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Article

A Comprehensive Thrips Species Assessment for Eco-Consistent Management of Infestations in Mediterranean Citrus Crops

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Abstract: Insects belonging to the Thysanoptera order are an important group of insect pests that require phytosanitary interventions for the protection of citrus crops. This study provides a general and complete overview on the thrips pest species present in citrus orchards in the main countries of the Mediterranean basin. For most species, the distribution areas, host plants, and IPM control methods are provided. The study also presents new data on the status of thrips infestations in three main crops in southern Italy (Calabria), including lemon, bergamot, and orange. The results concern the abundance and the co-occurrence of thrips species in the investigated area. Statistical analysis showed that there were differences between citrus species, canopy exposure, and monitoring period in thrips abundance. In particular, orange species showed the lowest density of thrips present on the plant. Three species, namely *Pezothrips kellyanus*, *Frankliniella occidentalis*, and *Thrips major*, were the most abundant in the monitored area with a marked seasonal increase, especially for the highest density species, *P. kellyanus*, between March and June. Moreover, for *F. occidentalis*, the close relationship between its presence on herbaceous flora inside crops and in citrus flowers confirms a thrips interaction with no crops and herbaceous plants and the numerical response of the thrips species. These latest results suggest that wild plants constantly host thrips and therefore an alternative ground cover could be an ecological tool to limit or mitigate the density and damaging activity of thrips populations in citrus crops.

Keywords: Thysanoptera; citrus orchards; thrips abundance; herbaceous plants; IPM; economic losses; environmental protection; southern Italy

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1. Introduction

Citrus crops constitute a significant component of world fruit cultivation, with a particular spread along the tropical and subtropical areas around the equator [1]. These plants are native to South-East Asia, belonging to the botanical family Rutaceae, and the most cultivated species belong to the genera *Citrus*, *Fortunella*, and *Poncirus*.

With an annual production of 18 million tonnes in 2020 [2], citrus fruit growing in the Mediterranean ranks among the top three production areas in the world. The species of greatest economic interest are the sweet orange, namely *Citrus sinensis* (L.) Osbeck and *Citrus reticulata* Blanco, with various groups or other species of the same genus (mandarin, satsuma, tangerine, and clementine), as well as the lemon (*Citrus lemon* Burm) [2]. The main citrus-producing Mediterranean countries are Turkey, Spain, Italy, Morocco, Greece, Algeria, Portugal, Israel, Georgia, France, and Montenegro [3]. According to Falcone et al. [4], citrus fruit production makes Italy the second largest producer in Europe. In Italy, the largest citrus fruit-producing regions are Calabria and Sicily, which together account for over 80% of the national production [5]. In addition to the economic aspect, in some territories, citrus groves have an important landscape value. According to Viggiani [6], the forms of plant cultivation, as well as the types of potting adopted in the production phases, are aspects of the cultivation technique that strongly influence the biotic and abiotic characteristics of the citrus grove agroecosystem, accentuating or limiting biotic stresses such as insects, pathogens, etc.

Therefore, the cultivation of citrus fruit, in addition to its commercial and economic aspects, is particularly important in terms of protection against old and newly introduced pests as well as changes in crop management imposed by environmental protection policies and climate change. The biocenosis of the citrus grove is one of the richest among cultivated agricultural crops. As far as entomological biodiversity is concerned, citrus crops can be considered "open" agroecosystems to the introduction of harmful and beneficial exotic species (e.g., *Icerya purchasi* Mask., *Rodolia cardinalis* (Muls.), *Aleurothrixus floccosus* (Maskell), *Cales noacki* Howard, *Phyllocnistis citrella* Stainton, *Planococcus citri* (Risso), *Cryptolaemus montrouzieri* Mulsant, *Aonidiella aurantii* (Mask.), *Aphytis lingnanensis* Compere, etc.) [6].

In citrus crops, the management of pests (thrips, mealybugs, etc.) in grown crops using predatory insects and mites has been successful in many countries by releasing natural predators [7]. The main species present are the insects of the order Hemiptera, suborder Sternorrhyncha, such as the superfamily Coccoidea and their parasitoids [6].

The phytosanitary strategy is not always made easy, especially due to the cryptic behaviour of certain pests in flower buds and due to the difficulty in regulating their population through pesticides. In particular, there are several thrips species that are pests of citrus in all areas cultivated with citrus. The relationship between thrips and citrus plants involves multiple factors that have not been thoroughly investigated [3]. One of the main problems is the difficulty in the taxonomic recognition of thrips pest species, which is limited by the number of taxonomic experts. Consequently, information on the biological cycle of the species, phenology and thus of the factors predisposing infestations is also poor and limits the findings of effective biological control agents [3].

The primary aim of the present study was to provide an updated overview of the *Thysanoptera* species that infest citrus crops in the Mediterranean Region, and to compare thrips species and their abundance in three citrus crops (orange, bergamot, and lemon) in Southern Italy. The research was completed through biological assessment of the main species and a detailed analysis of the phytosanitary controls adopted.

2. Citrus Thrips in the Mediterranean Area

To provide an overview of all the species of Thysanoptera present in citrus groves cultivated in the Mediterranean basin, a bibliographic survey was carried out on Scopus, Web of Science, and Google Scholar on papers published within 1991–2021 using "citrus thrips", "Thysanoptera", "Mediterranean countries" and "thrips citrus control" as keywords. The papers were selected based on the information reported: in particular, the authors' names; the reliability of the field data recorded (methodology, duration of field experiments and consistency of obtained results); the monitoring methods for the thrips species (collecting of fresh flowers and fruitlets and counting of thrips, placement of sticky traps on external canopies of trees to collect larvae and adults, collecting of all thrips specimens from wild plants and litter using Berlese funnels); the citrus crops studied and the habitats of the studied regional area; and the control techniques used for thrips pest management.

Despite the economic importance that thrips have assumed in the last decade, due to the damage they inflict on citrus crops, often requiring chemical control programmes, the literature review showed limited investigation of these biological pests, albeit with several updates of the specific list in the last two years. The analysis showed that the species most found in citrus cultivation in the Mediterranean basin are *Pezothrips kellyanus* Bagnall, *Thrips major* Uzel, *Frankliniella occidentalis* (Pergande) (Western Flower Thrips—WFT), and *Heliothrips haemorrhoidalis* Bouché. There have been several introductions such as Kelly's thrips, introduced from Australia in 1998, and, much more recently, *Scirtothrips aurantii* Faure was introduced from South Africa to Spain in 2020 [8]. *Thrips hawaiiensins* Morgan and

Scirtothrips dorsalis (Hood) were recently introduced to the Antalya Region (Turkey) [9,10]. *Chaetanaphothrips orchidii* Moulton has recently been reported in several citrus fields in Spain [11]. Other species of concern that are not yet present in the Mediterranean region but have been reported by the EU Pest Risk Lists and are already present in other citrus-growing world regions include *Chaetanaphothrips signipennis* (Bagnall), *Frankliniella bispinosa* (Morgan), and *Scirtothrips citri* (Moulton) [12].

However, 20 thrips species have been identified in citrus orchards and are listed in Table 1.

Table 1. Citrus thrips species and Mediterranean geographical distribution. The species marked in bold are considered the most common in the Mediterranean area.

Species	Family	Citrus Host Plant	Geographical Records	Sources
Aeolothrips collaris Priesner, 1919	Aeolothripidae	*Citrus* spp.	Tunisia	[13]
Aeolothrips intermedius Bagnall, 1934	Aeolothripidae	*Citrus* spp.	Tunisia	[13]
Ankothrips niezabitowskii (Schille, 1910)	Aeolothripidae	Navel oranges	Tunisia	[13]
Chaetanaphothrips orchidii (Moulton, 1907)	Thripidae	Lemon, orange, mandarins	Greece, Italy, Spain	[11,14,15]
Chirothrips manicatus Haliday, 1836	Thripidae	Navel oranges	Tunisia	[13]
***Frankliniella occidentalis* (Pergande, 1895)**	Thripidae	All citrus orchards	Worldwide	[13,14]
Franklinothrips vespiformis (D. L. Crawford, 1909)	Aeolothripidae	Navel oranges	Tunisia	[13]
Franklinothrips megalops (Trybom, 1912)	Aeolothripidae	*Citrus* spp.	Tunisia	[13]
***Heliothrips haemorrhoidalis* (Bouché, 1833)**	Thripidae	All citrus Orchards	Cosmopolitan	[16]
Isoneurothrips australis Bagnall, 1915	Thripidae	Lemon	Portugal	[17]
Megalurothrips sjostedti (Trybom, 1908)	Thripidae	Navel oranges	Tunisia	[13]
Melanthrips pallidior Priesner, 1919	Melanthripidae	Navel oranges	Tunisia	[13]
***Pezothrips kellyanus* (Bagnall, 1916)**	Thripidae	All citrus Orchards	Italy, Turkey, Cyprus, and Portugal	[13,14]
Scirtothrips aurantia Faure, 1929	Thripidae	*Citrus* spp.	Africa, Egypt, Yemen, and Spain	[8,14]
***Scirtothrips dorsalis* Hood, 1919**	Thripidae	Orange	Turkey	[10]
Scolothrips longicornis Priesner, 1926	Thripidae	Navel oranges	Tunisia	[13]
Thrips flavus Schrank, 1776	Thripidae	*Citrus* spp.	Italy, Tunisia	[13,14]
***Thrips hawaiiensis* (Morgan, 1913)**	Thripidae	Lemon	Turkey, Italy, France, and Spain	[9,14,18,19]
***Thrips major* Uzel, 1895**	Thripidae	Navel oranges	Italy, Tunisia	[13]
Thrips tabaci Lindeman, 1889	Thripidae	*Citrus* spp.	Worldwide	[14]

