STUDIA UNIVERSITATIS BABEŞ-BOLYAI BIOLOGIA, 68, 2, 2023 (p. 197-217)
doi:10.24193/subbbiol.2023.2.02

First notes on plant diversity, finding sites and sex ratio in natural populations of *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) in Algeria (Biskra province)

Rima Rechid[1,2]✉, Malik Laamari[2,3] and Arturo Goldarazena[4]

[1]Department of Natural Sciences and Life, University Mohamed Khider, Biskra, Algeria ; [2]Laboratoire d'Amélioration des Techniques de Protection Phytosanitaires en Agro-Système Montagneux (LATPPAM), University of Batna, Batna, Algeria; [3]Department of Agronomy, University of Batna, Batna, Algeria ; [4]Laboratorio Nacional de Referencia de Nemátodos y Artrópodos, Departamento de Biodiversidad y Ecología Evolutiva, Museo Nacional de Ciencias Naturales, Madrid, Spain; ✉***Corresponding author, E-mail: rima.rechid@univ-biskra.dz, rimarechid@gmail.com***

Article history: Received: 20 March 2023; Revised: 14 December 2023; Accepted: 14 December 2023; Available online: 28 December 2023.

Abstract. *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), commonly known as onion thrips, is a serious global pest of commercial onion, causing direct and indirect important damages. This survey carried out in natural areas of Biskra province (Algeria) during two periods, 2008/2009 and 2011/2012, aims to review the plant species harbouring *T. tabaci* in this region.

Algerian and Spanish researchers confirmed twenty-three thrips species. *T. tabaci* is the most abundant and polyphagous. Studies have indicated that it settled in fifty one plant species belonging to nineteen botanical families. The most important are Asteraceae, Brassicaceae, Fabaceae, and Amaranthaceae. In Biskra, *T. tabaci* was found in sites between -32 m and 1000 m of sea level. The results also indicate the presence of sexual and asexual populations.

This study shows that *T. tabaci* is ubiquitous in the natural habitat of Biskra province. Further research is needed to confirm its host plants and the most common mode of reproduction in this region by studying the largest number of plants in various environments and demonstrating the sex ratio over a broad survey spectrum.

Keywords: *Thrips tabaci*, ubiquitous, natural area, finding sites, plant diversity, sex ratio, Biskra region, Algeria.

Introduction

Onion thrips, *Thrips tabaci* (Thysanoptera: Thripidae), is harmful pest thrips vector of tospoviruses (Mound, 2002; Diaz-Montano *et al.*, 2011). The feeding behavior of this species causes severe damage (Mound, 2002; Diaz-Montano *et al.*, 2011). It is believed to have originated in the Mediterranean region. *T. tabaci* was firstly reported by Russian entomologist Karl Eduard Lindeman, represented by specimens collected in Bessarabia, Russia, which caused serious damage to tobacco plants (genus *Nicotiana*) (Diaz-Montano *et al.*, 2011). Later studies reported the presence of *T. tabaci* in more than 120 countries and territories (LoredoVarela and Fail, 2022). *T. tabaci* is extremely electic and cosmopolitan species because of its small size, polyphagy, presence of sexual and asexual populations (Bournier, 1983; LoredoVarela and Fail, 2022), great capacity for reproduction, short generation time, and its ability to disseminate to adjacent fields (LoredoVarela and Fail, 2022). Its host plants range from 355 flowering plants (Gill *et al.*, 2015) to 391 plant species (LoredoVarela and Fail, 2022). Some onion thrips populations have been found to utilize a single plant, such as tobacco, while others can be detected to exploit multiple species from different plant families (Fedorov, 1930; Gill *et al.*, 2015). The current genetic evidence suggests a cryptic species complex of three lineages within the species (LoredoVarela and Fail, 2022).

In North Africa, two interesting studies on thrips were carried out in Egypt by Priesner (1960) and Wafy *et al.* (2021). *T. tabaci* was mentioned among the Thysanoptera fauna list. However, in the Maghreb region, studies in this field are still very limited. They were mainly achieved in the cultivated regions. In Morocco, this species was reported by Le Gall (1961) on cotton. The author indicated that the Egyptian varieties reduced seed cotton production by 15 to 20 %. In Tunisia, *T. tabaci* was found in citrus (Elimem and Chirmiti,2013; Belaam-Kort and Boulahia-Kheder 2017; Attia *et al.*, 2019; Elimem *et al.*, 2019a; Belaam-Kort *et al.*, 2020; Hached *et al.*, 2020) and on two vine grape orchards (Elimem *et al.*, 2019b).

In Algeria, despite their importance, studies on thrips remain scarce. Until now, little is known about their biodiversity and biology. Few studies on thrips have been conducted in natural areas, except for Pelikan's (1988) first contact with 21 species complementary to the 20 previously recorded (a total of 41 species inventoried on the Algerian territory). Later studies focused solely on *T. tabaci* in some vegetable crops. Djebara *et al.* (2018) investigated this species in greenhouse-grown tomatoes, and Koutti *et al.* (2017) on citrus varieties: Thomson Navel and Clementine. In the Biskra region, it was collected on tomatoes by Laamari and Houamel (2015). Furthermore, it was recorded by

Razi *et al.* (2017, 2019) and Allache *et al.* (2020) on 16 vegetable crops. In this content, the present study aims to record the plant species harboring *T. tabaci* in natural area and to know its distribution in this region characterized by its particular climatic conditions (Sahara) and the endemism of its plant cover.

Materials and Methods

Study region

This study was carried out in Biskra province, a transition and arid region between the Northern and southern parts of Algeria. It is located in the south of the Saharan Atlas Mountains. According to Ozenda (1991) the major part of this region is the desert, where the vegetation is adapted to the different conditions (hot climate and saline soil). The natural vegetation is dominated by steppe plants in the north with high elevations reaching more than 1000 m of sea level and by Saharan plants in the south with very low elevations, reaching - 32 m (Fig. 1) and (Tab. 1). Collection locations were selected based on accessibility, and vegetation diversity in different sites, including the highest or lowest altitudes.

