion fields. *Journal of Economic Entomology*, 96(6), 2272–2281. https://doi.org/10.1603/0022-0493-98.6.2272

Mailhot, D., Maroi, J., & Wright, D. (2007). Species of thrips associated with cotton flowers. *Journal of Cotton Science*, 11, 186–198.

Marullo, R., & De Grazia, A.(2012). Notes on sex ratio and reproductive modes in field populations of two pest thrips species (Thysanoptera, Thripidae) in Italy. *Acta Phytopathologica et Entomologica Hungarica*, 47(1), 117–123. https://doi.org/10.1556/APhyt.47.2012.1.15

Mcdonald, J.R., Bale, J., &, Walters, K.F.A. (1998). Effect of temperature on development of the western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae). *European Journal of Entomology*, 95(2), 301–306.

Miliczky, E., & Horton, D.R. (2011). Occurrence of the western flower thrips, *Frankliniella* *occidentalis*, and potential predators on host plants in near orchard habitats of Washington and Oregon (Thysanoptera: Thripidae). *Journal of the Entomological Society of British Columbia*, 108, 11–28.

Mound, L.A., & Teulon, D.A.J. (1995). Thysanoptera as phytophagous opportunists. In BL Parker, M Skinner &T Lewis (Eds.) Thrips Biology and Management, (pp. 3-19), New York, Plenum Publishing Corp.

Nyasani, J.O., Meyhofer, R., Subramanian, S., & Poehling, H.M. (2013). Seasonal abundance of western flower thrips and its natural enemies in different French bean agroecosystems in Kenya 86:515-523. *Journal of Pest Science*, 86, 515–523. https://doi.org/10.1007/s10340-013-0491-0

Ozsemerci, F., Aksit, T., & Tunç, I. (2011). Composition, seasonal abundance and within- plant distribution of Thysanoptera species associated with seedless grapes (Sultana) in districts of Manisa, *Turkish Journal of Entomology*, 35(1), 103–118.

Paini, D.R., Funderburk, J.E., & Reitz, S.R. (2008). Competitive exclusion of a worldwide invasive pest by a native. Quantifying competition between two phytophagous insects on two host plant species. *Journal of Animal Ecology*, 77(1), 184–190. https://doi.org/10.1111/j.1365-2656.2007.01324.x

Palomo, L.A.T., Martinez, N.B., Johansen-Naime, R., Napoles, J.R., Leon, O.S., Arroyo, H.S.,& Graziano, J.V.(2015). Population fluctuations of thri.ps (Thysanoptera) and their relationship to the phenology of vegetable crops in the central region of Mexico. *Florida Entomologist*, 98(2), 430–438. https://doi.org/10.1653/024.098.0206

Pickett, C.H., Wilson, L.T., & Gonzalezi, D. (1988). Population dynamics and within-plant distribution of the western flower thrips (Thysanoptera: Thripidae), an early-season predator of spider mites infesting cotton. *Environmental Entomology*, 17, 551–559.

Pizzol, J., Nammour, D., Hervouet, P., Bout, A., Desneux, N., & Mailleret, L.(2010). Comparison of two methods of monitoring thrips populations in a greenhouse rose crop. *Journal of Pest Science*, 83(2), 191–196. https://doi.org/10.1007/s10340-010-0286-5

Pizzol, J., Nammour, D., Rabasse, J.M., Parolin, P., Desneux, N., Poncet, C., & Reynaud, P. (2014). Species and population dynamics of thrips occurring inside and outside greenhouses cultivated with roses in southern France. *International Journal of Agricultural Policy and Research*, 2, 141–153.

Puche, H., Berger, R.D., & Funderburk, J.E. (1995). Population dynamics of *Frankliniella* species (Thysanoptera : Thripidae) thrips and progress of spotted wilt in tomato fields. *Crop Protection*, 14(7), 570–583. https://doi.org/10.1016/0261-2194(95)00000-3

Ramachandran, S., Funderburk, J., Stavisky, J., & Olson, S. (2002). Population abundance and movement of *Frankliniella* species and *Orius insidiosus* in field pepper. *Agricultural and Forest Entomology*, 3(2), 129–137. https://doi.org/10.1046/j.1461-9563.2001.00097.x

Razi,S., Bernard, E.C., & Laamari, M. (2017). A survey of thrips and their potential for transmission of viruses to crops in Biskra (Algeria): First record of the species *Frankliniella intonsa* and *Thrips flavus*. *Tunisian Journal of Plant Protection*, 12(2): 197–205.