2.1. Commonly Occurring Species

The species *Pezothrips kellyanus* (Figure 1A) is the most abundant and damaging thrips on citrus trees in some areas of the Mediterranean. Adult and larval stages of the species are responsible for damage to young and adult citrus plants [20]. The nymphs develop very slowly during the winter, and the adults emerge in spring (March/April), which in Mediterranean countries coincides with the maximum flowering of citrus plants. The long flowering period suggests that the species carries out at least one generation in situ before the maximum infestation of populations, and consequently that it is very damaging during the critical period of the initial development of young citrus fruits [16].

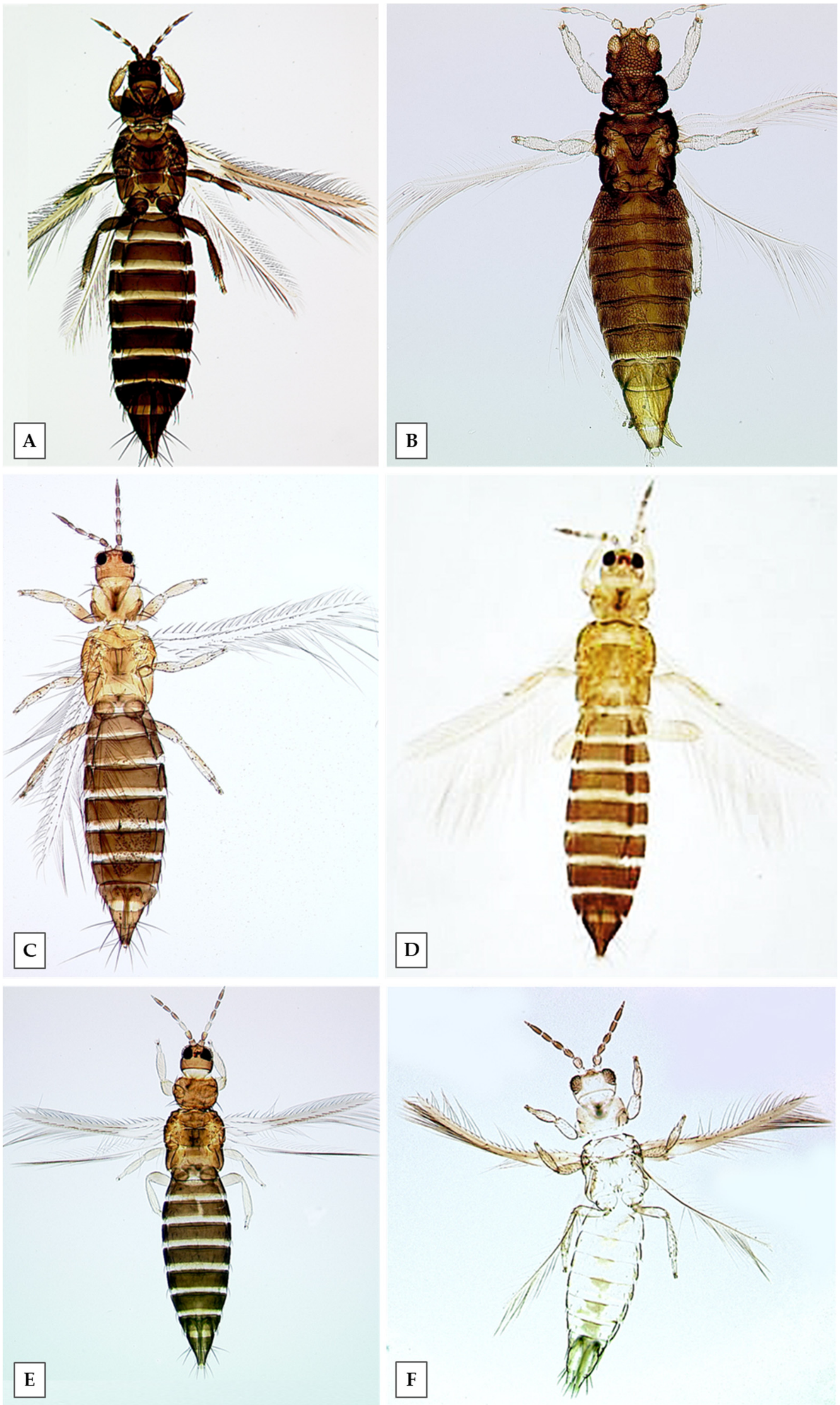

Figure 1. Adult females of *Pezothrips kellyanus* (**A**) *, *Heliothrips haemorrhoidales* (**B**) *, *Frankliniella occidentalis* (**C**) *, *Thrips major* (**D**) **, *Thrips hawaiiensis* (**E**) * and *Scirtothrips dorsalis* (**F**) * (* courtesy of Prof. Laurence A. Mound; ** courtesy of Dr. Allan H. Smith-Pardo and Dr. Cheryle O'Donnell).

Laboratory observations have shown that the duration of the entire cycle varies from 36 days at 15 °C to 10 days at temperatures of 31 and 35 °C. The rate of development increases with increasing temperature up to values of 31 °C; from 31 to 35 °C, a stabilisation of the increase in development is observed [16]. With different levels of preference, citrus species and varieties are the most favoured hosts of Kelly's thrips [14]. In Crete, lemons are the hosts of choice, followed by oranges, while mandarins are hardly damaged [21]. In Sicily, the greatest damage is also observed in lemons (Figure 2A), clementines (Figure 2B), and oranges (Figure 2C), with little preference for the Valencia Late cultivar [15]. Lemon and Navel orange are the most susceptible citrus varieties due to their long and narrow sepals; however, mandarin and small citrus varieties are less attacked by the thrips pest [20]. The damage caused by Kelly's thrips can be very severe, causing young fruits to abort or develop irregularly or even to be completely unmarketable due to widespread discolouration and necrosis on the epicarp of ripe fruits [20]. The chemical control of the species requires that both the first and second generation be sprayed when they occur [22].

Figure 2. Kelly's thrips damage symptoms on lemon (**A**), clementine (**B**), and orange (**C**) fruits; damage symptoms due to *Thirps hawaiiensin* on lemon flowers (**D**) * and fruits (**E**) * in Turkey (* courtesy of Prof. Ekrem Atakan).

The *Heliothrips haemorrhoidales* (Figure 1B) species is polyphagous, infesting many wild and cultivated plants wherever climatic conditions allow survival. Citrus leaves, other green tissues and fruits are important hosts for it. Injury to these tissues causes problems with exocarp colouration [23]. *H. haemorrhoidales* reproduces on a large scale in the laboratory on yellow oranges or lemons [24]. Damage is only present on young fruits, leaves and twigs; the plants may subsequently dry out. Wounded parts show diffuse silvering with brown spots of excrement. The alteration of the fruit then changes to a reticulated surface with a characteristic appearance [16]. Damage from *H. haemorrhoidalis* has a high economic impact. In New Zealand, Froud and Stevens [25] estimated that damage from this thrips in the citrus industry reached USD 2.6 million per year due to fruit rejected for export and the massive use of pesticides.