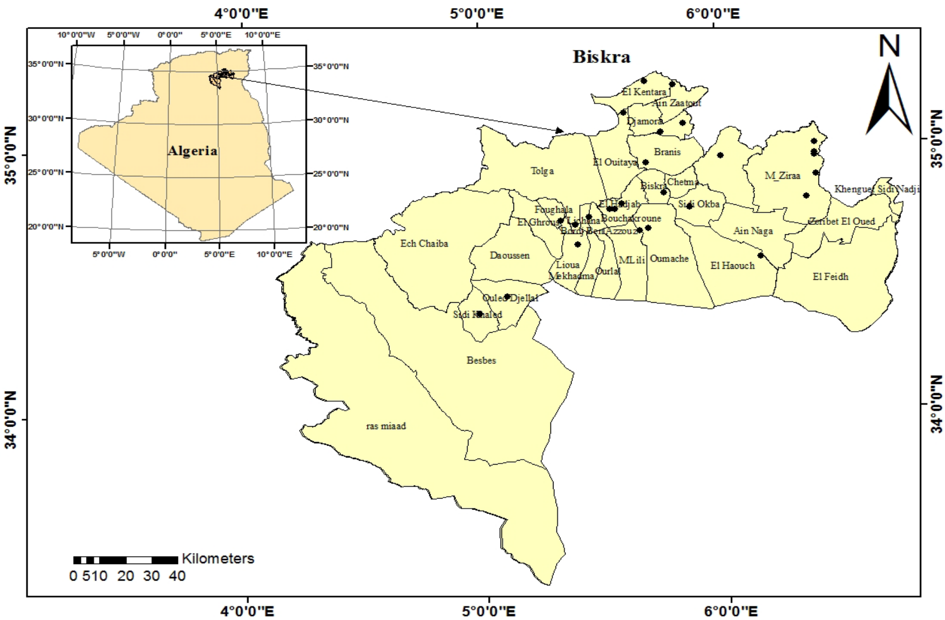


Figure 1. The geographical location of sampling sites in the study region.

Surveys were completed during two periods, 2008/2009 and 2011/2012, in the spring season when spontaneous plants are more abundant, from February, March, and April in 2009 and during March and May in 2012.

Table 1. GPS coordinates of sampled sites in Biskra region.

Localities	Sites	Altitudes (m)	Latitudes and longitudes
Sidi Okba	Sidi Okba	57	N:34°46'04", E:5°52'37"
Oumache	Oumache	49	N:34°41'29", E:5°41'54"
El-Hadjeb	El-Hadjeb	147	N:34°47'11", E:5°35'23"
	Bordj Enos	151	N: 34°45'59", E: 5°32'21"
		149	N:34°46'04'', E :05°33'42''
Biskra	Feliach	87	N: 34°49'26", E:5°46'07"
El Outaya	Fantaine des Gazelles	385	N: 35°07'44", E:5°36'32"
Foughala	Foughala	150	N: 34°43'39", E: 5°19'54"
Tolga	Tolga	139	N: 34°42'40", E: 5°23'36"
Branis	Dar Arous	198	N: 34°56'27" , E:5°41'53"
Sidi Kaled	Lehouimel	217	N: 34°22'53", E:4°59'8.2"
Ouled Djellal	Marmotha	188	N: 34°26'39", E: 5°6'2.8"
Lioua	Lioua	107	N: 34°38'12", E:5°24'11"
M'ziraa	Tadjemout	865	N:34°59'65'', E :06°24'38''
	Djemina	786	N:34°57'52'', E :06°24'25''
		719	N:34°57'19'', E :06°24'23''
	Kharboucha	126	N:34°47'53'', E :06°22'09''
	Oued Romane	298	N:34°53'02'', E :06°24'37''
El Haouch	Sidi Med Ben Moussa	- 32	N:34°34'40'', E :06°09'72''
Mlili	Mohit Essarig	45	N:34°40'61'', E:05°39' 44''
Lichana	Lichana	171.8	N: 34°44'21'', E:05°27'10''
Djemorah	Beni Souik	560	N:35°05'68'', E:05°52'64''
	Guedila	390	N:35°03'01'', E:05°45' 39''
El Kentara	El Kentara	550	N:35°15'09'', E:05°42' 56''
Mchouneche	Mchouneche	315.6	N:34°57'30'', E:06°00' 41''
		322	N:34°57'29'', E:06°00' 45''
Ain Zaatout	Ain Zaatout	970	N:35°15'09'', E:05°49' 51''

Collection and morphological identification of specimens

The floral and vegetative parts of different plant species were sampled over two periods, during which 91 plants were sampled weekly. It should be noted that due to the size of the survey area and the distance of some sites, it was impossible to visit these sampling sites at the same pace and on the same dates.

At each visit, a maximum number of new plant species available and characteristic of each site harbouring T. tabaci from which a maximum number of individuals of this thrips were shaken over a plastic beating tray. This is particularly effective because the pretarsal bladder of thrips adheres to the smooth surface of a picnic tray collector (Mound *et al.,* 1976). We also beat the maximum of plants of the same species present at the same site. Inflorescences of plants are also taken in a dense bags separated according to plant species (Priesner, 1960). At collection, thrips must be brought back alive or selected on site (Priesner, 1960).

The specimens were recovered in tubes containing 90% ethanol with a fine brush. In the laboratory, the thrips were sorted under a stereo-microscope (Carl Zeiss, Germany) based on certain morphological characteristics; similar individuals were placed separately in vials. The specimens were prepared according to the procedure reported by Mound and Marullo (1996). The best specimens of each species were mounted in permanent slides with Canada Balsam and the others in semi-permanent slides in Hoyer ringed and sealed. The identification of adult thrips was made using the keys of Moritz (1994); Zur-Strassen (2003), and Moritz *et al.* (2004). The majority of the specimens sampled were morphological identification performed on slides, with the exception of a few dozen, and some larvae were left preserved in alcohol, particularly those found on plants with large numbers of individuals. The larvae of thrips were also identified according to Vierbergen et al. (2010); in this study T. tabaci larvae do not appear to be among the larvae of other thrips. Reference collection of slides is deposited in the collection of the LATPPAM laboratory, Department of Agronomy, University Batna 1 (Algeria).

Statistical exploitation of results

Statistical analyses were performed to assess the effect of environmental variables on the activity of *T. tabaci* species sampled during two periods in different habitats in the study area.

The data were subjected to a multiple correspondence analysis (MCA) to determine the impact of inertia of environmental factors and the correlation between them on the activity of this thrips.

All analyses were performed using SPSS Software version 20.0.

Results

This survey constitutes the most important contribution to the knowledge on *T. tabaci* in the natural environment of Biskra province, Algeria. It was sampled in mountainous and steppe sites at different altitudes. It has been found in 27 sites belonging to 19 localities in this region (Tab. 1 and Fig. 1).

Analyzing environment factors that affect thrips activity, it revealed that systematic plant, sampling regions, and habitat types greatly influenced *T. tabaci* life (Tab. 2) and (Fig. 2 a, b).