Razi,S., Laamari, M., Ouamen, S., & Bernard, E.C. (2013). Thysanoptera survey on *Vicia faba* broad bean in the arid Biskra region of Algeria. *Agricultural and Biological Journal of North America*, 4(3), 268–274.

Reitz, S.R. (2002). Seasonal and within plant distribution of *Frankliniella* thrips (Thysanoptera:Thripidae) in North Florida tomatoes. *Florida Entomologist*, 85(3), 431–439.

Reitz, S.R. (2009). Biology and ecology of the western flower thrips (Thysanoptera : Thripidae): the making of a pest. *Florida Entomologist*, 92(1), 7–13. https://doi.org/10.1653/024.092.0102

Ripa, R., Funderburk,J., Rodriguez, F., Espinoza, F., & Mound, L. (2009). Population abundance of *Frankliniella occidentalis* (Thysanoptera: Thripidae) and natural enemies on plant hosts in central Chile. *Environmental Entomology*, 38(2), 333–344. https://doi.org/10.1603/022.038.0205

Roditakis, N.E. (1991). First record of *Frankliniella occidentalis* in Greece. *Entomologia Hellenica*, 9, 77–79. https://doi.org/10.12681/eh.13995

Rosenheim, J.A., Welter, S.C., Johnson, M.W., Mau, R.F.L., & Gusukuma-Minutoi, L.R.(1990). Direct feeding damage on cucumber by mixed-species infestations of *Thrips palmi* and *Frankliniella occidentalis* (Thysanoptera: Thripidae). *Journal of Economic Entomology*, 83(4), 1519–1525. https://doi.org/10.1093/jee/83.4.1519

Roth, F., Galli, Z., Toth, M., Fail, J., & Jenser, G. (2016). The hypothesized visual system of *Thrips tabaci* Lindeman and *Frankliniella occidentalis* (Pergande) based on different coloured traps' catches. *North-Western Journal of Zoology*, 12(1), 40–49.

Sevik, M.A.,& Arli-Sokmen, M. (2012). Estimation of the effect of Tomato spotted wilt virus (TSWV) infection on some yield components of tomato. *Phytoparasitica*, 40,87-93. https://doi.org/10.1007/s12600-011-0192-2

Tao, M., Wan, Y., Zheng, X., Qian, K., & Merchant, A., Xu, B.,Zhang, Y.,Zhou, X.,& Wu, Q. (2022). Tomato spotted wilt *orthotospovirus* shifts sex ratio toward males in the western flower thrips, *Frankliniella occidentalis*, by down-regulating a FSCB-like gene. *Pest Management Science*, 78(11), 5014–5023. https://doi.org/10.1002/ps.7125

Waiganjo, M.M., Gitonga, L.M., & Mueke, J.M. (2008). Effects of weather on thrips population dynamics and its implications on the thrips pest management. *African Journal of Horticultural Science*, 1(1), 82–90.

Wang, J.C., Zhang, B., Li, H.G.,Wang, J.P., & Zheng, C.Y. (2014) Effects of exposure to high temperature on *Frankliniella occidentalis* (Thysanoptera: Thripidae), under arrhenotoky and sexual reproduction conditions. *Florida Entomologist*, 97(2), 504–510. https://doi.org/10.1653/024.097.0222

Welter, S.C., Rosenheim, J.A., Johnson, M.W., Mau, R.F.L., & Gusukuma-Minuto, L.R. (1990) Effects of *Thrips palmi* and western flower thrips (Thysanoptera: Thripidae) on the yield, growth, and carbon allocation pattern in cucumbers. *Journal of Economic* Entomology, 83(5), 2092–2101.

Zhang, Z., Zhang, J., Li, X., Zhang, J., Wang, Y., & Lu,Y. (2023). The Plant Virus Tomato Spotted Wilt Orthotospovirus Benefits Its Vector *Frankliniella occidentalis* by Decreasing Plant Toxic Alkaloids in Host Plant. *International Journal of Molecular Sciences*, 24(19), 14493. https://doi.org/10.3390/ijms241914493