The species *Frankliniella occidentalis* (Figure 1C), i.e., Western Flower Thrips (WFT), is highly polyphagous and feeds on hundreds of different weed and crop hosts. The life cycle of WFT is strongly influenced by climatic variables, such as temperature and humidity, and it exhibits arrhenotokous reproduction as females arise from fertilized eggs and males from unfertilized eggs. Nevertheless, occasionally virgin females may produce female offspring (thelytoky) [26]. The life cycle is completed in about 20 days, at average temperature values of 25 °C. The mature females lay eggs in the parenchyma of leaves, flower parts, and fruits and most frequently under the epidermis of the leaves. Eggs of WFT usually hatch in about 4 days at 27 °C after oviposition. Winged adults generally emerge after 2–9 days, with temperatures needing to be above a minimum of 8–10 °C for growth. Optimal developmental rates occur between 25 °C and 30 °C [27]. WFT is always present in citrus groves in the Mediterranean regions [14] and causes enormous indirect damage by transmitting plant pathogenic Tospoviruses in various agricultural and floricultural crops [28]. *F. occidentalis* is a dominant thrips species in citrus groves; however, the abundant adult and larval populations do not cause damage in the citrus fruit, and it is therefore recorded as a pollen-feeding species [29].

The species *Thrips major* (Figure 1D) was found by Bournier [30] to be the dominant thrips species in orange groves in North Africa, causing damage to citrus fruits consisting of silvering and malformation of the epidermis of the fruits (oranges and lemons). Another study on Turkish thrips affecting citrus also showed the predominance of the species *T. major*, with 84% of thrips collected identified as this species [31]. Knowledge of the life history and biology of this species on citrus is limited.

2.2. Newly Introduced and Emerging Species

The species *Thrips hawaiiensis* (Figure 1E) is a polyphagous flower-dwelling thrips, widely distributed and common in tropical Asia and the Pacific Region. In recent years, its introduction has been reported in several Mediterranean countries such as Turkey, Italy, France, and Spain [9,14,18,19]. *T. hawaiiensis* damages various organs in lemon orchards by causing wounds in flower buds, all flower organs (Figure 2D), and young fruits (Figure 2E). Large silver spots are observed on the lemon fruits [32]. There is little information on the life history of *T. hawaiiensis* in citrus cultivation. Laboratory trials with populations reared on *Camellia sinensis* pollen at a constant temperature showed that the developmental period from egg hatching to adult emergence went from 38.9 days at 10 °C to 8 days at 30 °C [33]. In western Japan, *T. hawaiiensis* is a plurivoltine species, and the number of generations completing development varies between 11 and 18 annually. Longevity and fecundity are biological characteristics that, as in most thrips, vary with temperature. The development time is 92 days at 15 °C and decreases to 18 days at 25 °C. It has also been shown that a specimen can live up to 121 days at a temperature of 15 °C and that the optimum temperature for maximum fecundity (536 eggs) is 20 °C. Generally, daily egg production is constant throughout the female's life at 6–8 eggs per day at 20 °C. Therefore, *T. hawaiiensis* seems to tolerate low temperatures well. This characteristic makes it potentially more dangerous than other thrips parasites [12]. Murai [33] reported a high reproductive rate for the species with almost 20 generations per year. The countries of the Mediterranean basin, where the climatic conditions are particularly favourable to the thrips and where the cultivation of the lemon is very extensive, could become the habitats in which *T. hawaiiensis* expresses its maximum damage potential.

The species *Scirtothrips dorsalis* (Figure 1F) is characterised by high polyphagy and causes direct damage through feeding and indirect damage through disease transmission [34]. It can produce seven or eight generations per year in Korea [35]. This species breeds continuously for one year without an obligatory diapause and spends the winter mainly as an inactive adult stage in dry leaves in the soil or sheltered among apical buds [36,37] In early spring, as temperatures rise, adults move into the plant canopy [38]. The biological cycle of *S. dorsalis* is completed in the following stages: egg, first and second stage larva, prepupa, adult. Mature females lay their eggs within the plant tissue, and the eggs hatch between 5 and 8 days later, depending on environmental conditions [39,40]. Larval stages are completed in 8–10 days, and pupal stages in 2.6–3.3 days. The temperature range within which the species can survive varies between 9.7 °C and 33.0 °C [41]. It cannot successfully complete its entire life cycle on the citrus plant, as the genus *Citrus* is classified as a secondary host plant for this species [42,43]. For this reason, the population dynamic of *S. dorsalis* in citrus groves is strongly influenced by its abundance on surrounding primary host plants (wild and cultivated), on which *S. dorsalis* can successfully complete its entire life cycle, such as kiwi and green tea [35–44].

2.3. Integrated Pest Management of Citrus Thrips Species

The damage caused by thrips in citrus crops requires phytosanitary interventions with the aim of reducing product losses. Some Mediterranean countries such as Italy, France, and Portugal receive funding for the support of IPM practices from the European Union [3]. Over time, numerous active molecules (chemical and biological) have been tested for thrips control in citrus groves. For more than 30 years, the management of these dangerous pests has involved techniques that are environmentally friendly, especially with respect to species (e.g., anthocorid and coccinellid predators) that are useful to the citrus biocenosis [45,46]. Currently, in the major citrus-producing countries, local authority guidelines require the adoption of integrated pest management protocols, with the dual aim of protecting human health and the environment in its multiple aspects. According to Vacante and Bonsignore [47], visual sampling and monitoring of thrips pest populations as well as their natural predators reduce pest control costs and environmental impacts. This method needs to be integrated with the phenology of different citrus crops and the basic aspects of pest bio-ecology. For the main thrips species, they suggest counting the average presence of larvae in portions of the canopy circumference and sampling 100 young fruits during the peak infestation period from March to June. In Italy, the integrated production guidelines for citrus cultivation only refer to the phytosanitary measures that can be taken for the species *P. kellyanus*, *H. haemorroidalis,* and *F. occidentalis*. The general intervention criteria are based on the use of rational pruning for thinning the foliage, as well as the use of active ingredients, although some of them have deadlines for use and revocation of authorization for use is expected very soon. Azadirachtin and products based on sweet orange essential oil are also used [48,49].

Organic and agronomic tools. Agroecosystems such as citrus are particularly suitable for organic pest control. Almost all citrus species have a perennial vegetative state and have a high spatial variation in habitat compared to crops that lose their leaves during the winter season. Considering the economic importance of citrus crops in the Mediterranean region, biological control of thrips with the use of natural predators (e.g., anthocorid predators such as *Orius* sp. and predatory mites of the genus *Amblyseius*) can play a key role in preventing crop damage [14]. Organic control methods in citrus groves are pest control techniques that have limited environmental impacts compared to the sole use of chemical compounds. Interactions with natural predators of the most harmful citrus thrips species (*P. kellyanus*) are poorly investigated in the Mediterranean area. In 2020, Navarro-Campos et al. [50] demonstrated that the enhancement of some predatory mite species (*Gaeolaelaps aculeifer*) significantly reduced the damage caused by *P. kellyanus* in two commercial citrus orchards located in an extensive citrus-growing area of Valencia, eastern Spain. Some studies suggest that ground cover with plant species such as *Festuca arundinacea* Schreb. harbours fewer potential thrips species that are parasitic on citrus fruits than spontaneous ground cover, also promoting a greater abundance and diversity of predatory phytoseid mites in clementine mandarin orchards [51].

Chemical control. According to Colloff et al. [52], the presence of one or more harmful thrips can have a major effect on the costs citrus growers have to bear to contain infestations through chemical control. Chemical control of citrus thrips has always involved the use of insecticidal molecules such as organophosphates (chlorpyrifos), carbamates (methomyl), neonicotinoids (such as imidacloprid, which has already been revoked), and acetamiprid, as well as the microbial pesticide spinosad, often leading to resistance in the target species [15–53]. Recently, some studies conducted on Navel oranges, considered among the most preferred host plants for citrus thrips in Tunisia, have demonstrated the efficacy of some insecticides such as spinosad, acrinathrin, and terpenoids in reducing the population density of *F. occidentalis* [54].

3. Materials and Methods

3.1. Study Sites and Thrips Sampling Monitoring Methods in Southern Italy

This study involved three citrus orchards located in the Calabria region in the provinces of Reggio Calabria and Catanzaro where citrus crop growing covers large areas of the territories. The citrus groves were located at altitudes between 0 and 110 m, and the phytosanitary management system against the main pest species follows the requirements of the integrated production protocol provided by the Region [48]. The citrus groves were cultivated in pot form, and their age varied from 15 to 25 years. Weed control was carried out mechanically by tilling the soil, and plant irrigation was carried out during the summer through a drip system. The investigated citrus crops and relative areas are reported in Table 2.