In the (Tab. 2) the two dimensions are represented on the two horizontal and vertical axes by dimension 1 and dimension 2 (Fig. 2 a, b) while the 3rd column means the average of the values of the variables (environmental factors) of the two dimensions between (0-1) (Tab. 2). The Percentage of variance explained is significant by more than 50% in both dimension 1 and 2 (Tab. 2) and (Fig. 2 a, b).

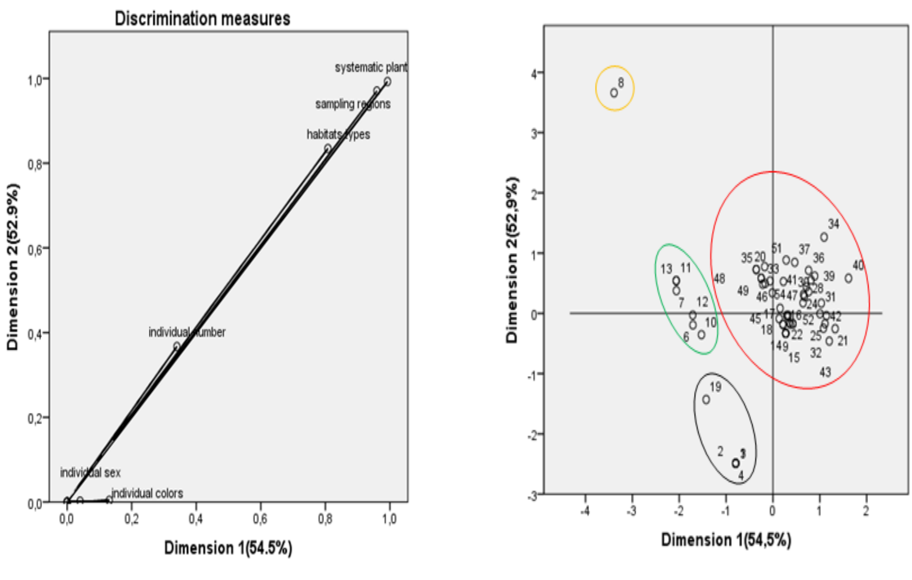
Table 2. Inertia of environment factors on *T. tabaci* activity in Biskra region in 2008/2009 and 2011/2012.

Discrimination measures			
	Dimension		Mean
	1	2	
Sampling regions	.959	.970	.965
Habitat types	.808	.835	.821
Individual number	.340	.367	.354
Individual colors	.130	.004	.067
Individual sex	.040	.002	.021
Systematic plant	.993	.993	.993
Active total	3.271	3.171	3.221
Percentage of Variance explained	54.509	52.851	53.680

In (Fig. 2 a, b) the most discriminating environmental factors on the activity of *T. tabaci* are systematic plant (.993), sampling region (.965) and habitat type (.821) which represent an inertia of 86. 27 % (Tab. 2) and (Fig. 2a) on the activity of this thrips from the total of the other factors (active total: 3.221) especially in the natural environment that is 84. 57% of the individuals of this thrips were collected on the natural environment where there is the greatest number of plants sampled, i.e. 64.7% of the total plant species sampled in all habitats (i.e. 4 groups) (Fig. 2b).

The impact of the inertia of the environmental factors on the activity of *T. tabaci* in this region we found four populations, of which the largest group represents the natural habitat followed by the population that represents the adjacent cultivated-urban and natural adjacent habitat and the last group by urban adjacent habitat (Fig. 2b).

In the first population (natural population) it was found that the environmental factors sampling regions and systematic plant are positively correlated with habitats types with a value of 0.9 (90%). The number of individuals has a moderately positive correlation with systematic plant with a value of almost (0.5) 50%. Furthermore, adult color and sex have no correlation with the other factors mentioned above, but the first factor (color) is weakly influenced or correlated with plant systematic by a value of 30% (Tab. 3).



(**a**) (**b**)

Figure 2. (a, b) : MCA ordination plot of different factors influencing *T. tabaci* activity (Red color: natural habitat, Green color: adjacent crop-urban habitat, Black : adjacent natural habitat, Orange color: adjacent-urban habitat).

Table 3. Correlation between environmental factors affecting *T. tabaci* activity in the study area.

Correlations of transformed variables

Dimension: 1	**sampling regions**	**habitats types**	**individual number**	**individual colors**	**individual sex**	**systematic plant**
sampling regions	1.000	.918	.486	.279	.222	.974
habitats types	.918	1.000	.291	.138	.119	.902
individual number	.486	.291	1.000	.134	-.092	.559
individual colors	.279	.138	.134	1.000	-.065	.359
individual sex	.222	.119	-.092	-.065	1.000	.207
systematic plant	.974	.902	.559	.359	.207	1.000
Dimension	1	2	3	4	5	6
Eigenvalue	3.271	1.124	.888	.672	.036	.009

T. tabaci was sampled on fifty (51) plant species belonging to nineteen (19) different botanical families (Tab. 4).

Table 4. Variations in numbers of *Thrips tabaci* on the different host plants founded in the Biskra region during the periods 2008/2009 and 2011/2012.

Families	**Plant species**	**Individual number**
Asteraceae	↑**Anvillea radiata* Coss. and Durieu	**10**♀☼
	Sonchus oleraceus L.	1♀♣
	Volutaria lipii (L.) Cass.	1♀♣
	○*Scorzonera undulata* Vahl	1♀(☼)
	Calendula arvensis M. Bieb.	1♀☼
	■○↑*▲*Artemisia herba alba* Asso.	(**44**♀+1♂) ☼
	Rhantherium adpressum (Desf.) Coss. and Dur.	1♀☼
	Scolymus hispanicus L.	1♀☼
	Pallenis spinosa (L.) Cass.	2♀☼
	Cynara cardunculus L.	2♀♣
	**Erigeron canadensis* (L.) Cronquist	2♀☼
Brassicaceae	*Rapistrum rugosum* (L.) All.	1♀♣
	Diplotaxis erucoides (L.) DC.	1♀♣
	Diplotaxis virgata (Cav.) DC.	3♀☼
	Moricandia arvensis (L.) DC.	1♀☼
	○*Eruca vesicaria* (L.)Thell	1♀♣
	○*Crambe cralikii* (Coss.)	2♀♣
	Muricaria prostrata (Desf.) Desv	1♀♣
	Eruca sativa (Link.)	1♀(☼)