Table 2. Citrus orchards and their locations involved in the study.

Citrus Species	Cultivar	Location	Province	Latitude	Longitude
Orange	Navel, Tarocco	Lamezia terme	CZ [1]	38°54′35.4″ N	16°19′29.5″ E
Lemon	Femminello	Gioia Tauro	RC [2]	38°26′31.9″ N	15°55′20.0″ E
Bergamot	Fantastico	Reggio Calabria	RC [2]	38°01′19.0″ N	15°39′14.2″ E

[1] Catanzaro, [2] Reggio Calabria.

In each citrus grove, a field monitoring plan was designed to be carried out every 15 days. Monitoring of adult thrips species and their distribution in the canopy was conducted in the bergamot, lemon, and orange orchards from the beginning of March to the end of June in 2020 and 2021. Each survey area had a range of 3 hectares, and thrips in flowers were counted on 10 plants randomly selected from the three citrus crops. Following the protocol used by Vono et al. [55] and Marullo et al. [56], from each plant, 40 flowers randomly distributed from the outskirts of the canopy were collected from the different sectors of sun exposure: northeast (NE); southeast (SE); southwest (SW); and northwest (NW). Morphological identification of the specimens was carried out using the identification keys of Mound and Kibby [57] and Marullo [16], and the mounting of adult specimens of both sexes on microscope slides was carried out following the method described by Mound and Marullo [58] and Marullo [16]. To relate WFT to the most abundant wild herbaceous species and the occurrence of this thrips species on *Citrus* spp., flowers of *Chrysantenum segetum* (L.) Fourr., *Amaranthus retroflexus* L., *Chenopodium album* L. and *Portulaca oleracea* L., inside the rows of the trees of the three citrus crops, were sampled from March to November. A main sample of 50 flowers/shoots (with one shoot constituted by 1 flower or inflorescence with 1or 2 leaves) was collected monthly (at the middle of each month). All cut flowers were examined under a stereoscopic microscope (SZX9, Olympus® Tokyo, Japan) within 24 h of sampling. Voucher specimens were deposited in the Dipartimento di Agraria, Università degli Studi Mediterranea, Reggio Calabria, Italy.

3.2. Statistical Analysis

Thrips recorded on citrus flowers were subjected to analysis of variance, with year, monitoring months, sectors of exposition, and thrips species included as factors in the statistical analysis. If significant differences were detected, mean separation was performed using LSD (Least Significant Difference). The mean abundance of thrips populations in each citrus grove was represented graphically to compare infestation levels at different times and citrus groves. Diagnostic plots were examined to check for heteroscedacity and normality of errors. Pearson's correlation analysis was used to determine correlations between WFT counts per month in *Chrysanthemum segetum* (vegetal species in citrus orchard with highest occurrence of WFT) and WFT on citrus flowers between March and June in all citrus species. We used SPSS v23 (2015 SPSS Inc., Chicago, IL, USA) [59] for all data analyses and Sigmaplot 13.0 (Systat Copyright © 2022 Systat Software, San Jose, CA, USA) [60] for production of graphs. All data are presented as non-transformed mean values with standard errors (SE).

4. Results

Abundance and Composition of Species in Southern Italy

The ANOVA ((Adjusted R Squared = 0.602), F = 49.25; $p < 0.01$ (Levene Test F (8.53) = 1.683)) for differences of the thrips abundance confirmed there were differences among sectors of exposure, citrus, and thrips species and period of monitoring and a minimal difference between years (F = 3.768; df = 1, $p = 0.053$) (see Table 3). Colonization of citrus species trees and sun exposure sectors had significant differences (Figure 3). There was a seasonal gradual increase in the numbers of thrips to a peak for each species (Figure 4). The peak periods of each species were variable with growing cycles. In terms of thrips density among citrus species, the differences were between lemon and orange (LSD mean difference value = 10.52, $p < 0.01$) and between bergamot and orange (LSD mean difference value = 12.69, $p < 0.01$), while no difference was detected between lemon and bergamot (LSD mean difference value = 2.17, $p = 0.236$). The morphological identification of the adult specimens of both sexes taken from the monitored citrus trees revealed that recorded thrips species were *F. occidentalis*, *P. kellyanus*, and *T. major*, all belonging to the Thripidae family (Figure 5). In terms of distribution of citrus species, *F. occidentalis* was the most abundant species on bergamot (mean of thrips 14.7 and 14.5 in 2020 and 2021, respectively), followed by *T. major* (8.2 and 9.0). Seasonal density of WFT on wild herbaceous plants highlighted an increase in the populations of thrips species on all four sampled plant species. It should be noted that for WFT, there was a clear preference for *C. segetum* (L.), which constituted a potential reservoir for the spread of thrips and its permanent presence in the ground cover of citrus groves (Figure 6). Population densities of WFT on *C. segetum* and WFT on citrus crops were positively correlated (r = 0.626; df =96; $p < 0.001$) (Figure 7).

Table 3. Univariate analysis (UNIANOVA) evaluating the abundance of thrips species in relation to the variables of monitoring citrus orchards.

Source	Df	F	Sig
Intercept	1	516.384	<0.01
Months	3	65.804	<0.01
Sun exposure sector	3	39.469	<0.01
Thrips species	2	41.203	<0.01
Year	1	3.768	0.053
Citrus species	2	21.449	<0.01

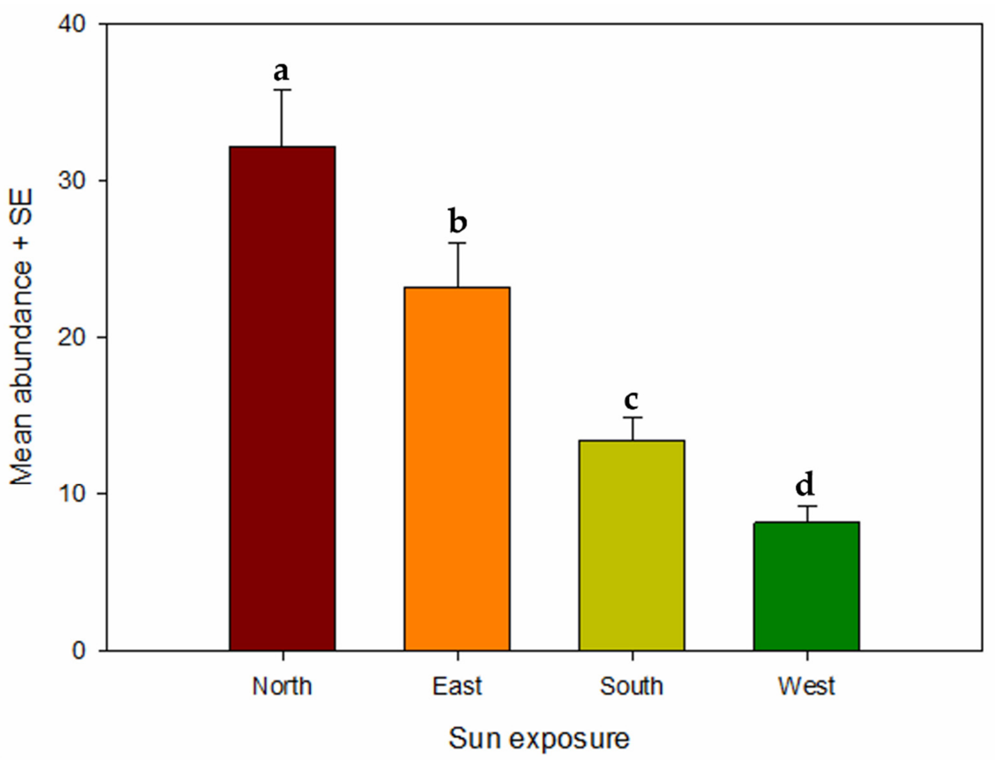

Figure 3. Thrips abundance at different sun exposure sectors of plant canopies. The different superscript letters show significant differences among the mean values ($p < 0.05$).

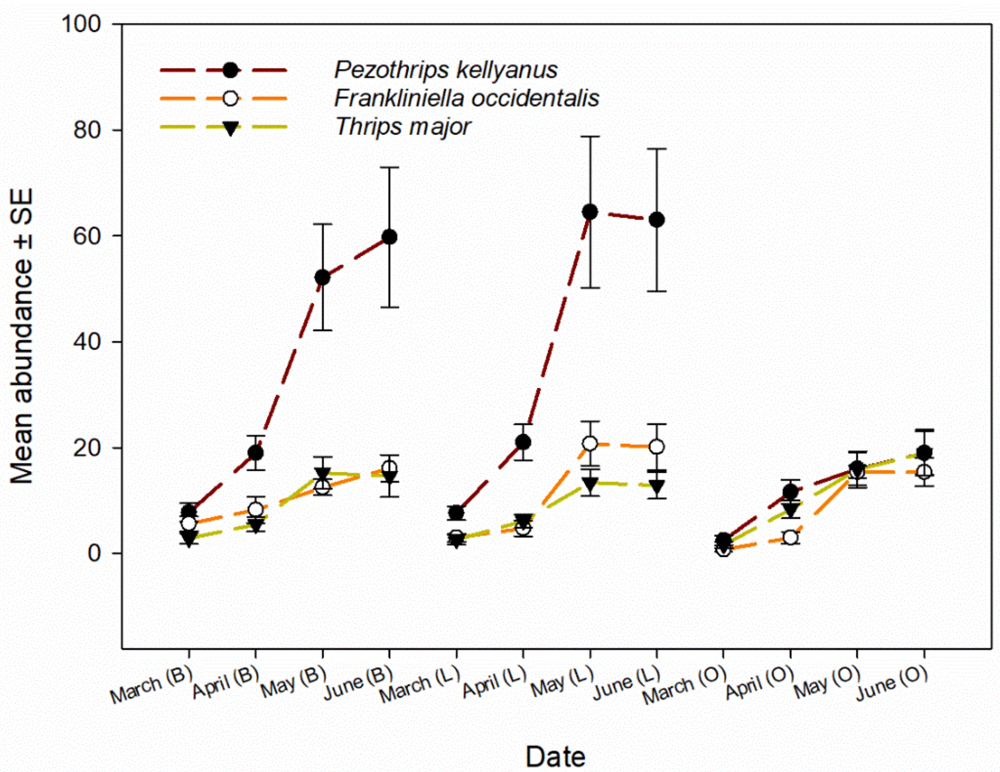

Figure 4. Abundance and seasonal distribution of monitored thrips species in different citrus fields (B = bergamot, L= lemon and O = orange).

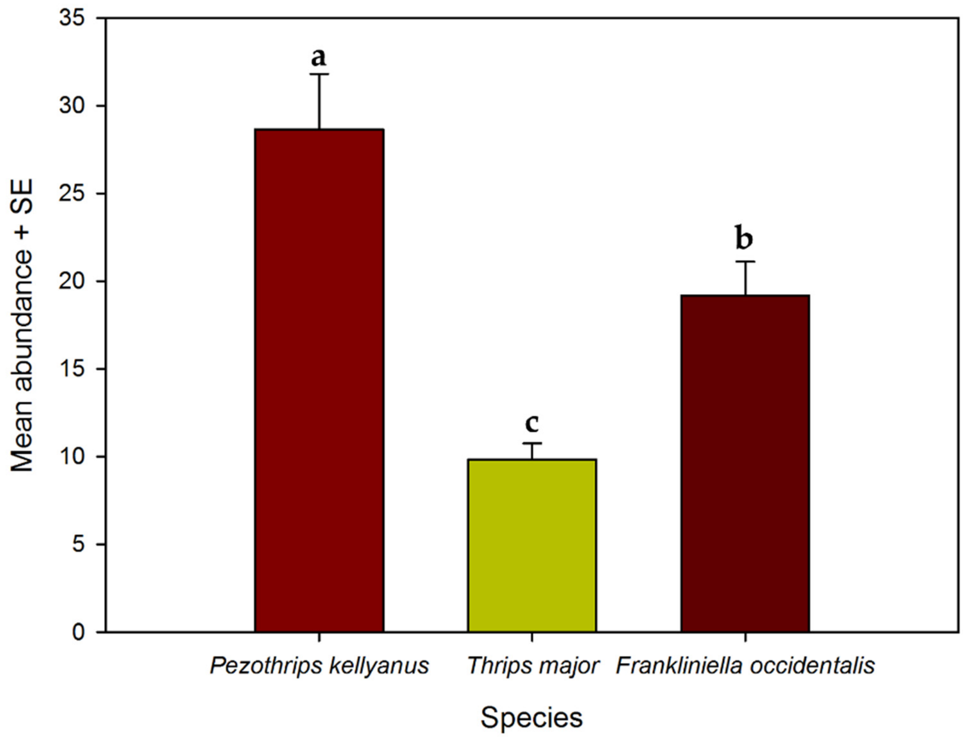

Figure 5. Abundance of different thrips species on *Citrus* spp. The different superscript letters show a significant difference among the means' values ($p < 0.05$).

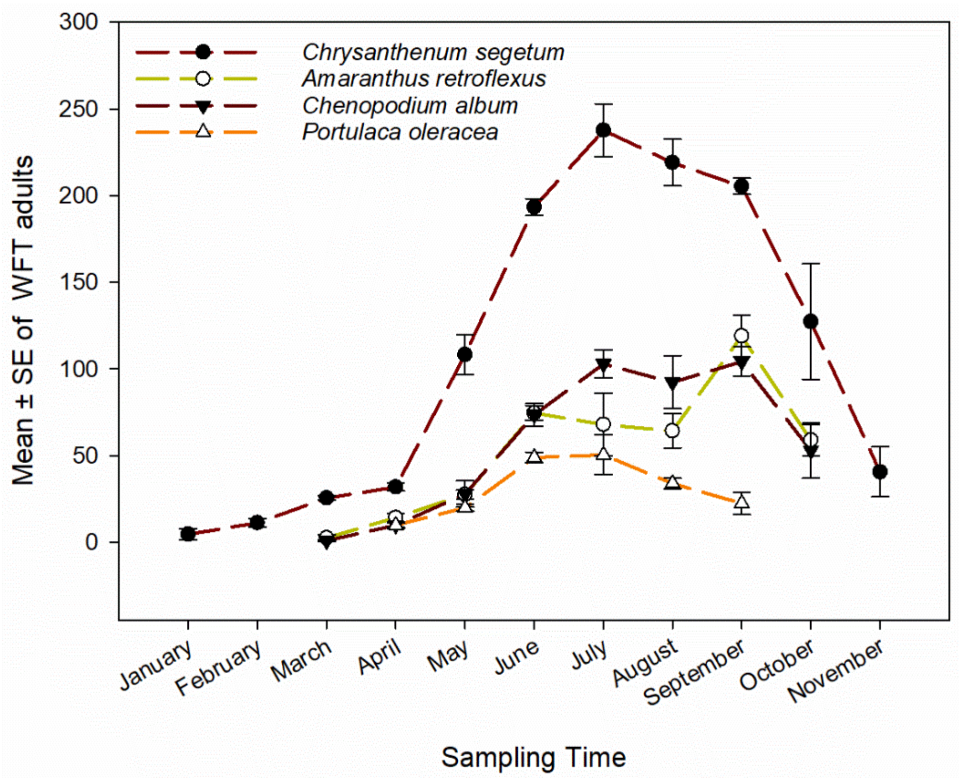

Figure 6. Seasonal density of WFT on wild herbaceous plant species.

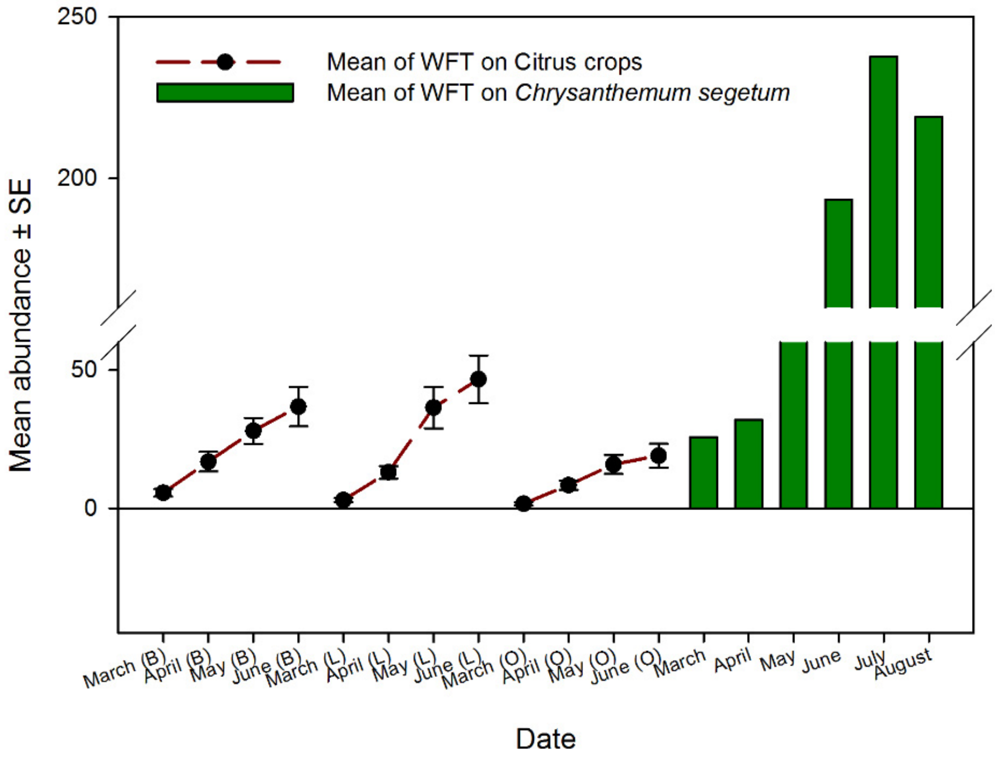

Figure 7. Monthly temporal dynamics of WFT presence on wild plant *C. segetum* and citrus crops (B = bergamot, L= lemon, O = orange).