Families	Plant species	Individual number
Fabaceae	*Vicia sativa* L.	2♀♣
	Ononis natrix L.	5♀☼
	*Melilotus infesta*Guss.	3♀♣
	○↑**Medicago truncatula* Gaertn.	8 ♀☼
	♂**Retama raetam* Webb and Berthel.	1♀☼
	Astragalus gombo Coss. and Dur.	4♀☼
	*Hedysarum pallidum*Desf.	1♀☼
	Genista microcephala Coss. and Durieu	1♀☼
Amaranthaceae	*Chenopodium album* L.	2♀♣ and 1♀☼
	Nucularia perrini Batt.	2♀☼
	■ *Beta vulgaris* L.	4♀♣
	Suaeda mollis(Desf.) Del	1♀♣
Resedaceae	*Reseda lutea* L.	2♀♣
	Reseda alba L.	4♀☼
	Reseda alphonsii (Coss) Mull Arg.	2♀☼
Apiaceae	○*Thapsia garganica* L.	7♀☼
	Daucus carota L.	2♀☼
Scrophulariaceae	*Linaria aegyptiaca* (L.) Dum.	1♀☼
	○*Scrophularia hypericifolia* Wudl	2♀☼
Boraginaceae	*Echium parviflorum* Moench	1♀♣
	Heliotropium undulatum (Vahl.)	1♀♣
Liliaceae	*Asphodelus refractus*Boiss.	1♀♣
Plantaginaceae	**Plantago lanceolata* L.	1♀☼
Juncaceae	*Juncus articulatus* L.	2♀☼
Thymelaeaceae	*Thymelaea hirsuta*(L.) Endl.	6♀ ☼
Primulaceae	*Anagallis arvensis* L.	1♀♣
Zygophyllaceae	↑*Peganum harmala* L.	**34**♀☼
Tamaricaceae	*Tamarix Africana* Poir.	4♀ ☼
Caryophyllaceae	*Silene velutinoides* Pomel.	1♀(☼)
Labieae	*Marrubium alysson* (L.)	1♀(☼)
Plombaginaceae	*Limonium fallase* (Miller.)	1♀(☼)
Poaceae	*Phalaris brachystachys* (Link.)	1♀♣
Total = 19	**51**	**188 (187♀ + 1♂)**

*Plant hosted only *T. tabaci*, ▲ First record of males in Algeria, ↑ largest number of individuals, ■ Black body color, ○ white body color, ♣ adjacent habitat in 2008/2009, (☼) natural habitat in 2008/2009, ☼ natural habitat in 2011/2012.

This species was found more numerous in Asteraceae with 11 plant species, 8 plant species in Fabaceae and Brassicaceae and 4 plant species in Amaranthaceae (Tab. 4). Among these plants it was collected in 3 weeds of Asteraceae, 5 of Brassicaceae, 2 of Fabaceae and 3 of Amaranthaceae (Tab. 4), and (Fig. 2b). The latter family includes one plant species common between wild plants and weeds in two different habitats (Fig. 2b). The Asteraceae, Fabaceae, and Brassicaceae families are the most attractive to *T. tabaci* in the desert and mountainous regions of Biskra.

188 specimens of this species were collected in this study, the majority of them was sampled in the natural habitat where the most plant species were sampled. Over 100 plant species were examined for thrips during the study.

A total of 187 females (♀) and one male (1 ♂) of *T. tabaci* were sampled in the natural habitat and its adjacent environment. One male with 158 females were found in the natural environment. However, 29 females were collected in adjacent habitats to natural, crop, or urban areas (Tab. 4). In 2008/2009, this thrips was collected from 24 plants belonging to 12 botanical families at 12 sites, 4 of which are part of the natural environment. In this period 05 females of *T. tabaci* harboured 05 different plants belonging to 05 different botanical families, of which two females were collected on the same site (Tab. 4).

This is the adjacent environment regarding the samples taken, especially in 2008/2009. The cases of *C. album* was collected in a natural environment at Tadjemout and in Feliach near of crop plant, and *E. parviflorum* was sampled at El Hadjeb near the urban environment that is closer to the natural habitat. In Oumache, the available plants were sampled in the adjacent-urban environment (Tab. 4, Fig. 2b).

On the other hand, some plant species were swept in adjacent-cropfields, especially in Sidi Okba near the bean field and in 6 sites near the date palms (Feliach, Oumache, Foughala, Tolga, Marmotha, and Lehouimel) (Tab. 4, Fig. 2b).

For the second and third population (the adjacent cultivated-urban and adjacent natural habitat). These populations are represented by the presence of the environment adjacent to the cultivation of date palms which represent the sites cited above where *T. tabaci* was collected on the weeds between the plots of date palms while for the third group (the environment adjacent to the natural environment) which includes the sites of Marmotha and Sidi okba whose spontaneous plants collected a little closer to the natural environment, in the last site the Asteraceae family is the most important surveyed. In the fourth population which is characterized by a single plant *E. parviflorum* was found at El Hadjeb near the urban environment that is closer to the natural habitat.

Very low numbers of adults collected (70 % of plants had no more than 2 females; indeed 50% of plants had only one female (Tab. 4).

We have recorded higher number of larvae of Thripidae, Aeolothripidae and one larvae of Phlaeothripidae present on *M. truncatula* but show not larvae of *T. tabaci*.

Forty plants and 10 botanical families surveyed in the study area not inhabited by this species (Tab. 5).

Table 5. Surveyed plants not inhabited *T. tabaci* in 2008/2009 and 2011/2012 in Biskra region.

Families	Plants species
Asteraceae	*Leontodon mulleri* (Ball.) *Senecio gallicus* (L.) *Anacyclus clavatus* (Desf.) *Leontodon hispidus* (L.) *Phagnalon saxatile* (L.) Cass. *Matricaria chamomilla* L. *Launaea nudicaulis* (L.) Hook. fil. *Cotula cinerea* Del. *Carduus microcephalus* Ten. *Centaurea nicaeensis* All.
Brassicaceae	*Pseudorucaria teretifolia* (Desf.)(DE) *Sinapis arvensis* L. *Diplotaxis harra*(Forssk.)Boiss.
Fabaceae	*Hedysarum cornosum* (Desf.) *Hedysarum naudinianum* Coss. & Durieu
Amaranthaceae	*Suaeda fructicosa* (Forsk.) *Atriplex halimus* (L.) *Salsola tetragona* (Delile) *Bassia muricata* (L.) *Halocnemum strobilaceum* (Pall.) Bieb.
Plumbaginaceae	*Limonium sinuatum* (L.) Miller *Limoniastrum guyonianum* Coss. & Dur.
Caryophyllaceae	*Polycarpaea prostrata* (Dec.)
►Renonculaceae	*Adonis annua* (L.)
►Aizoaceae	*Aizoon hispanicum* (L.)
Resedaceae	*Reseda luteola* L.