5. Discussion

Thrips are a widespread insect order in the citrus agroecosystem all over the world. Our study revealed that the thrips distribution in the citrus canopy was not uniform. In all fields monitored, a greater distribution of specimens was observed in the flowers collected from the northeast (NE) sun exposure sector. Decreasing values of abundance were observed in the southeast (SE), southwest (SW), and northwest (NW) sectors, in this order. Studies carried out in Tunisia also revealed that the distribution of thrips was not uniform over the plant canopy. In the same study, it was shown that the highest average number of thrips was found on the north side [61].

Our results of thrips monitoring in citrus groves in southern Italy showed that *P. kellyanus* was confirmed as the most abundant species in all the citrus species investigated, followed by *F. occidentalis* and *T. major*. In 1998, two years after its introduction to Italy, Conti et al. [15] considered *P. kellyanus* as the key pest in citrus fruits on the coastal area of eastern Sicily citrus fruits. Population dominance of this species has also been recorded on citrus fruits in Spain, Greece, and Portugal [17,21,62]. *P. kellyanus* is particularly attracted to the oily exudates produced by the nectars and peels of the three citrus species involved in the study; these attractive exudates stimulate the glandular areas of the male sternites of *P. kellyanus*, which are also responsible for producing sex pheromones [63]. These conditions lead to an exponential increase in *P. kellyanus* populations in the open field during the spring, which coincides with the flowering of most citrus fruits in the Mediterranean basin.

In the carried-out investigations, *F. occidentalis* was persistently present, in accordance with what has been reported in the literature [14,54,62]. Its constant presence is probably due to its high polyphagy (over 500 know host plant species) [64], the genetic adaptability of its populations [65], as well as its ability to prey on some small arthropods present in the same habitat [16]. Considering the cyclical flowering of citrus fruits in Mediterranean areas and therefore the abundant availability of pollen as a food source, WFT can have continuous generations, even at the end of the summer season, until the citrus fruits develop on the plants. The occurrence density of WFT in citrus flowers is directly related to its abundance in the spontaneous flora present in citrus groves, and this makes the possibility of predicting the species more complex if the surrounding habitat of the species is not investigated [66]. Thus, determining the presence of the arthropod community is important, including species of different trophic levels that potentially benefit from natural pest control due to a greater diversity and abundance of natural predators [67,68]. The results will assist citrus growers to identify the best time to implement suitable management tactics to reduce thrips populations in an environmentally sustainable context.

The literature analysis showed that there are 20 thrips species ascribed to citrus cultivation in the Mediterranean countries. Most of the described species belong to the family Thripidae, many belong to the family Aeolothripidae, and only one to the family Melanthripidae. Among these species, there are four that are most prevalent and recognised as the most damaging agents for citrus cultivation; these include *P. kellyanus*, *H. haemorrhoidales*, *F. occidentalis,* and *T. major* [13,14]. In recent years, *T. hawaiensis* has been increasing in importance, mainly in lemon tree cultivation in Turkey [9]. In addition, citrus cultivation in the Mediterranean basin is constantly threatened by the entry of new species, as has recently occurred with *S. dorsalis* in some orange crops in Turkey [10]. Several studies report that Kelly's thrips is currently the most damaging species on many species belonging to the *Citrus* genus. *P. kellyanus* is in fact reported as the most damaging species in Turkey, Italy, Spain, and Cyprus [13,14,69]. All other species belonging to the Thripidae family (e.g., *C. orchidii*, *C. signipennis*) have also been recorded in different areas of the Mediterranean as harmful thrips to citrus crops but are characterised by very low population levels [70]. The presence of species belonging to the Aleothripidae family and of *A. intermedius* must be considered ecologically interesting, as the species is known as a predator of thrips and other small arthropods [61]. Thrips control in citrus groves is a very difficult practice. In recent years, control techniques based on the concepts of biological control have experimented with the use of environmentally friendly molecules and the use of natural predators such as predatory mites belonging to the genus *Gaeolaelaps* spp. [13,50,54]. However, in most citrus-growing areas, defence against thrips, and more generally against harmful insects, does not exclude the use of active ingredients of chemical origin.

6. Conclusions

The relationship between agricultural crops and their pests, understood as the damage generated by trophic activity and more generally by the constant presence and survival of herbivores on vegetative organs (leaves, flowers, and fruit), generates substantial productive and economic losses for farmers. The abundance of thrips populations is also influenced by the climatic conditions of an area and by the agronomic and phytosanitary management techniques adopted in the different citrus agroecosystems.

Our study showed that citrus groves with a good presence of herbaceous plants host large populations of mites and predatory insects. The adoption of agronomic practices involving the maintenance of soil cover with wild or cultivated herbaceous species promote natural pest control provided as an ecosystem service. In recent years, the study of citrus thrips in these regions has focused mainly on ecological aspects and the evaluation of insecticidal molecules. Citrus thrips control strategies therefore need to be improved and supported using modern and useful tools. Molecular characterisation of citrus thrips in the Mediterranean basin could prove to be valuable for understanding some aspects of thrips population biology (e.g., genetic polymorphisms), as demonstrated for some thrips species of other crops [71], as well as for investigating the geographical pathways taken by newly introduced species.

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References

1. Liu, Y.Q.; Heying, E.; Tanumihardjo, S.A. History, global distribution, and nutritional importance of citrus fruits. *Compr. Rev. Food Sci. Food Saf.* **2012**, *11*, 530–545. [CrossRef]
2. Singh, J.; Sharma, V.; Pandey, K.; Manveen, A.K.; Singh Sidhu, G. Horticultural Classification of Citrus Cultivars. In *Citrus Research, Development and Biotechnology*, 3rd ed.; Khan, M.S., Khan, A.I., Eds.; IntechOpen: London, UK, 2020; pp. 1–24.
3. Franco, J.C.; Garcia-Marí, F.; Ramos, A.P.; Besri, M. Survey on the situation of citrus pest management in Mediterranean countries. *Bull. IOBC/WPRS* **2006**, *29*, 335–346.
4. Falcone, G.; Stillitano, T.; De Luca, A.I.; Di Vita, G.; Iofrida, N.; Strano, A.; Gulisano, G.; Pecorino, B.; D'Amico, M. Energetic and economic analyses for agricultural management models: The calabria PGI clementine case study. *Energies* **2020**, *13*, 1289. [CrossRef]
5. ISTAT. Available online: http://dati.istat.it/Index.aspx?QueryId=33705# (accessed on 30 November 2021).
6. Viggiani, G. *Lotta Biologica e Integrata Nella Difesa Fitosanitaria, Lotta Integrata ai Fitofagi*, 1st ed.; Liguori Editore: Napoli, Italy, 1997; Volume 2, pp. 84–104.
7. Belaam Kort, I.; Moraza, M.; Attia, S.; Mansour, R.; Kheder, S.B. Beneficial arthropods as potential biocontrol candidates of thrips (Thysanoptera: Thripidae) occurring in Tunisian citrus orchards. *Biologia* **2020**, *75*, 2261–2270. [CrossRef]
8. EPPO Global Database. Available online: https://gd.eppo.int/taxon/1THYSO (accessed on 23 December 2021).
9. Atakan, E.; Pehlivan, S. A harmful thrips species on lemon in the eastern Mediterranean Region of Turkey: *Thrips hawaiiensis* (Morgan) (thysanoptera:Thripidae). *KSU J. Agric. Nat.* **2020**, *23*, 19–25.
10. Atakan, E.; Pehlivan, S. A new harmful thrips species in orange in Antalya Province: *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae). *Mediterr. Agric. Sci.* **2021**, *34*, 273–277. [CrossRef]
11. Campos, R.J.M.; Martínez, F.M.T.; Navarro Campos, C.; García Marí, F. First damage caused by Chaetanaphothrips orchidii (Moulton) (Thysanoptera: Thripidae), orchid thrips, in citrus in Spain. In Proceedings of the Meeting of the Working Group Integrated Control in Citrus Fruit Crops, Valencia, Spain, 25–27 September 2017; IOBC-WPRS: Valencia, Spain, 2017.
12. Reynaud, P. Thrips (Thysanoptera). In *Alien Terrestrial Arthropods of Europe*, 1st ed.; Roques, A., Kenis, M., Lees, D., Lopez-Vaamonde, C., Rabitsch, W., Rasplus, J.Y., Royvol, D., Eds.; Pensoft BioRisk: Sofia, Bulgaria, 2010; pp. 767–791.
13. Belaam-Kort, I.; Marullo, R.; Attia, S.; Boulahia-Kheder, S. Thrips fauna in citrus orchard in Tunisia: An up-to-date. *Bull. Insectology* **2020**, *73*, 1–10.
14. Marullo, R.; De Grazia, A. Thripidae. In *Integrated Control of Citrus Pests in the Mediterranean Region*, 1st ed.; Vacante, V., Gerson, U., Eds.; Bentham Science: Sharjah, United Arab Emirates, 2012; pp. 109–118.
15. Conti, F.; Tumminelli, R.; Amico, C.; Fisicaro, R.; Frittitta, C.; Perrotta, G.; Marullo, R. Monitoring *Pezothrips kellyanus* on citrus in eastern Sicily. In *Thrips and Tospoviruses, Proceedings of the 7th International Symposium on Thysanoptera, Reggio Calabria, Italy 1–8 July 2001*; Australian National Insect Collection: Canberra, NSW, Australia, 2002; pp. 207–210.
16. Marullo, R. *Conoscere i Tisanotteri. Guida al Riconoscimento delle Specie Dannose alle Colture Agrarie*; Edagricole: Bologna, Italy, 2003; p. 75.
17. Costa, L.; Mateus, C.; zur Strassen, R.; Franco, J. Thrips (Thysanoptera) associated to lemon orchards in the Oeste region of Portugal. *IOBC/WPRS Bull.* **2006**, *29*, 285–291.
18. Reynaud, P.; Balmès, V.; Pizzol, J. *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae), an Asian pest thrips now established in Europe. *Bull. OEPP* **2008**, *38*, 155–160. [CrossRef]
19. Goldarazena, A. First record of *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae), an Asian pest thrips in Spain. *EPPO Bull.* **2011**, *41*, 170–173. [CrossRef]
20. Marullo, R. *Pezothrips kellyanus*, un nuovo tripide parassita delle colture meridionali. *Inf. Fitopat.* **1998**, *48*, 72–75.
21. Varikou, K.; Tsitsipis, J.A.; Alexandrakis, V.; Mound, L.A. *Pezothrips kellyanus* (Bagnall) (Thysanoptera: Thripidae), a new pest of citrus trees in Crete. In Proceedings of the VII European Congress of Entomology, Thessaloniki, Greece, 7–13 October 2002; p. 33.
22. Planes, L.; Catalán, J.; Jaques, J.A.; Urbaneja, A.; Tena, A. *Pezothrips kellyanus* (Thysanoptera: Thripidae) nymphs on orange fruit: Importance of the second generation for its management. *Fla. Entomol.* **2015**, *98*, 848–855. [CrossRef]

23. Perrotta, G.; Conti, F. A threshold hypothesis for an integrated control of thrips infestation on citrus in South-Eastern Sicily. *IOBC/WPRS Bull.* **2008**, *38*, 204–209.
24. Gonzalez, R.H. *El Trips de California y Otros Tisanopteros de Importancia Hortfruticola en Chile (Thysanoptera: Thripidae)*; Serie Ciencias Agronomicas n°1. BASF; Universidad de Chile: Santiago, Chile, 1999.
25. Froud, K.J.; Stevens, P.S. Importation biological control of *Heliothrips. haemorrhoidalis* by *Thripobius semiluteus* in New Zealand. A case study of nontarget host and environmental risk assessment. In Proceedings of the 1st International Symposium on Biological Control of Arthropods, Honolulu, HI, USA, 3–5 June 2003; USDA-Forest Service FHTET: Washington, DC, USA, 2003; pp. 366–369.
26. Kumm, S.; Moritz, G. Life-cycle variation, including female production by virgin females in *Frankliniella occidentalis* (Thysanoptera: Thripidae). *J. Appl. Entomol.* **2010**, *134*, 491–497.
27. Reitz, S.R. Biology and ecology of the western flower thrips (Thysanoptera: Thripidae): The making of a pest. *Fla. Entomol.* **2009**, *92*, 7–13. [CrossRef]
28. Riley, D.G.; Shimat, V.J.; Rajagopalbabu, S.; Stanley, D. Thrips Vectors of Tospoviruses. *J. Integr. Pest Manag.* **2011**, *2*, 1–10. [CrossRef]
29. Atakan, E.; Ölçülü, M.; Pehlivan, S.; Özgür, O. An analysis of western flower thrips *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) in lemons: Its abundance, distribution and damage. *J. Entomol. Zool. Stud.* **2016**, *4*, 109–114.
30. Bournier, A. Un nouveau déprédateur des agrumes en Afrique du Nord: Thrips major Uzel. *Rev. De Pathol. Végétale Et D'entomologie Agric.* **1963**, *42*, 5.
31. Teksam, I.; Tunç, I. An analysis of Thysanoptera associated with citrus flowers in Antalya, Turkey. Composition, distribution, abundance and pest status of species. *Appl. Entomol. Zool.* **2009**, *44*, 455–464. [CrossRef]
32. Atakan, E.; Pehlivan, S.; Achiri, T.D. Pest status of the Hawaiian flower thrips, *Thrips hawaiiensis* (Morgan) (Thysanoptera: Thripidae) in lemons in the Mediterranean region of Turkey. *Phytoparasitica* **2021**, *49*, 513–525. [CrossRef]
33. Murai, T. Development and reproductive capacity of *Thrips hawaiiensis* (Thysanoptera: Thripidae) and its potential as a major pest. *Bull. Entomol. Res.* **2001**, *91*, 193–198. [PubMed]
34. Dickey, A.M.; Kumar, V.; Hoddle, M.S.; Funderburk, J.E.; Morgan, J.K.; Jara-Cavieres, A.; Shatters, R.G., Jr.; Osborne, L.S.; McKenzie, C.L. The *Scirtothrips dorsalis* Species Complex: Endemism and Invasion in a Global Pest. *PLoS ONE* **2015**, *10*, e0123747. [CrossRef] [PubMed]
35. Hwang, R.Y.; Hyun, J.W. Kim, D-S. Models of forecasting the generation peak time of *Scirtothrips dorsalis* (Thysanoptera: Thripidae) adults based on degree-days on Jeju Island, Korea. *Korean J. Appl. Entomol.* **2013**, *52*, 415–425. [CrossRef]
36. Okada, T. Searching behavior for pupation place by late second instar larvae of *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae). *Jpn. J. Appl. Entomol. Zool.* **1981**, *25*, 10–16. [CrossRef]
37. Shibao, M.; Tanaka, F.; Nakasuji, F. Seasonal changes and infestation sites of the chillie thrips, *Scirtothrips dorsalis* (Thysanoptera: Thripidae) on grapes. *Jpn. J. Appl. Entomol. Zool.* **1990**, *34*, 145–152. [CrossRef]
38. Okada, T.; Kudo, I. Overwintering sites and stages of *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) in tea fields. *Jpn. J. Appl. Entomol. Zool.* **1982**, *26*, 177–182. [CrossRef]
39. Seal, D.R.; Klassen, W.; Kumar, V. Biological parameters of *Scirtothrips dorsalis* (Thysanoptera: Thripidae) on selected hosts. *Environ. Entomol.* **2010**, *39*, 1389–1398. [CrossRef]
40. Dev, H.N. Preliminary studies on the biology of Assam thrips, *Scirtothrips dorsalis* Hood on tea. *Indian J. Entomol.* **1964**, *26*, 184–194.
41. Holtz, T. *NPAG Report: Scirtothrips Dorsalis Hood*; New Pest Advisory Group, Center for Plant Health Science and Technology, APHIS, USDA: Raleigh, NC, USA, 2006; p. 7.
42. EPPO/CABI. *Scirtothrips* aurantii, *S. citri*, *S. dorsalis*. In *Quarantine Pests for Europe*, 2nd ed.; CAB International: Wallingford, UK, 1996; pp. 497–508.
43. Nietschke, B.S.; Borchert, D.M.; Magarey, R.D.; Ciomperlik, M.A. Climatological potential for *Scirtothrips dorsalis* (Thysanoptera: Thripidae) establishment in the United States. *Fla. Entomol.* **2008**, *91*, 79–86. [CrossRef]
44. Song, J.H.; Kim, C.S.; Yang, Y.T.; Hong, S.Y.; Lee, S.C. Annual occurrence pattern of *Scirtothrips dorsalis* (Thysanoptera: Thripidae) on citrus trees and surrounding host plants. *Korean J. App. Entomol.* **2013**, *52*, 185–191.
45. Grout, T.G.; Stephen, P.R.; Croix, N.J. *Citrus thrips* (Thysanoptera: Thripidae) in Swaziland develop tolerance to tartar emetic bait. *Afr. Entomol.* **2006**, *4*, 15–20.
46. Conti, F.; Tumminelli, R.; Fisicaro, R.; Perrotta, R.; Marullo, R.; Liotta, G. An IPM system for new citrus thrips in Italy. *IOBC/WPRS Bull.* **2003**, *26*, 203–208.
47. Vacante, V.; Bonsignore, C.P. Implementation of IPM in Citriculture. In *Integrated Control of Citrus Pests in the Mediterranean Region*, 1st ed.; Vacante, V., Gerson, U., Eds.; Bentham Science: Sharjah, United Arab Emirates, 2012; pp. 28–52.
48. Regione Calabria, Dipartimento N° 8 Agricoltura e Risorse Agroalimentari Servizio Fitosanitario Regionale, Disciplinari di Produzione Integrata 2021. Available online: https://www.regione.calabria.it/website/organizzazione/dipartimento8/subsite/fitosanitario/produzione-integrata/ (accessed on 20 December 2021).
49. Regione Siciliana, Assessorato Regionale dell'Agricoltura, dello Sviluppo Rurale e della Pesca Mediterranea | Dipartimento dell'Agricoltura, Servizio Fitosanitario Regionale, Disciplinari di Produzione Integrata 2021. Available online: http://pti.regione.