Families	Plants species
►Malvaceae	*Malva cretica* (Cav.)
►Urticaceae	*Forsskaolea tenacissima* (L.)
Apiaceae	*Ridolfia segetum* (L.) Morris
Scrophulariaceae	*Antirrhinum ramosissimum* Coss. & Dur.
►Convolvulaceae	*Convolvulus arvensis* (L.)
►Rosaceae	*Crataegus monogyna* Jacq.
Juncaceae	*Juncus maritimus* Lam.
Thymelaeaceae	*Thymelaea microphylla* Coss. et Dur.
►Lamiaceae	*Ballota hirsuta* Benth.
Zygophyllaceae	*Zygophyllum cornutum* (Coss.)(DR)
►Apocynaceae	*Nerium oleander* L.
Poaceae	*Stipa parviflora* Desf.
►Pinaceae	*Pinus halepensis* Mill.
►Cupressaceae	*Juniperus phoenicea* L.
Total = 23	**40**

►Botanical families on which the presence of onion thrips *T. tabaci* has not been observed.

Sampling by altitude

The highest individual number of this pest species were collected during May 2011/2012 in three sites with an altitude of more than 300 m, particularly in Beni Souik (560 m) on *A. herba alba* (Asteraceae), Ain Zaatout (970 m) on *P. harmala* (Zygophyllaceae) and in Mchouneche (322 m) on *M. truncatula* (Fabaceae). *A. herba alba* sheltered the largest individual number with (44 females and 1 male) followed by *P. harmala* with (34 females) and *M. truncatula* with (8 females). The latter plant and *A. herba alba* which is harboured only by this species of thrips while *P. harmala* was sheltered by 4 other species of thrips. In addition, at the same altitude, some plant species were sheltered only by the onion thrips as *R. raetam* and *P. lanceolata* in Tadjmout, *E. canadensis* in Guedila. However, at a lower altitude (126 m) in Kharboucha and during March 2011/2012, only 10 females were collected on *A. radiata* (Asteraceae) dispersed over a large area (Tab. 4).

Color variations

In our study, we found three colors; white, brown, and black. In March 2011/2012 the white color of this species was found in Lichana on *T. garganica*, *S. hypercifolia*, and on *R. raetam* in Tadjemout. In May 2011/2012, some individuals with black color were found among light and brown females in Beni Souik on A. herba alba and other white individuals were found in Mchouneche on M. truncatula. In this study, the adult male is smaller and paler than females. In 2008/2009, all individuals collected had a brown to black body color during the months of February, March and April. Black individuals were collected at Feliach on B. vulgaris in March, but a few very light colored individuals were collected at Fantaine des Gazelles on S. undulata in the same month; in April, other white individuals were collected at Lehouimel on Crambe cralikii and on E. vesicaria (Tab. 4).

Sex ratio

In this study, one male were sampled for the first time in Algeria in a natural environment in 2011/2012; this individual was detected on the Wadi plant species, it was collected among 44 females on *A. herba alba* in Beni Souik (Tab. 4).

Discussion

The present study showed that *T. tabaci* was sampled in mountainous and steppe sites at different altitudes. Ecologically, it is a very plastic thrips species (Fedorov, 1930). Lewis (1973) noted that it is a cosmopolitan pest of onion grown until 2000 m of sea level (Diaz-Montano *et al.*, 2011; Gill *et al.*, 2015).

The obtained results show that environment factors affect thrips activity, it seemed that systematic plant, sampling regions, and habitat types greatly influenced *T. tabaci* life.

Our results confirm that plant diversity in different habitats seems to play an important role in the ubiquitous behavior of *T. tabaci*. 84.57% of the individuals of this thrips were collected on the natural environment where there is the greatest number of plants sampled, about 64.7% of the total plant species sampled in all habitats.

In our samples very low numbers of adults collected (70 % of plants had no more than 2 females; indeed 50% of plants had only one female). It therefore seems likely that the individuals had drifted from some of the plants on which they had reproduced; rather than actually living on the plants from which we collected them. Our data is not a reliable measure of "polyphagy" host plants.

Adult thrips can be found on many plants (Mound *et al.*, 1976). Plant species provide an important feeding or behavioral resource (Mound, 2013) but are not used for breeding (Mound *et al.*, 1976; Mound, 2013). Not all of them are suitable for the food of larvae; only the adult stage, which occasionally feeds on them (Fedorov, 1930).

For this reason, it is not easy to consider the sampling plant species in our study, which are the true hosts of *T. tabaci* species. When it comes to adult of this thrips, hundreds of various plant species have provided samples (LoredoVarela and Fail, 2022).

Most crucially, it is usually impossible to tell the difference between the terms "finding site" and "host plant" in published data of onion thrips and other Thysanopteran species (LoredoVarela and Fail, 2022; Mound, 2013). Only adult thrips are discovered at the sites, and their existence may be explained by a variety of circumstances, such as an accidental landing or the plant serving solely as an occasional feeding source (LoredoVarela and Fail, 2022; Mound, 2013).

The morphological identification of immature stages is another factor influencing the incorrect association of thrips species with the host plant. The identification of immature stages is frequently overlooked while identifying different species of thrips since adult stages are prioritized (LoredoVarela and Fail, 2022; Mound, 2013).

Due to the weak association between the larvae and the plant species sampled in our study, especially those of the Thripidae collected from *M. truncatula*, they do not show all the morphological criteria of those of *T. tabaci* (Vierbergen *et al.*, 2010), with the presence and absence of other morphological characters, it cannot be affirmed that it is a host plant of this thrips.

According to LoredoVarela and Fail (2022) the onion thrips' hosts must use a variety of techniques, such as frequent sampling of the intended plants. Many samples of the target plants are taken, morphological and genetic identification techniques are used, and host preference research is done in controlled environments.

In Tunisia it was the most abundant species as it was collected from 9 plant species belonging to 7 botanical families out of 23 plant species referred to 15 botanical families listed (Belaam-Kort *et al.*, 2020).

Most of these plants' yellow color and flower structure are probably responsible for this preference. Usually, thrips inhabit medium-sized flowers with sweet scents with or without nectar, and the petal may be lightly shaded, ranging from white to yellow (Varatharajan *et al.*, 2016). These floral features have been observed in some plants belonging to the basal angiosperm families, such as Asteraceae (Varatharajan *et al.*, 2016).

It can actively participate with other pollinating insects in the ecology of the fragile desert vegetation cover. Further studies can confirm this ecological role.

Although it has a wide range of hosts due to its polyphagous nature, onions are a favorite host and one of the few crops that the same species attacks over the world (Diaz-Montano *et al.*, 2011).