sicilia.it/portal/page/portal/PIR_PORTALE/PIR_LaStrutturaRegionale/PIR_AssessoratoregionaledelleRisorseAgricoleeAlimentari/PIR_DipAgricoltura/PIR_AreeTematiche/PIR_Servizi/PIR_ServizioFitosanitarioRegionale (accessed on 20 December 2021).
50. Navarro-Campos, C.; Beltrà, A.; Calabuig, A.; Garcia-Marí, F.; Wäckers, F.L.; Pekas, A. Augmentative releases of the soil predatory mite *Gaeolaelaps aculeifer* reduce fruit damage caused by an invasive thrips in Mediterranean citrus. *Pest Manag. Sci.* **2020**, *76*, 2500–2504. [CrossRef]
51. Aguilar-Fenollosa, E.; Jacas, J.A. Effect of ground cover management on Thysanoptera (thrips) in clementine mandarin orchards. *J. Pest. Sci.* **2013**, *86*, 469–481. [CrossRef]
52. Colloff, M.J.; Lindsaya, E.A.; Cook, D.C. Natural pest control in citrus as an ecosystem service: Integrating ecology, economics and management at the farm scale. *Biol. Control.* **2013**, *67*, 170–177. [CrossRef]
53. Baker, G.J.; Keller, M.; Crisp, P.; Purvis, S.; Jackman, D.J.; Barbour, D. The Biological Control of Kelly's Citrus Thrips in Australian Citrus Orchards. In Proceedings of the XXII International Congress of Entomology, Brisbane, QLD, Australia, 15–21 August 2004.
54. Belaam-Kort, I.; Mansour, R.; Attia, S.; Kheder, S.B. Thrips (Thysanoptera: Thripidae) in northern Tunisian citrus orchards: Population density, damage and insecticide trial for sustainable pest management. *Phytoparasitica* **2021**, *49*, 527–538. [CrossRef]
55. Vono, G.; Bonsignore, C.P.; Gullo, G.; Marullo, R. Olive production threatened by a resurgent pest *Liothrips oleae* (Costa, 1857). (Thysanoptera: Phlaeothripidae) in Southern Italy. *Insects* **2020**, *11*, 887. [CrossRef]
56. Marullo, R.; Bonsignore, C.P.; Vono, G. Thrips: A review of sampling methods in relation to their habitats. *Bull. Insectology* **2021**, *74*, 241–251.
57. Mound, L.A.; Kibby, G. *Thysanoptera: An Identification Guide*; CABI International: Wallingford, UK, 1998; p. 70.
58. Mound, L.A.; Marullo, R. *The Thrips of Central and South America: An Introduction. Memoirs on entomology, international*; Asociated Publishers: Gainesville, FL, USA, 1996; Volume 6, pp. 1–488.
59. IBM Corp. *Released (2015): IBM SPSS Statistics for Windows*; Version 23.0; IBM Corp.: Armonk, NY, USA, 2015.
60. Systat Software. *Sigmaplot 13.0*; Systat Copyright © Systat Software: San Jose, CA, USA, 2018.
61. Belaam-Kort, I.; Boulahia-Kheder, S. Thrips in citrus orchards, emerging pests in Tunisia. *Entomol. Faun.* **2017**, *70*, 77–87.
62. Navarro-Campos, C.; Pekas, A.; Aguilar, A.; Garcia-Marí, F. Factors explaining variation in citrus fruit scarring by *Pezothrips kellyanus* (Thysanoptera: Thripidae). Integrated control in Citrus fruit crops. *IOBC/WPRS Bull.* **2013**, *95*, 71–76.
63. Webster, K.W.; Cooper, P.; Mound, L.A. Studies on Kelly's citrus thrips, *Pezothrips kellyanus* (Bagnall) (Thysanoptera: Thripidae): Sex attractants, host associations and country of origin. *Aust. J. Entomol.* **2006**, *45*, 67–74. [CrossRef]
64. Morse, J.G.; Hoddle, M.S. Invasion biology of thrips. *Annu. Rev. Entomol.* **2006**, *51*, 67–89. [CrossRef] [PubMed]
65. Liu, L.; Hou, X.L.; Yue, W.B.; Xie, W.; Zhang, T.; Zhi, J.R. Response of Protective Enzymes in Western Flower Thrips (Thysanoptera: Thripidae) to Two Leguminous Plants. *Environ. Entomol.* **2020**, *49*, 1191–1197. [CrossRef] [PubMed]
66. Reitz, S.R.; Gao, Y.; Kirk, W.D.J.; Hoddle, M.S.; Leiss, K.A.; Funderburk, J.E. Invasion biology, ecology, and management of western flower thrips. *Annu. Rev. Entomol.* **2020**, *65*, 17–37. [CrossRef] [PubMed]
67. Cruz, W.P.; Sarmento, R.A.; Teodoro, A.V.; Neto, M.P.; Ignacio, M. Driving factors of the communities of phytophagous and predatory mites in a physic nut plantation and spontaneous plants associated. *Exp. Appl. Acarol.* **2013**, *60*, 509–519. [CrossRef] [PubMed]
68. Bonsignore, C.P.; Vacante, V. Natural Enemies. In *Integrated Control of Citrus Pests in the Mediterranean Region*, 1st ed.; Vacante, V., Gerson, U., Eds.; Bentham Science: Sharjah, United Arab Emirates, 2012; pp. 66–87.
69. Vassiliou, V.A. Ecology and Behavior of *Pezothrips kellyanus* (Thysanoptera: Thripidae) on Citrus. *J. Econ. Entomol.* **2010**, *103*, 47–53. [CrossRef]
70. Mound, L.A.; Wang, Z.H.; Lima, E.F.B.; Marullo, R. Problems with the concept of "pest" among the diversity of pestiferous thrips. *Insects* **2022**, *13*, 61. [CrossRef]
71. Marullo, R.; Mercati, F.; Vono, G. DNA Barcoding: A Reliable Method for the Identification of Thrips Species (Thysanoptera, Thripidae) Collected on Sticky Traps in Onion Fields. *Insects* **2020**, *11*, 489. [CrossRef]