Most available work treats onion thrips as a single species with a wide range of host plants (LoredoVarela and Fail, 2022). According to Diaz-Montano *et al.* (2011) *T. tabaci* has a wide host range compared with other thrips species. Some reports mention *T. tabaci* out of 141 plant species belonging to 41 families, while others list it on 355 plant species (Gill *et al.*, 2015), but the last one reveals the presence of three *T. tabaci* species lineages on 391 plants species from 46 families (LoredoVarela and Fail, 2022). Plant species on which selection and development of *T. tabaci* occur include the Asteraceae, Fabaceae, Brassicaceae, Poaceae, and Solanaceae (LoredoVarela and Fail, 2022).

For the second and third population (the adjacent cultivated-urban and adjacent natural habitat) where *T. tabaci* was collected on the weeds between the plots of date palms while for the third group which includes the sites of Marmotha and Sidi okba whose spontaneous plants collected a little closer to the natural environment.

According to Bournier (1983) since *T. tabaci* is the most polyphagous and widespread species of the thrips. Many weeds are food plants for the Tobacco Thrips (Fedorov, 1930).

Although there were some marginal effects, indicating some movement into the field from surrounding areas, the distribution pattern of onion thrips between plants was random (Diaz-Montano *et al.*, 2011).

T. tabaci was also discovered on various weed species. These plants have developed adaptations to cope with constantly shifting habitats (Diaz-Montano *et al.*, 2011). The weeds that grow along the fields' edges make up the grass where the thrips hibernate (Fedorov, 1930).

LoredoVarela and Fail (2022) noted that the list of most important plants includes wild and weedy species. According to Belaam-Kort *et al.* (2020) *T. tabaci is* common on citrus trees and herbaceous wild plants in Tunisia.

In the fourth population which is characterized by a single plant *E. parviflorum* was found at El Hadjeb near the urban environment that is closer to the natural habitat.

Thrips must develop coping mechanisms for continuously changing habitats (Diaz-Montano *et al.*, 2011). This generalist insect has access to various food resources, allowing them to move more easily from one habitat to another

(Pizzol *et al.*, 2017). Polyphagous species, which were present throughout the year long and used a variety of food sources depending on the plants in season, tended to have large populations (Pizzol *et al.*, 2017).

According to Smith *et al.* (2015), insects may be transported long distances at different altitudes with good wind conditions. These authors indicated that *T. tabaci* dispersal behaviors are classified as “long-distance” or short-distance “trivial”. The altitude at which winged insects travel can reveal whether they are engaged in long-distance or short-distance dispersal. It is unknown what effect immediate weather conditions have on *T. tabaci* dispersal activities.

According to our results, altitude has no effect on these four populations, The most activity of *T. tabaci* was recorded in the mountainous sites with more than 300 m of altitude in May 2011/2012 as well as at a low altitude of 126 m in March 2011/2012. In this period it recorded its maximum number with (44 females and 1 male) found on *A. herba alba* followed by *P. harmala* with (34 females). Only 10 females were collected on *A. radiata* dispersed over a large area.

In our sample we found three colors of *T. tabaci*. The great variability of body and antennae colors has been reported, and several forms have been described. These colors are very light yellow to dark brown (Bournier, 1983). These intraspecific structure and color variations might be explained by food quality or quantity (Mound, 2005a; 2005b). It seemed that the color variations of *T. tabaci* are not strongly influenced by temperature fluctuation, as the different colors were observed on the same plant and in the same site. Accoording to Kirk (2002) the rearing temperatures of *Frankliniella occidentalis* do not specify whether the colored forms were reared at the same or different temperatures. In both cases, the dark and light forms were likely obtained in different sites, rather than color forms coexisting in the same place (Kirk, 2002). Males are smaller and paler than females (Diaz-Montano *et al.*, 2011). All this color variation was seen on the *A. herba alba* with the highest number of this thrips. It seems likely that males will be collected only where there is a large population particularly in the naturel habitat. According to LoredoVarela and Fail (2022) in sympatric populations of onion thrips lineages, the low male proportion may thus be undetected during sampling, especially with small sample sizes, and as a result, an inaccurate inference is made based on the samples' solely including females.

Our results indicate the presence of sexual and asexual populations in the study region, it was confirmed for the first time in our country, allowing Algeria to reach number forty and to be added to the list of countries reported by the study conducted by LoredoVarela and Fail (2022). Onion thrips can reproduce asexually (parthenogenesis) and sexually (Bournier 1983; Gill *et al.*, 2015). Thelytoky is parthenogenesis in which females are created from unfertilized eggs, the most prevalent reproductive mode (Nault *et al.*, 2006; Gill *et al.*, 2015). In Arrhenotoky reproduction, males are formed from unfertilized eggs, and females are produced from fertilized eggs (Nault *et al.*, 2006; Gill *et al.*, 2015). It is also used by *T. tabaci* lineages that generate both sexes' progeny throughout the growing season. Their sex ratio varies with the season; latitude, longitude, elevation (m), and food supply (Woldemelak *et al.*, 2021). Most found specimens are females, while males are rare (Mound and Walker, 1982; Chatzivassiliou, 2002).

Lewis (1973) mentioned that in the eastern Mediterranean and Iran, known as the area of origin of *T. tabaci*, the sex ratio is about 1:1 (Chatzivassiliou, 2002; Diaz-Montano *et al.,* 2011), whereas, in most parts of the world, the males are unknown (Chatzivassiliou, 2002). In the colder parts of the earth, significantly lower ratios have been seen (Woldemelak *et al.*, 2021). In southern France, no male was identified by Pizzol et al. (2017) of this thrips species. Male onion thrips are described in 33 countries and territories. Therefore, their existence is revealed in 39 countries and regions when combining the information from these records with the information on distribution collected (LoredoVarela and Fail, 2022). In Iran, sex ratio progeny revealed no presence of males. Only females emerged on cucumber (var. Soltan) in laboratory conditions (Pourian *et al.*, 2009). Several studies show that *T. tabaci* males are present in the Western Hemisphere, and the factors determining the presence of the parthenogenetic and the bisexual form of this species are quite ambiguous (Chatzivassiliou, 2002). The same author noted that *T. tabaci* forms a complex of two biotypes or subspecies, one, denoted *T. tabaci spp. tabaci* consists of males and females and the other, *T. tabaci spp. communis*, which include populations composed only of females. The parthenogenetic mode of reproduction and the foliar-feeding (rather than feeding on pollen) habits in hot and dry weather provide *T. tabaci* an ecological advantage to increase its populations over the other thrips species (Shelton *et al.*, 2006).

Several life history studies of *T. tabaci* have been published, but little is known about the impact of a wide range of temperatures on development and reproduction (Murai, 2000). Several studies have investigated the influence of the host plant on the life cycle (Murai, 2000).

Numerous causes of the large variation in observed sex ratios in natural populations and the impact on mating systems must be understood (Woldemelak *et al.*, 2021). Comprehension of the mechanisms that influence the natural sex ratio is crucial for carrying biocontrol techniques that interrupt *T. tabaci* reproduction (Woldemelak *et al.*, 2021).

Conclusions

Most collected specimens of *T. tabaci* are related to Asteraceae (11plant species). It was collected on 8 plant species of Brassicaceae and Fabaceae. It was detected on 4 plant species of Amaranthaceae. All samples were taken in 27 sites belonging to 19 localities with different altitudes. Six plant species, including 3 plant species of Asteraceae and 2 plant species of Fabaceae, were inhabited only by the onion thrips. Five were sampled in mountainous regions with an altitude of over 300 m. Plant diversity greatly influenced *T. tabaci* life; 84. 57% of the individuals of this thrips were collected on the natural environment where there is the greatest number of plants sampled, about 64.7% of the total plant species sampled in all habitats.

One male and 158 females among 187 females were found in the natural environment during sampled periods. However, 29 females were collected in adjacent habitats to natural, crop, or urban areas. Despite the rarity of males of onion thrips, we have been able to find one individual among 44 females on *A. herba alba* plant species, especially in a natural environment. The presence of sexual and asexual populations was confirmed for the first time in our country. In some cases, three kinds of colors were found, and the body color varies from very light yellow (white) to dark brown, all this color variation was seen on the last plant with the highest number of this thrips. More research is needed to confirm the host plants and the most common way of reproduction in our region by surveying the greatest number of plants in various mediums and demonstrating the sex ratio across a broad spectrum of prospection.

Acknowledgements. The authors would like to express their gratitude to Prof. Oudjehih Bachir (Department of Agronomy, Institute of Veterinary and Agronomic Sciences, University of Batna 1, Algeria) for his help in identifying thrips host plants. We would like to thank Dr. Souad Tahar Chaouche (*Centre de Recherche Scientifique et Techniques sur les Régions Aride (CRSTRA)*, Biskra, Algeria) for his help in data analysis.

References

Allache, F., Demnati, K., & Razi, S. (2020). Thrips diversity and *Frankliniella occidentalis* trends on three melon cultivars at Biskra, Algeria. *Entomol. Faun. – Faun. Entomol.*, 73, 191- 206.

Attia, S., Khouja, S., Belaam-Kort, I., Limam, E., Ammar, M. & Grissa Lebdi, K. (2019). Pest thrips infesting citrus orchards in the South-East region of Tunisia. *J. Entomol. Zool. Stud.*, 7, 1078-1081.

Belaam-Kort, I. & Boulahia-Kheder, S. (2017). Thrips in citrus orchards, emerging pests in Tunisia. *Entomol. Faun. – Faun. Entomol.*, 70, 77-87.

Belaam-Kort, I., Marullo, R., Attia, S., & Boulahia-Kheder, S. (2020). Thrips fauna in citrus orchard in Tunisia: an up-to-date. *Bull. Insectol.*, 73, 1-10.

Bournier, A. (1983). Les Thrips : Biologie, Importance Agronomique. *Inra*Paris pp. 128.

Chatzivassiliou, E. K. (2002). *Thrips tabaci*: an ambiguous vector of TSWV in perspective. In *Thrips and Tospoviruses . Proceedings of the 7th International Symposium of Thysanoptera*, Italy, 2-7 July 2001, Marullo, R. and Mound, L. A. (ed.), Australian national insect collection, Canberra, pp. 69 -75.

Djebara, F., Benzahra, A., Mimeche, F. & Saharaoui, L. (2018). Diversity of entomofauna associated with greenhouse-grown tomatoes in Algiers (North Algeria). *Studia UBB Biologia*, 63, 139-151.

Diaz-Montano, J., Fuchs, M., Nault, B. A., Fail, J., & Shelton, A. M. (2011). Onion Thrips (Thysanoptera: Thripidae): A Global Pest of Increasing Concern in Onion. *J. Econ. Entomol.*, 104, 1-13. doi:10.1603/ec10269.

Elimem, M. & Chermiti, B. (2013). Thrips species composition and seasonal dynamic populations in an organic citrus orchard in the central eastern coast of Tunisia. *Integrated Control in Citrus Fruit Crops IOBC-WPRS Bull.,* 95, 77-82.

Elimem, M., Guesmi, M., Lahfef, C., Jammeli, B., Bessouda, B., & Fersi, R. (2019a). A preliminary checklist and survey of the diurnal entomofauna associated to Citrus orchards in the region of Mograne (Zaghouan) in Tunisia within environmental parameters. *J. N. Sci.*, 11, 231-241.

Elimem, M., Karouia, W., Lahfef, C., Ben Othmen, S., Limem-Sellemi, E., & Mliki, Y. (2019b). Thrips species composition, biodiversity and seasonal dynamic populations in two vine grape orchards in the north-eastern region of Tunisia. *J. N. Sci. Agricul. Biotechnol.*, 64, 4028-4039.

Fedorov, S. M. (1930). Tobacco Thrips (*Thrips tabaci* Lind.) as a pest of Tobacco plant in Crimea. *Entomological Section of the Governmentn Botanical Garden Yalta Crimea*, 229-248.

Gill, H. K., Garg, H., Gill, A. K., Gillett-Kaufman, J. L. & Nault, B. A. (2015). Onion Thrips (Thysanoptera: Thripidae) Biology, Ecology, and Management in Onion Production Systems. *J Integ Pest Mngmt*, 6, 1-9. doi :10.1093/jipm/pmv006.

Hached, W., Sahraoui, H., Attia, S. *&* Grissa-Lebdi, K. (2020). Importance of Thrips (Thysanoptera: Thripidae) in Tunisian citrus groves. *J. N. Sci. Agricul. Biotechnol.*, 77, 4493-4498.

Kirk, W. D. J. (2002). The pest and vector from the West: *Frankliniella occidentalis*. In *Thrips and Tospoviruses. Proceedings of the 7th International Symposium of Thysanoptera*, Italy, 2-7 July 2001, Marullo, R. and Mound, L. A. (ed.), Australian national insect collection, Canberra, pp. 33-42.

Koutti, A., Bounaceur, F. & Razi, S. (2017). Diversité et distribution spatiale des thrips sur différentes variétés d'agrumes en Algérie. *Rev. Agrobiol.*, 7, 263-273.

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

Le Gall, J. (1961). Les problemes phytosanitaires poses par la culture du cotonnier*. Al Awamia*, 1, 75-105.

Lewis, T. (1973) Thrips- Their biology, ecology and economic importance. *Academic Press* London, U K, NY, USA, pp. 349.

Loredo Varela, R. C. & Fail, J. (2022). Host Plant Association and Distribution of the Onion Thrips, *Thrips tabaci* Cryptic Species Complex. *Insects*, 13, 298. doi:10.3390/insects13030298.

Moritz, G. (1994). Pictorial key to the economically species of Thysanoptera in central Europe. *Bull. OEPP\EPPO Bull.*, 24, 181-208. doi :10.1111/j.1365-2338.1994. tb01060.x.

Moritz, G., Mound, L. A., Morris, D. C. & Goldarazena, A. (2004). Pest thrips of the world, visual and molecular identification of pest thrips. *Australie University of Queensland, Center for Biological Information Technology AUD*, Lucid, CD-ROM.

Mound, L. A. (2002). So many Thrips – so few tospovirus?. In *Thrips and Tospoviruses . Proceedings of the 7th International Symposium of Thysanoptera*, Italy, 2-7 July 2001, Marullo, R. and Mound, L. A. (ed.), Australian national insect collection, Canberra, pp. 15-18.

Mound, L. A. (2005a). Fighting, flight and fecundity: behavioural determinants of Thysanoptera structural diversity. In: *Insects and Phenotypic Plasticity* Ananthkrishnan, T.N., Whitman, D. (ed.), Enfield, NH Science, pp 81-105.

Mound, L. A. (2005b). Thysanoptera: Diversity and interactions. *Annu Rev Entomol*, 50, 247-269. doi: 10.1146/annurev.ento.49.061802.123318.

Mound, L. A. (2013). Homologies and host-plant specificity: recurrent problems in the study of thrips. *Florida Entomol*, 96, 318-322. doi:10.1653/024.096.0250.

Mound, L. A., Morison, G. D., Pitkin, B. R. & Palmer, J. M. (1976). Thysanoptera: Handbooks for the Identification of British Insects. *Department of Entomology British Museum (Natural History)* London pp. 79.

Mound, L. A. & Marullo, R. (1996). The thrips of Central and South America: an introduction. *Mem Entomol Int*, 6, 1–488.

Mound, L. A. & Walker, A. K. (1982). Terebrantia (Insecta: Thysanoptera). Fauna of New Zealand. *Wellington,* Dsir New Zealand, pp.1, 120.

Murai, T. (2000). Effect of temperature on development and reproduction of the onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), on pollen and honey solution. *Appl Entomol Zool*, 35, 499- 504. doi:10.1303/aez.2000.499.

Nault, B. A., Shelton, A. M., Gangloff-Kaufmann, J. L., Clark, M. E., Werren, J. L., Cabrera-La Rosa, J. C. & Kennedy, G. G. (2006). Reproductive modes in onion Thrips (Thysanoptera: Thripidae) Population from New York onion fields. *Environ. Entomol*, 35, 1264-1271. doi:10.1093/ee/35.5.1264.

Ozenda, P. (1991). Flore et végétation du Sahara. *CNRS* Paris, France pp. 662.

Pelikan, J. (1988). Records, notes and list of Thysanoptera from Algeria. Acta Entomol. Bohemoslov., 85, 21-27.

Pizzol, J., Reynaud, P., Bresch, C., Rabasse, J. M., Biondi, A., Desneux, N., Parolin, P. & Poncet, C. (2017). Diversity of Thysanoptera species and associated host plants in Southern France. *J. Mediterr. Ecol.*, 15, 13-27.

Pourian, H. R., Mirab-balou M., Alizadeh, M., & Orosz, S. (2009). Study on biology of onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) on cucumber (var. Sultan) in laboratory condition. *J. P. Protec. Resear.*, 49, 390-394. doi: 10.2478/v10045-009-0061-x.

Priesner, H. (1960). A mongraph of the Thysanoptera of the Egyptian deserts. *Institut du Désert d'Egypte* El Mataria, pp. 541.

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*. *Tunis. J. P. Protec.*, 12, 197-205.

Razi, S., Ouamen, S. & Bernard, E. C., Laamari, M. (2019). Thysanoptera of date palm: First records from Biskra (Algeria). *Agr Nat Resour,* 53, 33–37.

Shelton, A. M., Zhao, J. Z., Nault, B. A., Plate, J., Musser, F. R., & Larentzaki, E. (2006). Patterns of Insecticide Resistance in Onion Thrips (Thysanoptera: Thripidae) in Onion Fields in New York. *J Econ Entomol*, 99, 1798-1804. doi :10.1603/0022-0493-99.5.1798.

Smith, E. A., Fuchs, M., Shields, E. J., & Nault, B. A. (2015). Long-Distance Dispersal Potential for Onion Thrips (Thysanoptera: Thripidae) and Iris yellow spot virus (Bunyaviridae: Tospovirus) in an Onion Ecosystem. *Environ Entomol*, 1–10. doi:10.1093/ee/nvv072.

Varatharajan, R., Maisnam, S., Shimray, V. C. & Rachana, R. R. (2016). Pollination Potential of Thrips (Insecta: Thysanoptera) – an overview. *Zoo's Print*, 31, 6-12.

Vierbergen, G., Kucharczyk, H., & Kirk, W. D. J. (2010). A key to the second instar larvae of the Thripidae of the Western Palaearctic region (Thysanoptera). *Tijdschr. Voor Entomol.*, 153, 99- 160. doi: 10.1163/22119434-900000294.

Wafy, M. E., El- Sebaey, I. I. & Henaish, M. Y. H. (2021). Revision of the thysanopterous (Terebrantia: Thripidae) in Egypt. *Egypt J Plant Prot Res Inst*, 4, 64 –83.

Woldemelak, W. A., Ladányi, M., & Fail, J. (2021). Effect of temperature on the sex ratio and life table parameters of the leek-(L1) and tobacco-associated (T) Thrips tabaci lineages (Thysanoptera: Thripidae). *Pop. Ecol.*, 63, 230–237. doi:10.1002/1438-390X.12082.

Zur-Strassen, R. (2003). Die terebranten Thysanopteren Europas und des Mittelmeer-Gebietes. In *Die Tierwelt Deutschlands*; Dahl, F. (ed.), Goecke & Evers, Keltern, Germany, 74, pp. 1–277.